

THE PRODUCTION OF THE SEDIMENT OF THE SOUTH AMERICA CONTINENT: PROPOSE OF MAPPING OF THE EROSION RATES BASED ON GEOLOGICAL AND GEOMORPHOLOGICAL ASPECTS

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Abstract

The present paper shows the classification of the terrains on South America Continent in respect to the sediment production resulting from the study of its geology, geomorphology, soil types, land use, slope and rain rates. This study was developed in Arc GIS platform and checked with the sediment data collect in the stations net of monitoring. The product of this study is a map showing the potential sediment production. The immediate effects of the rates of production of sediments focus the reduction in the life time of hydroelectric reservoirs and the degradation of the ecosystem in areas of low relief, for example, the Pantanal Basin and Rio de La Plata Basin and the Amazon region.

Keywords: sediment production; hydroelectric reservoirs; degradation of the ecosystem

Resumo

O presente artigo apresenta a classificação das terras do continente Sul-americano quanto à produção de sedimentos com base em estudo de suas características geológicas, geomorfológicas, pedológicas, de uso do solo, declives e precipitação pluviométrica. O estudo foi desenvolvido em plataforma Arc GIS e correlacionado às amostras coletadas na rede de estações de monitoramento. O produto do estudo corresponde ao mapa de potencial de produção de sedimentos, cuja aplicação imediata é prever a redução de vida útil de reservatórios de usinas hidroelétricas e a degradação de certos ecossistemas, como por exemplo, as bacias do Pantanal, do Rio da Prata e da Amazônia.

Palavras-chave: produção de sedimentos, reservatórios hidroelétricos, degradação de ecossistemas

Introduction

The South American Continent is a big area with many kind of climate, relief, types of rain (covering annual values between 300 to 3,000 mm) and temperatures varying since negative temperatures of the high lands of the Andes Ridges until hot deserts how Atacama, on Chile. In Brazil, the biggest country, the grain production is increasing, coming close to the 100 million tons. This issue increases substantially the Gross National Rate, currently around 450 million of dollars (2002).

With expectation of economic growth of the countries, the lands of the continent must be preserved to receive the adoption of immediate politics in the infrastructure sector,

as transport, energy, mining and sanitation. For that, in Brazil, the government established regulating agencies, including the National Agency of Electric Energy - ANEEL, an autarchy created in 1996.

The purpose of the ANEEL is to regulate and supervise the production, transmission, distribution and commercialization of electric energy. The viability of news hover dam constructions is managed by the ANEEL. This autarchy analyzes basic studies of rivers inventory, viability and projects. These studies will subsidize the grant given from ANEEL to the enterprises in order to offer a business orientation for the market. The management of this process depends on the engineering projects technique evaluation made by ANEEL.

The hover dam Brazil's power plants are the major kind of electric energy generation, corresponding over than 80 % of this issue. The Country's *hydro-power* potential is about 260 GW; 165 GW of this having been currently inventoried. This scenario indicates that the country has an open space for investments in this sector (95GW).

The hydro availability for such investments depends on the river hydraulic potential, which depends on the river fall and outflow. The present *river's rules* studies in the engineering projects aim to get an estimation of the water bodies' behavior, which is based on the fluviometric station outflows.

These studies are sent to the ANEEL to be analyzed by the agency technical staff, which evaluates the patrimonial management of the hydroelectric reservoirs, i.e. the lake and its marginal limits, although its interactions with the contributing watershed. This procedure is developed in order to guarantee the public welfare after the concession period for the public and private agents.

The present work has the objective to subsidize the management of the hydroelectric reservoirs, as one Union patrimony, that is inside the respective hydro basins, indicating the proper uses of the ground.

As a specific objective, the author elaborated a cartographic zoning of the South America territory for hydro-sedimentologic projects analysis, in order to improve the studies of the qualitative and quantitative effects in the real and future hydroelectric enterprises, considering the international rivers and basins.

After the projects legal adequacy and ANEEL agreement, the technicians will be able to validate, with security, the useful life of the reservoirs, as well as its curves quota-area-volume. The cartographic product quantifies, in regional level, the production of sediments. It can also be

used for the territorial management and regional planning.

