A HYDROLOGICAL ASSESSMENT REPORT FOR THE PROPOSED ABSTRACTION FROM KINGI RESERVOIR WITHIN KIRITA LOCATION, PONDO WARD, NDARAGWA SUB-COUNTY IN NYANDARUA COUNTY

PROPONENT:

KINGI DAM SMALL SCALE IRRIGATION PROJECT

P. O. BOX 203
NDARAGWA,
NYANDARUA
COUNTY

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1.0 NAME AND DETAILS OF CLIENT

KINGI DAM SMALL SCALE IRRIGATION PROJECT

P. O. BOX 203 NDARAGWA.

1.1 LOCATION AND DESCRIPTION OF THE ACTIVITY.

The proposed abstraction point is along Kingi Reservoir which is fed by permanent Kingi spring located 300m upstream and is a tributary of the Large Ewaso Narok River. It is marked by the coordinates - UTM 37 N 212888 5900 or Grid reference 0.054. This is Kiriita Location, Leshau-Pondo ward, Ndaragwa sub-county in Nyandarua county.

The abstraction will be by construction of a pump chamber & installation of a Solar-powered submersible pump in it; a power house & installation of a control panel in it; and a solar-panels support structure & installation of solar panels on it at Kingi Dam site. Also proposed is installation of a 90mm diameter rising main-pipeline from the dam to the Kiriita Community Water Point plot where a 9m high water tower will be constructed and a 2No. $10m^3$ Plastic tank installed. Subsequently, a water conveyance and reticulation system to the project area will be put in place.

The proposed pump house will be for Kingi Dam Phase II project for small scale Irrigation with 200 members. The water will be used for subsistence irrigation of 0.25 acres per household through sprinkler technology to 200 households resulting to a total of 50 acres under irrigation. The total water demand is **1,995.4m^3/day** for subsistence farming while irrigating using sprinkler technology at an interval of 6 days. The water demand in a full 3 months season gets to **179,586 m^3** while the available water over the same season is **274,463.051m^3.**

Figure 1: google earth map of the area

Figure 2: photo of proposed abstraction point

2.0 DETAILS OF CLIMATE

Regional factors that include Aberdare ranges modify the rainfall of Nyandarua County. Topography is the major determining factor of the climatic conditions of the Nyandarua County. The great range of altitude (300m – 3,999masl) influences the atmospheric conditions leading to a variety of micro- climates as well as agro-ecological zones.

Temperature

Annual Mean Temperature

- The Temperature of the area during the driest period is Jan-Feb when temperatures are high ranging between 22º-23ºC while July is the coolest month with temperatures as low as 6ºC accompanied by high humidity. The area lies in the agroecological zone UH2, with two cropping seasons.

Rainfall

The highlands lessen the effect of high temperatures and rate of evaporation and force rain bearing winds to deposit most of the moisture on the windward side (eastern side of Aberdare ranges) leaving the leeward sides of both massifs in the rain shadow area and the low-lying areas with very little rainfall, and therefore offering lesser potential for agriculture without the use of irrigation. Local factors such as the water bodies and vegetation further complicate the rainfall distribution.

Annual mean rainfall

Nyandarua County experiences a bimodal rainfall pattern, characterized by two distinct rainy seasons. The long rains typically occur from March to May, while the short rains span from October to December. This rainfall distribution plays a crucial role in determining the region's agricultural cycles and water resource management strategies.
The county's average annual rainfall varies significantly across different areas, influenced by topography and proximity to the Aberdare Ranges. In the eastern highlands, particularly near the Aberdare Ranges, annual rainfall can reach up to 1,600 mm. Conversely, the western lowlands, adjacent to the Rift Valley, receive comparatively less rainfall, averaging around 700 mm per year. The nearest rainfall station is the Ol Joro Orok Agric station which recorded an average annual rainfall of 1000 mm.

Monthly rainfall in mm for Ol Joro Orok Agric station no 9037015 at an elevation of 2057 m asl

Month	Annual rainfall	J	F	M	A	M	J	J	A	S	O	N	D
Monthly rainfall in mm	1000	63	70	45	251	291	17	41	50	40	147	223	139

Table1: Average rainfall.

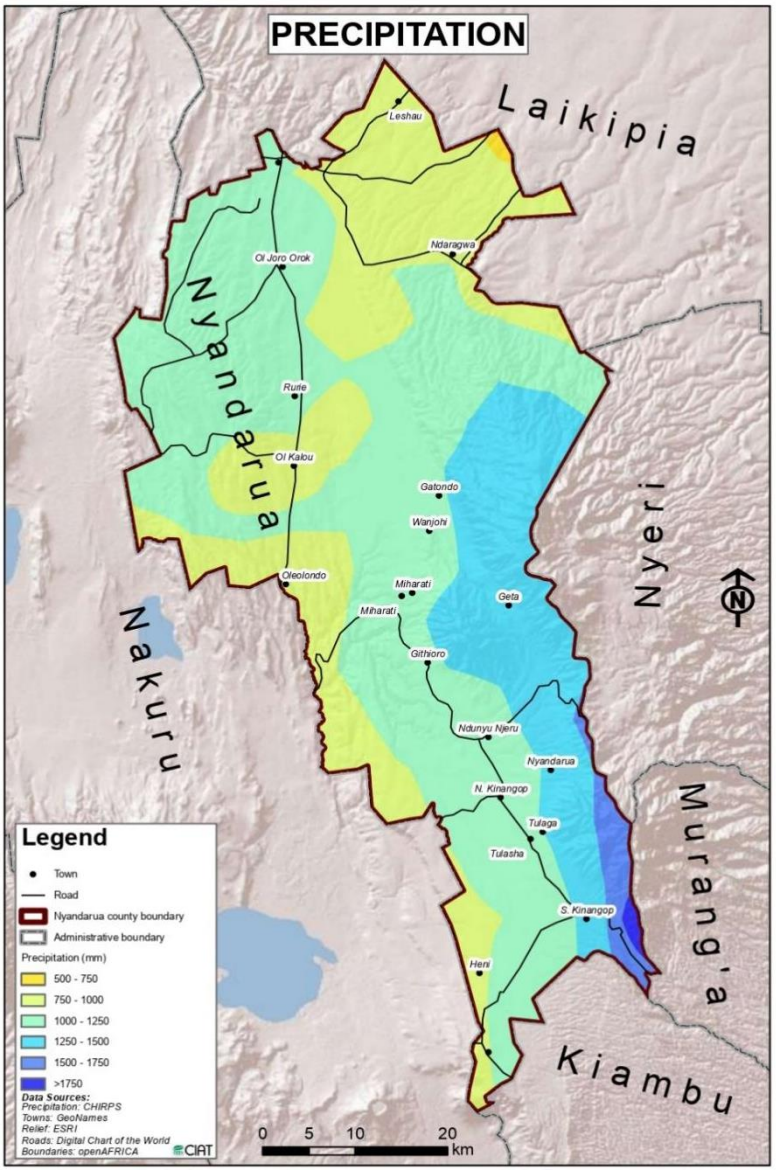


Figure 3: average annual rainfall in Nyandarua county (CHRPS)

Topography.

