

CYANOSOILS PROJECT SITE AND SOIL CHARACTERIZATION

B.M. Msanya, D.N. Kimaro, S.M.S. Maliondo, S.S. Madoffe, E. Semu & Z.K.S. Mvena (2002)
Sokoine University of Agriculture, Morogoro, Tanzania

INTRODUCTION

The objective of the study was to select sites for the Cyanosoils project and to characterize the soils on which experiments will be carried out. Through field visits and studies three sites were identified and described in Morogoro Urban and Mvomero Districts. Soil profiles were excavated, described and sampled for laboratory analyses.

Morogoro Urban District

One site situated in the Sokoine University of Agriculture (SUA) was studied.

Climate

An extensive account of the climate of the study area (SUA Farm) has been documented (Msanya, 1980; Moberg *et al.*, 1982 and Kaaya *et al.*, 1994) based on data collected from Morogoro Meteorological Station. The climate at SUA farm is of a sub-humid tropical type. The area experiences a weakly bimodal rainfall distribution with two rainfall peaks in a year (Figure 1). The short and lighter rains last from November to January with a peak in December. These rains are followed by a short dry period, which normally occurs in mid-January or February. The long and heavier rains start in March and end in May, with a peak in April. The onset and distribution of the rainfall are irregular and unreliable.

Information on air temperature is also presented in Figure 1. The mean monthly air temperature is about 24.4° C. January is the hottest month with mean monthly temperature above 25° C, while July and August are the coldest months with mean monthly temperatures of about 22.5° C.

Physiography, geology and parent materials

The site at SUA is located in the SUA farm, the centre of which is approximately at longitude 37° 39'E and latitude 6° 50' S. SUA farm is bordered on the east by Morogoro town, on the south-east by the Uluguru Mts. and to the north-west by the Mindu and Lugala Hills. The landform around the studied site is undulating and can be described as a peneplain.

