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Reabilitation of degraded area by erosion, using soil bioengineering techniques in Bacanga river basin, Sao Luis City – Maranhao State, Brazil.

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The aim of this paper is to assess the stages of rehabilitation of a degraded site by erosion, in Salina/Sacavém district, São Luís City, considering geomorphologic characteristics and soil bioengineering techniques. This technique has been applied in different situations to rehabilitate degraded areas, with positive results from the use of biodegradable materials (e.g. vegetal fibres, wooden stakes and re-vegetation). These techniques stabilize the soil at low cost and improve the environment. Bioengineering involves the planned and strategic application of selected materials, involving biodegradable materials, often in combination with 'hard engineering' structures constructed from stone, concrete and steel.

The settlement of São Luís was established in 1612 and has evolved in distinct phases. Rapid urban growth was associated with industrialization in the second half of the 18th Century. Rapid population and urban growth has intensified problems, compounded by poor planning and improper soil use. São Luís, like many other Brazilian cities, has experienced rapid population growth in recent decades, which has created a series of socio-economic and environmental problems, including accelerated soil erosion. Sacavém is one of these communities where natural and human factors contribute to the severe gully erosion. The local lithology is mainly Tertiary sandstones and, to a lesser extent, shales, argillites and siltstones, all of which belong to the Barreiras Formation. Weathering on these rocks produces erodible soils, including lithosols, latosols, concretionary red/yellow clay soils and concretionary plinthosols. Thus, erodible soils and regolith are subject to high erosion rates, especially on steeper slopes subject to additional human interventions. Furthermore, although regional slopes are quite gentle, there is localized high relative relief. Sacavém vegetation, in the gullied area, consists of brushwood. Secondary mixed forest and brushwood are the dominant vegetal cover adjacent to the urban gullies. The local climate is humid tropical, with average annual temperatures of 26ºC, reaching higher values in October to December and lower from April to June. Rainfall distribution throughout the year is irregular, marked by two very distinct seasons (rainy and dry). The highly seasonal erosive rains incise a complex series of soil erosion landforms, mainly gullies in this area.

The following procedures have been carried out: fieldwork with monitoring of gully head erosion; Environmental Education Program; handcraft workshop regarding the prodution of geotextiles from Buriti fiber. The rehabilitation of this degraded site, follows these stages: 1. Acquisition of equipment and materials; 2. Contracting workers; 3. Reshaping selected gully walls; 4. Adding organic palm materials to the topsoil and 30 kg of grass seeds; 5. Application of geotextile anchored on the ground by using wooden stakes; 6. Maintenance work with photographic records; 7. Photo comparison to measure the vegetal cover percentage, with the aid of geoprocessing software. Some of the gully walls presented steep slopes, around 90 degrees, and therefore, it was necessary to reshape them for the application of soil bioengineering techniques. It was selected a sample area of 2.000 m2 to be rehabilitated. The knowledge of soil and geomorphological characteristics was essential to understand surface runoff, considering the direction of water flows.

Due to the difficulties in diverting the flows, which would require more extensive engineering works, the channel was maintained, and the base of the slopes was strengthened to support the flows. In the upper part of this area, which had 8º slope angle, contour lines were surveyed and barriers of wooden stakes were used to retard runoff velocity from adjacent vegetated slopes. Some slopes in this part had a 45º slope angle, due to the local topography. However, this angle is considered too steep for the application of palm-mats. In some parts of gully, work was

completed to reshape the gullies and construct the ~2 m high terraces using the gully material. Tractor work was impeded, because on the second terrace the tractor had difficulty in working, because of the high sand content, which made the slope unstable. These terraces are crossed by a flow convergence area, which was formed by men inserting sand bags, decomposing palm leaves and grass seeds, to form a vegetated channel after grass growth.

Key-words: Rehabilitation, gully, geotextile, soil bioengineering.