Characterization of some soils of the Miombo Woodlands Ecosystem of Kitonga Forest Reserve, Iringa, Tanzania: Physicochemical properties and classification

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INTRODUCTION

Understanding soil types of an area is the basis for sustainable soil use and management. Few studies have characterized and classified the soils in Tanzania and especially those of the miombo woodlands ecosystem (Munishi *et al*., 2011). Miombo woodland soils have significant implications in global climate change processes.

Characterizing the dominant soil types of the miombo woodlands ecosystem soils in Tanzania would facilitate availability of information on potentials and constraints of soils for different management and uses which will contribute to reduced disturbances and land degradation.

In Tanzania, the miombo woodlands cover 31.6 million ha, or 93% of the total forested land area, 40% of total country land area are regarded as important pool for SOC storage and provide diverse ecosystem services which support livelihoods to adjacent communities (FAO, 2009; Woollen *et al.* 2012). However, limited studies on SOC have been reported from miombo woodlands located at different elevations.

AIMS AND OBJECTIVES

The major aim of the study was to study the dominant soil types in the miombo woodlands in the KFR with the specific objectives:

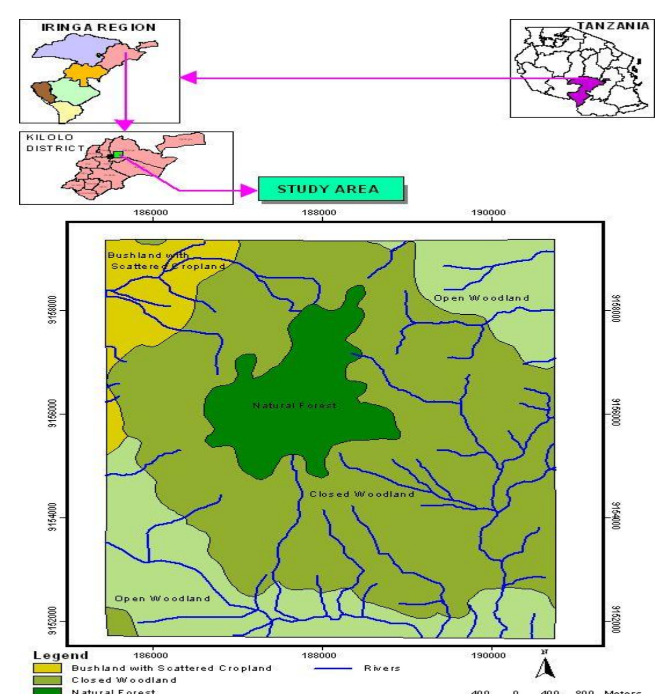
i. to map the soils and their spatial distribution over the study area
ii. to characterize the soils based on physicochemical properties
iii. to classify the soils using the World Reference Base (WRB) for Soil Resource and (FAO, 2006) and the United States Department of Agriculture Soil Taxonomy system (Soil Survey Staff, 2010)
iv. to provide data for use by stakeholders in planning sustainable land management in miombo woodlands

METHODOLOGY

Table 1: Site characteristics of Kitonga Forest Reserve

Location	Kilolo Disrtict, Iringa Region
Latitude/Longitude	07°35' - 07°43' S - 37°07' - 37°10' E
Altitude	660- 1880 masl
Annual Rainfall	600- 700 mm
Annual meanTemperature	12.0to 29.0 ^{0}C

Study area



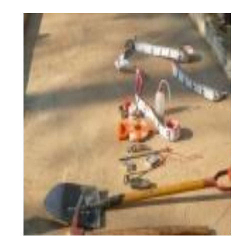
Field methods

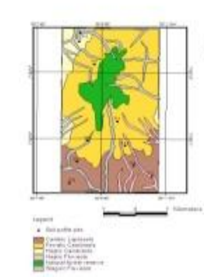
Using standard procedures (FAO-WRB, 2006); Munsell Color Co., 1992), ten soil profiles were located using the Global Positioning System (GPS) receiver, and were examined, described and samples collected from natural horizons. In each profile pit, disturbed and undisturbed samples were taken from each horizon for physical and chemical analysis in the laboratory.

