AN ASSESSMENT OF THE IRRIGATION SUITABILITY OF THE SOILS AND WATER OF THE MUKUTAN, LOIMINANGE AND LOGUMKUM SITES (MARIGAT DIVISION, BARINGO DISTRICT)

By

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1. INTRODUCTION

At the request of the Provincial Irrigation unit (PIU) Rift Valley Province, soil and water investigations were carried out at three sites in Marigat division, Baringo district. This was a quick study to asses the suitability of the soils and water for small scale basin irrigation for the growth of subsistence crops like vegetables, maize, beans, sorghum, millet and peas.

Since this is a preliminary assessment, the results and recómmendations are based on the physical environment, a few field observations and limited chemical data. Emphasis was made on soil depth, soil texture, soil salinity and/or sodicity. Water samples from rivers in the area intended for irrigation were analyzed for their chemical composition. It is hoped that on the basis of the findings, a more detailed investigation will be carried out.

A field trip was made between the 23rd and 30th march 1987. The fieldwork was conducted in collaboration with Messrs. P.K. Kanake, P.M. Mureithi and T.R. Wachira.

The author acknowledges the assistance of Mr. Kamau of PIU Nakuru during the fieldwork and Mr. Knopps for meeting all the expenses.

2. ENVIRONMENT

2.1 Location and Communication

All the three sites are in Marigat division of Baringo district, Rift Valley Province. They are all accessed by the Marigat-Tangulbei all weather road.

2.1.1 Mukutan

The Mukutan scheme is about 25 ha with a proposed extension of 12.5 ha. It lies approximately 40km north-east of Marigat along the Marigat-Tangulbei road near the Mukutan Mission School/Dispensary. It lies along Mukutan river that drains part of Laikipia Plateau. Its co-ordinates are approximately 0°37.5'N, 36°15'E and is at an altitude of about 1170 m a.s.l.[1]

2.1.2 Loiminange

The scheme will cover more than 100 ha divided into two blocks to the right and left of the Ol Arabel river. It includes a proposed extension of about 30 ha to the north of the Loiminange airstrip. It lies on the south eastern side of lake Baringo within the 980m contour. It extends to the limits of the seasonal swamps, scrub and woodland towards the lake. The co-ordinates of its centre are about 0°32'N and 36°7'E at an elevation of about 970 m a.s.l. and approximately 25km north-east of Marigat.

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1) altitude above sea level

2.1.3 Logumkum

The scheme measures about 40 ha and is approximately 12.5 km north-east of Marigat township. It lies on the relatively higher ground of Olomaitashu seasonal swamp. It is about 2km north-east from where the Marigat-Tangulbei road crosses Molo river. Its co-ordinates are 0°29'N and 36°5'E at an elevation of about 980 m a.s.l.

2.2 Climate

There are no rainfall stations in any of the survey sites but the rainfall data of Perkerra Irrigation Scheme (station no. 89.36053) was considered representative of Logumkum and Loiminange sites. Tangulbei (station no. 89.36019) was found to be representative of Mukutan site. Perkerra Irrigation station is to the west of Logumkum and to the south-west of Loiminange sites. Tangulbei station is to the north of Mukutan site. Perkerra Irrigation Scheme and Tangulbei rainfall stations have 8 (upto 1964) and 24 (upto 1971) years of record and are at altitudes of 1067 and 1280 metres respectively.

2.2.1 Average annual and seasonal rainfall

The mean annual rainfall (r) for Logumkum and Loiminange sites is about 670 mm while Mukutan is about 762 mm. In all the sites, the rainy season is from April to August which totals to 363 mm (Logumkum and Lominange) and 494 mm (Mukutan). The mean monthly rainfall for Perkerra Irrigation scheme and Tangulbei stations are shown in tables 1 and 2.