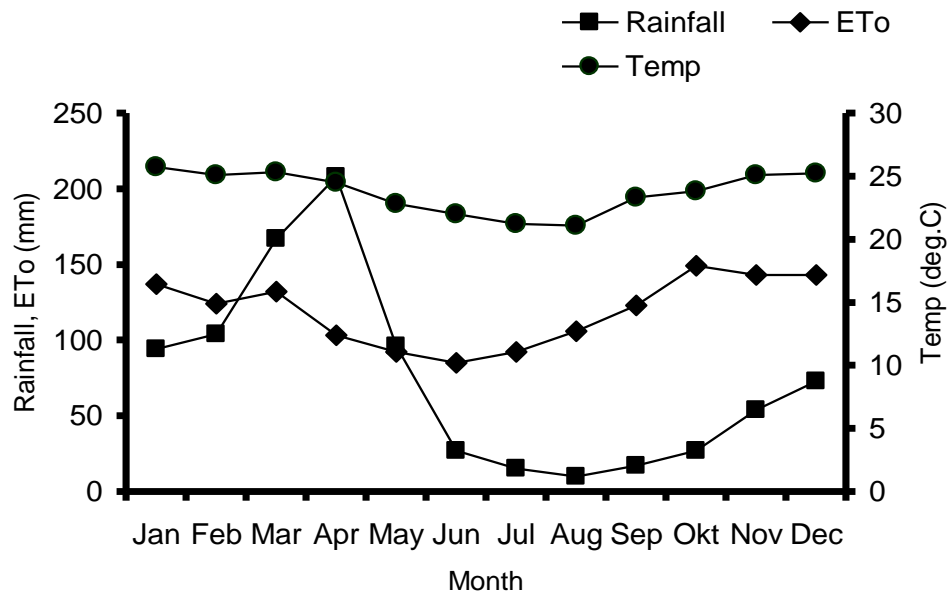


Figure 1. Climatic data for SUA farm

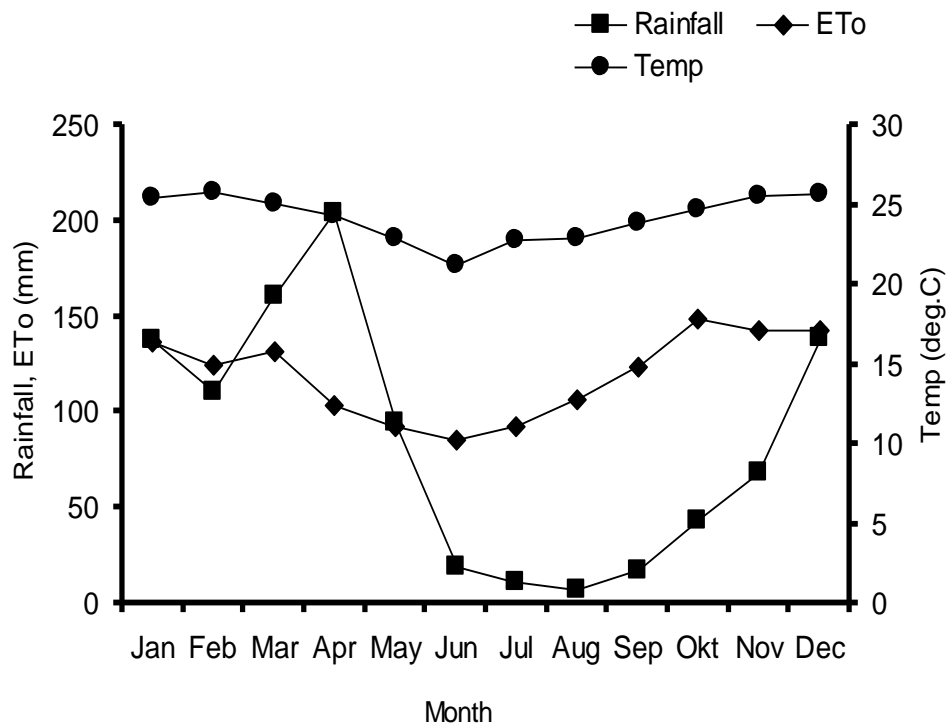


Figure 2. Climatic data for Mkindo village

The soils of this site are derived largely from colluvium originating from the Uluguru Mountains (Kesseba *et al.*, 1972), which got deposited on the current surface a long time ago. Soil profiles are generally red and appear to have undergone substantial in-situ pedogenesis as expressed by their morphological features (Kesseba *et al.*, 1972; Msanya, 1980; Kaaya *et al.*, 1994). The geological survey of Morogoro (Sampson *et al.*, 1961) in fact indicates that the site is covered by red and reddish brown soils. The Uluguru Mountains which is the source of parent materials for the soils in this site, belong to the Precambrian Geological System of meta-sedimentary rocks that are dominantly composed of hornblende-pyroxene granulites containing plagioclase and quartz-rich veins.

Land use and vegetation

Nearly all the natural vegetation in the SUA farm has been cleared for cultivation. Locally some annual grasses including *Themeda spp.*, *Andropogon spp.* and *Hyparrhenia spp.* can be observed in different parts of the farm. Crops normally grown in the farm include maize, sorghum and beans under rainfed conditions.

Mvomero District

Two sites both within Mkindo Village were described.

Climate

Mkindo does not have a meteorological station in its vicinity. The nearest station is the Wami-Dakawa Prison Meteorological Station, about 18 km away. The data from this station could be taken as representative for Mkindo area. The rainfall pattern is also weakly bimodal with a small peak in November/December and a strong peak in March/April. The rainfall pattern for SUA and Mkindo are comparable except for the fact that Mkindo may be receiving more rain than SUA Farm during the short rain season.

Temperatures are likely to be slightly higher than those of SUA as the latter is located at 510 m compared with 360 m at Mkindo. December, January and February are the hottest months with mean monthly temperature of slightly above 25°C. June is the coldest month with a mean monthly temperature of about 22.5°C.

Physiography, geology and parent materials

Mkindo Irrigation Scheme is located on the edge of the extensive Wami Flats, a huge floodplain with an elevation ranging between 350 and 360 m asl. Wami Flats is very swampy and is built up by very thick strata of alluvial sediments of diverse nature and origin. In the

west the Wami Flats is bounded by the Nguru Mountains rising abruptly to 1600 – 1700 m asl. Numerous small streams drain water from the mountains to the Flats and carry with them substantial amounts of sediments derived from the products of weathering and mass movement in the hills and mountains. The Dizingwi or Mkindo stream is one of the larger streams coming from the mountains. Nearly all soils of the study area are developed in materials that originated from the Nguru Mountains and were brought down to the plain by runoff or colluviation (hillwash) or by the Dizingwi stream. These materials are the weathering products of Precambrian metamorphic rocks consisting of migmatitic gneiss, a complex mixture of gneisses and granular granites.

Land use and vegetation

Most of the natural vegetation in Mkindo has been cleared for agriculture. Where land has been left fallow, tall grass vegetation is found with *Rottboellia exaltata* as the most dominant species. On the poorly drained areas small Acacia bushes are common. Crops grown in the area include rice, maize, bananas, millet, beans, coconuts and mangoes.

