Analysis and quantification of erosion by splashing "splash effect", on a quartzarnic neosol from the state university of feira de santana (BA)

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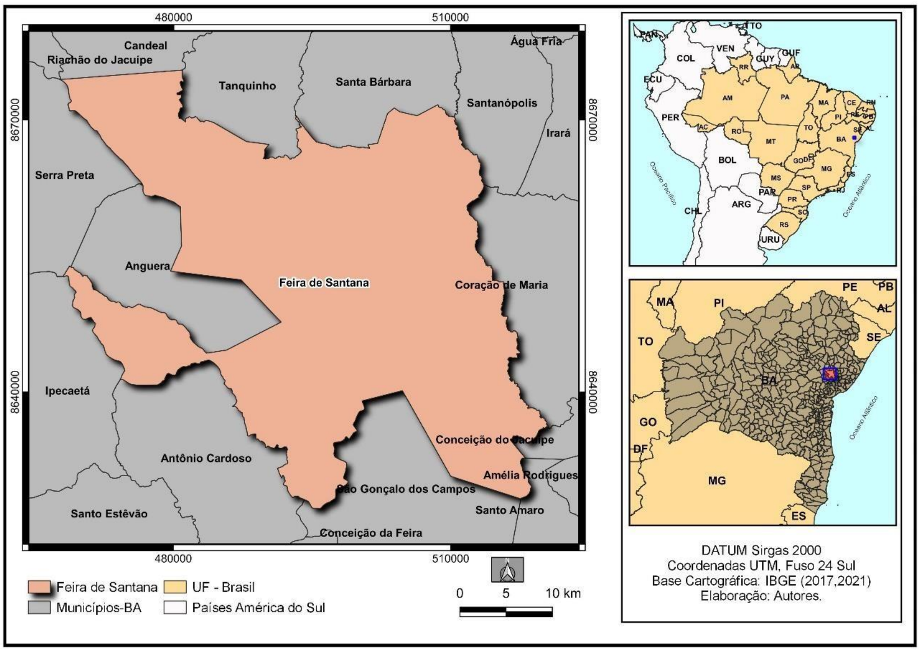
1 INTRODUCTION

Erosion is a natural process of the Earth, which has been occurring over time, preceding even the first life forms of 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 changes 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 it, it is estimated approximately four centuries, while in a few years with anthropization, 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 the transport of the particles itself in the traffic order, causing them to occupy the pores of the soil, covering it and preventing the water from infiltrating, and thus 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 the resistance that each soil presents to this phenomenon but also the kinetic energy of raindrops (GUERRA et al., 2007, p. 18). Bertoni & Lombardi Neto (1993) when studying the behavior of a soil with exposed surface found that the higher the intensity of the rain (mm/h), the greater the disruption and detachment of aggregates from the soil mass. These authors point out that generally aggregates between 0.063 and 0.250 mm are the most vulnerable to detachment, coarser aggregates are resistant to detachment due to the weight of 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 distance, contributing to the erosion of three main forms: a) desquendo and breaking the soil particles at the site that suffers the impact of the water drop on the surface; (b) speckling particles, unfastened and ruptured; (c) printing energy, in the form of turbulence in the shallow runoff. Studies related to splashing 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 individually. Unfortunately, the results of laboratory studies are not easily converted to field situations, because the works with simulated rainfall have kinetic energy, drop sizes and rainfall intensities most often different from natural rains. In natural rains there are times when the size of drops can increase with the variation of intensity and even in low intensity rains there are drops with high erosive capacity. Being the main objective of the present work to present some data related to the production of sediments by the action of splash in a flat area, therefore with unidirectional splash, the characteristics of this material and the relationship between the quantities and intensity of rainfall with the amount material produced during the events.