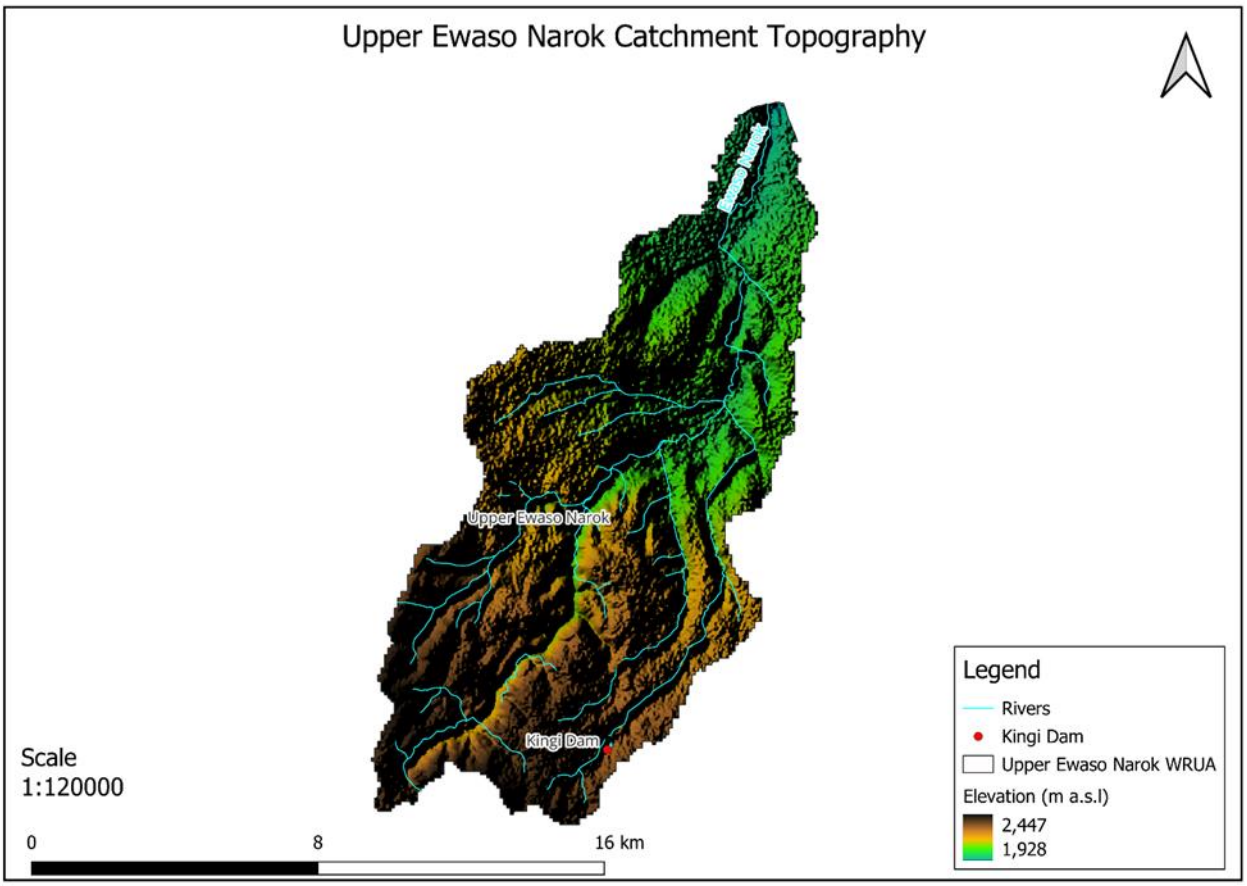


Figure 4: topographic map of the catchment

Climate is determined largely topography. The area's climate is impacted to a large extent by the Aberdare ranges

3.0 DETAILS OF THE WATER BODY (NAME, NEAREST RGS, SUB-CATCHMENT)

The Kingi Dam lies at latitude 0.0548N and longitude 36.412 E which is within the middle Ewaso Narok Sub catchment that lies in the 5AA sub basin that forms the part of the larger Ewaso Nyiro North basin area. The dam main sources water is surface runoff from its 5.396 km^2 watershed and the Kingi (Kibiro) spring situated 300m upstream. There may also be inflows from additional springs inundated within the reservoir area. overflow from the dam flows through a stream that forms part of tributary network for the Ewaso Narok river. The physical characteristics of the dam are described by an Integrity assessment report done by Edonk Ltd dated 2023. According to the report, the embarkment has crest elevation of 2248m, has a maximum height of 6m and a normal water level of 6m in depth. For the reservoir part, it has a 904m in perimeter and an area of 16,829.242m^2 with an elevation of 2245m at Normal water level and 24,164m^2 with an elevation of 2246m during high flood level. The live storage was captured at 164,735.051m^3 while the dead storage is at 0m3.

