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ESTIMATE OF EROSION IN BASIN OF BOARD INDIGENOUS LAND IN BRAZILIAN AMAZON

ESTIMATIVA DE EROSÃO EM BACIA HIDROGRÁFICA DE BORDA DE ÁREA INDÍGENA NA AMAZÔNIA BRASILEIRA

ESTIMATION DE L'ÉROSION DANS LE BASSIN DE CONSEIL D'ADMINISTRATION DES TERRES INDIGÈNES DE L'AMAZONIE BRÉSILIENNE

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ABSTRACT
The region of the Arinos River, a tributary of the Tapajós River in the Brazilian Amazon, has had areas of deforestation since the 1970s, with activities without rational use of soil. The deep and sandy soils of the Amazon region become susceptible to erosion due to the action of compaction of the cattle herd implanted after deforestation. The water erosion has serious impacts on the equatorial climate region, with erosivity in the order of 14,000 MJ.mm/h/ha/year. The objective of the research was to estimate the rate of erosion in a basin with 1 million hectares, located in an area of deforestation in the Amazon Forest. A geographic database was developed in a geographic information system to map land cover areas, slopes and soil types. From the application of the Universal Equation of Soil Losses, the indices of the factors related to the areas contained in the watershed were used. The result was an estimate of approximately 150,000 tons/hectare/year, with the production of 24 million tons of sediments.
Key-words: deforest; land cover; soils

RESUMO
A região da Bacia do Rio Arinos, um tributário do Rio Tapajós na Amazônia Brasileira, tem áreas com desflorestamento desde a década de 1970, com atividades sem o uso racional do solo. Os solos arenosos e profundos da região amazônica se tornaram suscetíveis à erosão devida ação da compactação causada pelo pisoteio do rebanho na área desflorestada. A erosão hídrica tem sérios impactos na região de clima equatorial, com erosividade de aproximadamente 14.000 MJ.mm/h/ha/ano. O objetivo da pesquisa foi estimar a taxa de erosão em uma bacia hidrográfica com 1 milhão de hectares, localizada na área desflorestada da Amazônia. Foi desenvolvido um banco de dados geográfico com informações sobre cobertura da terra, declividades e tipos de solos. A partir da aplicação da Equação Universal de Perdas de Solo, os fatores que se destacaram foram das condições superficiais da bacia hidrográfica pelo uso do solo. Como resultado, a estimativa de perda de solo foi de 150.000 t/ha/ano, com uma produção de 24 milhões de toneladas de sedimentos.
Palavras-chave: desflorestamento; cobertura da terra; solos

RÉSUMÉ
La région de la rivière Arinos, un affluent de la rivière Tapajós en Amazonie brésilienne, connaît des zones de déforestation depuis les années 1970, avec des activités sans utilisation rationnelle des sols. Les sols profonds et sablonneux de l'Amazonie deviennent sensibles à l'érosion en raison de l'action de compactage du troupeau bovin implanté après la déforestation. L'érosion hydrique a de graves impacts sur la région climatique équatoriale, avec une érosivité de l'ordre de 14 000 MJ.mm/h/ha/anoThe'objectif de la recherche était d'estimer le taux d'érosion dans un bassin de 1 million d'hectares, situé dans une zone de déforestation de la forêt amazonienne. Une base de données géographiques a été développée dans un système d'information géographique pour cartographier les zones d'occupation du sol, les pentes et les types de sols. À partir de l'application de l'équation universelle des pertes de sol, les indices des facteurs liés aux superficies contenues dans le bassin versant ont été utilisés. Le résultat a été une estimation d'environ 150 000 tonnes/hectare/an, avec la production de 24 millions de tonnes de sédiments.
Mots-clés: déboiser; occupation; solos

INTRODUCTION

The soil losses pose a threat to food security and sediments deposition of river plains. The phenomenon of soil loss can occur in areas of preserved forest, but the intensity is numerous times greater in areas with agricultural crops in soils susceptible to erosion and regions with equatorial climates of voluminous rainfall. The erosion of soils caused by agricultural activities

represents three times the estimates in relation to natural erosion, being in the order of 75 billion tons per year (MONTGOMERY, 2007).