2 METHODOLOGIES

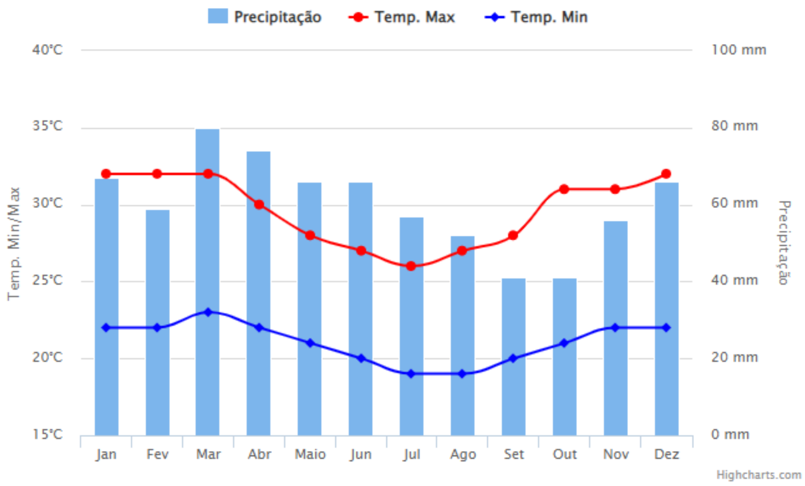
The experiment was carried out at the Climatological Station of the State University of Feira de Santana (UEFS), located in the municipality of Feira de Santana, Bahia (Figure 1). This municipality is located in an intermediate area between the humid climof the coast and semi-arid of the interior. It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

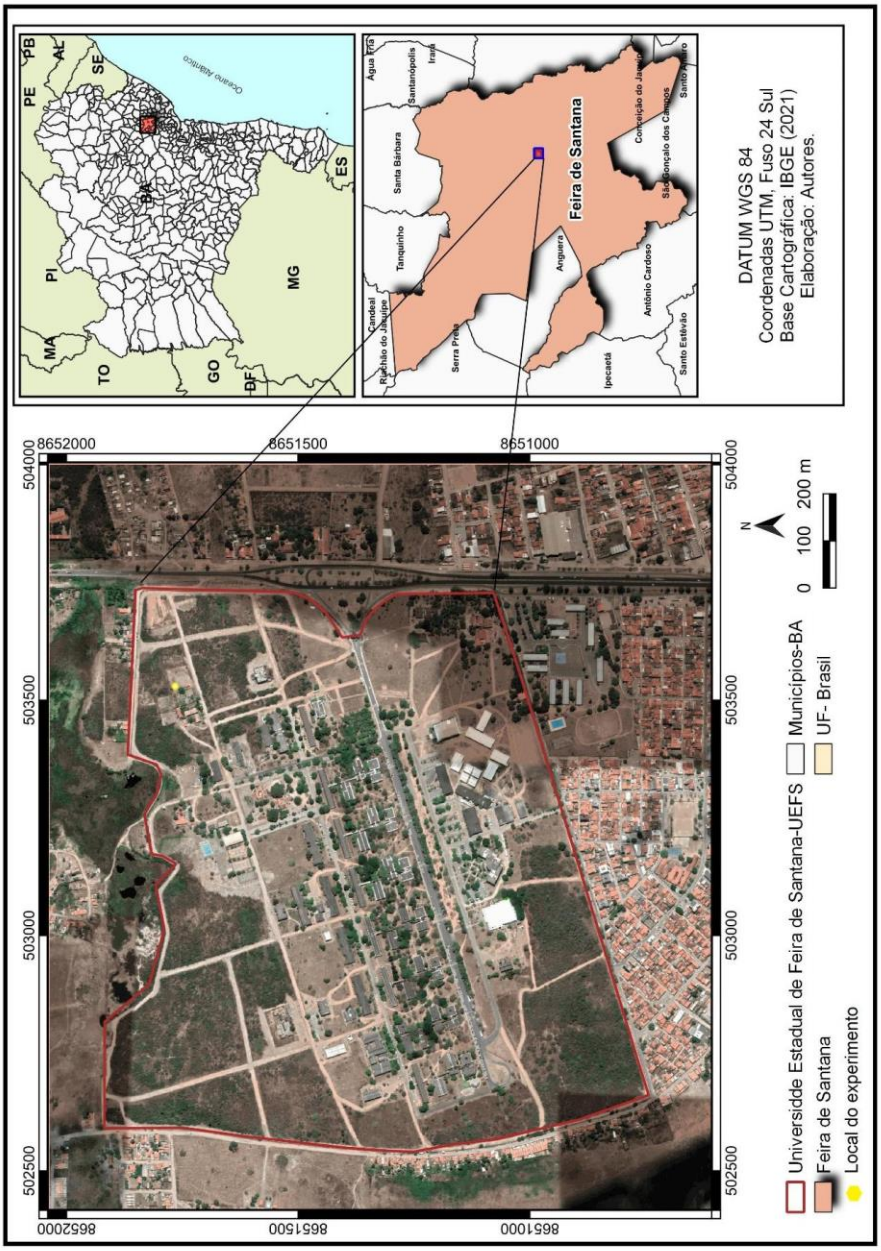


According to Jesus et al (2017), there is a very specific spatialization on the UEFS campus with the predominance of Quartzarenic Neosols in the low-lying areas, near the lagoons, particularly in the region and in the vicinity of where the experiment was mounted. The experiencewas implanted in the external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

Figure 4: Field experiment awaiting withdrawal.