Table 1: Perkerra Irrigation scheme Station

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yr
50.1	21.1	53.9	62.5	95.5	42.6	71.3	91.4	36.1	29.5	58.5	57.8	670.3

Table 2: Tangulbei rainfall station

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yr
20.1	24.8	57.2	87.2	126.5	63.7	113	104	43.1	34.8	63.4	24.5	762.3

2.2.2 Temperature, Evaporation and Agro-climatic zonation.

The mean annual, mean annual maximum and mean annual minimum temperatures (°C) are given below.

	mean annual	mean max.	mean min.
Logumkum	23.7	29.6	17.9
Loiminange	23.7	29.3	17.7
Mukutan	21.5	27.5	15.3

The annual potential evaporation (E_o) is about 2066, 2063 and 2029 mm (woodhead, 1968) for the above sites respectively. Tables 3 and 4 show the monthly distribution of the potential evaporation after Braun (in prep). The ratio of rainfall to evaporation (r/E_o) is 32% for both Logumkum and Loiminange sites and 38% for Mukutan site. This places the first two sites in agro-climatic zone V-2 and Mukutan in agro-climatic zone V-3 both with medium to low potential for plant growth (Sombroek, et al 1982).

2.2.3 Crop water requirements and seasonal rainfall deficits.

The potential evapotranspiration (E_t) i.e crop water requirements can be estimated to be 2/3 E_o. For both Logumkum and Loiminange sites, 517 mm would be required during the rainy season in order to meet the moisture demand of a seasonal crop. For Mukutan site, 509 mm would be required. There is a seasonal rainfall deficit of 154 mm in Logumkum and Loiminange sites. Mukutan site has a deficit of
15 mm. Tables 3 and 4 give a simple water balance of the sites.

Table 3: Water balance for Logumkum and Loiminange

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
r	50.1	21.1	53.9	62.5	95.5	42.6	71.3	91.4	36.1	29.5	58.5	57.5
E°	205	205	205	143	164	164	143	164	184	184	143	164
E_t	137	137	137	95	109	109	95	109	123	123	95	109
$r-E_t$	-86.9	-115.9	-83.1	-32.5	-13.5	-66.4	-23.7	-17.6	-86.9	93.5	-36.5	51.2

Where:-

r- mean monthly rainfall
E_o- mean monthly potential evaporation
E_t- mean monthly potential evapotranspiration

Table 4: Water balance for Mukutan

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
r	20.1	24.8	57.2	87.2	126.5	63.7	113.0	104.0	43.1	34.8	63.4	24.5
E°	201	201	201	141	161	161	141	161	181	181	141	161
E_t	134	134	134	94	107	107	94	107	121	121	94	107
$r-E_t$	-113.9	-109.2	-76.8	-6.8	19.5	-43.3	19	-3.0	-77.9	-86.2	-30.6	-82.5

It can be observed from table 3 that crop water requirements are higher than the rainfall received in Logumkum and Loiminange sites. From table 4, rainfall is on average able to meet the crop water requirements during the months of May and July in Mukutan site. In all the sites, additional irrigation water is considered necessary to grow a seasonal crop.

2.3 Water supply and quality

Water for irrigation will only be available in the area after the rains (flood water) otherwise during the dry season the water levels in the rivers are very low. Results for the analysis of the three water samples in the area is given in table 5.

Table 5: Water samples for irrigation suitability

Field Ref.	Molo river	Mukutan river	Ol Arabel river
Lab.no./87	4070	4071	4072
pH	7.2	8.2 8.3	
Conductivity mS/cm	180	680	550
Sodium m.e./litre	0.75	5.95	4.72
Potassium "	0.50	0.16	0.26
Calcium "	0.50	0.40	0.40
Magnesium "	0.10	NIL	0.10
Carbonates "	NIL	0.1	0.1
Bicarbonates "	1.64	5.32	5.04
Chlorides "	0.60	1.20	0.80
Sulphate "	trace	0.01	0.01
Nitrates "	-	-	-
Fluorides "	-	-	-
Sodium Adsorption Ratio	1.36	13.30	9.44

Logumkum

The scheme will be supplied with water from Molo river diverted through an old river course. At the offtake from the main river, a weir was almost complete during the survey.

