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KENYA SOIL SURVEY

IRRIGATION SUITABILITY OF THE OLKERAMATIAN EXPERIMENTAL AREA

By

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SITE EVALUATION NO.3

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(November 1972)

ITINERARY:

The trip was made by Landrover

6th October 1972: Nairobi - Olkaramatian; field studies

7th October 1972: Olkeramatian field studies

8th October 1972: field studies; Olkeramatian - Nairobi

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INTRODUCTION:

At the request of Mr. Slade, Administrative Officer of the Masai Rural Training Center at Sanya, two members of the Kenya Soil Survey Project made a trip to the Olkâramatian Experimental Area. The purpose of the trip was to investigate whether the soils of the Experimental Area and the water of the Ewaso Ngiro are suitable for the irrigation of fodder crops.

The Olkeramatian Experimental Area (O.E.A) of 2000 acres approximately is situated in Masai land just East of the Ewaso Ngiro and South of the track which leads from the Magadi Soda Factory to the Nguruman escarpment (see sheet 160/3 of the Kenya 1:50,000 series). On the attached sketch map (fig. 1) the approximate boundaries of the experimental area have been drawn.

Many areas in Masai land are overgrazed. The purpose of the O.E.A. is to show the local Masai that a less intensive utilization by livestock (i.e. a lower stock density) will result in more profitable returns.

The climatic conditions in the Olkeramatian area are such that there is no forage available in the dry season. The local Masai escape the area during this period and move to the morehumid Nguruman highlands. As the O.E.A. does not have such a dry season refuge a small irrigation scheme is planned to provide the necessary dry season forage.

GEOLOGY, PHYSIOGRAPHY & TOPOGRAPHY:

A few kilometers to the East and North of the O.E.A. stony ridges occur which on Baker's geological map (1958) are described as alkali-trachytes, a rock-type of volcanic origin which is rich in sodium. These ridges are indicated on the attached map with a dotted pattern. The remainder of the area is mapped as "Loessi soil and hill-wash" by Baker. The O.E.A. and its immediate surroundings are flat. The area gives the impression of being an old lake bottom. The Ewaso Ngiro has cut itself 15 meters into these supposedly lake deposits. No river levees have been found. It therefore seems unlikely that the river ever floods beyond its streambed. The topographical map (160/3) nevertheless bears a notice "liable to flood".

CLIMATE:

No meteorological data are available for the O.E.A. Magadi is the nearest station and because its distance from the O.E.A. is less than 20 km. its climatic data might be representative. Some data derived from East African Meteorological Department reports are given below. Average annual rainfall at Magadi is 384 mm. (15 inches). Over a period of 30 years the lowest yearly rainfall was 153 mm (1948) and the highest 621 mm (1937). A graphical representation of monthly

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rainfall expectancy is given in fig. 2. It shows the marked dry season from June to October very clearly. It should be noted however that even in the peak rainfall month of April the chance of getting a 75 mm precipitation is less than 50%.

Average annual temperature 28.5°C

Average annual relative humidity at 6.00h 55%

Average annual relative humidity at 12.00h 35%

In view of these data it is not surprising that the potential evaporation has been estimated by Woodhead (1968) at 2200 mm ~~per year (i.e.~~ roughly 6 times as high as the average precipitation).

VEGETATION AND GRAZING:

Most of the O.E.A. is covered by Acacia tortilis woodland or wooded grassland in which besides the dominant tree Acacia tortilis only the small tree or shrub Cadaba farinosa seems of importance. Perennial herbaceous vegetation is virtually absent. Annuals were not seen but they emerge in the rainy season.

The O.E.A. is partly fenced and livestock is kept out. Though not in great numbers several species of wild animals were seen to make use of the vegetation resource: Thomson's gazelle, Grant's impala, eland, giraffe, steenbok, warthog and hare in the woodland area, and baboon plus vervet monkey in the riverine vegetation.

For areas with a low and erratic rainfall the potential forage production is estimated to be in the order of 2kg dry matter per hectare per millimeter of rain. For 800 ha and 250 mm of rain the annual forage production would be 400,000 kg. Allowing 30% utilization and assuming that the dry matter requirement of cattle is 10 times their live weight per year, the O.E.A. could support an animal biomass of 12,000 kg (e.g. 40 head of cattle at 300 kg each).