In Brazil, the soil losses are estimated at approximately 848 millions tons per year (MERTEN; MIRELLA, 2013).

Although the intensity of soil loss processes due to water erosion is evident in equatorial and tropical regions, according to Golosov and Walling (2019), only 9% of global estimates of soil losses are from areas of South America and Africa.

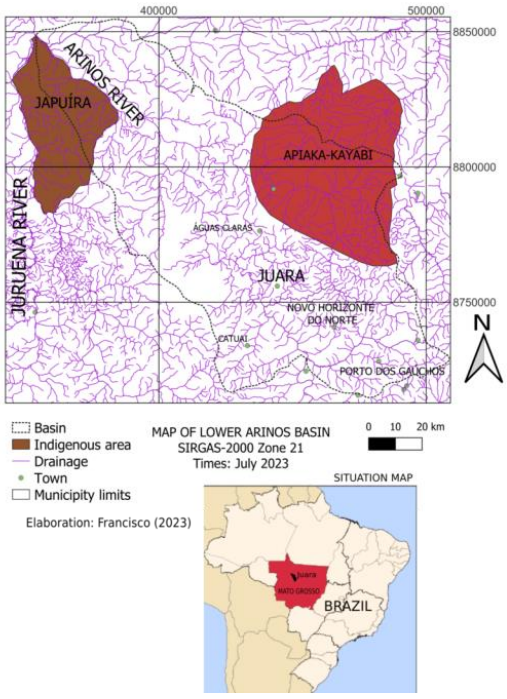
According to Panagos et al. (2022), as a result of climate change, rainfall erosivity will increase by 27% by 2050. The Amazon Region has annual rainfall above 4,000 mm, and soil losses due to deforestation are worrisome. If the predicted scenario occurs in 2050, the erosivity of rainfall in the municipality of Juara will be 18,000 MJ.mm/ha/h/ano.

The phenomenon of soil loss can be quantified through estimates, whose methods were improved from the Universal Soil Loss Equation, being developed from the studies of Wischmeier and Smith (1961) from 10 thousand data on soil loss rates in experimental plots in the territory of the United States of America (LAFLEN; MOLDENHAUER, 2003). In the United States of America, studies on soil conservation were the result of a severe wind erosion event in 1932, with the creation of a national policy for soil conservation by the Department of Agriculture (BENNETT, 1972).

The Arinos River Basin has more than 5.8 million hectares, with 1,155 river channels. In this territorial dimension, it was decided to perform the analysis of the lower part of the watershed. The Lower Arinos River Basin has approximately 1.1 million hectares, distributed by the municipalities of Juara, Novo Horizonte do Norte, Porto dos Gaúchos, Nova Bandeirantes and Tabaporã. The Arinos River is a tributary of the Juruena River, belonging to the Great Tapajós River Basin. Regarding the territorial distribution, about 50% of the municipality of Juara and the entire municipality of Novo Horizonte do Norte is located in the area, with parts smaller than 5% of the municipalities of Nova Bandeirantes and Tabaporã.

Figure 1 shows the location of the lower Arinos River basin, with the localities and municipalities, including the existence of indigenous lands.