The results of the sample analysis on table 5 indicate that this water is suitable for irrigation. It can be used on most crops and most soils with little likelihood of causing soil salinity or water percolation problems.

Loiminange

Canals to the left and right banks of Ol Arabel river will supply water for the scheme. From table 5 (laboratory sample no. 4072), the water is moderately suitable for irrigation and may be used on most crops and most soils. Appreciable leaching of salts may, however, be necessary for salt sensitive crops. An infiltration problem may develop on fine textured soils.

The high bicarbonate content as indicated from the sample analysis may precipitate calcium and magnesium carbonates. This would decrease Ca2+ and/or Mg2+ ions necessary to replace Na+ on the soil exchange complex. This would increase sodium hazard and subsequent soil physical deterioration (Landon, 1984).

Mukutan

Canals dug from Mukutan river (about 400 m long) will divert water to the scheme. On analysis, this water is classified as marginally suitable for irrigation especially on fine textured soils (see table 5). The high sodium content may pose water percolation problems. The fairly high bicarbonate content may cause appreciable calcium precipitation increasing sodium hazard. This problem may be aggravated by the shallow ploughing that has caused a hard pan at less than 30 cm depth.

To avert sodium hazard for Loiminange and Mukutan, application of gypsum and/or organic matter to the soil is recommended. Water and soils on Loiminange and Mukutan will require periodic monitoring to observe their effects on crop performance and yields.

2.4 Geology and Physiography

2.4.1 Logumkum

The area is underlain by Quaternary sediments of various volcanic rocks. The soils have developed on alluvium (old river sediments) and colluvium from the Laikipia escarpment and the surrounding volcanic hill ridges.

The site consists of flat to very gently undulating (slopes 1-3%) terrain. There is evidence of silt sedimentation on the surface which is reflected by the strongly sealed and crusted soil surface. This is an indication of seasonal flooding.

The vegetation on the site and along the course of the Molo river suggests that though the site is within the Olomaitashu seasonal swamp, it is part of an old levee of the river.

2.4.2 Loiminange

The geology comprises a mixture of alluvium of old river sediments, colluvium added to the floodplain and lacustrine deposits from lake Baringo all of Recent geologic origin as evidenced by minimal soil development. The materials may have emanated from ashes and other pyroclastic rocks of Recent volcanoes.

The site is within the lowest reaches of the piedmont plain of the Laikipia ridges (nearly flat to gently undulating, slopes 1-4%) and the limit of the lake Baringo swamp. To the east and north-western parts of the site are small volcanic hills. Otherwise, much of the site embraces the flat (slopes <2%) floodplain of Ol Arabel river. While the flood-plain has

deep soils, the eastern fringes have shallow soils with occasional rock outcrops. The soils are variously developed. They have, however, been subjected to geological and accelerated (human induced) erosion making them lose their original characteristics.

2.4.3 Mukutan

The soil parent material is derived from Tertiary basic igneous rocks (phonolites, olivine basalts and other basic tuffs).

The site is part of a Step-faulted floor of the Rift Valley (flat to gently undulating, with minor scarps). It has a rather homogenous terrain which has been subjected to alluvial and colluvial materials. Rainsplash and rillwash erosion is evidenced by the almost bare, crusted (unless ploughed) and compacted soil surface.

2.5 Vegetation and Present Landuse

Van Engelen (1983) described Loiminange site as a homogeneous piedmont plain (slope less than 1%) dominated by the herb *Portilaca persica*. Bushes of *Acacia nubica* along water course channels.
The area falls in agroclimatic zone V, which classifies as semi-arid with the typical vegetation of open bushland. Due to the proximity to the Lake and the flood plain of Ol Arabel river, parts of Loiminange have some lake swamp vegetation.