SOILS:

General

The scope of the investigation did not allow a detailed mapping of the soils in the O.E.A.. Most soil augerings were made along a transect between a possible water take-off point at the river and the O.E.A. buildings. According to the local officer-in-charge this would be the line along which irrigation is intended to be developed. The accompanying map shows three broad soil groupings in the Olkaramatian area. The O.E.A. falls within the alluvial zone. It is shown below however that aeolian deposits occur very frequently.

Within the O.E.A. soil textures range from sand to silt loam and clay. Even-textured silts or fine sands which are thought to have been deposited by wind were most frequently encountered. The areas delineated as unit

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3^a on the map (fig. 3) probably consist only of this aeolian material. In the remainder of the O.E.A. very coarse sandy layers, likely of alluvial origin, were found locally or extensively. In the area mapped as unit 3^b a coarse sand layer (0.5 to 1.5 cm thick) was found on top of the soil while this material was also present in two augerings through the top soil proper (very difficult to penetrate because of its looseness). It is thought that the desert pavement-like layer on top of the soil originated through selective wind erosion of the fine material. In the area mapped as 3^c no desert pavement layer was found on top of the soil but coarse sandy layers were found locally lower down. In this area two profile pits were dug to investigate the textural sequence in more detail. One of the pits showed a very distinct alternation of coarse and fine-textured layers, while the other profile also showed a conspicuous layering but with only minor textural differences. In both profiles the textural sequence is caused by deposition and definitely not by profile development.

No lime concretions were encountered in any of the soil layers. As only in some subsoils a barely noticeable reaction with hydrochloric acid was observed the free calcium carbonate level in these soils seems low.

Soil salinity and alkalinity:

In the field no visual signs of salinity were observed. From the samples collected at the augering localities and profile pits, the electrical conductivity was measured in 1:2.5 extracts in the laboratory. From these measurements the impression was gained that the soils are non-saline to slightly saline, the latter especially in some subsoils. More detailed analyses at the N.A.L. show that all 33 samples taken from 9 sites have a conductivity of less then 4 millimho/cm and following the standards of USDA Handbook 60 they can be classified as non-saline.

No visual signs of alkalinity were observed in the field. Analyses carried out by the N.A.L. show that from 8 sites the pH is below 8.2 and the exchangeable sodium percentage (ESP) below 10%. At one site only, i.e. in front of the office/store, both the pH is above 8.5 and the ESP above 15% at the surface as well as in the subsoil. According to Handbook 60 standards this soil would be classified as alkaline. The area in front of the office/store has been irrigated with spill water from the Oloibortoto pipeline. No sample of this water source was collected and therefore no definite conclusion can be made about the cause of the alkalinity in that particular spot.

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Soil infiltration and percolation

At the site were profile No. 22 was described two measurements of the infiltration rate were carried out. In both case the infiltration rate was fairly high (9 and 6 cm/hour). On the basis of these measurements and observations of profile texture in other places it seems likely that infilttation rates of 5 cm/hour or more must be expected. This relatively high infiltration rate would make the soils of marginal suitability for surface-irrigation.

Percolation rates are estimate to be high especially in the coarse-textured layers. Consequently high losses of irrigation water are expected if earth canals would be used.

Soil moisture retention capacity:

No measurements on moisture retention capacity were made except for the two infiltration samples. These contained 25% and 33% water which is rather low, taking into account that because of the recent infiltration the water content was well above field capacity. In the coarse textured soil layers a very low moisture retention capacity must be expected.

Soil erosion:

Under the prevailing low rainfall conditions and the apparent over-utilization by livestock the vegetation cover is very poor. Reduction of stock pressure probably will increase the herbaceous cover. This herb cover will be very vulnerable, especially in those parts with dusty (aeolian) soils. At present large tracts of land are deteriorating by the too intensive traffic with landrovers and other vehicles. Particularly the area near the camp (which seems the most vulnerable) is heavily affected. By driving over the dust soils the top layers are loosened and the strong eastern winds have been seen to cause real dust bowls. Great care in driving should be taken and properly surfaced roads should be laid out prior to any further development in the area.