Methodology

The project developed a unique methodology, based on the elaboration of erosion risk maps, already applied by Campagnoli (1998, 2002, 2004), Diniz (1998) and IPT (2000). These authors tried to analyze the variables which cause erosions, disposing them in a matrix format with its sub-titles overlapped.

The project used, as tools to crossing information, the available softwares *ArcGis 3.0* and *ArcMap 8.2*, and regional thematic maps in scale 1:2,000,000.

Once the product ready, the gauging of the results begins. This project step was made by applying the generated computational model in areas admittedly known in field and picking out sedimentological measurements data, from fluviometric and sedimentometric stations, which had trustworthy historical series. As basic geology, geomorphologic and ground entrance data, this project used the mineral project RADAMBRASIL and the CPRM - Brazilian Company of Mineral Research and Resources - services.

Hydrographic and nomenclature data had been gotten from the IBGE - Brazilian Institute of Geography and Statistics' topographical bases.

During the current work, numerical and slopes land models had been developed, in scale 1:1,000,000, with basic data available in the InterNet, from the United States Geological Service.

Pluviometric data had been gotten from the National Hydro-meteorological Net available in the Inter-Net.

Figure 1 presents the used methodological flowchart.

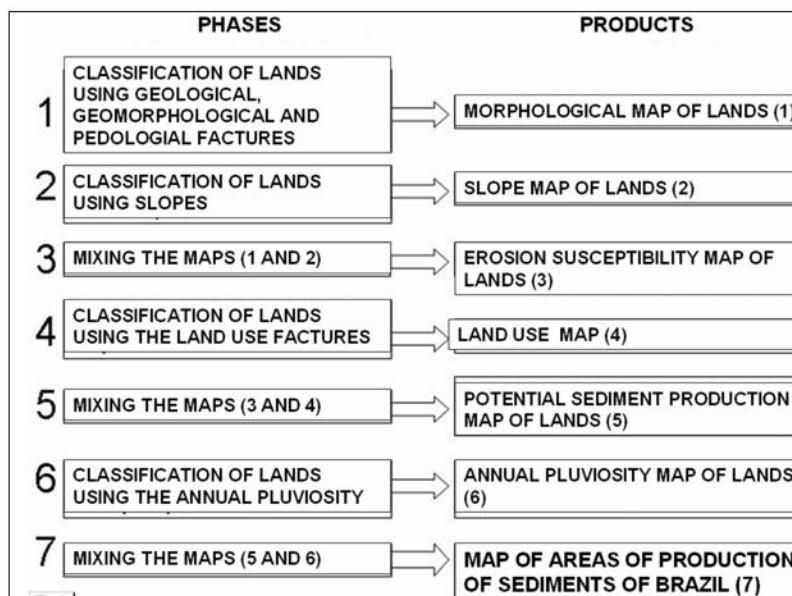


Figure 1. Elaborated methodological flowchart

Results

The work results were quite satisfactory. The high sediment production areas had correspondence with the sediment data of the stations and/or presented notorious erosive issues in the land, as shown in Figures 2 to 5.

High potential sediment production areas, preserved by the use of the ground, as in the region of the Amazonian forest, could be analyzed basing on citizens' information about deforestation areas, with abrupt change of the erosion degree.