Figure 1 - Map of Lower Arinos Basin in Mato Grosso State



Elaboration: Francisco (2024)

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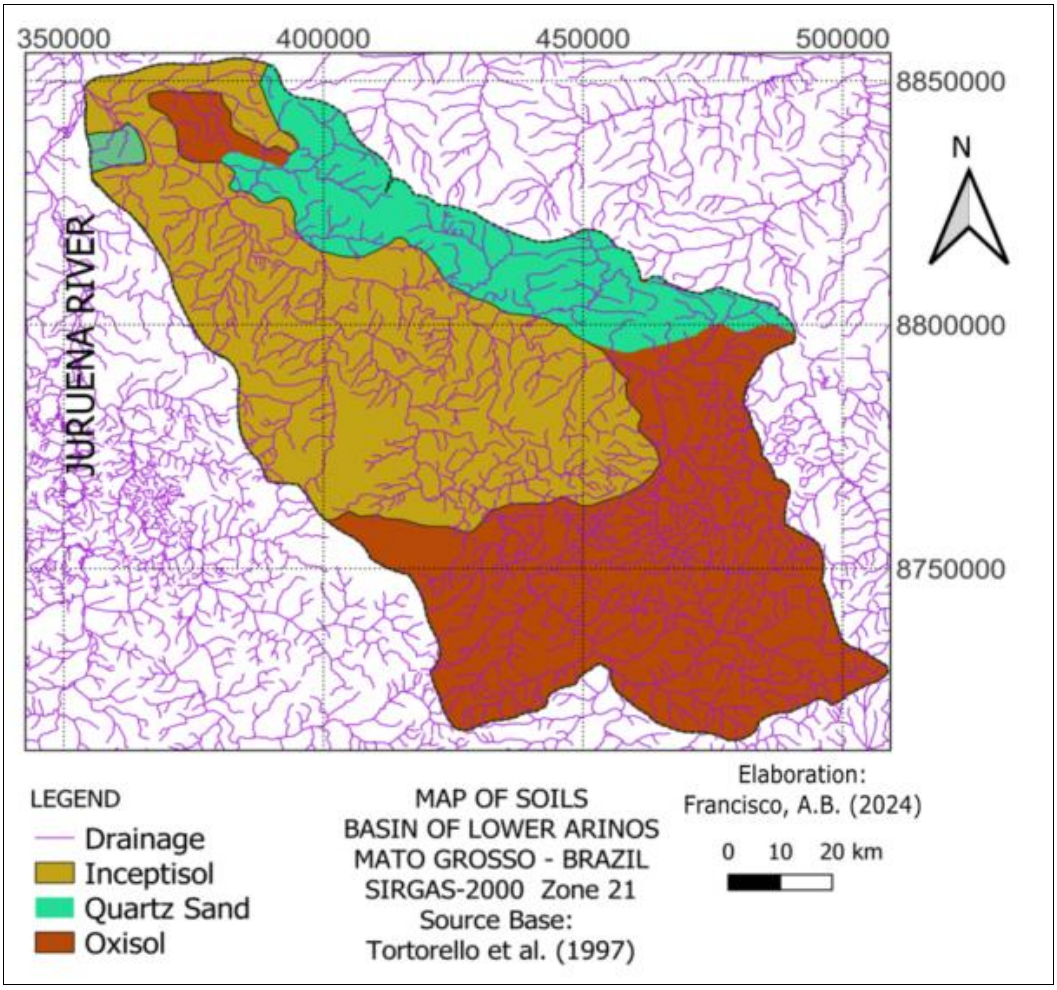
The lithology of the area is located at Depression of South-Amazon's Craton, with present Arinos Formation by fire rocks dated of Proterozoic (Lacerda Filho et al., 2004). About geomorphology of basin, according Araújo et al. (2015), is distributed in the Depression of Juara's Plateau, with a set of hills and mountains separated by deep valleys sculpted by the fluvial dynamics of the equatorial climate, in the context of the Middle Juruena River.

Regarding the geographical distribution of soil types in the Arinos River valley, according to Tortorello et al. (1997), in the municipality of Juara occurs Quartz Sand soil, at north area of watershed. In the south area this watershed, with distribution between Novo Horizonte do Norte and Porto dos Gaúchos, occurs predominance of Red-Yellow Oxisol and Red-Dark Oxisol. In the west and central area of watershed occurs the distribution of Red-Yellow Inceptisol.

Figure 2 shows the types of soil by geographical distribution.