WATER:

River discharge:

Flow in the Ewaso Ngiro was estimated in a straight river section just North of the Southern boundary. With a cross section of $5m^2$ and an average velocity of 0.4 m^1/sec. the discharge is $2m^3$/sec. It should be pointed out that such measurements should be repeated before any decision on minimum discharge can be made.

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Water requirement and pumping lift costs:

For the planned 25 ha (60 acres) irrigation scheme approximately 40 liter water per second would be needed. If minimum flow in the Ewaso Ngiro is $2m^3$/sec. (2000 l/sec) it could amply satisfy the irrigation needs. The annual water requirement would be in the order of one million m^3. With an estimated pumping lift of 15 m it might cost up to 10,000 shillings per annum for the water lift alone if continuous irrigation would take place.

Quality of Ewaso Ngiro water:

At the site where the discharge was measured three water samples were taken. They were analysed at the N.A.L.. The total salt concentration is rather low and although Sodium constitutes more than 60% of the cations the Sodium Adsorption Ratio (SAR) is low. The Ewaso Ngiro water would be classified as "good" were it not that the relatively high amount of bicarbonates makes its suitability for irrigation purposes "marginal" (Handbook 60 USDA, 1954).

The silt content of the water was not determined. In the samples taken there was very little deposition and for surface-irrigation purposes the silt load of the water does not seem harmful.

Use of water:

The Olkiramatian area has a very high evaporation. This implies that the amount of water used per kg of dry matter produced will be very high. In the areas nearer to the source of the Ewaso Ngiro rainfall is more favourable, evaporation is lower and use of the scarce water there seems more sensible. Moreover it would appear that if the water of the Ewaso Ngiro is to be used at all, it should be used for the production of food or horticultural crops rather than forage.

CONCLUSIONS AND RECOMMENDATIONS:

(i) The rainfall is low and erratic while the evaporation is very high. As a consequence the natural grass production is low and erratic. If irrigation is to be installed it should be used year round.

(ii) The herbaceous vegetation cover is virtually absent. Some years of protection are likely to cause an increase in the perennial herbaceous cover.

(iii) The soils are non-saline.

(iv) Except for a site in front of the office/store which had been irrigated the soils are non-alkaline.

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(v) The soils appear to have a high infiltration rate and a low moisture retention capacity. These characteristics make them of limited suitability for irrigation.

(vi) Some of the soils are highly susceptible to wind erosion.

(vii) The water of the Ewaso Ngiro is non-saline and non-alkaline but its bicarbonate content renders it of marginal suitability for irrigation purposes.

(viii) No evaluation of the minimum dry season discharge of the Ewaso Ngiro can be made at present.
One measurement on October 7th yielded $2m^3$/sec. which is mush more than needed for the proposed 25 ha irrigation scheme.

(ix) Only a very tentative calculation of pumping costs has been made; it is expected that the project as a whole will be expensive.

Contrary to expectation the soils of the O.E.A. in general seem non-saline and non-alkaline. Although the water of the Ewaso Ngiro was of marginal quality at the time of sampling, no immediate salinity/alkalinity troubles are envisaged for irrigated crops. Because of the relatively high bicarbonate content of the water soil alkalinity might well develop after some years of irrigation.

The high infiltration rate which was observed at one site and the presence of coarse soil layers with high percolation rates seems of more immediate concern. Both effect the feasability, the layout and the cost of the irrigation project. Detailed investigations of these aspects should be carried out prior to any irrigation development.

The proposed irrigation scheme at the O.E.A. is unlikely to provide much information which could help in solving the land use problems in Masailand because water for irrigation generally is not available. Overstocking is the main problem and although it will be no easy task to change the Masai attitude in this respect, it seems recommendable to devote the available financial resources to demonstrate conservation practices rather than to develop a highly technical, and probably problematic, irrigation scheme for forage production.

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Baker, B.H. (1958). "Geology of the Magadi area."
Geological report nr 42, Government Printer, Nairobi.

Richards, L.A. edit. (1954). "Diagnosis and improvement of saline and alkali soils". Agricultural Handbook 60, United States Department of Agriculture.