Source: Prepared by the authors (2018)

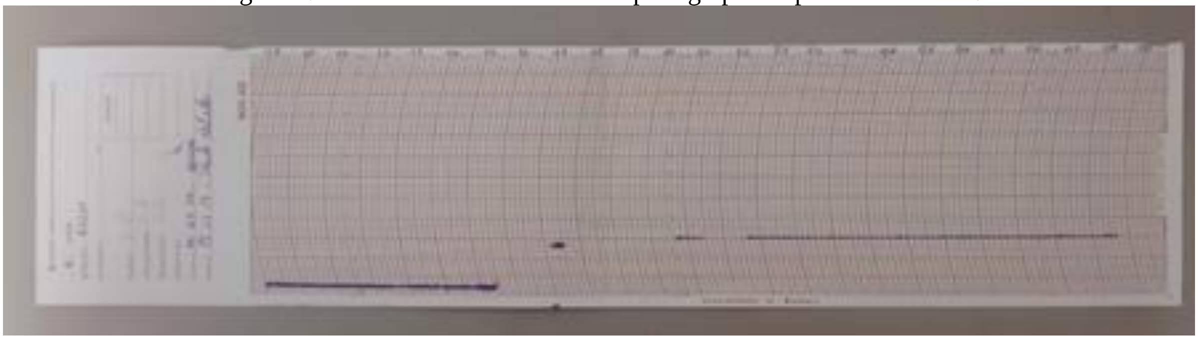
Figure 5 - Location of the experiment in UEFS (Climatological Station)



Prepared by Luana Almeida (2022)

This study was carried out under 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 brush (Figure 7). Quartzarenic Neosols is mainly formed by sands, and at the study site, its granulometry varied from fine to medium, approximately 50 cm deep (Figure 8).

Figure 6: Graduated rain marcan rain pluvigrapher tape on 15 /03/18.



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 the 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 perform the following steps:

1º The weight of the foam must 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 released from the soil and that reached the surface of the foam.

Figure 8 – Quartzarenic Neosol soil, located in the experiment area

Source: Photo by Jhenifer Gonçalves (2022)

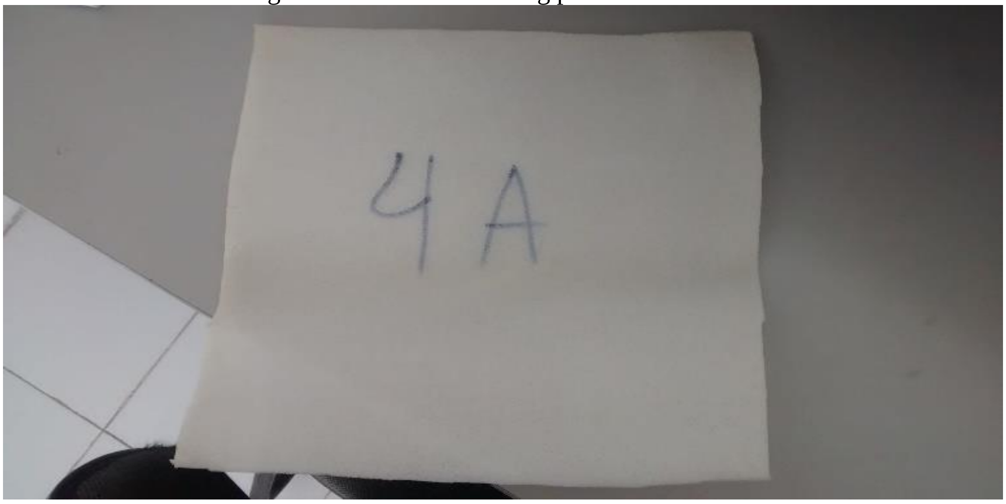
Rainfall of higher intensity and with great frequency increase the risk of erosion. These characteristics are more significantwhen associated with the conditions of busy relief, physical-water characteristics of the soil adverse, inadequate soil use and management. Rainfall shall be considered erosive and individual provided that they are greater than or equal to 10 mm or greater than or equal to 6.0 mm, provided that they occur in a maximum of 15 min and separated from each other for a period of at least 6 hours with a rain blade of 1.0 mm or less (WISCHMEIER & SMITH, 1978; ALMEIDA, 2009). Therefore, it is essential to determine the degree of erosivity of rain in the respective climatic region. Conceptually, this erosivity is described as an interaction between kinetic energy and the moment of surface runoff. The erosivity index is a function of intensity and duration, precipitation, mass, diameter and speed of raindrop (HUDSON, 1971). For the determination of erosivity, rainfall records of periods of rain from 20 to 30 years that should be analyzed (CASSOL et al., 2008) become necessary. Of the factors responsible in this process, the ability of rain to cause erosion, that is, its erosivity, is considered as 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 were recorded in March, where it was possible to notice rainfall of relevant intensity, above 30mm/hour. To know the intensity of the rains, the relationship between the time and the amount of precipitated water was made, data that were provided by the afo rain of the climatological season (Figure 6) and recorded in its millimeter tape (Figure 5). The foams were collected immediately after the respective rainy events, when they were measured before and after drying in the greenhouse, in order to obtain, thus, the respective weight levelsbefore and after the rainfall event and allow the quantification of the sediments captured by the foam, transported by the speckle action.

