United Republic of Tanzania
Ministry of Water, Energy
and Minerals

Kingdom of the Netherlands
Ministry of Foreign Affairs
DGIS

Morogoro Domestic Water Supply Plan

Volume III

Hydrology

Final Report

August 1980

DHV

DHV Consulting Engineers

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1. INTRODUCTION

1.1. General

At the beginning of 1977, following on the "Administrative Arrangement" between the Governments of Tanzania and The Netherlands, the International Technical Assistance Department of the Ministry of Foreign Affairs of the Netherlands charged DHV Consulting Engineers with the execution of the Morogoro Domestic Water Supply Plan (MDWSP). The Tanzanian Government appointed the Ministry of Water, Energy and Minerals as executive authority for the implementation of the project.

The aim of the MDWSP is to study the possibilities for improvement of the rural water supply in the northern part of the Morogoro Region.
Carrying out a Domestic Water Supply Plan, instead of a Water Master Plan, implies that the study has to be focused on the supply of drinking water for the villagers only. During the discussion with the Tanzanian and Dutch Governments on the determination of the Terms of Reference, the need was felt to incorporate an implementation component in the study. Based on information derived from earlier studies in the Morogoro Region it was decided to incorporate a drilling programme for exploration and exploitation of deep ground water in the survey.

A first report "Identification of the present conditions and problems of rural water supply in the northern part of Morogoro Region" was issued in December 1977.

In September 1978 a Progress Report was presented, dealing with the surveys and studies carried out during the period end May- end August 1978 and presenting the plan of operations of the team for the following months.
A first review of available and collected data concerning existing water supply systems, water quality aspects, hydrology and hydrogeology was presented in the interim report, which was submitted in April 1979.

The domestic water supply plan is presented in this final report. The report consists of six volumes.

Volume I	Main Report
Volume II	Water Supply Conditions
Volume III	Hydrology
Volume IV	Hydrogeology
Volume V	Water Supply Development
Volume VI	Village Data Handbook.

1.2. Aim

The hydrological studies presented in this volume were performed to obtain a basis for the estimation of the surface water potential in respect to domestic water supply in the project area.

The study aims in particular at identifying sources of surface water situated at a reasonable distance from the demand area and having a sufficient yield and acceptable quality.

In combination with the results of the hydrogeological studies concerning deep and shallow groundwater, basic data are provided for the design of alternatives for domestic water supply systems.

2. APPROACH

2.1. General

Data collection, fieldwork, processing and evaluation of the findings are determined by the surface water sources under consideration and the required reliability of the source and the system attached to it. In the following paragraphs these points will be discussed.

2.1.1. Types of surface water sources

The different sources to be considered initially are:
a. springs
b. rivers (including small reservoirs fed by rivers and creeks)
c. lakes and swamps

For obvious reasons, springs above the level of the demand area are the most preferred sources for domestic water supply in rural areas, because in most cases spring water requires little or no treatment to make it suitable for consumption. Unfortunately only few possibilities for the supply from springs are present and most of the attention is paid to rivers. In general river water needs treatment except if the river emerges from uninhabited area. In this case river water is comparable with that of springs. Lakes and swamps are usually fed by rivers, but especially if the lake is remote from sources of pollution and the size of the lake is large in comparison with the amount of river water flowing into it, the long detention time of the water in the lake will cause a natural process of self-purification and the water can be of a good quality. No further attention has been paid to this subject, because no large lakes and swamps are found near demand areas.

2.1.2. Reliability

Reliability is related to two parts of the proposed system:
a. reliability of the source (safe yield)
b. reliability of the system to convey water from the source to the demand area

The reliability of the source is typically a hydrological problem; the following approach has been pursued with regard to minimum flows.
Rivers and springs have the advantage of not being easily exhausted by human interference, although the possibility should not be excluded. As the cost of construction of large storage reservoirs is prohibitive for projects of the size of the one being studied, the minimum flow of the river mainly dictates the water available for the future systems.
Such minimum flows are not an absolute minimum but one still has to accept a certain chance of failure. For a water supply system drawing from a single

(river) source, the safe yield recommended for the design is the river discharge which on the average is exceeded in 19 out of 20 years by the actual river flow.
Under certain circumstances it pays to combine low flows of several rivers (e.g. Gairo area). It is possible to enlarge low flows or zero-flows of the rivers by reservoirs created by small earth dams. Some attention will be paid to this aspect, although small reservoirs are easily polluted.
As regards reservoirs the reliability of the yield can be concluded from a water balance study of the reservoir, as e.g. in the case of lakes and swamps, or even of the catchments feeding the sources.
Complete (long-term) observations for the different items such as infiltration rates and soil moisture retention which are required for a detailed calculation of catchment water balance, were neither available nor required within the scope of this study.