Figure 2 - Map of Soils in Basin of Lower Arinos River



Elaboration: Francisco (2024)

The preservation of Amazon Forest in watershed analyzed due to existence of indigenous lands with demarcation, how Japuíra Reserve located in northwest and near the Juruena River, and the Apiaka-Kayabi Reserve located in the Apiacás mountain range, northeast portion of the Lower Arinos basin, containing a population of 885 inhabitants (INSTITUTO SOCIOAMBIENTAL, 2014).

The colonization in Juara began in the 1970s with coffee planting. From the 1980s, even with the existence of indigenous peoples, the area was deforested for the implementation of agricultural projects, mainly for removal of the forest and implementation of pasture. Currently, there are 1,620 rural establishments in Juara, with a total of 770,000 cattle, and production of

150,000 tons of soybeans (BRAZILIAN GEOGRAPHY AND STATISTICS INSTITUTE, 2017).

In summary, the research has the importance of analyzing the intensity of soil erosion in a basin of deforestation in the Brazilian Amazon. The estimation of soil loss contributes to the implementation of zoning to discipline deforestation, not depending only on the regularization of indigenous lands.

METHODOLOGY

The methodology was defined by applying the Universal Soil Loss Equation from a database in a Geographic Information System. The geographic data of the basin were entered into the QGIS, version 3.28. From the geographical data in the GIS environment, the areas of soil types and land cover were obtained by visualization.

The erosivity of rainfall in the Arinos River's Basin was estimated from Salton et al. (2013).

To estimate soil erodibility, the Pedological Map of the State of Mato Grosso (TORTORELLO; FARRAN; SANTOS, 1997) and were used soil erodibility indices as presented by Raimo et al. (1999).

From the data of the Shuttle Radar Topography Mission with treatment made by the Brazilian Institute of Space Research, a QGIS tool was used to generate the map of slopes.

The estimation of the LS factor, when considering the topographic aspects of the Lower Arinos River Basin, the parameters presented by Bertoni and Lombardi Neto (1999) were analyzed, with the calculation of the average slope in the basin and the ramp length.

The land cover was estimated from the linear design of the areas with high-resolution remote sensing images available in the Google Earth application, whose files of the polygons of the areas were converted into vector format of the shapefile type to be imported into the QGIS database. The indices of each land cover were adopted according to Bertoni and Lombardi Neto (1999).

RESULTS AND DISCUSSION

The rainfall erosivity for the Arinos River's basin in lower area was estimated at 14,251 KJ.mm/ha/year.

The estimate of erodibility of the soils of the basin from the areas of each soil type is presented in table 1.

Table 1 – Estimation of erodibility for the Lower Arinos River's Basin

Soil	Factor K	Area (ha)	Estimated (t/ha/y)
Oxisol	0.09	449,705	40,473.75
Inceptisol	0.31	464,200	143,902
Quartzer Sand	0.55	176,700	97,185
	Σ	1,090,605	281,560
		Average Index	3.8734

Source: Elaboration Francisco (2024)