Woodhead, T. (1968) "Studies of potential evaporation in Kenya". Ministry of Natural Resources, Nairobi.

Figure 1

SKETCH MAP OF OLKERAMATIAN AREA

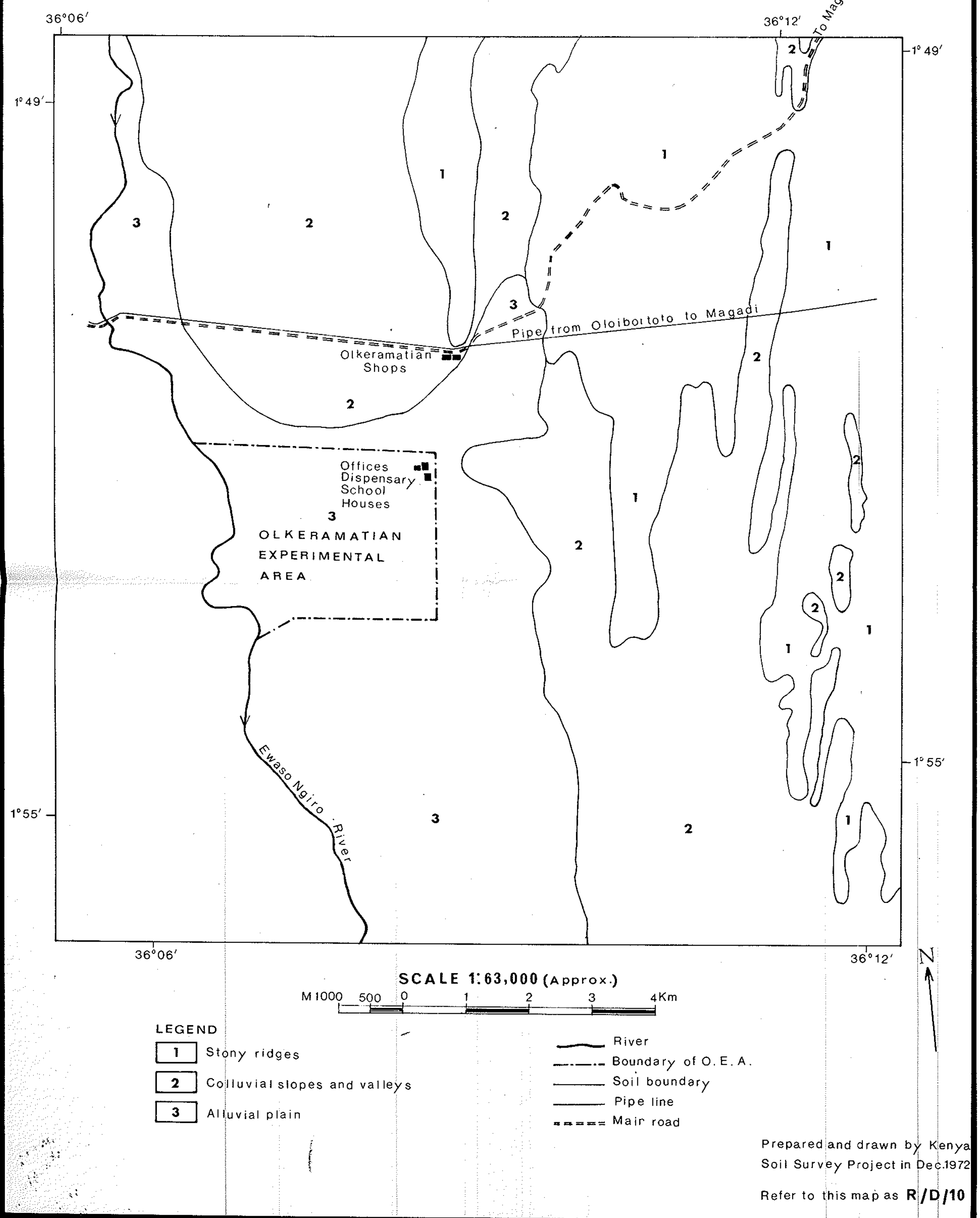
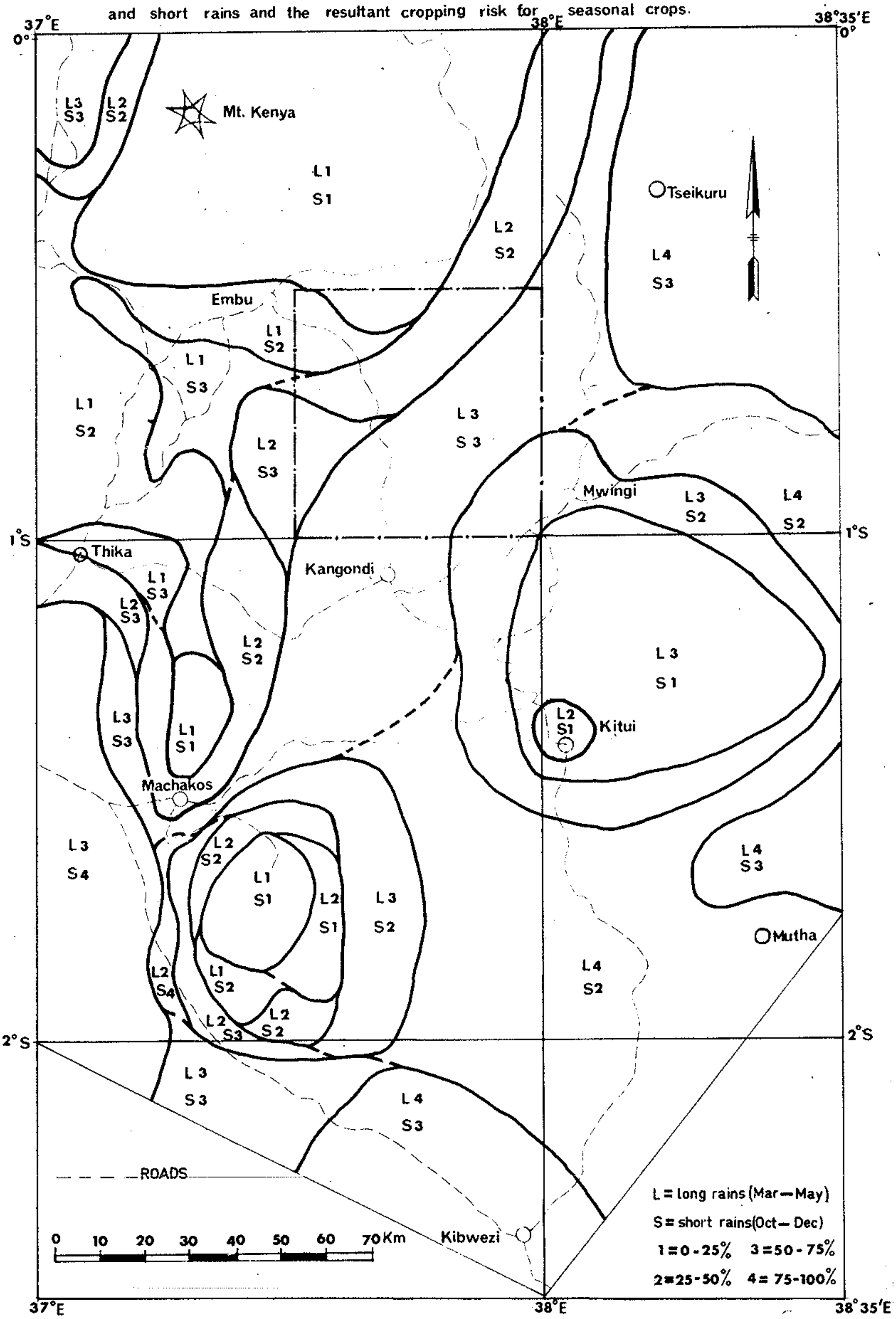