3 CONCLUSIONS

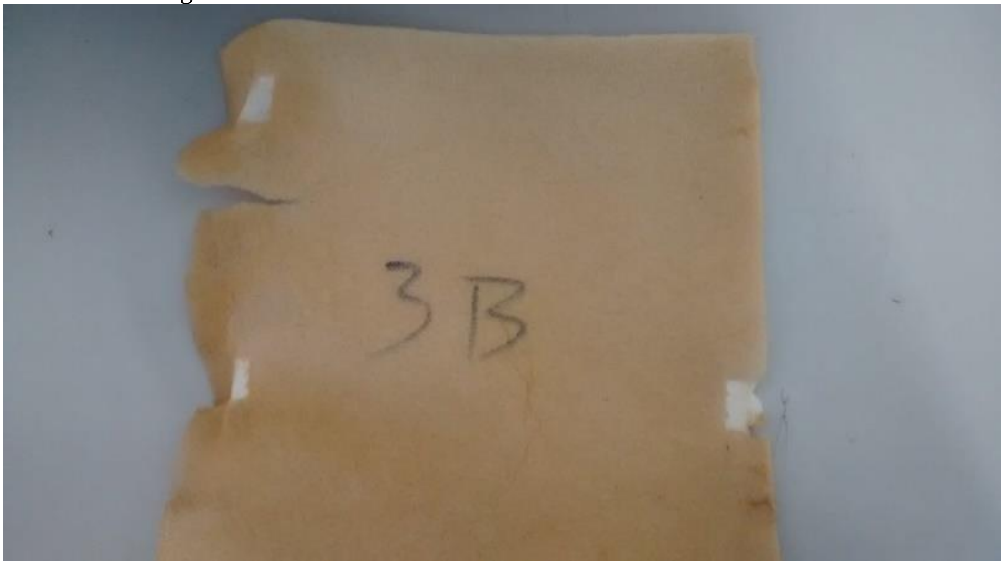
After the samples were taken from the field, they were transported to the Soil Laboratory to be submitted to the drying process in the greenhouse, to ensure that there was no influence of moisture on the weighing (Figure 9 and 10). Thus, the foam weights were compared before and after being placed on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

Figure 9: Foam before being placed in the field.



Source: Prepared by the authors (2018).

Figure 10: Foam after removal of the field and seamd.



Source: Prepared by the authors (2018).

Table 1: Result of weighing foams before rain and after rain

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 captured in two foams, one on the "front" and the other on the "back" part of the equipment, after weighing the difference of foams "**a**" and "**b**" was extracted. As can be seen from the results of **Table 1**, the intensity of thechuv a is directly linked to the rate of sediment detached from the soil and transported by the *splash effect*. However, we must point out that the experiment was elaborated in uncovered soil, which makes it more conducive to the actions of erosion by peppering, which although it seems insignificant, at the end of the amount after one year, would be equivalent to a loss of 46 kg/ha/year, a loss considered average per Oak (2008) that classifies erosion rates according to the estimated loss dand soil from null to very strong, in a total that is due both to the direct impact of the raindrop when it collides with the soil and detach 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 groundwater, as well as increase the rate of surface runoff, thus favoring the erosion in sheet or linear of the ground, triggering a greater intensity of the erosive processes superficial.