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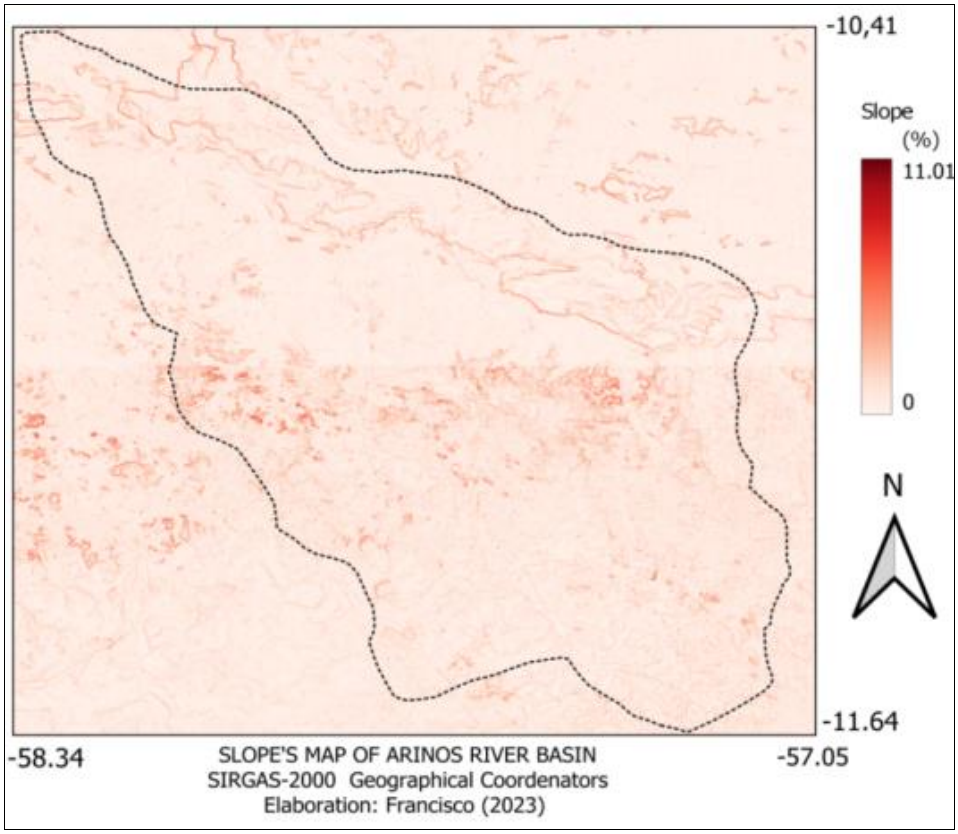
The estimation of the LS factor considers the aspects of slopes and lengths of the slopes of the watershed. Figure 3 shows slopes in the Lower Arinos Basin.

Figure 3 - Map of Slopes in Arinos River Basin



Elaboration: Francisco (2023)

When considering the average slope at 5.5% and ramp length at 9,000 meters, the LS factor can be estimated at the expression:

$$S = 0.00654 \times 0.055^2 + 0.0456 \times 0.055 + 0.065 \quad (1)$$

When applied to the parameters to estimate the LS factor, the index 607.75 was calculated.

The changes in land cover directly influence runoff and the dynamics of water erosion. Table 2 presents erosion rates according to areas by respective land cover classes.