Figure 2. Flat ridges in areas of moderate production of sediments



Figure 3. Little gullies in areas of high production of sediments

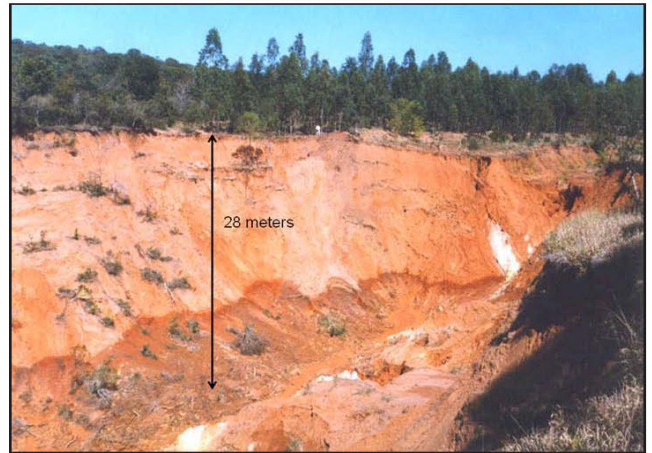


Figure 4. Gully in area of high production of sediments



Figure 5. Landslides in areas of very high production of sediments

At the same time, areas preserved in the Amazonian Brazilian territory, with high concentration of sediments in suspension due to an efficient transport of the draining system had evidenced the great basins bordering sediment yield, as it is the case of the Madeira River, whose headboard of draining is in the mountain range of Andes. It carries about 600,000 tons a year of sediments that enter in the occupied territory, as shown in Figure 6, and suffer an increase of only 5 % until its estuary (Filizola Junior, 1999).

The map of Brazilian sediment production areas is shown in Figure 7, with 5 degrees of production of sediments that correspond to estimate interval ranges, expressed in $t\ km^{-2}\ y^{-1}$.

Those ranges are: (1) areas of very low production of sediments $< 5\ t\ km^{-2}\ y^{-1}$; (2) areas of low production, between $5\ to\ 70\ t\ km^{-2}\ y^{-1}$; (3) areas of moderate production, between $70\ to\ 200\ t\ km^{-2}\ y^{-1}$; (4) areas of high production of $200\ to\ 400\ t\ km^{-2}\ y^{-1}$ and (5) areas of very high production, with values bigger than $400\ t\ km^{-2}\ y^{-1}$.

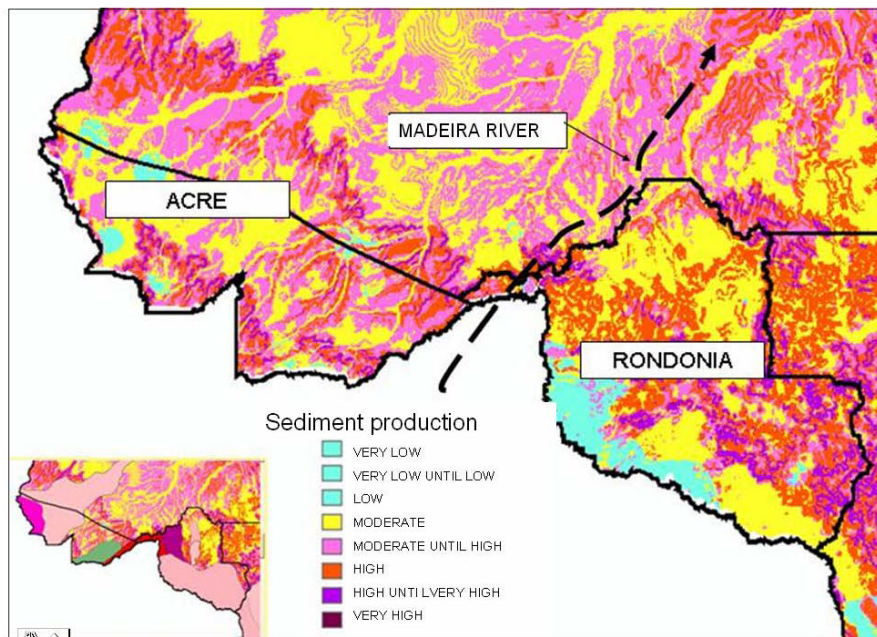


Figure 6. Areas of high potential of production of sediments in the southwestern portion of the Amazonian forest, in the region of the Madeira River