The proposed experience has been shown to be efficient in quantifying soil loss by peppering because it allowed that, from the measured area, it is possible to estimate soil loss by this process. It is noteworthy that erosion by the *splash effect* is greatly underestimated by the apparent irrelevant amount of material transported, but when it is transposed to a scale at the municipal and temporal level, it is perceived that this loss can be significant. Thus, it is emphasized that no erosive process is irrelevant, and even few amounts, when extrapolated to larger areas, in a given time interval can be usedas 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 a first version of this device, it is recommended that it be made and used in the same ways mentioned in the text in other locations and under different soil conditions, relief and vegetation cover, aiming at an evaluation of the performance in different situations from those found in this study.

The peppering 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 water drop reaches the soil and also allowed quantifying this isthe first stage.

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

Among the activities developed in this work, it was possible to identify new gaps to be answered in future studies, including the role of antecedent soil moisture in reducing or intensifying particle disaggregation during periods, thecharacterization of the kinetic energy of rainfall and the distribution of droplet size.

REFERENCES

Aciesp (academia de ciências do estado de são paulo). Glossário de ecologia. 1º edição. Secretaria da ciência e tecnologia, 1987.

Almeida, c. O. S. Erosividade das chuvas no estado de mato grosso. Brasília: unb, 2009. 81p. Dissertação mestrado

Bertoni, j.; lombardi neto, f. Conservação do solo. 3. Ed. São paulo: editora ícone, 1993.
Brady, nyle c. Natureza e propriedade dos solos. 5. Ed rio de janeiro, rj: freitas bastos, 1968. 647p.

Carvalho, n. O. Hidrossedimentologia prática. Rio de janeiro: cprm – companhia de pesquisa em recursos minerais, 600p. 2008.

Cassol, e. A.; eltz, f. L. F.; martins, d.; lemos, a. M.; lima, v. S.; bueno, a. C.
Erosividade, padrões hidrológicos, período de retorno e probabilidade de ocorrência das chuvas em são borja, rs. Revista brasileira de ciência do solo, v.32, p.1239-1251, 2008.

Cogo, p. N.; levien, r.; schwarz, a. R. Perdas de solo e água por erosão hídrica influenciadas por métodos de preparo, classes de declive e níveis de fertilidade do solo. Revista brasileira de ciências do solo, 27:743-753, 2003.

Controle de erosão. Bases conceituais e técnicas: diretrizes para o planejamento urbano e regional; orientação para o controle de voçorocas urbanas. São paulo, daee/ipt, 1989.

Guerra, a.j.t; silva, a.s; botelho, r.g.m. Erosão e conservação dos solos: conceitos, temas e aplicações. 3.ed. Rio de janeiro. Bertrand brasil, 2007. 340 p.

Hudson, n. Soil conservation. Ithaca: cornell university press, 1971. 320p.

Jesus, juliele nascimento; souza, gracinete bastos de ; santos, nadine de jesus; almeida, igor ferreira de. Caracterização geomabiental do campus da uefs através do mapeamento geotécnico. Xxi semic, feira de santana: uefs, 2017, pag. 1-4.

Machado, r. L.; carvalho, d. F.; costa, j. R.; oliveira, d. H.; pinto, m. F.
Análise da erosividade das chuvas associada aos padrões de precipitação pluvial na região de ribeirão das lajes (rj). Revista brasileira de ciência do solo, v.32, p.2113-1223, 2008.

Seixas, b. L. Sampaio. Fundamentos do manejo e da conservação do solo. Salvador: centro editorial e didático da ufba, 1984, 304 p.

Silva, a.m.; schulz, h.e. E camargo, p.b. (2007). Erosão e hidrossedimentologia em bacias hidrográficas, 2ª edição– revista e ampliada. Editora rima, são carlos – sp, brasil, 153 p.

Silva, a. M. & schulz, h. E. Avaliação do desprendimento das partículas dos solos (salpicamento) e uso de resíduos vegetais no seu controle. Rev. Bras. De engenharia agrícola e ambiental, campina grande, pb, 6/2:531-534, 2002.

Silva, a. M.; schulz, h. E. E camargo, p. B. Erosão e hidrossedimentologia em bacias hidrográficas, 2ª edição– revista e ampliada. Editora rima, são carlos – sp, brasil, 2007, 153 p.

Val, l. A.; bahia, v. G.; freire, j. C.; dias júnior, m. S. Erosividade das chuvas em lavras, mg. Ciência e prática, v.10, n.2, p.199-209, 1986.

Wischmeier, w. H.; smith, d. D. Predicting rainfall erosion losses: a guide to conservation planning. Washington: usda, 1978. 58p