INTERNATIONAL
SOIL AND WATER
CONSERVATION RESEARCH

Linking landforms and land use to land degradation in the Middle River Njoro Watershed

Zackary G. Mainuri[1] and James O. Owino[2]

Abstract

Land degradation is the decline in the productive capacity of an ecosystem. This mainly occurs due to processes induced by human activities, such as deforestation, poor farming practices, or enhanced industrial growth leading to various land degradation processes such as, flooding, drought and accelerated erosion. The objective of the study was to link landforms and land uses to land degradation. Soils in the catchments were distinguished on the basis of Physiographic, parent material/ geology and soil characteristics. Eight soil mapping units were identified in the area. The validity of the identified soil mapping units were checked in the field using auger hole, mini pits, road and erosion cut observations. Representative profile pits were sighted in the major mapping units. The profile pits were described according to FAO (1977) and Kenya Soil Survey (1987). Soil classification was done according to FAO/UNESCO (1997). Soil mapping units were found to follow soil physiographic units/ land forms. Soils on mountains and hills were found to be somewhat excessively drained, shallow to moderately deep. Those from uplands and plateaus were well drained, deep to very deep. Soils on plains fell on two extremes; those that were well drained, deep to very deep and those that were imperfectly drained to poorly drained, moderately deep to very deep. Physical, chemical and biological land degradation was found to take place in the different physiographic units/ land forms at varying degrees. Soil erosion, nutrient depletion and vegetation depletion were found to be the most important degradation processes. Soil, physiographic units, soil susceptibility and hazard maps were drawn and their classes in the different landforms established.

KeyWords: Land use, Landform, Land degradation

1 Introduction

Land degradation is defined as the decline in the productive capacity of an ecosystem due to processes induced by human activities, such as introduction of large scale irrigation, deforestation, or enhanced industrial growth leading to various land degradation processes including, flooding, drought, and accelerated erosion (UNEP, 1993). Soil erosion reduces soil productivity (Aboud, 1992; Anyango, 2000) on agricultural lands. Soil erosion by water occurs due to complex interactions of sub processes of detachment and transport of soil material by raindrop impact and overland flow and of deposition causing sedimentation of water bodies (Karanja et al., 1986); thus adversely affecting the aquatic life. Soil and water are very important resources in agricultural production. In order to increase and sustain productivity in both crops and animals, proper land management is essential. The design and implementation of proper land management strategies, however, presupposes the identification of the problems related to soil and water that limit agricultural production. Agriculture plays a crucial role in economic development of the country directly and through linkages with other sectors. Growth in agriculture and improved rural incomes has a significant and direct impact on the reduction of overall poverty. Land use influence on hydrology has generated interest worldwide, especially in developing countries, where forest areas have been converted to other land uses including, agriculture and

[1] Lecturer, Department of Crops, Horticulture and Soil Science, Egerton University, P. O. Box 536, Egerton, Kenya. Corresponding author: E-mail: mainuri2004@yahoo.com

[2] Senior Lecturer, Department of Agricultural Engineering, Egerton University, P. O. Box 536, Egerton, Kenya. E-mail: joowin@yahoo.com

grazing. These processes lower the current and potential capability of land to produce goods and services (FAO, 1979). While it is true that human activities, through different types of land use and management, trigger and accelerate degradation, it is also true that some processes of land degradation occur naturally. The major types of soil degradation in the study area are physical including erosion, chemical including fertility decline, and biological including organic matter decline and deforestation. Land degradation in the form of decline in soil fertility due to erosion and crop harvesting has led to continuous decline in crop production to an alarmingly low level. This is attributed to land subdivision, intensive cultivation and urbanization which have resulted in the conversion of large-scale farms into small-scale farms and the gradual diminishment of plantation forests (Chemilil, 1995).

The population in the River Njoro Watershed has continued to grow. For example, within a period of twenty years between 1979 and 1999 the population in Nakuru district, in which the River Njoro Watershed is found, increased twofold; from 523,000 to 1,197,000 persons (GoK, 2001). This high population growth rate and the accompanying land fragmentation have strained land resources (Mathooko, 2001) resulting in massive soil erosion and other forms of land degradation. While aspects of land degradation have been successfully tackled, most past research to address these problems have fallen short of solving the problems of land degradation especially under smallholder production systems. This increasing influence of land use change poses a threat to the conservation of soils in the watershed.

Changes in land use has the potential of influencing the flow of surface runoff to the stream network and infiltration in a watershed (Ziegler and Giambelluca, 1997). For instance, surfaces with low infiltration capability such as overgrazed or intensively cultivated land act as source areas for overland flow in areas where it is otherwise rare. Other surfaces having high infiltration capability may serve as buffers by infiltrating surface runoff generated directly upslope (Ziegler et al., 2000). Detailed knowledge of runoff sources and buffers is therefore important in understanding the hydrology of watersheds. Knowledge of soils with respect to their extent, distribution, characteristics, degradation risks, and use potential is the objective of this study in order to optimize land resource use in the River Njoro watershed.

2 Research methodology

2.1 *Study area*

The Middle River NjoroWatershed is located at the Central Rift Valley zone within the Kenyan part of the East African Rift System. It lies between longitudes 35˚05′E and 36˚05′E, and latitudes 0˚15′S and 0˚25′S. The area watershed covers about 8,500 hectares, and is located about 200 km northwest of Nairobi in Nakuru County. The catchment lies between altitudes 1,600 m above sea level (asl) and 3,000 m asl (Fig. 1). The Njoro River has its source from Mau escarpment and drains into Lake Nakuru.

According to Sombroek et al. (1982), the catchment area covers agro-climatic zones (ACZ) I – IV which have mean annual rainfall (r) to mean annual potential evaporation (Eo) ratios (r/Eo) of > 0.8 – 0.5. These zones range from humid to semi-arid with very high to medium potential for plant growth. Rainfall ranges from 800 mm in agro-climatic zone IV to 2,700 mm in agro-climatic zone I, while potential evaporation ranges from 1,200 mm in ACZ I to 2,200 mm in ACZ IV. Mean annual temperatures range from 10˚C in ACZ I to 18˚C in ACZ IV.

The area is covered by volcanic rocks, ranging in age from tertiary quaternary to recent, basically consisting of pyroclastic rocks of recent volcanoes. The rocks are predominantly agglomerates, sediments, welded tuffs, and phonolites on mountains, ciders, pumice, sanidine minerals, basaltic tuffs and black ashes on hills, plateaus, uplands, plains and valleys and alluvium and lacustrine and fluviatile sediments derived directly from them (Sombroeck et al., 1982). The soils and geology of the area are influenced by the volcanic nature of the Rift valley. The River Njoro watershed is covered by loamy soil in the upper forested parts having developed from ashes and other pyroclastic rocks of recent volcanoes and deep to very deep well drained to moderately deep loamy sandy clays (vitric andosols). The lower reaches of the watershed are covered by erosive lacustrine soils (Chemilil, 1995) which have been developed on these pyroclastic rocks. The drainage classes range from poorly drained, moderately well drained, well drained to excessively drained, with textures ranging from loam, clay to clay loam and structures in the range of moderately strong to strong.