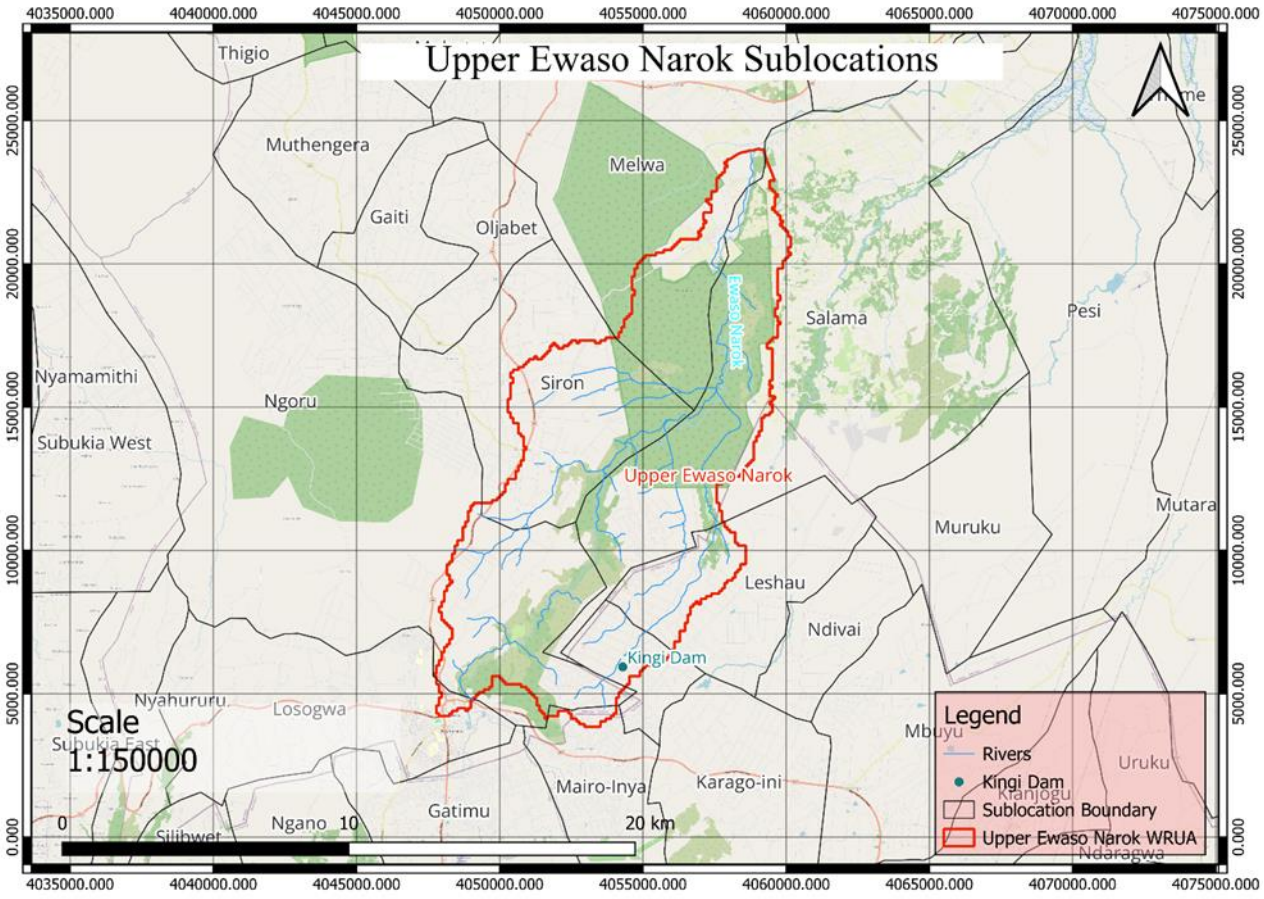


Figure 5: proposed abstraction map on upper Ewaso-Narok

Figure 6: showing the area of the reservoir

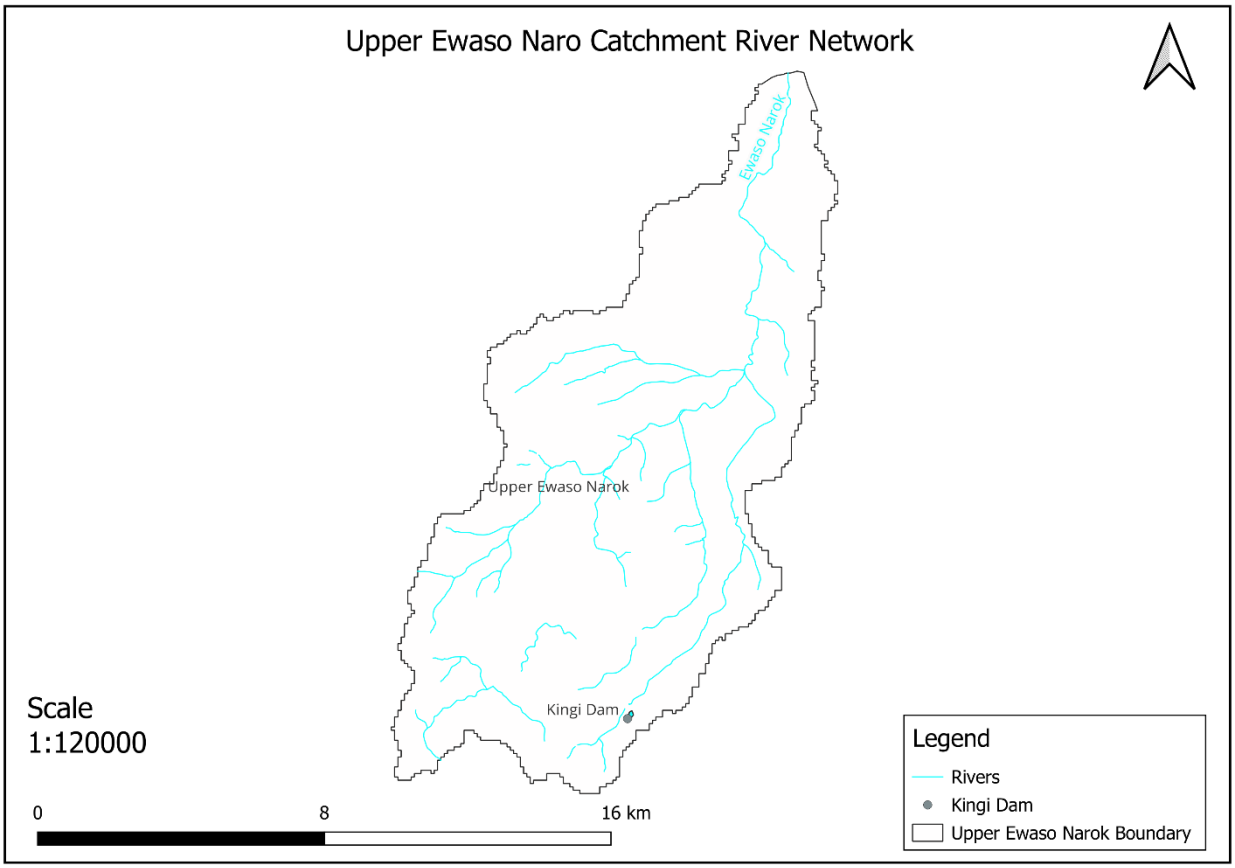


Figure 7:Upper Ewaso Narok river network

4.0 DETAILS OF CATCHMENT AREA (AREA, SLOPES, SOILS)

The watershed area for Kingi Dam is 5.396 km² within Engare Narok Melghis (Rumuruti) Sub-Basin 5AA which has a total area coverage of approximately 147 km² for the entire sub-basin. The spring is well protected with the natural vegetation. The slope is gentle towards westerly toward the dam with a gradient of 0° to about 5°.

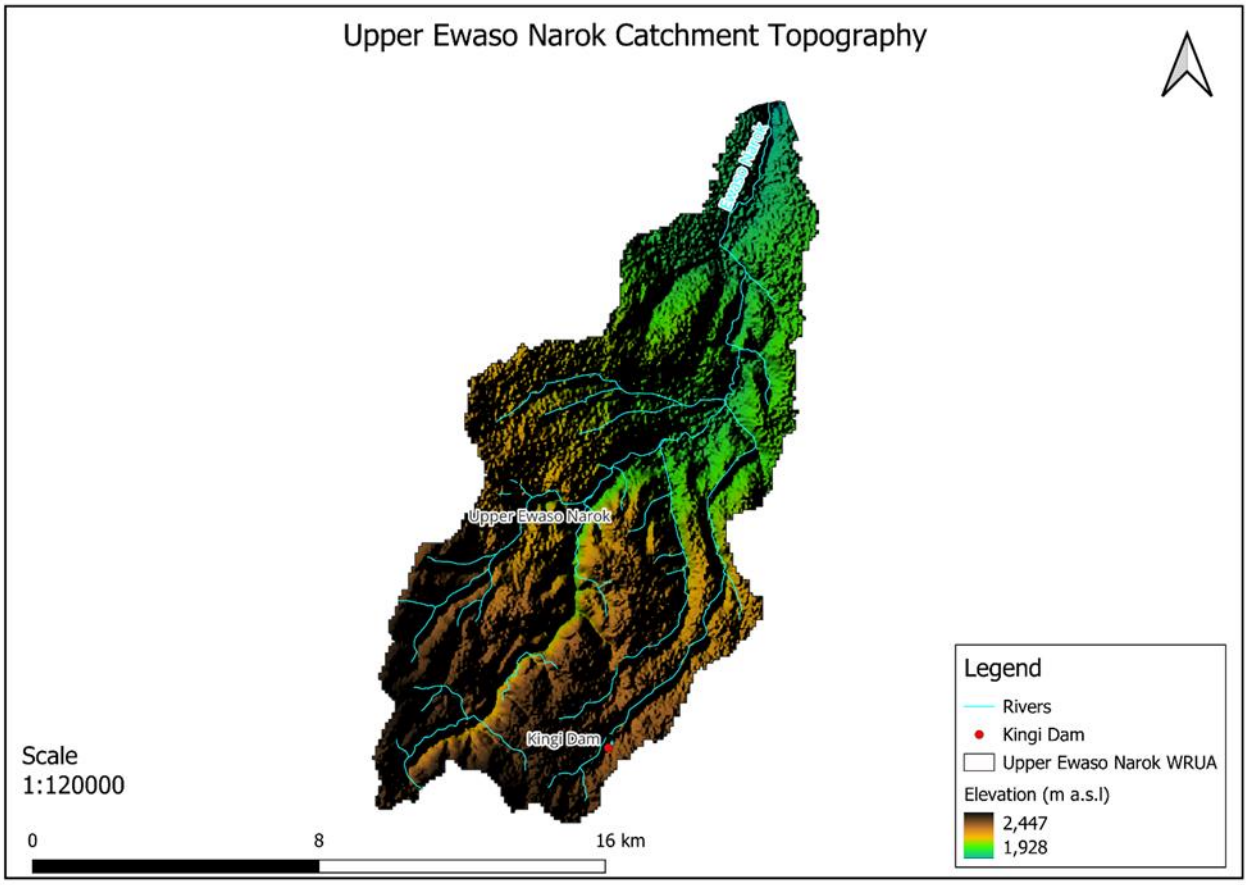


Figure 8:topographical map of upper Ewaso Narok

Temperature

It is along the equator; hence annual mean temperature variation is minimal.

The average annual temperature is around 25.29 °C with the highest temperatures on average in March, at around 33.43 °C, with July as the coldest month, with temperatures averaging 21.39°C.