The reliability of the source is strongly related to the variability of precipitation to which much attention has been paid. Rainfall-runoff relations have been studied to distinquish areas of different surface water potential.

Item b, the reliability of the system, is only partly related to hydrology. A gravity system is, for instance, usually more reliable than a pumped system under present Tanzanian circumstances. This subject will be discussed in detail in part E on water supply. Much attention has been paid by the Consultant to the siting of water sources above the demand areas.

2.2. Data collection

2.2.1. General

The data collection aims at collecting hydro-meteorological and flow data in order to give:

a. a general review of the hydrological conditions of the project area
b. specific information about the water sources that can be used for domestic water supply

The data collection can be divided into two parts:

a. collection of existing data (including reports)
b. data collected during fieldwork, carried out by the Consultant

Paragraph 2.3. discusses the fieldwork approach, while the following subpar. discusses which available data were worth collecting for the present study.

2.2.2. Earlier studies and reports

A collection of all available reports and memoranda related to the hydrology of the project area was carried out. The following libraries and institutes were consulted: University of Dar es Salaam, BRALUP Research Institute, Meteorological Department, Agricultural Department and the libraries of the Water Department at the Headquarters and at Morogoro. Some reports were obtained from other Consultants. A reference list can be found in paragraph 2.7. Not all these reports will be quoted in the following study but for the sake of completeness the whole list is given.

2.2.3. Hydro-meteorological data

In view of the scope of the study, monthly data were sufficient in most cases, while from the daily data only annual daily minimum flow data seemed important.

a. Flow data:

All monthly flow data and annual daily minimum and maximum flows of gauged rivers in the Morogoro and Kilosa Districts, published in the three hydrological year books covering the years 1950-1970, and unpublished data, covering the years 1971-1975, obtained from the Water Department at Ubungo, have been collected.

b. Rainfall data:

All monthly rainfall data from 1950 onwards have been collected at the East African Meteorological Service (EAMS) in Dar es Salaam. Note that the year 1950 corresponds with the beginning of the first flow measurements. From selected stations longer records were collected, which were used in time series analyses.

c. Other data:

Recent monthly data, required for evapotranspiration calculations, were collected at the existing Meteorological stations in the Region.

2.3. Fieldwork

2.3.1. General

The following approach was pursued: a survey was carried out to obtain a general idea of:

a. quantitative and qualitative problems of the existing domestic water supply
b. hydrology of the project area
c. potential and availability of surface water for domestic water supply

These surveys were carried out either in areas where villages are located or in areas where the possibility exists to convey the water to inhabited areas. Surveys in other areas were not considered necessary. Based upon this general survey, a regular flow measurement programme was devised, in order to give more insight into the low-flows of ungauged rivers.

2.3.2. Regular measurement programme

Based on the general survey, a number of rivers were selected and incorporated into a regular measurement programme which started in August 1978 and which has been carried out, on a monthly basis, up to the end of the dry season, medio November 1978.

The programme involved:
a. rivers which are used for existing domestic water supplies
b. rivers which are potentially usable for gravity water supplies
c. rivers which may give specific information on the hydrology of parts of the project area
d. rivers which will be used for specific purposes as e.g. for the Mindu dam development

The measurement programme included data collection of discharge (either measurement or estimation), salinity, and water levels. At first the temperature was also measured, but the data obtained did not seem to be of great value, because they only reflected the average air temperature of the surrounding area.

To gather specific information on the feasibility of small reservoirs in the Ngerengere valley for water supply purposes, one reservoir in this area has been studied in detail. Because of the importance of the Mindu dam project, the Upper Ngerengere River was studied in more detail. Regular measurements were carried out upstream and downstream of the proposed dam site. Detailed flow and sediment measurements were carried out in the Kikundi River.

2.3.3. Equipment and measuring methods

2.3.3.1. General

A short résumé will be given of the most important equipment used in the office and the field. If not stated otherwise, equipment was purchased by the Consultants on behalf of the project. In some cases advantages or disadvantages of the equipment used will be discussed. An outline of the applied discharge measuring methods and discharge calculation method is included in this paragraph.