Logumkum has a seasonal influence of Olomaitashu swamp (substantial shrub undergrowth with sparse Acacia trees). The rest of the area has an open bushland vegetation, and in some places little undergrowth due to clearing. About 30% of the ground is bare.

Mukutan site being further north-east, has little lake influence and is predominantly open bushland of thorny shrubs and Acacia trees.

The local population is sparse and generally semi-sedentary i.e more inclined to livestock keeping than cultivated agriculture.

Basin irrigation will be practised. Farming will entirely rely on the flood water from the erratic, unreliable and short lived rainfall. Therefore, subsistence and early maturing crops like maize, beans, sorghum, millet and vegetables will be grown.

At the time of the survey, much of the Ol Arabel flood plain and the Mukutan site was under land preparation. This included the construction of small (3 X 4 m) flood basins and ridges and the drainage canals in anticipation of the long rains (April to May). There was an extensive clearing of the dry tree swamp extending towards lake Baringo on Loiminange scheme. A weir was almost complete on Molo river to divert water through an old river course to Logumkum scheme.

The proposed extensions of Mukutan and Loiminange schemes were mainly under open Acacia bushland. The landuse was mainly grazing with evidence of severe overstocking by particularly browsers.

3. THE SOILS

3.1 Working methods

There was no previous soil information available at a reasonable detail covering Mukutan and Logumkum sites.

A site evaluation (Van Engelen, 1983) described the soils of Loiminange site as well drained, deep, strong brown to dark brown, friable, saline clay loams. pH levels varied between 6.2 and 7.4. Moderate to high EC values in topsoils (0.5 to 2.5 mS/cm). From a depth of 20 cm, the EC was above 1.4 mS/cm increasing with depth to 3.0 mS/cm at 100 cm. The soils are classified as saline (orthic SOLONCHAKS) and considered unsuitable for any irrigation development.

Soil information for Loiminange and Logumkum schemes was obtained through auger borings. These were made to a depth of 1.2 m where the soil depth was not limiting. In addition to soil characteristics like colour, texture, consistence and depth, pH and EC of a 1:2.5 soil: water suspension were determined for all the horizons. Due to the compactness of both the surface (strongly sealed) and subsurface (plough pan) horizons at Mukutan scheme, minipits were dug to 50 cm then extended with auger borings.

For Mukutan and Logumkum sites, a grid system was used for auger sampling (every 250 m for Logumkum and 200 m for Mukutan). At Loiminange, observations were made based on visual surface soil differences. A total of 32 augerhole observations were made. One profile pit was dug, described and sampled for Mukutan site. Physical and chemical determinations of this profile were carried out at the National Agricultural Research Laboratories according to methods described by Hinga et al (1980).

Due to the absence of a base map(s) covering the sites, the boundaries of the sites are not well defined and since the three sites are far apart, no soil or location map was made for this preliminary investigation.

3.2 Description of the soils (general)

For the purposes of this study and at the detail of the survey, each of the three sites can be considered rather homogeneous in terms of major soil characteristics. The area is semi-arid and organic matter is almost absent. Chemical soil forming processes are therefore limited. The situation is aggravated by the occasional alluvial depositions from the river floods and mass wasting from the surrounding higher ground. The weak soil profile development makes it difficult to distinguish between the soils formed on in situ parent material from those

4. CONCLUSIONS AND RECOMMENDATIONS

1. All the soils of the three sites are suitable for irrigation in terms of physiography (slopes 1-3%, flat to gently undulating). Logumkum and parts of Loiminange are within the floodplains of rivers Molo and Ol Arabel respectively. The soils are deep having developed on alluvium of volcanic origin.

2. The three sites are dominated by 'young soils' (Fluvisols) that have developed on alluvium of recent, mixed and varied origins. They vary widely in nutrient status and texture both within and between sites due to the differences in geogenesis.

