Soil bioengineering applied to soil erosion in Sao Luis City, Brazil

Maria-Curie Skłodowska University in Lublin, Institute of Earth Sciences
Polish Geographical Society, Lublin Branch
Association of Polish Geomorphologists

Human Impact on Gully Erosion

5th International Symposium on Gully Erosion

Lublin (Poland), April 19th-24th, 2010

Book of abstracts

Edited by Wojciech Zgłobicki

Lublin 2010

Scientific Committee

Sean J. Bennett (USA), John Boardman (UK), Javier Casali (Spain), Markus Dotterweich (Germany), Antonio Guerra (Brazil), Marian Harasimiuk (Poland), Nigussie Haregeweyn (Ethiopia), Andrij Jacyshyn (Ukraine), Mike Kirkby (UK), Kazimierz Klimek (Poland), Yong Li (China), Michael Marden (New Zealand), Jean Poesen (Belgium), Frank Simpson (Canada), Milos Stankoviansky (Slovakia), Dino Torri (Italy), Robert R. Wells (USA), Wojciech Zgłobicki (Poland)

Abstracts were evaluated and accepted by members of Scientific Committee

S.J. Bennett, J. Casali, M. Dotterweich, A. Guerra, N. Haregeweyn, K. Klimek, J. Poesen, F. Simpson, M. Stankoviansky, R. R. Wells, W. Zgłobicki

Manuscript editor and typesetting: Wojciech Zgłobicki

Cover photo: Markus Dotterweich

Publication has been financed by

International Visegrad Fund

http://www.visegradfund.org

Visegrad Fund 2010 years

ISBN 978-83-89720-54-2

KARTPOL

Kartpol s.c. Lublin 2010

www.kartpol.lublin.pl

CONTENTS

SOIL BIOENGINEERING APPLIED TO SOIL EROSION IN SAO LUIS CITY, BRAZIL

Bezerra J.F.R.[1], Guerra A.J.T.[1], Fullen M.A.[2], Teles T. S.[3]

[1]Federal University of Rio de Janeiro, Brazil, [2]The University of Wolverhampton, U.K.
[3]Federal University of Maranhão, Brazil
e-mail: fernangeo@yahoo.com.br

INTRODUCTION

Soil Bioengineering techniques 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) (Fullen et. al., 2002; Bezerra et. al., 2005; Guerra et. al, 2004). 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.

Currently, particular attention is paid to the use of biodegradable geotextiles made from fibre or straw of some native palm trees, such as Buriti (*Mauritia Flexuosa*). The use of these biogeotextiles in an adaptation of techniques used in other places similar vegetation, as The Gambia (West Africa) where the native palm tree Borassus, which is similar to Buriti, is being used in a similar fashion.

Take into consideration Soil Bioengineering techniques and its importance for soil erosion studies were set up an experimental station in Sao Luis City - Brazil to evaluate the Buriti geotextile and its protection of soil surface.

STUDY AREA

The settlement of Sao Luis was established in 1612 and has involved in distinct phases. Rapid urban growth was associated with industrialization in the second half of the 18^{th}. Rapid population and urban growth has intensified problems, compounded by poor planning and improper soil use.

In Sao Luis, geological formations are composed of sedimentary rock, dominated by permeable and generally friable and porous sandstones and shales of the Tertiary *Barreiras* Formation. Weathering on these rocks produces erodible soils, including lithosols, concretionary red/yellow clay soils and concretionary plintosols (Maranhao, 1998).

Local vegetation consists of mangrove swamps, riparian forests, secondary mixed forest, brushwood and water meadows. 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 26°C, reaching higher values in October to December and Lower from April to June. The rainfall distribution along year is rather regular, marked by two distinct periods: a rainy one and a dry one.

METHODS AND MATERIALS

The experimental stations have been playing an important role in analysis on initial stage and development of the erosive processes. Take into acount the advances in Geomorphology, the experimental stations have been applied at different researches, for example, at runoff and erosion control using plots (Morgan, 2005; Mendonça et al, 2005).

The experimental station is located on 20° slope of Bacanga Basin in São Luís City (577.222,206 m E 9.717.497,056 m N) at Federal University of Maranhão. It was established with four plots (2 buriti geotextiles plots and 2 bare plots) on mainly wet months (from February to June).

In order to monitoring runnoff and soil loss were placed 4 gallons (100 l at geotetexiles plot and 200 l at bare plots) at the bottom of experiment site. Braquiarao grass (*Brachiaria brizantha*) was planted on two plots (Geotextiles - GEA, GEB), and after that, geotextiles were placed over the soil surface and attached with wood stacks with 10 cm of length. 40 geotextiles (50 cm^2) was made by buriti mat, using needles (15 cm) and hardboard (55 cm^2). On the other hand, bare soil plots (BEA, BEB) have not needed any treatment.