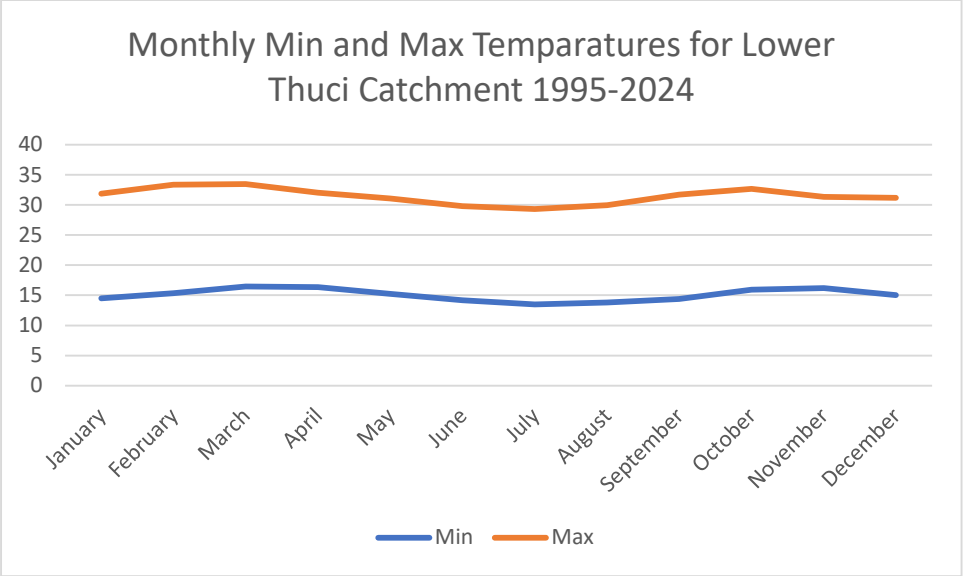


Figure 9: Temperature

Rainfall

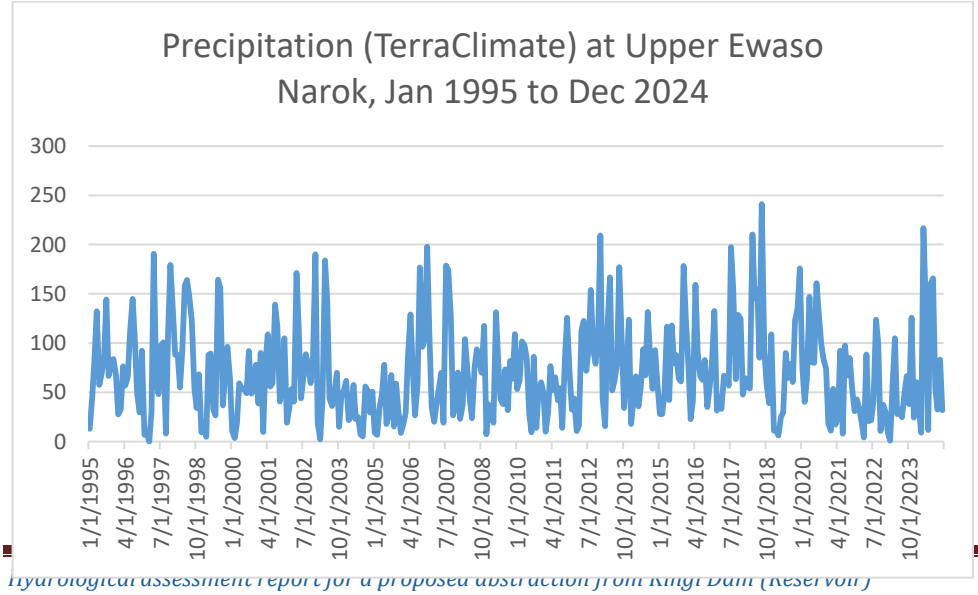
The distribution of rainfall is typically bimodal with two distinct rainy seasons, March-May (first rainy season) the longer with its peak in April and; the October -December (second rainy season) with the peak in November. The March–May rainfall is more intense and reliable around Mt. Kenya compared to the October–December rainfall, the shorter one. The mean annual rainfall for the area is 1000 mm per annum. The nearest rainfall station is the Ol Joro Orok Agric station which recorded an average annual rainfall of 1000 mm.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average	35.22	28.74	51.01	106.59	74.04	56.93	86.35	110.04	64.92	62.94	87.27	71.50

Table 1: Mean annual precipitation (tera climate satellite)

The: -

- Annual average rainfall is 400mm- 1300mm
- 66% reliability of rainfall in the 1st rainy season is 450mm – 800mm
- 66% reliability of rainfall in the 2nd rainy season is 450mm – 800mm



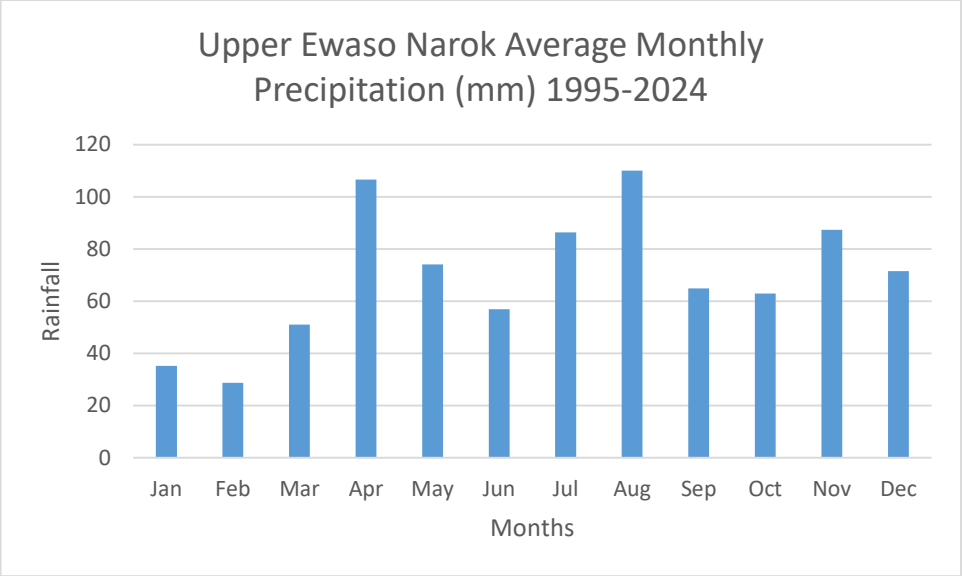


Figure 10: MEAN MONTHLY RAINFALL- https://app.climateengine.org/climateEngine

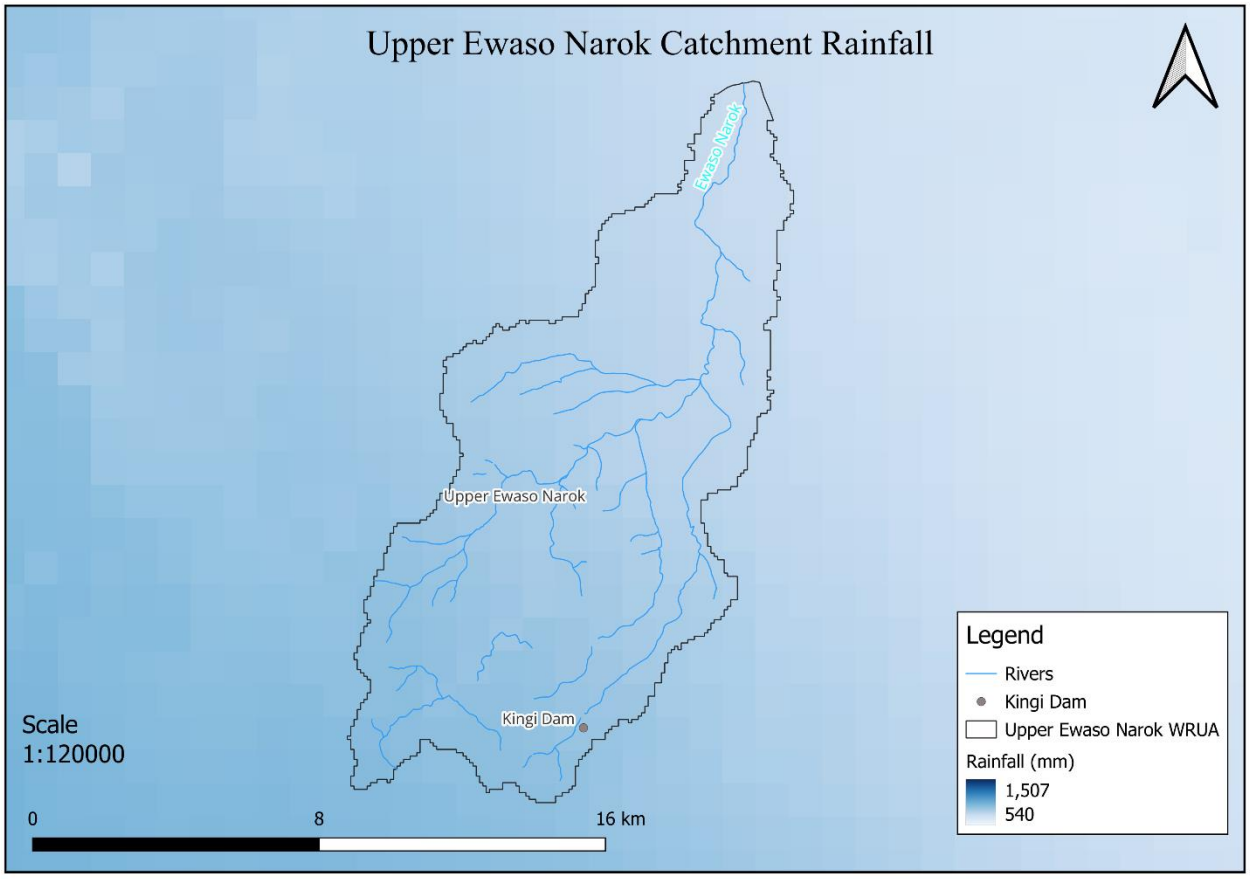


Figure 11:Rainfall distribution within Ewaso Narok catchment

Geology

The Sub Catchment has the same geological features like the Abadare ecosystem, which has been strongly influenced by volcanicity.

In general, the area is underlain by extrusive volcanic rocks of Mt. Kenya series of the tertiary period. All these rocks are in turn underlain by the Pre- Cambrian Basement rocks. The surface geology is composed of the Achaean age Mozambique belt basement system rocks which are mostly metamorphic rocks, the Pleistocene volcanic rocks.

Soils

The factor which determines the soil type is the parent rock and climate. The soils are products of weathering of mainly volcanic rocks. The soil as in the map is classified as loamy and in some parts clay loam for the area. The soils are suitable for most horticultural crops.