Soil profile description

Profile No.: **SUA-P1** (SUA Farm). Region: Morogoro District: Morogoro Urban Map sheet no.: 183/3
Coordinates: 37° 38' 50.3" E / 06° 50' 34.4" S Location: SUA Farm, 420 m east of Morogoro-Iringa Highway. Elevation: 510 m asl. Parent material: colluvium derived from metasedimentary rocks of the Uluguru Mountains (hornblende pyroxene granulites). Landform: Peneplain; undulating Slope: 6 %; straight. Relief intensity: 20 m. Surface characteristics: Erosion: slight sheet erosion. Deposition: none. Natural drainage class: well drained. Runoff: moderate. Erosion: water, interrill (sheet), moderate. Sealing/crusting: evident, 2 mm thick. Vegetation/Land use: annual grasses; normally cultivated every year with maize and / or sorghum, beans. Soil moisture regime: ustic. Soil temperature regime: isohyperthermic.
Described by B.M. Msanya, S. Maliondo and D.N. Kimaro on 02/11/2002.

Ap 0 - 20/25 cm: dark reddish brown (5YR3/4) dry, dark reddish brown (5YR3/3) moist; clay; hard dry, friable moist, sticky and plastic wet; moderate coarse subangular blocks; many fine and medium pores; very few very fine roots; few termite nests; clear wavy boundary to

Bt 20/25 - 40 cm: red (2.5YR4/6) dry, dark reddish brown (2.5YR3/4) moist; clay; slightly hard dry, friable moist, sticky and plastic wet; moderate fine subangular blocks; fine faint clay cutans; many very fine and fine, few medium pores; very few very fine roots; common termite nests; diffuse smooth boundary to

Btc1 40 - 95 cm: red (2.5YR4/6) dry, reddish brown (2.5YR3/6) moist; clay; hard dry, friable moist, sticky and plastic wet; strong fine angular blocks; common distinct clay cutans; many fine and very fine pores; very few very fine roots along cracks; common fine and medium soft and hard round and elongated clay-sesquioxide nodules; common termite nests; diffuse smooth boundary to

Btc2 95 - 145 cm: red (2.5YR4/6) dry, moist; dark red (2.5YR3/6) clay; hard dry, friable moist, sticky and plastic wet; moderate to strong coarse angular blocks; common distinct clay cutans; common medium and many fine and very fine pores; very few very fine roots along cracks; common fine and medium soft and hard round and elongated clay-sesquioxide nodules; few termite nests; diffuse smooth boundary to

BC 145 – 190+ cm: yellowish red (5YR4/6) dry, yellowish red (5YR4/6) moist; clay loam; soft dry, very friable moist, slightly sticky and slightly plastic wet; strong fine and medium subangular blocks; common very fine and few medium pores; no roots.

PROVISIONAL SOIL CLASSIFICATION: USDA Soil Taxonomy (SSS, 1999): Kanhaplic Haplustalf
FAO-UNESCO (1988) Legend : Ferric Lixisol (LXf)

“Cyanosoils” - Use of indigenous N₂-fixing cyanobacteria for sustainable improvement of soil biogeochemical performance and physical fertility in semiarid tropics

Profile No.: **MK-P2** (Mkindo village) Region: Morogoro District: Mvomero. Coordinates: 37° 33' 19.4" E / 06° 15' 49.8" S Location: Mkindo village 800 m east of Dakawa-Turiani Road. Elevation: 360 m asl. Parent material: Aluvium and partly colluvium derived from migmatitic gneisses of the Nguru Mts. Landform: Alluvial plain, part of the Wami Flats, flat or almost flat, Slope about 1%, straight. Relief intensity: 10 m. Surface characteristics: Erosion: splash and surface wash, moderate. Deposition: slight in local depressions. Natural drainage class: somewhat poorly (imperfectly) drained. Runoff: slight, otherwise ponding. Sealing/crusting: not evident. Vegetation/Land use: Natural vegetation: grass cover of mostly tall grass (*Rottboellia exaltata*); land use is rice cultivation. Soil moisture regime: aquic. Soil temperature regime: isohyperthermic.

Described by D.N. Kimaro, S. Maliondo, S. Madoffe and B.M. Msanya and D.N. Kimaro on 31/10/2002.

