BUSITEMA UNIVERSITY
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P.O. Box 236, Tororo, Uganda
Gen: +256 - 45 444 8838
Fax: +256 - 45 4436517
Email: info@adm.busitema.ac.ug

www.busitema.ac.ug

FACULTY OF ENGINEERING

DEPARTMENT OF WATER RESOURCES AND MINING ENGINEERING

FINAL YEAR PROJECT REPORT

APPLICATION OF GIS IN ASSESSMENT OF SOIL EROSION RISK

(Case study: Mbale district)

OKUU KENNEDY AKONA

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SUPERVISOR(S)

MR. MUGISHA MOSES

ENG. BADAZA MOHAMMED

A final year project report submitted to the Department of Mining and Water Resources Engineering as a partial fulfillment of the requirements for the award of a Bachelor of Science degree in Water Resources Engineering.

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ABSTRACT

Land degradation has already been treated as one of the most serious problem all around the world. Soil erosion is defined as the physical degradation of the landscape over time. The process is initiated when soil particles are detached from its original configuration by erosive forces such as rainfall. The soil particles may then be transported by overland flow into nearby rivers and oceans. Current developments in geographic information systems (GIS) make it possible to model complex spatial information. A GIS is used in this project to determine soil erosion rate and risk throughout a watershed. Hydrological data is also analyzed to give some understanding of the watershed response to the primary erosive input: rainfall. The goals of this research project is to obtain the erosion rate from the model and erosion risk area of the catchment. This study is a GIS-based to study which devotes to calculate annual soil loss value and erosion risk, seek for soil erosion trends linked with precipitation and land use in Mbale district, on Mount Elgon region, Uganda. Revised Universal Soil loss Equation (RUSLE) is implemented in the application to obtain the erosion risk in the catchment. The modeling is carried out for the years and is based on ASTER remotely sensed data, digital elevation models, precipitation data from the study area, as well as existing soil maps from DSMW. Over exploitation of land is probably compensated by improved agricultural management and no significant increase in precipitation. Even if there are reports of more intense and increasing amounts of rainfall in the area, this could not be verified, neither through analysis of climate data, nor by trends in estimated soil erosion risk and rate.

The predicted surface soil erosion in Mbale catchment mostly depends on the slope conditions and precipitation records while the major easily manageable factors are the conservation and cover management factors on the land.

Key words: ArcGIS, RUSLE, and soil erosion

DEDICATION

This piece of work is dedicated God Almighty and those who supported me on my journey to complete this level of my education especially my brothers who have worked sacrificially and tireless to ensure I attain education.

DECLARATION

Except where otherwise stated, I hereby declare that this piece of work is my own original work and has never been submitted wholly or partially to any University or institution of higher learning for any award whatsoever.

Signature: .....

OKUU KENNEDY AKONA

Date: 30 · MAY · 2017

APPROVAL

This piece of work has been approved by;

Main Supervisor

Mr. MUGISHA MOSES

Signature.....

Date.....

Co-supervisor

ENG. BADAZA MOHAMMED

Signature.....

Date.....

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List of acronyms

USLE	Universal Soil Loss Equation
RUSLE	Revised Universal Soil Loss Equation
MULE	Modified Universal Soil Loss Equation
GIS	Geographical Information Systems
DEM	Digital Elevation Model
TIN	Triangulated irregular Network
SWAT	Soil and Water Assessment Tool
MWE	Ministry of Water and Environment
DWRM	Directorate of Water Resource Management
NEMA	National Environmental Management Authority
UNMA	Uganda National Metrological Authority
FAO	Food and Agricultural Authority
DSMW	Digital Soil Map of the World
USGS	United States Geographical Survey
MOA	Ministry of Agriculture, Animal industry and Fishery
NRCS	National Research Conservation Service
CN	Curve Numbers
t ha-1 y-1	tons per hectares per year.
NFA	National Forest Authority
UTM	Universal Transverse Mercator
WGS	World Geographical System

LULC	land use and land cover
UBSO	Uganda Bureau of Statistics
WHO	World Health Organization
K factor	Soil erodibility factor
R factor	Rain fall erosivity factor
LS factor	Slope length and slope stiffness factors
C factor	Cover management factor
P factor	Conservation practice

CHAPTER ONE

1.0 INTRODUCTION

1.1 BACKGROUND

As one of the most important basic natural resource, land relates to almost all human activities directly or indirectly, and is crucial for sustaining livelihoods. Rational utilization of the land resource has been treated as the key factor in the development pathways of many countries. However, land degradation is one of the major and widespread environmental threats both in the past and present years.

Soil erosion is regarded as the most serious form of land degradation around the world, especially in developing countries like Uganda, China, and India, as well as some developed countries like In order to meet their livelihoods, address the economic stress, and accelerate development, some people and development actors in the developing countries utilize land and soil resources in unsustainable and irrational ways as manifested by overgrazing, destruction of forest for urban extension, heavy intensity and unscientific agricultural activities, and land use changes in high As a result, soil erosion becomes a serious issue, which negatively impacts the soil quality reducing agricultural efficiency, worsening water quality, causing flooding and debris flow, and habitat.