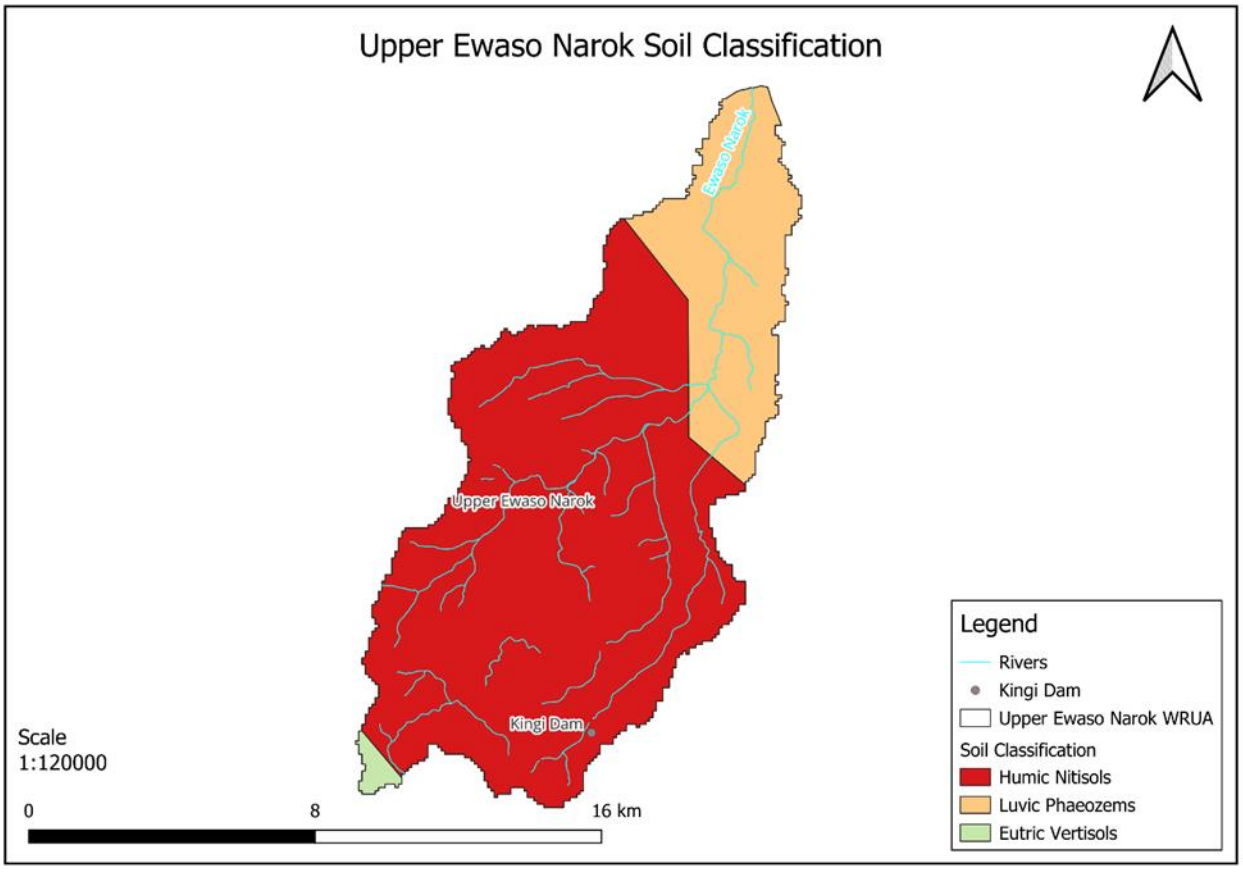


Figure 12:Fao UNESCO soil classification

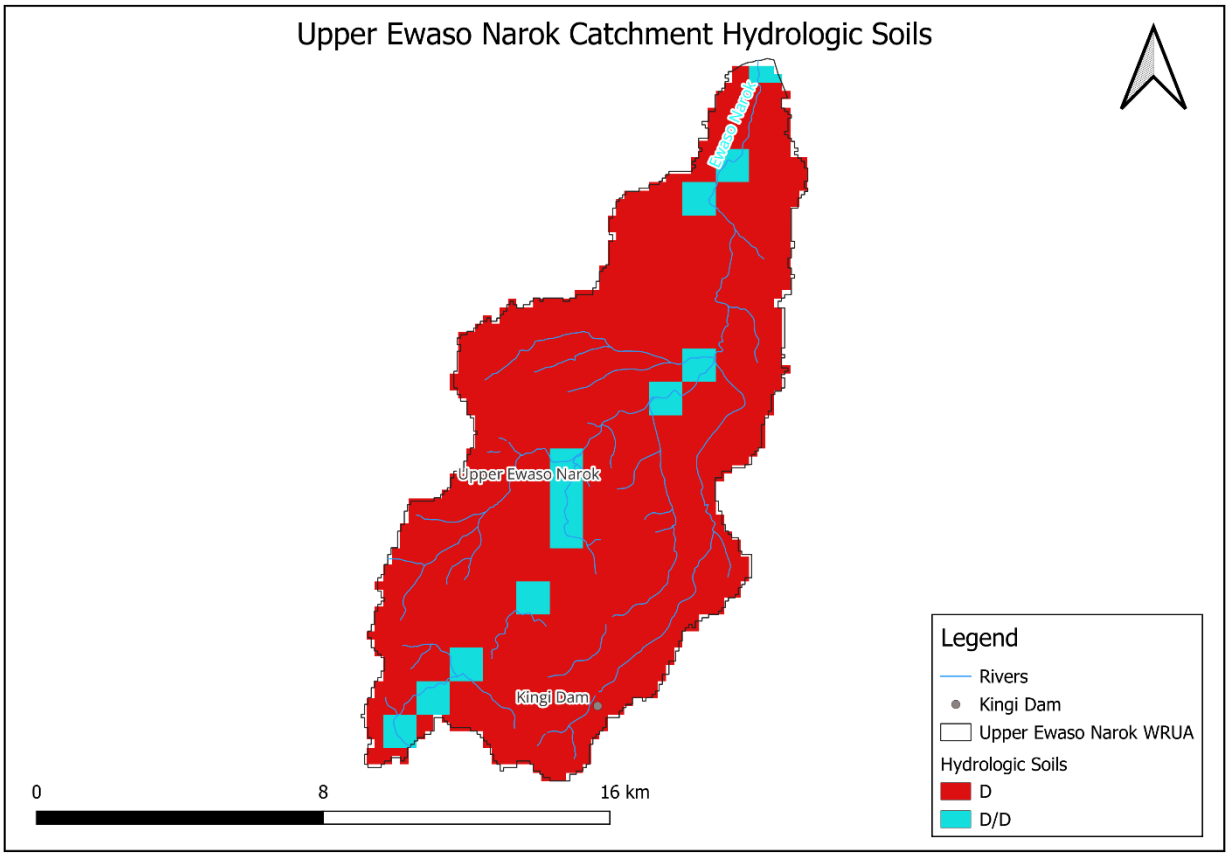


Figure 13:Hydrologic soils

The sub catchment soils fall under the hydrological soil group D, and D/D. Group D soils have high runoff potential. They have very low infiltration rates when thoroughly wetted and consist chiefly of clay soils with a high swelling potential, soils with a permanent high-water table, soils with a claypan or clay layer at or near the surface, and shallow soils over nearly impervious material. These soils have a very low rate of water transmission (0.00 to 1.27 mm/hr).