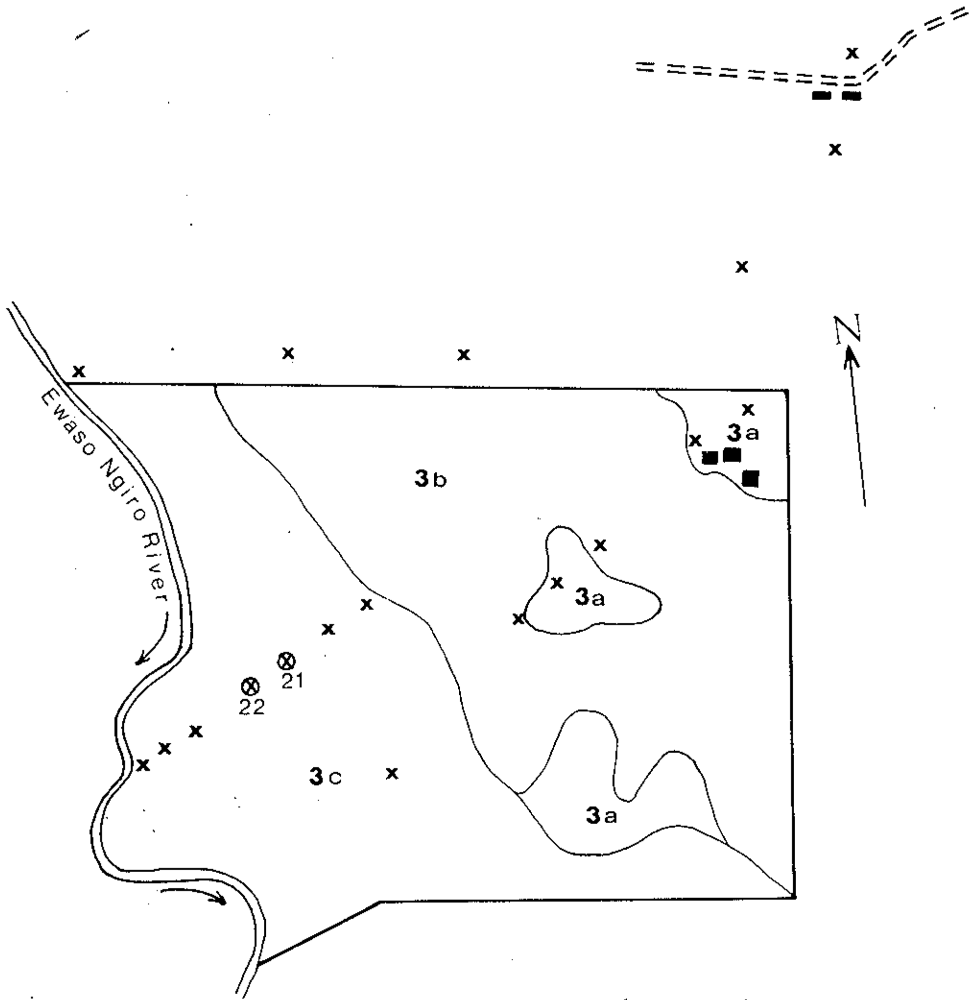
Fig. 2 The probability of receiving less than 300 mm during the long and short rains and the resultant cropping risk for seasonal crops.



High cropping risk:	On average 6/8 seasons with less than 300 mm rainfall	(L4S3, L3S4)
Fairly High	" : " " 5/8 " " " " " " "	(L4S2, L3S3, L2S4)
Medium	" : " " 4/8 " " " " " " "	(L3S2, L2S3)
Fairly Low	" : " " 3/8 " " " " " " "	(L3S1, L2S2, L1S3)
Low	" : " " 2/8 " " " " " " "	(L2S1, L1S2)
Very Low	" : " " 1/8 " " " " " " "	(L1 S1)

Figure 3

MAP SHOWING THE MAJOR SOIL BOUNDARIES IN THE OLKERAMATIAN EXPERIMENTAL AREA



SCALE 1:40,000 (Approx)

M1000 500 0 1Km

3a	Aeolian soils
3b	Alluvial and aeolian complex with "desert pavement"
3c	Alluvial and aeolian complex without "desert pavement"

==== Road

River

Soil boundary

x Augerhole examinations

⊗ Soil profile pits

■ ■ Buildings

Prepared and drawn by Kenya Soil Survey Project in Dec 1972

Refer to this map as R/D/11