Mountain ecosystems are considered as one of the most significant ecosystems, providing huge amount of benefits to humans both in natural and economic aspects via various ecosystem services and products. Nevertheless, unsustainable and unscientific land use practices and improper land management cause serious soil erosion in mountain regions. More and more studies are carried out focusing on mountainous areas in order to get better understanding of why the phenomenon happens and what could be done to solve the problems In recent years, governments started to pay attention to sustainable agriculture and development. As a result, many environment and land degradation assessment policies were announced and published, which pointed out that soil erosion and land degradation in mountain areas are being increasingly regarded as more serious than in other ecosystems. One of the major reasons for this is land use changes in high frequency, not only modifications but also conversion of the land cover, which has a negative impact on the environment, especially replacement of forest

6.0 REFERENCE

Brown, L. C., & Foster, G. R. (1987).Storm erosivity using idealized intensity distributions. Transactions of American Society of Agricultural Engineers, 30, 379 - 386.

Blaszczynski, J. (2001). Regional Sheet and Rill Soil Erosion Prediction with the Revised Universal Soil Loss Equation (RUSLE) - GIS Interface. Resource Notes No.46.

Ioannis Z. Gitas ET. Al2001 Multi temporal soil erosion Risk assessment in N. Chaldiki using modified USLE raster model

Goldman, S. J., Jackson, K., &Bursztynsky, T. A. (1986).Erosion and sediment control handbook. New York a.o.: McGraw-Hill.

Mills, T. R., & Clara, M. L. (1976).Erosion and Sediment Control in Surface Mining in the Eastern U.S. Washington, D.C.: U.S. Environmental Protection Agency

Mitasova H. 1996 GIS tools for Erosion Modelling. University of Illinois: Illinois

Morgan, R.P.C. 1994. Soil Erosion and Conservation. Silsoe College, Cranfield University.

Virginia Soil and Water Conservation Commission. (1980). Virginia Erosion and Sediment Control Handbook (2nd Ed.). Richmond, VA.

Williams, J. (1975). Sediment Yield Prediction with Universal Equation using Runoff Energy Factor. Agricultural Research Service Report ARS-S-40, U.S. Department of Agriculture.

Wischmeier, W., & Smith, D. (1978).Predicting Rainfall Erosion Losses- a Guide to Conservation Planning. U.S. Department of Agriculture Handbook No.537. U.S.A

Wischmeier, W., & Smith, D. (1965). Predicting Rainfall Erosion Losses from Cropland, Finland.

Boyi Jiang (2013) GIS-based time series study of soil erosion risk using the Revised Universal Soil Loss Equation (RUSLE) model in a micro-catchment on Mount Elgon, Uganda

Cléber Domingos Arruda (2011) Developing a Pedestrian Route Network Service (PRNS)

Arash Amiri (2012)Automatic Geospatial Web Service Composition for Developing a Routing System

Adelina Osmani (2012) Forests as carbon sinks - A comparison between the boreal forest and the tropical forest

Natural Resource Conservation Service. 1999. Revised Universal Soil Loss Equation field handbook for the Pacific Basin. US Dept of Agriculture

Wischmeier, W.H., and D.D. Smith. 1978. Predicting rainfall erosion losses. Agricultural Handbook 537. U.S. Dept. of Agriculture.

Ma JW, Xue Y, Ma CF, Wang ZG. 2003. A data fusion approach for soil erosion monitoring in the Upper Yangtze River Basin of China based on Universal Soil Loss Equation (USLE) model. International Journal of Remote Sensing 24: 4777–4789.

Milward AA, Mersey JE. 1999. Adapting RULSE to model soil erosion potential in a mountainous tropical watershed. Catena 38: 109-129.

Morgan, R.P.C. 1994. Soil Erosion and Conservation. Silsoe College, Cranfield University.

Morgan, R.P.C. 1974. Estimating regional variation in soil erosion hazard in Peninsular, Malaysia. Malayan Nature Journal 28: 94-106.

Williamson, I. P., Rajabifard, A., & Feeney, M.-E. F. (2003). *Developing Spatial Data Infrastructure:*

from Concept to Reality. New York.

Wischmeier, W. H. (1976). Use and Misuse of the Universal Soil Loss Equation. *Jounal of Soil and Water Conservation, 31*, 5 - 9.

Wischmeier, W. H., & Smith, D. D. (1965). *Predicting rainfall erosion losses from cropland east of Rocky Mountains - Guide for selection of practices for soil and water conservation.* Washington, D.C.: U.S. Department of. Agriculture Handbook No. 282.

Wischmeier, W. H., & Smith, D. D. (1978). *Predicting Rainfall - Erosion Losses*. Washington, DC.: USDA Science and Education Administration.

Wischmeier, W. H., Smith, D. D., & Uhland, R. E. (1958). Evaluation of factors in the Soil Loss Equation. *Agricultural Engineering, 39*, 458-462.

Yin, S., Xie, Y., Nearing, M. A., & Wang, C. (2007). Estimation of rainfall erosivity using 5- to 60-minute fixed-interval rainfall data from China. *Catena, 70*, 306 - 312.

Yu, B., Rose, C. W., Yin, D., & Anecksamphat, C. (1999). Re-interpretation of USLE Datasets for Physically Based Erosion Models with Examples from Southern China and Nothern Thailand, *10th international soil conservation organization meeting*. Pudue University.