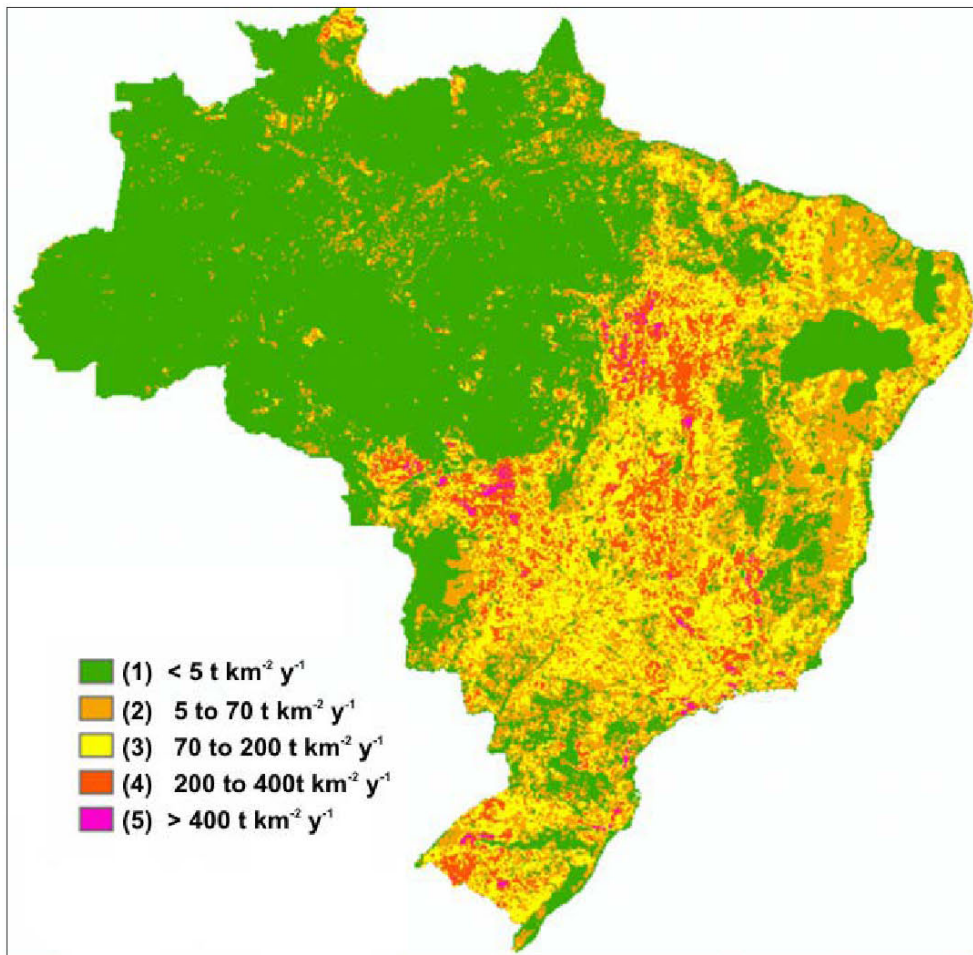


Figure 7. Map of sediments production areas in Brazil.

The production of sediment of the South America continent is being estimated using geological and geomorphological features, land use forms and the rain rates.

Actually the ANEEL is making the study of the last step showed in the flowchart of the Figure 8. The Figure 9 shows the detail of the map of the potential production of sediment.

Conclusions

ANEEL elaborated Brazil's map of sediment production areas and is making the same study to the South America Continent, aiming to subsidize the management of the hydroelectric reservoirs, elaborating a cartographic zoning of the south America territory related with the erosion risk