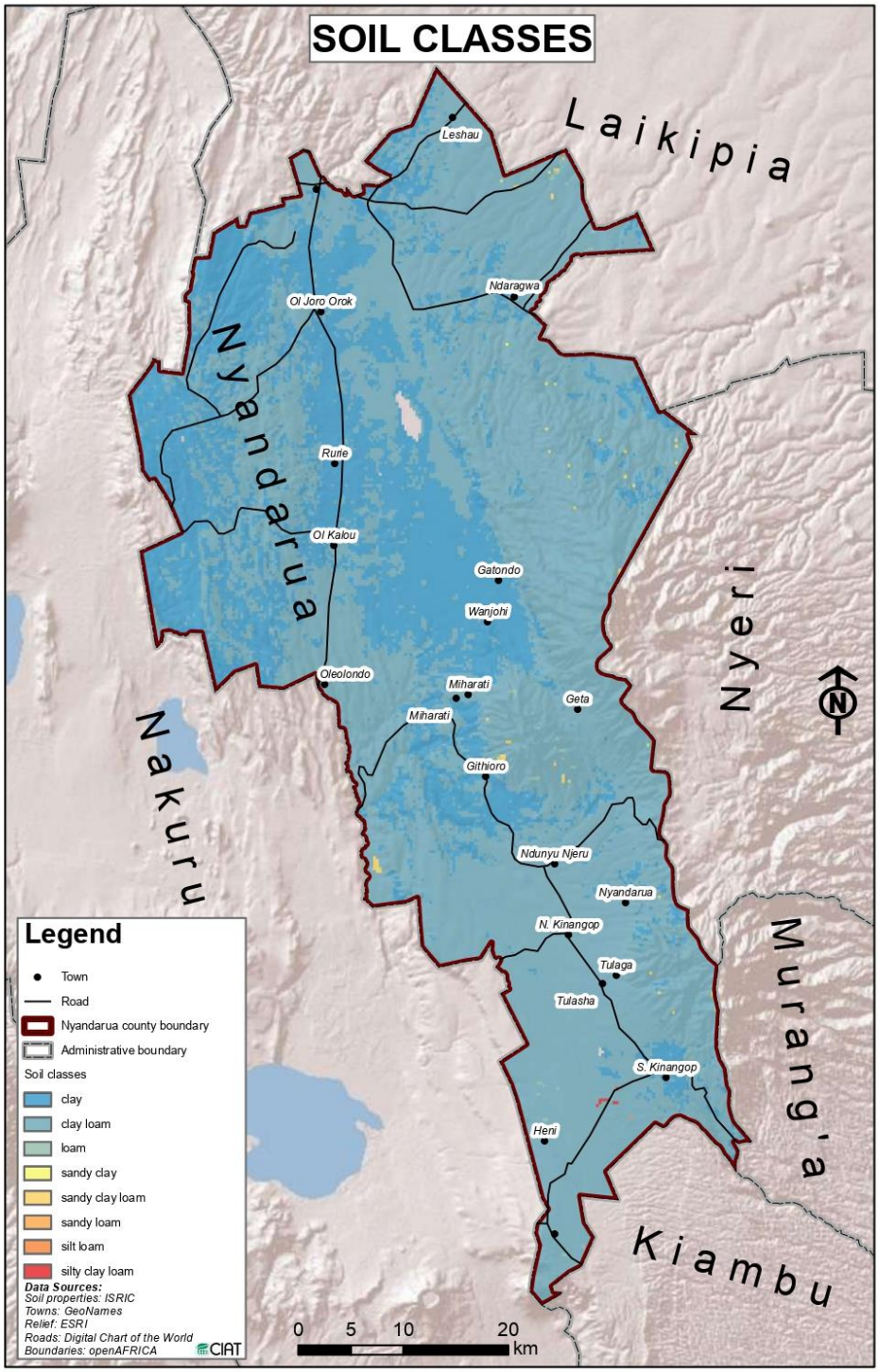


Figure 14: soils of Nyandarua county (ISRIC)

Soil description

- MV2 - Well drained, very deep, dark reddish brown to dark brown, very friable and smeary, clay loam to clay, with thick acid humic topsoil; in places shallow to moderately deep and rocky: Humic ANDOSOLS, partly lithic phase
- RB2 - well drained, extremely deep, dusky red to dark reddish brown, friable clay, with a acid humic topsoil described as humic NITISOLS

Characteristics of Andosols

Andosols are black, well drained, less weathered, mostly shallow soils which have developed on volcanic ashes in the Upper Highland Zones (UH) and the lower parts of the Tropical Alpine Zones (TA) of Mt. Kenya and the Nyandarua Range. Due to high fertility and sufficient rainfall in these areas, vegetation on these soils – particularly in the UH- is performing well, so that the topsoil is enriched with organic/humic substances; therefore, they mainly appear as humic and mollic types

Characteristics of Nitosols

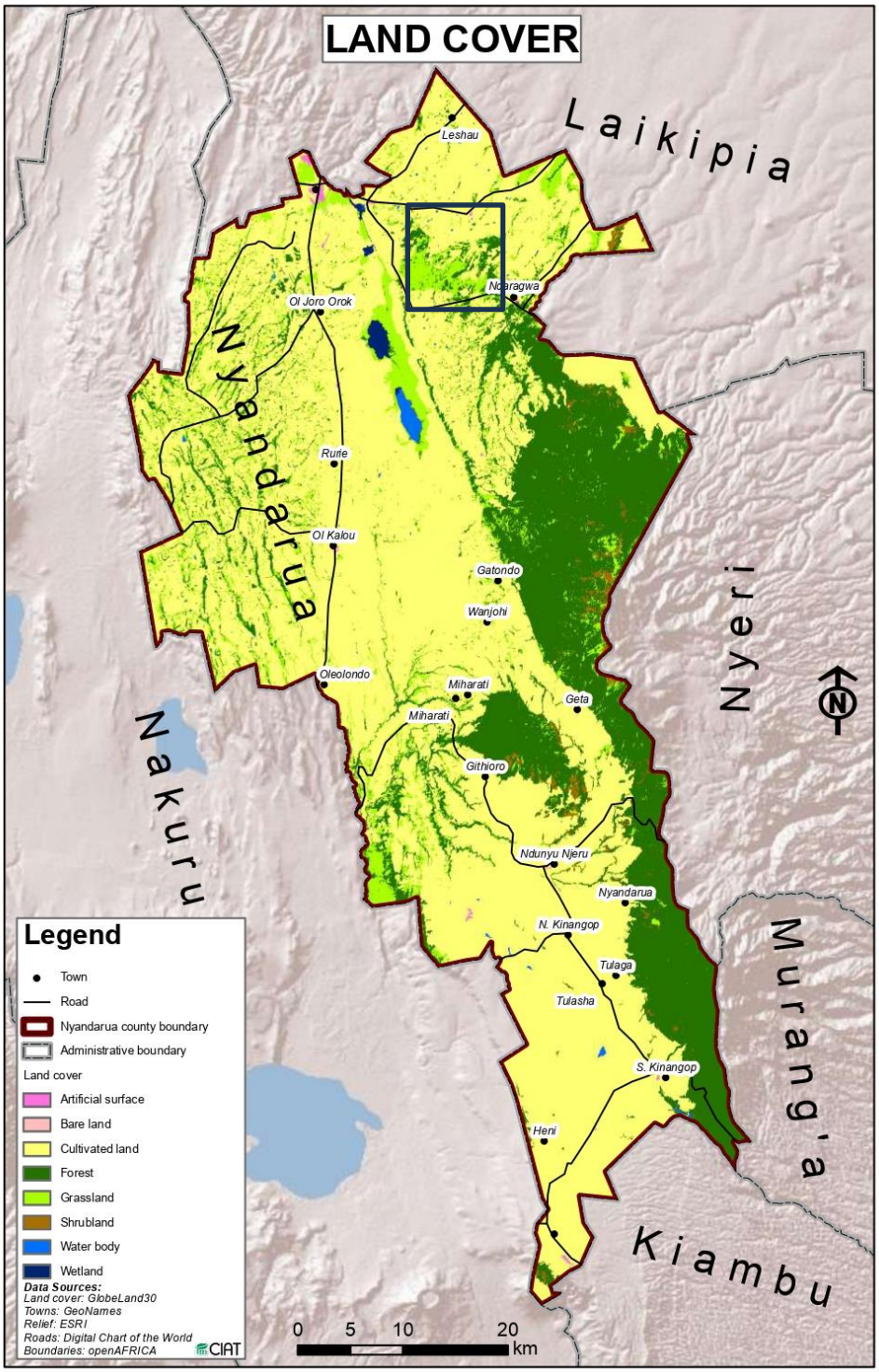
Nitosols or Nitisols develop on tertiary and even older basic igneous rocks (like basalts, tuffs etc.) and contain emerging argillic horizons with prominent shiny clay skins. They are soils with normally high fertility due to high contents of montmorillonites (as dominating clay minerals), minerals and available soil water as well as a high Cation Exchange Capacity (CEC) and mainly occur on the upper slopes of Mt. Kenya and the Nyandarua Range, covering the Lower Highland, Upper Midland and in smaller strips the Lower Midland Zones. These soils possess very good potentials for growing tea and coffee.

Almost all types of Nitosols are occurring in Central Kenya. The dystric type has a moderate fertility with a relatively low base status and a BSP of less than 50 %; the eutric type has a relatively high base status and a BSP of more than 50 %, but is also moderately fertile. The mollic and humic types are more fertile and have a mollic/humic A horizon.

5.0 DETAILS OF VEGETATION AND LAND USE

The Kingi catchment has grasslands, lit and agricultural land vegetation. For the purpose of this document, concentration will be on the abstraction point location and supply area only.

There has been a gradual tremendous increase in population density in the supply area leading to land use intensification and sub-division of land.



As indicated by the map, the area is classified as cultivated land meaning its more reliable on farming

Figure 15: General Land use for Nyandarua county

Land use involves the management and modification of natural environment or wilderness into built environment such as settlements and semi-natural habitats such as arable fields, pastures, and managed woods. It also has been defined as "the total of arrangements, activities, and inputs that people undertake in a certain land cover type. Upper Ewaso Narok basin is mainly covered by crop land with tree cover mainly being at the north western parts which is part of the Rumuruti Forest. Grasslands and shrubs are mainly integrated with crop land and are evenly distributed within the basin. The area is uniformly populated with the highest population settling at the south most area near Mairo-inya town.

Land use and agricultural zoning

Both human activities and changing environmental conditions have contributed to changes in the vegetation cover of the sub-catchment.

Vegetation on uncultivated land

The proposed site is at Kiriita Location with the area mainly cultivated. There are a few uncultivated areas within the location which are mainly covered with shrubs and grassland (both indigenous and exotic).