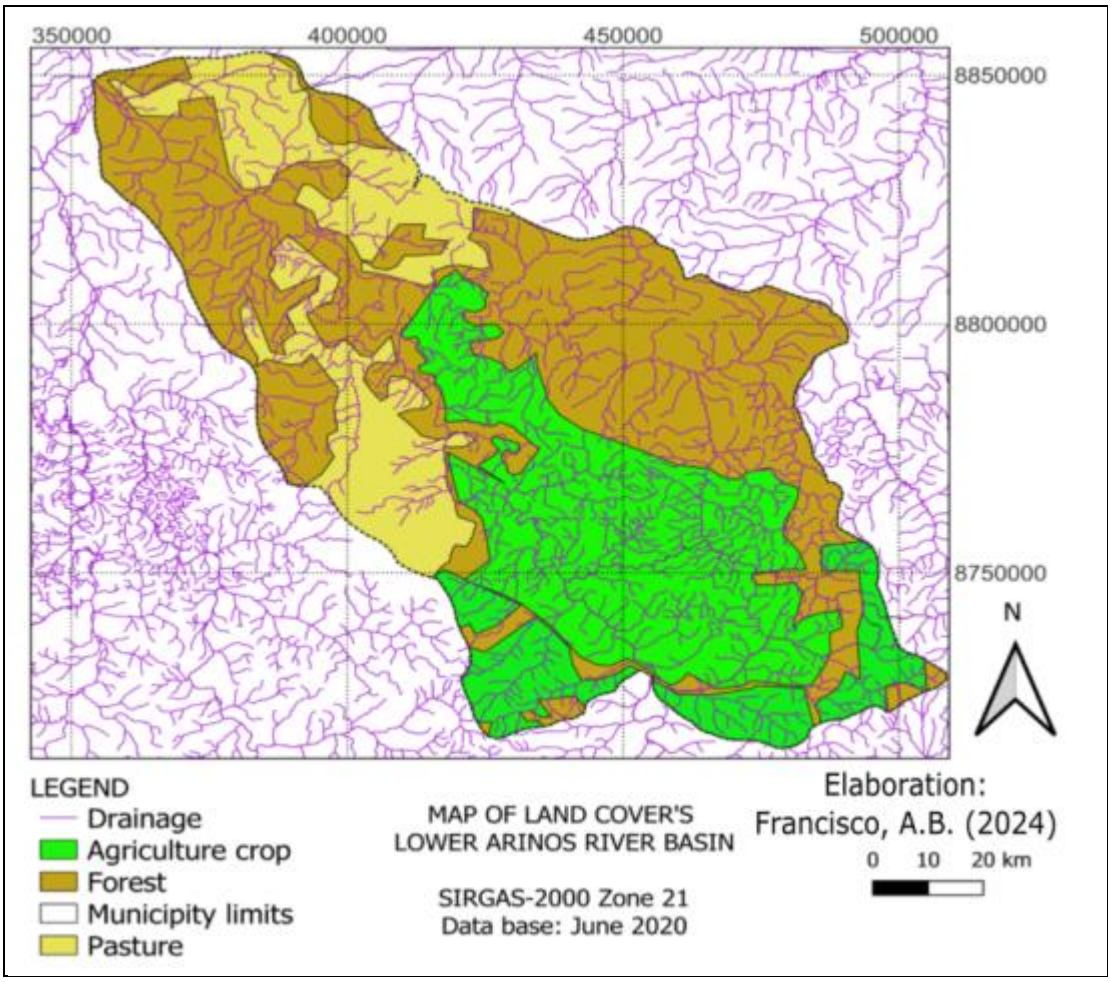
Table 2 – Estimation of land cover for the Lower Arinos River's Basin

Land cover	Factor C	Area (ha)	Estimated (t/ha/y)
Agriculture	0.1142	383,190	43,760.3
Forest	0.0003	465,707	139.7
Pasture	0.0377	241,708	9,112.4
	Σ	1,090,605	53,012.4
		Average Index	20.5728

Elaboration: Francisco (2024)

The map in figure 4 shows the land cover classes in the Arinos River Basin.

Figure 4 - Map of Land Cover's Lower Arinos River Basin



Elaboration: Francisco (2024)

About the conservation practice factor, approximately 57% of the area of the Arinos River basin has been altered by human action with deforestation and 22% has pastures without soil conservation practice. From this context, the parameter of 0.22 was adopted, considering the conditions of absence of conservation practices in 22% of the area of the Arinos River basin.

In summary, the Universal Soil Loss Equation applied in the Lower Arinos River Basin obtained the following expression:

$$A = 14{,}251 \times 0.0039 \times 20.57 \times 607.75 \times 0.22 \qquad (2)$$

The estimated water erosion rate for the Lower Arinos River Basin was 152,859 t/ha/year.

The sediment production rate in the Lower Arinos River Basin, from this estimate, was 24 million tons of sediments.

CONCLUSIONS

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Although the Universal Soil Loss Equation has been a method applied since the 1970s, there are few works applied in Geography, whose spatial analyses of geoprocessing contribute to scientific improvement.

The deforestation of the Amazon is a problem due to the fragility of sandy soils with impacts caused by precipitation volumes in the equatorial climate. From the cartographic bases and results, reports can be indicated for public policies to implement measures to control deforestation and monitor economic activities in areas that need to be preserved.

Geography can contribute to the analysis of the causes of soil losses and definitions of the territorial areas to be preserved, such as the demarcation of indigenous areas.

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