3. On Mukutan site, the soils are compact (very hard to auger) from a depth of 20 cm. This is due to the very shallow plough layer that has created a hard pan. Also due to moderate to strong surface sealing as a result of strong sheet/rillwash where much of the A-horizon has been truncated. This is due to the scanty vegetation cover caused by overgrazing/overstocking by particularly browsers. There is therefore, need for soil conservation measures and reduction of livestock numbers to sustain the vegetative cover thus, regenerate the organic matter rich A - horizons.

4. Parts of Logumkum and Loiminange sites are prone to frequent seasonal flooding. There is horizontal surface and vertical soil texture stratification. Surface silt is high and increases with distance from the river causing strong surface sealing and crusting on drying. This may impede surface drainage and water infiltration. To improve infiltration and drainage will require regular mechanized deep ploughing to mix the fine silty surface soils with the coarse textured soils in the subsurface horizons. An elaborate drainage system has to be designed on the lower reaches of Logumkum site due to this high silt accumulation on the surface.

5. Water from Molo river for Logumkum site is classified as very suitable for irrigation for most field crops with least likelihood of salinity/sodicity or percolation problems. Water sample from Ol Arabel river is classified as moderately suitable. That from Mukutan river is only marginally suitable due to the high sodium content that has injurious effect on crops (toxicity) and destruction of soil structure. This may create impediment of drainage. Both sources will require periodic monitoring and leaching of salts for salt sensitive crops. There exists a sodium hazard especially near the Loiminange airstrip. This is evidenced by the high pH (>8.5). The high EC (>4.0 mS/cm) values, high bicarbonate content may precipitate calcium and magnesium increasing sodium hazard. Application of gypsum and organic matter will be necessary before these soils can be considered for irrigation.

6. The rainfall characteristics of the agro-climatic zone(s) covering the three sites (V-2 and V-3) are erratic, short lived and inadequate in amounts thus of little effectiveness to crop growth. There is therefore, almost a total reliance on flood water of rains from higher areas and rivers for crop growth. This then requires selection of crops

and varieties that are early maturing, high yielding with relatively less water requirements. These include Katumani maize, sorghum, millet, beans, cow and pigeon peas, green grams, onions and other vegetables.

7. Cautionary measures in management of these flood basin soils should be taken. This is mainly in water control including flood protection, drainage and land preparation. There is need, for example, of deep ploughing to prevent and where present break the hard plough pan that appears at
20-30 cm depth. This will improve water infiltration. Construction and management of irrigation canals to reduce water losses before it reaches the plots is necessary. Construction of stronger flood basin ridges especially for Mukutan and Loiminange sites is recommended.

8. For all the three sites, a more detailed soil survey is essential. This should be preceeded by a topographical survey of the three sites that would provide a base map to fix the augerhole observations and/or profile pits. This is a provisional report. For a final report complete with a soil map, a topographical survey of the sites as opposed to the sketch maps that were provided is necessary for soil observations to be precisely located.

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Appendix: Profile description with analytical data

LABORATORY DATA OF PROFILE DESCRIPTION NO.1
Observation no. 91/3-5 Mapping unit: Mukutan Site. Soil classification: Chromic Cambisols, sodic phase