Agriculture and livestock farming

This is marginally a farming zone. The community practises mixed farming. The food crops grown include maize, beans, Napier grass, potatoes, pyrethrum, and wheat.

Land use

The main source of energy for cooking in the homesteads within the catchment is firewood. The demand for firewood has led to increased planting of exotic trees and scarcity of wood resources, deforestation, high prices and introduction of eucalyptus species thus dominating most of the riparian land.

The land use of an area is determined by its agricultural potential which is mainly the interplay of geology and climate - which influences the formation of soils, and their fertility and quality; altitude - which determines temperatures that in turn, influences plant growth rates; and rainfall which determines plant growth and production.

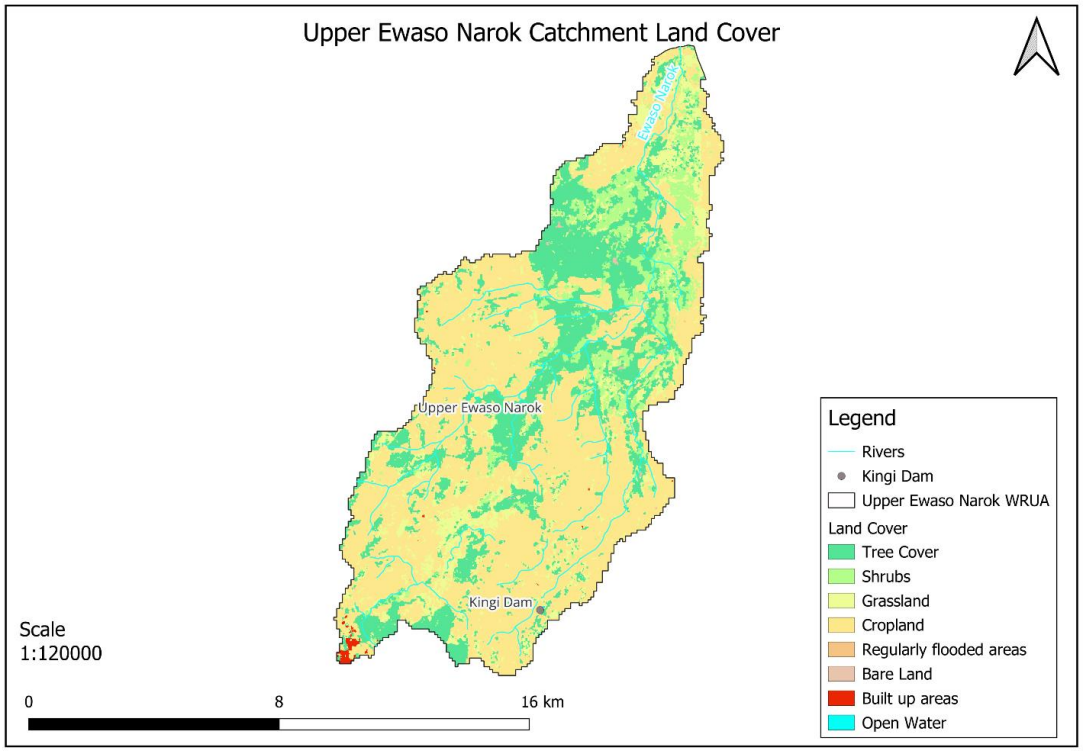


Figure 16: Land cover for the Sub-catchment

Table 2: Land cover

S/No	Land Cover	Area km2	Percentage
1	Tree Cover areas	30.79	23.54 %
2	Grassland	15.92	12.17 %
3	Shrubs	11.46	8.76 %
4	Cropland	72.01	55.05 %
5	Bare areas	0.20	0.16 %
6	Regularly flooded areas	0.06	0.04 %
7	Open water	0.03	0.02 %
8	Built up areas	0.34	0.26 %
	Total	**130.81**	**100.00 %**

The community practices mixed farming with irrigated agriculture of high value crops; which are mainly horticultural crops being the preference. The crops grown include potatoes, onions, maize, beans, kales, cabbages, carrots, passion fruits, snow peas and tomatoes among others. The farmers keep grade cattle mainly for production of milk, poultry, sheep and goats.

The road network is fairly good and comprises of bound and loose surface, dry weather, main tracks (motorable), track and footpaths. One of the main tarmac roads is Nyahururu- Nyeri road. The preferred telephone network is the mobile with Safaricom and Airtel being the main service providers.

6.0 DETAILS OF REGISTERED AND NON-REGISTERED ABSTRACTIONS

There are no registered abstractors from the dam. The non registered abstractors are mainly individual who only depend on the ever-spilling water

7.0 DETAILS OF ALL OTHER PERMITS RELATED TO THIS ABSTRACTION

According to the available abstraction data held by the Water Resources Authority Under 5AA sub basin in Rumuruti sub basin Catchment, there isn't any authorized abstraction upstream of the Spring or the dam.

8.0 HYDROLOGICAL CHARACTERISTICS AND ANALYSIS

8.1 Desk study

The study involved the collection and correlation of the available data with regard to the river flows and rainfall data. The data was analysed to generate the possible surface water flow scenarios at the proposed site.

8.2 Field study

A reconnaissance survey of the project area was undertaken in order to assess the resource, note other relevant issues on the ground and have a first-hand view of the area under consideration. The intake site is in the lower parts of Upper Ewaso Narok 5AA at coordinates 0.053328859 N, 36.42032531E at an altitude of 2298 m a.s.l.

8.3 Surface water Availability

Hydrological analysis requires the use of long-term continuous discharge data (preferably daily discharge) to determine the flow duration at various probability of exceedance. The Kingi (kibiro) spring is one of the many springs in the larger Ewaso Narok River System (Sub catchment 5AA) in the Ewaso Nyiro North basin area. The river IS generally ungauged with no active RGS in the sub catchment.

The dam main sources water are surface runoff from its 5.396 km2 watershed and the Kingi (kibiro) spring situated 300m upstream. There may also be inflows from additional springs inundated within the reservoir area. overflow from the dam flows through a stream that forms part of tributary network for the Ewaso Narok river.

The physical characteristics of the dam are described by an Integrity assessment report done by Edonk Ltd dated 2023. According to the report, the embarkment has crest elevation of 2248m, has a maximum height of 6m and a normal water level of 6m in depth. For the reservoir part, it has a 904m in perimeter and an area of 16,829m^2 with an elevation of 2245m at Normal water level and 24,164m^2 with an elevation of 2246m during high flood level. The live storage was captured at 164, 735m^3 while the dead storage is at 0 m^3.

The levels of the water do not change respectively with the season. Since construction in 2011, it has been observed that the levels in dam are constant even during the dry periods. For the reservoir part, it has a 904m in perimeter and an area of 16,829m^2 with an elevation of 2245m at Normal water level and 24,164m^2 with an elevation of 2246m during high flood level.

The bucket method was used to measure discharge. The bucket method is a simple and practical technique used to measure discharge in small water flows, such as springs, taps, or low-flow channels. It involves collecting the entire flow of water into a container of known volume over a measured period of time. By dividing the collected volume by the time taken, the discharge or flow rate can be easily calculated.

This method was done at two separate points and an average sought. Discharges rate was calculated by dividing the volume of water by the time it takes to collect that volume using a 20 litres container.

Flow rate is given by;

$$Q = \frac{V}{t}$$

Where;

Q = discharge (M^3/s or L/s)

V = volume of the container (m^3 or L)

t = time to fill the container (seconds)

First Reading:

$$Q = \frac{20\ l}{1.42\ s} = 14.29\ l/s$$

$$Daily\ flow\ = \frac{14.29 \times 86400}{1000} = 1234.2 m^3/day$$

Second Measurement;

$$\frac{20\ l}{1.42\ s} = 14.29\ l/s$$

$$Daily\ flow\ = \frac{14.29 \times 86400}{1000} = 1234.2 m^3/day$$

First Measurement(m^3/day)	Second Measurement (m^3/day)
1234.2	1234.2
Average Flow =1234.2	

9.0 HYDROCHEMISTRY

9.1 Domestic water

Water for specific uses is required in the suitable quality for that use. Natural and anthropogenic activities however influence the quality of water, making it either suitable or unsuitable. The physico-chemical quality of water is suitable for both domestic and irrigation purposes.

The basic requirements for domestic (drinking) water are that it should be

A) Free from pathogenic (disease causing organisms)

b) Containing no compounds that have adverse acute or long-term effect on human health

c) Fairly clear/Colourless (i.e low turbidity)

d) Not saline (salty)

e) Containing no compounds that cause an offensive taste or smell.

f) Not causing corrosion or encrustation of the water supply system: not staining clothes washed in it.