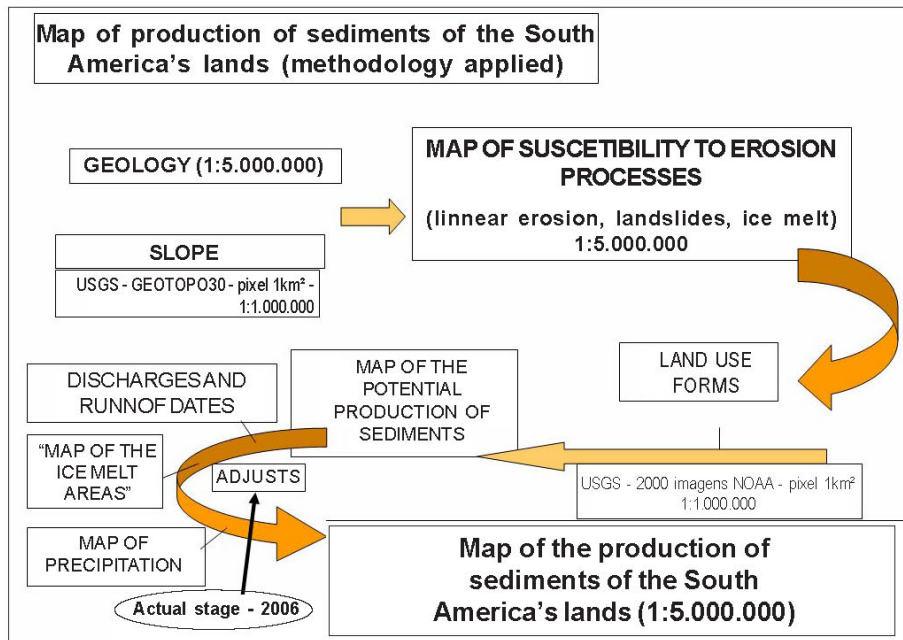


Figure 8. Elaborated methodological flowchart to South America Continent

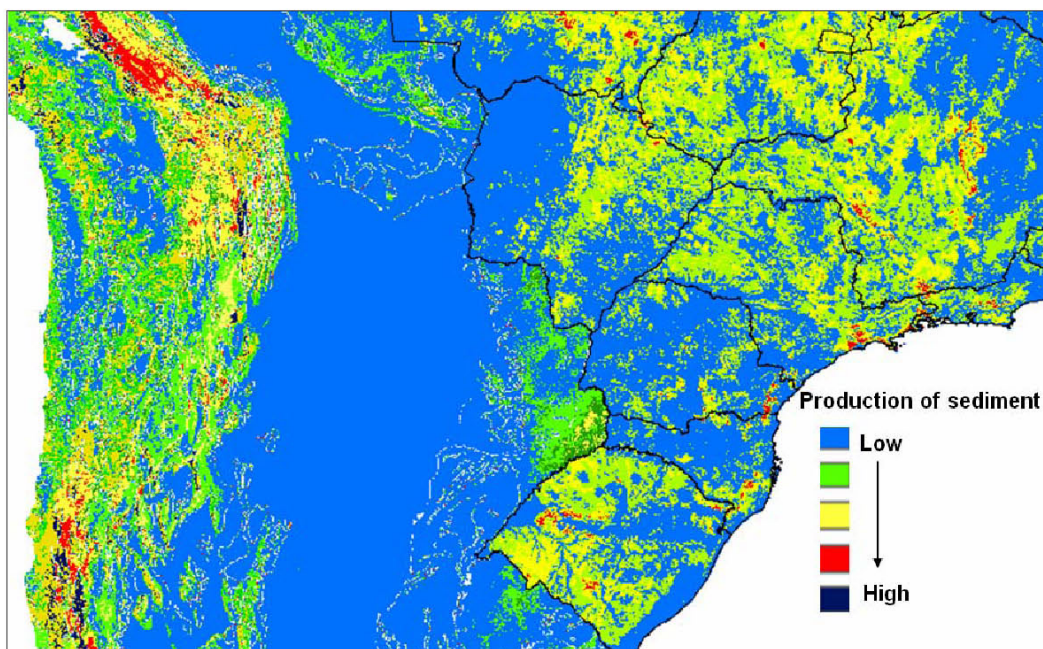


Figure 9. Detail of the map of the potential production of sediment

and silting, for the real and future hydroelectric enterprises. After ANNEL map's regulation and official adequacy, it will be possible to estimate, with bigger accuracy, the useful life of reservoirs and its quota-area-volume curves.

It's worth to stand out two new alterations in the recent use of the ground due to: (1) the frontier expansion of the agriculture, stimulated by the extensive soy-bean cultures development, mainly in the Pantanal region (Southwestern of Brazil) and due to (2) the deforestation for cattle and wooden exploration, in the Amazon region.

These scenarios contribute for the taxes increase of sediment yield.

The immediate effects of these new taxes of production of sediments are the reduction in the useful life of hydroelectric reservoirs and the degradation of the ecosystem in areas of low relief, as for example, the Pantanal watershed and the Amazonian estuarine region.

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