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INTEGRATING GIS AND RE!v'lOTE SENSING TECHNIQUES FOR THE ASS~SSMENT OF EROSION VULNERABLE AREA: THE CASE OF JABI TEHINAN WOREDA, \VEST GOJJAM ZONE, Al'vlHARA REGION.

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INTEGRATING GIS AND REMOTE SENSING TECHNIQUES FOR THE ASSESSMENT OF EROSION VULNERABLE AREA: THE CASE OF JABI TEHINAN WOREDA, WEST GOJJAM ZONE, AMHARA REGION.

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Thesis

Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Science in Geo-Information System

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The thesis titled "INTEGRATING GIS AND REMOTE SENSING TECHNIQUES FOR THE ASSESSMENT OF EROSION VULNERABLE AREA: The Case of Jabi Tehnan Woreda, West Gojjam Zone, Amhara Region." by **Mr. Abebe Mengaw** is approved for the degree of Master of Science in Geo-Information System.

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Abebe Mengaw

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List of Abbreviations

FAO- Food and Agricultural Organization

SCRP- Soil Conservation Research Programme

ANRS- Amhara National Regional State

MOARD- Ministry of Agriculture and Rural Development

SRTM- Shuttle Radar Topography Mission

NDVI- Normalized Different Vegetation Index

DEM- Digital Elevation Model

GPS- Global Positioning System

GCP- Ground Control Point

GIS- Geographic Information System

RS- Remote Sensing

NRM- Natural Resource Management

GMOE- Geological Map of Ethiopia

LULC- Land use/ Land cover

EWG- Expert Working Group

UNU- EHS-United Nations University Institute of Environment and Human Security

MCE- Multi-Criteria Evaluation

MCA- Multi-Criteria Analysis

AHP- Analytical Hierarchy Process

WEPP-Water Erosion Prediction Project

EUROSEM- European Soil Erosion Model

UNEP- The United Nations Environmental Programme

m.a.s.l- Meters Above Sea Level

RDBMS- Relational Database Management System

PESERA-Pan European Soil Erosion Risk Assessment

Abstract

Soil degradation in the form of soil erosion is a serious and continuous environmental problem in Jabi Tehinan Woreda. Uncontrolled land use, deforestation, land over cultivation, overgrazing and exploitation of biomass for firewood, construction and other household uses due to increasing population ultimately leads to severe soil erosion. The impact of natural hazards like erosion hazard can be minimized and ultimately controlled by disaster preparedness maps. Therefore, the overall objective of this paper is to identify and map erosion vulnerable areas for the planning and implementations of sustainable soil conservation and management system in the study area.

This study had integrated GIS, RS and MCE models to assess and map erosion vulnerable areas and RUSLE model to quantify an estimated soil loss in Jabi Tehinan Woreda. Slope gradient, soil type, LULC, rainfall and drainage pattern were used as input model parameters/variables. The data had been collected and analyzed from different land sat imageries, SRTM data, topomaps and point interpolations of primary data. Finally the aggregated effects of all parameters had been analyzed and priority rating of erosion vulnerable area was calculated using weighted overlay techniques.

After analyzing all model parameters, areas in steeper slope with Lithosols, Eutric Nitosols, Orthic Luvisols, croplands, bare lands and river banks have been identified as the most erosion vulnerable areas. Quantitatively, 3,644 ha (3.1%), 12,867.8 ha (11%) and 33,995.5 ha (29%) of the entire land is endangered to extremely vulnerable, highly vulnerable and vulnerable areas respectively. The remaining almost half 59,310.7 ha (50.7%) and 7,165.5 ha (6.2%) of the land is explained to less and very less erosion vulnerable areas respectively. In general the northern, northeastern and a little bit of the southern margins of the woreda is the most exposed or vulnerable areas to erosion. While the south and central parts of the study areas are insignificantly vulnerable to erosion by water. The estimated annual soil loss in Jabi Tehinan Woreda ranges from nearly 0 in south and central parts of the study area to 504.6 t/ha/yr in the steeply sloping mountainous areas of the north and north- eastern parts of the catchments.

CHAPTER ONE
INTRODUCTION

1.1. Background

Nowadays, people in developing countries are increasingly forced to use more marginal and sensitive lands for agricultural purposes in every aspect to sustain their living. These uncontrolled uses of land due to population growth ultimately leads to deforestation, land over cultivation, overgrazing and exploitation of biomass for firewood, construction and other household uses, often causing severe soil erosion.

Soil erosion is the direct result of the mismanagement of the soil by man in his effort to obtain a living from it (Gustafson, 2005). Studies reported that, cultivation without using specific control techniques and unplanned land use, such as uncontrolled urban development, deforestation and mal-agricultural practice are fundamental factors of soil erosion (Biard and Baret, 1997). It is clearly evident that the ultimate cause of erosion is human himself contributing about 60 to 80% of all soil erosion and soil degradation (McNeill, 2000). Further Gerrard (2000) stated that soil erosion by wind and water are natural processes, but enhanced by human mismanagement of the land. Due to uncontrolled and unmanageable interference of people to the land, world wide 80% of agricultural land suffers from moderate to severe erosion. Consequently, 65% of the soil in sub-Saharan Africa is said to have undergone degradation (Ludi, 2004).

Because of favourable topographical factors and strong human impact over the environment, especially the northern highlands of Ethiopia have been characterized by severe erosion. At country level, total soil loss by erosion from all land is estimated at almost 1.5 billion tons per year and on average 42 tones per hectare, of which 45% originates from croplands alone. But, in the highlands of Ethiopia, annual soil loss reaches up to 200 - 300 ton per hectare, making the total loss 23,400 million ton per year (FAO, 1984; Hurni, 1993). With the increment of such environmental problems, identification and mapping of erosion (hazard) vulnerable area has become an important discipline in the world of Geo-Information Systems.

Mapping of erosion vulnerable area using the integration of GIS, RS and MCE technique can identify areas that are at potential risk of extensive soil erosion. The formulation of proper soil management for sustainable development requires an explicit inventory and rating of vulnerable areas. This information is very useful in the decision making context to avoid land acquisition in erosion risk areas, or, alternatively, to recommend soil conservation measures to reduce soil loss if developments continue (Yusof and Baban, 1999). On the other hand, the modeling of soil movement and their consequences plays a significant role for natural resource management and/or sustainable environmental planning processes; like optimization of agricultural productivity.

Studies on erosion undertaken at spatial scales covering local to regional areas have provided both qualitative (e.g., erosion vulnerable areas) and quantitative information (e.g., soil loss rates). Methods for evaluating erosion vulnerable area on catchments or regional scales include both the application of erosion models or qualitative approximations using GIS and RS technologies.

Thus, by this study GIS and RS were employed to evaluate potential erosion vulnerable area including the determinations and prioritizations of different factors that accelerate soil erosion in the study area.

1.2. Statement of the Problem

Erosion is regarded as the major and most widespread form of environmental problems in the highlands of Ethiopian. Rapid population growth, cultivation on steep slopes, rugged topographical feature, clearing of vegetation, mal-agricultural practice, overgrazing and even higher demand for firewood are the main factors that accelerate soil erosion in the area. According to Ministry of Agriculture (MOA, 1984) erosion classification algorism, the Northwestern Highlands of Ethiopia has been categorized in to severe to moderate soil loss.

The economic implication of soil erosion is more serious in Northwestern Highlands of Ethiopia because of mainly its rugged topographical features and lack of capacity to cope