Soil classification

Using field and laboratory data, the soils were classified to tier-2 of the FAO World Reference Base (FAO-WRB, 2006), and to subgroup level of the USDA Soil Taxonomy (Soil Survey Staff, 2010).The soils were classified as Cambisols/Inceptisols, Fluvisols/Entisol and Leptosols/Entisols (FAO/USDA classification systems).

Data collection and laboratory analysis





RESULTS

Table 1: Salient features of the study area- Kitonga Forest Reserve

Altitude (masl)	Location	Profile No.	Slope gradient	Land form	Slope form	SMR	STR
831	36° 9′ 0″ E 07° 39′ 36″ S	5	25	Lower slope	Straight	Ustic	Thermic
928	36° 11′ 24″ E 07° 36′ 0" S	3	15	V- Shaped Valley bottom	Concave	Aquic	Thermic
980	36° 10′ 48″ E 07° 39' 33.66" S	4	12	Ridge summit (Lower)	Convex	Ustic	Thermic
1083	36° 9′ 36″ E 07° 39′ 0″ S	2	17	Ridge Middle slope	Straight	Ustic	Thermic
1241	36° 9′ 36″ E 07° 34′ 45″ S	8	10	U- Shaped Valley bottom	Concave	Aquic	Mesic
1258	36° 9′ 36″ E 07° 35′ 24″ S	9	10	Foot slope	Straight	Ustic	Mesic
1320	36° 10′ 48″ E 07° 38' 24" S	10	22	Ridge Lower slope	Straight	Ustic	Mesic
1377	36° 9′ 36″ E 07° 36′ 0″ S	7	25	Ridge Middle slope	Straight	Ustic	Mesic
1548	36° 9′ 36″ E 07° 38′ 24″ S	6	10	U-Shaped Valley bottom	Concave	Ustic	Mesic
1598	36° 10' 12" E 07° 37′ 48″ S	1	1	Ridge Summit	Convex	Ustic	Mesic

SMR= soil moisture regime STR= soil temperature regime

Table 2: Summary of soil mapping units and their areal extent, Kitonga Forest Reserve

Soil mapping units (SMUs)	Soil types (FAO-WRB, 2006)	Area extent of SMUs in ha	% distribution
SF	Stagnic Fluvisol	404	7.81
HF	Haplic Fluvisol	167	3.23
HC	Haplic Cambisol	330	6.38
CL	Cambic Leptosol	992	19.18
FC	Ferralic Cambisol	2816	54.45
NR	Natural reserve (not described because of inaccessibility	463	8.95
Total area		5,172	100.00

DISCUSSION

Soil mapping units, soil classification and their relationship to topography.

The detailed classification of soils representative of the mapping units of Kitonga Forest Reserve showed that the soils were classified as Leptosols, Fluvisols and Cambisols, (FAO-WRB, 2006) or Entisols and Inceptisols (USDA Soil Taxonomy). Different soil types were found under specific topographical features. Cambisols (Inceptisols) were found on ridge summit slopes with convex slopes, Fluvisols (Entisols) were found on U and V shaped valley bottoms with concave slopes, and Leptosols were found on ridge middle slopes with straight slopes (c.f Table 1). This explains the contribution of topographical features (landforms) in forming different soil types. The findings agreed with those of Aticho (2013) that topographic features affect physical and chemical properties of the soils. Table 2 gives a summary of the mapping units and their areal extent with Cambisols being the dominant soil type (61%).

CONCLUSION AND RECOMMENDATIONS

Cambisols, Fluvisols and Leptosols were identified as the dominant soil types by the FAO-WRB (2006), which were equivalent to Inceptisols and Entisols in USDA Soil Taxonomy classification. Each dominant soil type was found in specific topographical features, and exhibited with varied physicochemical properties. This implies the need for specific land management and conservation strategies for each soil type. The low levels of nutrient status in the miombo woodlands justifies the need for conservation and management strategies including avoiding fires, charcoal burning, grazing, deforestation and cultivation, as adaptation and mitigation measures.

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