Surface water generally should be known from the physical, chemical, and bacteriological points of view. The following list is given as an indication of the most importance parameters that should be known for complete assessment of water quality.

a) Physical parameters-colour, odour, taste, turbidity, temperature, PH, conductivity, suspended and settable solids

b) Chemical characteristics- alkalinity, acidity, hardness, Biological oxygen demand (BOD), Chemical Oxygen demand (COD), ammonia, Nitrite, Total Dissolved Solids (TDS) and the Ionic contents of calcium magmesium, sodium, potassium, manganese, iron, chlorides, silphates, carbonates, bicarbonates, fluorides,

c) Bacteriological characteristics- bacteriological counts of total and faecal coliforms.

The analysis of water samples to assess these parameters and the interpretation of their results should be made by a specialist. Generally, all domestic (drinking) water should conform to the KEBS EAS12:2018 standards and or WHO guidelines for drinking water.

Because this an open system, the water gets contaminated with total and faecal coliforms from the living animals and humans in the environment making it unsafe for human consumption. It is advisable to boil or disinfect before consumption.

A full analysis is recommended before issuance of water permits

9.2 Irrigation water

Water used for irrigation can vary greatly in quality depending upon type and quantity of dissolved salts. Salts are present in irrigation water in relatively small but significant amounts. They originate from dissolution or weathering of the rocks and soil, including dissolution of lime, gypsum and other slowly dissolved soil minerals. These salts are carried with the water to wherever it is used. In the case of irrigation, the salts are applied with the water and remain behind in the soil as water evaporates

or is used by the crop.

The suitability of a water for irrigation is determined not only by the total amount of salt present but also by the kind of salt. Various soil and cropping problems develop as the total salt content increases, and special management practices may be required to maintain acceptable crop yields. Water quality or suitability for use is judged on the potential severity of problems that can be expected to develop during long-term use.

The problems that result vary both in kind and degree, and are modified by soil, climate and crop, as well as by the skill and knowledge of the water user. As a result, there is no set limit on water quality; rather, its suitability for use is determined by the conditions of use which affect the accumulation of the water constituents and which may restrict crop yield. The soil problems most commonly encountered and used as a basis to evaluate water quality are those related to salinity, water infiltration rate, toxicity and a group of other miscellaneous problems.

The most influential water quality guideline on crop productivity is the water salinity hazard as measured by electrical conductivity (ECw). The primary effect of high ECw water on crop productivity is the inability of the plant to compete with ions in the soil solution for water (physiological drought). The higher the EC, the less water is available to plants, even though the soil may appear wet. Because plants can only transpire "pure" water, usable plant water in the soil solution decreases dramatically as EC increases.

Actual yield reductions from irrigating with high EC water varies substantially. Factors influencing yield reductions include soil type, drainage, salt type, irrigation system and management.

The amount of water transpired through a crop is directly related to yield; therefore, irrigation water with high ECw reduces yield potential. Beyond effects on the immediate crop is the long-term impact of salt loading through the irrigation water.

	% yield reduction			
Crop	**0%**	**10%**	**25%**	**50%**
	EC_w			
Barley	5.3	6.7	8.7	12
Wheat	4	4.9	6.4	8.7
Sugar beet	4.7	5.8	7.5	10
Alfalfa	1.3	2.2	3.6	5.9
Potato	1.1	1.7	2.5	3.9
Corn (grain)	1.1	1.7	2.5	3.9
Corn (silage)	1.2	2.1	3.5	5.7
Onion	0.8	1.2	1.8	2.9

Dry Beans	0.7	1	1.5	2.4
Adapted from "Quality of Water for Irrigation." R.S. Ayers. Jour. of the Irrig. and Drain. Div., ASCE. Vol 103, No. IR2, June 1977, p. 140.				
EC_w = electrical conductivity of the irrigation water in dS/m at 25°C.				

Table 4: Potential yield reduction from saline water for selected irrigated crops

The laboratory results show that the pH is within the acceptable range 0f 7.1, and the temperature is 17.0°C. The conductivity was as low as 27.1uS/cm and total dissolved solids of 17.6 mg/l with turbidity of 6.5 NTU meaning that the suspended solids were at low acceptable levels and that was the reason the water looked relatively clean. The color and turbidity of the water becomes unacceptable during the rainy season due to increased levels of total solids in the water. Fluoride concentrations are low.

Generally, the physical and chemical parameters of the water are good whereby this includes the color, turbidity, temperature, smell and taste. The electrical conductivity, pH, Sulphates, nitrates, total alkalinity, total hardness, total dissolved solids values are impressively within the allowable limits. The water is clear, soft, neutral and with ambient temperatures. These values are almost constant during the rainy and dry spell. These physio-chemical parameters of the water are suitable for both domestic use and irrigation.

10.0 ANALYSIS OF RESERVE

The water resources management rules define flood flow as any flow that exceeds the Q50 flow value, i.e. the flow that is equalled or exceeded fifty percent of the time and, normal flow as that flow which is equal or exceed the Q80 flow value. The Q95 flow value currently represents the Reserve, i.e. that quantity and quality of water required to satisfy basic human needs for all people who are or may be supplied from the water resource and, for the protection of aquatic ecosystems, in order to secure ecologically sustainable development. Unlike rivers in the area, springs exhibit less flow variation throughout the year.

10.1 Irrigation Demand

The Primary objective of the project is to supply water for irrigation and livestock to 200 target beneficiaries, each irrigating 1/4 of an acre.

From the feasibility and design reports of this project, the daily irrigation water demand is 1,440 m^3/day while the daily livestock water demand is 15.4m^3/day.

10.7 Total Water Demand for the Entire Scheme

The total water demand for the entire scheme is the grand total of the irrigation, domestic and livestock water demand for a period of 3 months during the dry spell when the demand is at its peak. Table 5 below gives a summary of the water requirements and the total demand.

SNO.	Water Demand Entity	Water Requirement for a 3 Month period in m^3
1	Irrigation water requirement for 150 HH of Kingi Phase I Project	48,600
2	Irrigation water requirement for 200HH of Kingi Phase II Project	129,600
3	Livestock water requirement for (350HH)	1,386
	Total Water demand for the entire Irrigation Scheme	**179,586**

Daily water demand for the entire scheme covering irrigation and livestock = 179,586/90 = 1,995.4m^3.

11.0 ASSESSMENT OF AVAILABILITY OF FLOW

The sub-catchment doesn't have a river gauging station. Kingi spring site is on the Ewaso Ngiro River Water Management Unit.

The Use a 20-liter container and a stopwatch were used to measure how long it took to fill the container. This method was done at two separate points and an average sought. Discharges rate was calculated by dividing the volume of water by the time it takes to collect that volume.

Estimation of River Water flows

Formula

$Q=V/t=20/1.42$

Where:

Q = discharge (M^3/s or L/s)

V = volume of the container (m^3 or L)

t = time to fill the container (seconds)

Q m3/s= 14.10 liters/s convert to l/hr.;

= 14.10 x 60x60=50,760 l/hr.

Thus, daily flow will be;

50,760L/Hr. *24= 1,218,240 L/Day.

$=1,218.24M^3/day$

The water resources management rules define flood flow as any flow that exceeds the Q80 flow value, i.e. the flow that is equaled or exceeded eighty percent of the time and, normal flow as that flow which is less than the Q80 flow value. The Q95 flow value currently represents the Reserve, i.e. that quantity and quality of water required to satisfy basic human needs for all people who are or may be supplied from the water resource and, for the protection of aquatic ecosystems, in order to secure ecologically sustainable development. The flow duration analysis for the catchment area upstream of abstraction point was analyzed by use of rainfall data the Ol joro orok Agric Station.

12.0 IMPACT OF THIS ACTIVITY ON FLOW REGIME, WATER QUALITY, OTHER ABSTRACTORS

The proposed abstraction from Kingi Spring will not significantly affect the downstream flow regime.

Kingi Dam has an estimated reservoir capacity of 164,735.051 cubic meters. Kingi spring, which supplies water to Kingi dam, produces 1,218.24 m^3/day which translates to 109,728m^3 in 90 days. Available water over the entire three months season is the dam capacity plus the spring discharge which is equal to 274,463.051m^3. The water demand over the entire irrigation season of 3 moths is 179,586m^3.

This shows that the available water (274,463.051m^3) is more that the water demanded of 179,586m^3 hence the project has adequate amount of water to serve the intended purpose with no risk of threatening sustainability of the local ecosystem.

13.0 RECOMMENDATIONS ON THE EXISTING ACTIVITY

The recommendation is that:

1) The proponent to be allocated 180m^3/day of water for subsistence farming from the Normal flow
2) The project to construct a self-regulating suction to ensure the reserve is maintained downstream.
3) The Project to install measuring and controlling device at the suction intake to only abstract authorized volumes.
4) The project to ensure there is adequate water storge facilities for use for subsistence irrigation during the dry spells.
5) The proponent to be an active member of the pesi WRUA for the effective management of the resources.

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