Runoff was estimated after each rainfall event on experimental station, which was determined by measurements of the capacities in gallons. Runoff volume and sediment yield were collected from each plot, using a 10 litre capacity bucket. Rainfall rates were determined using a rain gauge. Following, sediment samples were weighed on NEPA (Nucleo de Estudo e Pesquisas Ambientais) at Federal University of Maranhao.

RESULTS

During current monitoring experiment were measured 2,067.50 mm of rainfall (from february to june), being generated on each plots significantly runoff (l) and soil loss (g) production in this period: GEA 1,959.30 l and 2,196.86 g; GEB 2,212.00 l and 2,920.09 g; BEA 4,783.40 l and 50,148.16a; BEB 5,109.20 l and 37,671.13 g.

These results showed that were significally difference from geotextiles and bare plots. Geotextiles were the most effective in reducing soil erosion and runoff production. On the other hand, bare plots had the greatest runoff and erosion rates, due to soil and local characteristics such as slope, textures, surface rock fragments and geologic formation.

These data can be very interesting and relevant to observe during the five months of monitoring, being possible to describe the influence of geotextiles on surface runoff and soil detachment. Despite the soil loss by water from plots, in February the results signaled particular features due to the start of the wet season, after the period of low rainfall.

This climate characteristics has pronounced effect on flow and sediment transport, due to higher soil surface evaporation rate associated with unstable soil aggregates, causing low-cohesion in soil particle, which may predispose soils to erosion. During the first month of the monitoring, lack of vegetation cover on geotextiles plots can contribute to high soil losses. The tested geotextiles reduced the soil surface evaporation and maintain the high moisture, which was a very important factor controlling seed germination.

FINAL CONSIDERATION

During this research study, geotextiles has offered an immediate soil surface protection, reducing the kinetic energy of rains drop, sediment transport and runoff surface. Buriti geotextiles were designed to hold soil particles, seeds and soil moisture, aid in plant growth. On the other hand, bare plots showed significantly higher rates of soil loss and runoff. Futhermore, the aim of this research is to apply soil bioengineering techniques on gullies slopes.

Acknowledgements

All authors thank the local communities of São Luís City for their continued and valuable contribution to this Environmental Educational Programme. This research forms part of the *BORASSUS Project* 'The environmental and socio-economic contributions of palm-leaf geotextiles to sustainable development and soil conservation' (INCO-CT-2005-510745), funded by the European Commission (EC), Specific Targeted Research Projects (FP6- STREPs) for Developing Countries (INCO-DEV) Programme. This project is dedicated to the memory of Dr Kathy Davies, who was the initiator and inspiration for palm-leaf geotextile research.

REFERENCES

Bezerra, J.F.R, Guerra, A.J.T, Rodrigues, S.C. (2005), Monitoramento e avaliação de geotêxteis na recuperação de um solo degradado por erosão, Fazenda Experimental do Glória, Uberlândia - MG. In: XI Simpósio Brasileiro de Geografia Física Aplicada. São Paulo.

Fullen, M. A., Davies, K. and Guerra, A.J.T. (2002), The potential of palm (Borassus) mat geotextiles as a soil conservation technique. In: IV Simpósio Nacional de Geomorfologia. São Luís.

Guerra, A.J.T, Mendonça, J.K.S, Rêgo, M. and Alves, I.S. (2004), Gully erosion monitoring in São Luis City - Maranhão State - Brazil. In: Yong Li; Jean Poesen; Christian Valentin. (Eds). Gully Erosion under Global Change. 1 Chengdu: Sichuan Science and Technology Press, v. 1, p. 13-20.

Maranhão. (1998), 'Secretaria de Estado do Meio Ambiente e Recursos Hídricos.' Diagnóstico ambiental da Microrregião da Aglomeração Urbana de São Luís e dos municípios de Alcântara, Bacabeira, Rosário e São Luís.

Mendonça, J.K.S., Bezerra, J.F.R, Gonçalves, L.D.P., Gonçalves, M.F.P., Guerra, A.J.T. and Feitosa. A.C. (2005), Study of rainfall rates and erosive processes in the urban area of São Luís - MA. International Symposium on Land Degradation and Desertification. Special Issue, Uberlândia, Brazil.

Morgan, R.P.C. (2005), Soil Erosion and Conservation. Blackwell Publishing, Oxford, 3rd Edition, 304p.