Ah 0 - 30 cm: black (10YR2/1) moist; sandy loam; very friable moist, non-sticky and non-plastic wet; weak fine subangular blocks; many very fine and few medium pores; common very fine roots; clear smooth boundary to

AB 30 - 60 cm: very dark brown (10YR2/2) moist; sandy loam; friable moist, non-sticky and non-plastic wet; weak fine subangular blocks; many very fine and few medium pores; common very fine roots; clear smooth boundary to

2Cg 60 - 90 cm: dark brown (10YR3/3) moist; sandy clay loam; firm moist, slightly sticky and plastic wet; structureless massive; few medium prominent sharp strong brown mottles; common fine pores; few fine roots; gradual smooth boundary to

3Cg 90 – 100+ cm: strong brown (7.5YR4/6) moist; sand; very firm moist, sticky and plastic wet; very weak coarse subangular blocks (almost massive); few medium prominent sharp brown mottles; common fine pores; no roots

SOIL CLASSIFICATION:	USDA Soil Taxonomy (SSS, 1999):	Tropofluvent
	FAO-UNESCO (1988) Legend:	Eutric Fluvisol

Chemical properties of surface soils in the vicinity of the studied soils

Table 1 gives some topsoil chemical data of soils close to the described soil profiles. The data show that generally the topsoils of the studied sites have poor fertility status. OC and N and P contents for SUA Farm are low while those of Mkindo are low to medium. Soil reaction ranges from slightly acid to neutral for both areas.

Table 1. Selected topsoil chemical data of soils close to the studied soil profiles

Soil profile near	USDA Soil Taxonomy*	Soil type**	pH _{water}	pH _{KCl}	%OC	%TN	Bray P mg/kg	CEC cmol(+)/kg	%BS
SUA-profile 1	Kanhaplic Haplustalf	Ferric Lixisol	6.8	4.9	1.3	0.11	1.4	11.4	65.3
Mkindo profile 1	Typic Tropaquept	Gleyic Cambisol	6.1	4.6	2.3	0.15	9.6	19.1	47.1
Mkindo profile 2	Tropofluent	Eutric Fluvisol	6.7	4.9	1.2	0.09	14.8	14.2	60.1

*Soil Survey Staff (1999) **FAO-UNESCO (1988)

References

- FAO, 1988. FAO-Unesco soil map of the world, revised legend. World Soil Resources report 60, FAO, Rome. Reprinted as Technical Paper 20, ISRIC, Wageningen, 1989.
- Kaaya, A.K., B.M. Msanya and J.P. Mrema, 1994. Soils and land evaluation of part of the Sokoine University of Agriculture, Farm(Tanzania) for some crops under rainfed conditions. African Study Monographs 15(2):97-117.
- Kesseba, A., J.R. Pitblado and A.P. Uriyo, 1972. Trends of soil classification in Tanzania 1. The experimental use of 7th Approximation. Journal of Soil Science 23:235-247.
- Moberg, J.P., B.M. Msanya and M. Kilasara, 1982. Pedological and edaphological properties of the soils of two soil associations in the Morogoro area, Tanzania. Tropical Agriculture (Trinidad) 59(2):139-148.
- Msanya, B.M., 1980. Study of the soils of a toposequence on metasedimentary rocks of the Morogoro Region (Tanzania), with special attention to texture determination and soil classification. MSc (Soil Science) thesis. Ghent State University, Belgium.
- Sampson, D.N., A.E. Wright and B.N. Temperley, 1961. Geological survey of Tanganyika, Morogoro. Quarter Degree Sheet no. 183. Geological Survey Division, Dodoma.

“Cyanosoils” - Use of indigenous N₂-fixing cyanobacteria for sustainable improvement of soil biogeochemical performance and physical fertility in semiarid tropics

Plates

1. Mkindo rice fields overlooking the Nguru Mts.



2. Rice fields with Azolla



“Cyanosoils” - Use of indigenous N₂-fixing cyanobacteria for sustainable improvement of soil biogeochemical performance and physical fertility in semiarid tropics

3. Soil description in Mkindo



4. Mkindo Village Headquarters



“Cyanosoils” - Use of indigenous N₂-fixing cyanobacteria for sustainable improvement of soil biogeochemical performance and physical fertility in semiarid tropics

5. Soil profile MK-P1



“Cyanosoils” - Use of indigenous N₂-fixing cyanobacteria for sustainable improvement of soil biogeochemical performance and physical fertility in semiarid tropics

6. Profile MK-P2 filled with seepage and rain water



7. Soil description at SUA Farm



“Cyanosoils” - Use of indigenous N₂-fixing cyanobacteria for sustainable improvement of soil biogeochemical performance and physical fertility in semiarid tropics

8. Soil profile SUA-P1 at SUA Farm



“Cyanosoils” - Use of indigenous N₂-fixing cyanobacteria for sustainable improvement of soil biogeochemical performance and physical fertility in semiarid tropics

9. Project leader with Mr. Temi Officer Incharge of Mkindo Farmers’ School