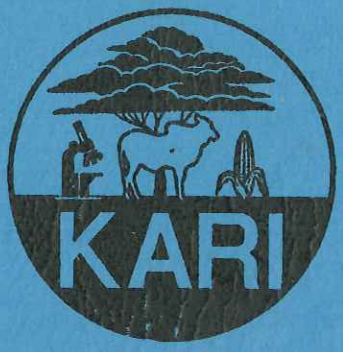
Laboratory no. /87	4077	4078	4079	4080	4081
Horizon	Ap	AB	Bu1	Bu2	Bu3
Depth (cm) 0-13	0 - 12	12 - 36	36 - 65	65 - 94	94 - 110
PH-H_2O (1:1:2.5 v/v)	7.2	7.2	6.5	6.4	7.2
pH-KCl "	6.0	5.7	5.3	5.2	6.0
EC(mmho/cm) "	.0.35	0.13	0.07	0.08	0.29
$CaCO_3$ (%)					
$CaSO_4$ (%)					
C (%)	1.18	0.44	0.44	0.21	0.17
N (%)					
C/N					
CEC(me/100g), pH 8.2	28.6	21.5	20.0	16.9	20.6
CEC (" "), pH 7.0					
Exch. Ca (me/100g)	13.3	9.5	7.1	8.3	11.9
" Mg "	6.7	6.0	4.5	4.5	5.19
" K "	2.8	3.9	2.3	2.9	3.0
" Na "	1.6	1.9	1.4	2.0	1.6
Sum of cations	22.4	21.3	15.3	17.7	21.6
Base sat. %, pH 8.2	78.3	94.4	76.5	100	100
" " %, pH 7.0					
ESP at pH 8.2	5.59	8.83	7.00	11.83	7.76
Texture (limited pretreatment)					
Gravel % (>2.0 mm)					
Sand % (2.0-0.05 mm)	22	32	32	32	32
Silt % (0.05-0.02 mm)	38	30	30	28	32
Clay % (0.02-0 mm)	40	38	38	40	36
Texture class	C/Cl	Cl	Cl	C/Cl	Cl
Fertility aspects 0-20 cm		Laboratory no. 4076/87			
General		Available nutrients			
pH-H_2 (1:2½ v/v)	7.3	Na/me/100g	1.16	Mn (me/100g)	1.80
Exch. acidity (me/100g)		K "	1.18	P (ppm)	28
C %	0.94	Ca "	5.0	(P-Olsen (ppm)	10
N %	0.06	Mg "	4.3		
Remarks:					

General site information

Soil classification	:	FAO (1988): (Chromic Cambisols, sodic phase)
	:	USDA (1987): Typic Eutropepts
Observation no./date	:	91/3-5 /26-3-87
Location/altitude	:	~400 m south of Mukutan river/ ~1170 m
Parent material	:	collaluvial material of volcanic origin
Physiography	:	volcanic plain
Macro relief	:	flat to very gently undulating
Slope at site	:	2%
Vegetation/landuse	:	bushland/ cultivation
Erosion	:	moderate sheetwash
Surface stoniness	:	nil at site
Groundwater level	:	deep (inferred)
Internal drainage	:	well drained

Profile description

Ap	0-12cm	dark reddish brown (5YR3/3, moist); clay to clay loam; strong, fine to medium subangular blocky structure; hard when dry, friable when moist, sticky and plastic when wet; many, very fine to medium, few coarse pores; few fine, common medium roots; clear and wavy transition to:
AB	12-36cm	dark reddish brown (5YR3/3, moist);clay loam; strong, very coarse prismatic breaking into strong, medium to coarse subangular blocky structure; very hard when dry, friable when moist, sticky and plastic when wet; patchy, thin clayskins; many very fine and fine, common medium pores; very few fine, common medium and dead roots; gradual and smooth transition to:
Bu1	36-65cm	dark reddish brown (5YR3/4, moist); clay loam; strong, very coarse prismatic breaking into strong, medium to coarse angular blocky structure; very hard when dry, friable when moist, sticky and plastic when wet; broken, moderately thick clayskins; many very fine to fine, common medium, few coarse pores; few fine, common medium and dead roots; gradual and smooth transition to:
Bu2	65-94cm	dark reddish brown (5YR3/3, moist); clay to clay loam ; strong, medium angular blocky structure; hard when dry, friable when moist, sticky and plastic when wet; broken, thick clayskins; many, very fine, fine and medium pores; few iron concretions; few fine and dead roots; clear and smooth transition to:
Bu3	94-110+cm	dark reddish brown (5YR3/3); clay loam; strong, medium subangular blocky structure; hard when dry, friable when moist, sticky and plastic when wet; continuous, moderately thick clayskins; many, very fine and fine, common medium pores; frequent iron concretions (2-5 mm diameter).



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KENYA SOIL SURVEY

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