2.3.3.2. Equipment

All calculations were carried out with Hewlett Packard pocket calculators (model HP 25c and HP 69).

For studying aerial photographs a Topcon mirror stereoscope was used.

Levelling was carried out with a Wild (NAK 2) levelling apparatus, while for determining approximate altitudes in the field a Thommen pocket altimeter was used.

Electrical conductivity (EC) of water was measured with an EC-meter developed by the Free University of Amsterdam, the Netherlands. (IVA-VU-EC-meter)

An Ott-planimeter was used for measuring areas on maps.

Low flows up to approximately 0,75 m water depth were measured with two Ott-Laboratory-Minor C1 propeller current meters on wading rods. Flows above this water level up to about 1.50 m were measured with an Ott-universal propellor flow meter C31 on wading rods.
For higher water levels the same current meter was used in connection with a cable, boom and winch to measure from bridges. All Ott-meters were attached to Ott-41 counters to count revolutions. By means of a rating formula, revolutions per second were converted into velocities.

Two pneumatic Van Essen continuous water stage recorders were installed. Leaks in the system made the recorders work very erratically and not much use could be made of the output.

Use was made of a compound Crump weir (three 1.0 m sills), a stilling well and an Ott continuous water stage recorder, installed by the University of Dar es Salaam (Morogoro-Campus) in the Kikundi River. It should be noted that the Crump weir is very sensitive to sediment. Not until measures were taken to clean up sediment after every flood and the intake of the stilling well had been changed by the Consultant, did the weir function properly. The Consultant installed a standard 90°-V-notch weir in the Kikundi River. The weir was washed away at the beginning of the rainy season.

The Consultant was responsible for the operation of one recording and one manual rain gauge, borrowed from the Water Department at Ubungo. The recording gauge is a syphoning type, with weekly charts and a 5 inch aperture. The manual gauge, which was used as a control gauge, was of the standard EAMD type, also with an aperture of 5 inches. Both gauges were located in the catchment of the Kikundi River.

Sediment samples were taken by means of two point-integrating hand sediment samplers. The US DH 48 hand sampler with a 0.47 (1 pint) glass container was borrowed from the Water Department Morogoro, while a Nilsson type was borrowed from the Eng. Depart. of the University of Dar es Salaam (Morogoro Campus). Dry weight of the sediment of the samples was determined in the laboratory of the University.

2.3.3.3. Flow measuring methods

The following methods were used to determine mean velocities in a vertical

line with the current meter:
1. six-tenth depth method
2. two-point method

The six-tenth depth method consists of measuring the velocity at 0,6 of the depth from the water surface (0,4 of the depth from the bottom) and was used for shallow flows up to 0,6 m depth. The velocity measured at this depth is considered to be the average velocity.

The two-point method consists of measuring the velocity at 0,2 and 0,8 of the depth from the water surface and using the average of the two measurements as the mean velocity of the cross section.

Usually a cross section perpendicular to the axis of the river was chosen. The propellor axis was taken parallel to the axis of the river. The type of propellor used was not sensitive to small deviations of the stream flow from the axis of the river.

The cross section was divided into 10 to 20 sections, and the discharge was computed by means of the midsection method.
In using this method, the depth at each vertical is applied to a sectional width, which extends halfway to the preceeding vertical and halfway to the following vertical to develop a cross sectional area. The product of the mean velocity at a vertical and the corresponding cross-sectional area gives the discharge for the elementary area. The sum total of all elementary discharges gives the total discharge.

For very small discharges the bucket-stopwatch method was used. The flow was diverted into a bucket of known content, while the stopwatch was used to measure the filling time.
For gauged rivers the discharge was measured at or as close as possible to the site of the gauge. Under certain circumstances it was impossible to carry out the discharge measurements at the site of the gauge itself e.g. when flows were too high for wading, and once wild bees had their nest near the gauge! Measurements were then carried out some distance up or downstream from the gauge. If the water level changed during measurement, measured flows had to be adjusted for the flow entering or leaving the section between gauge and place of gauging e.g., if the water table dropped by 0.02 m per hour during a gauging, which was carried out 100 m upstream from the site of the gauge, while the average width of the river was estimated at 15 m, then the actual measured flow had to be increased by:

$$\frac{15 \times 1000 \times 0{,}02}{3600} = 0.083 \text{ m}^3/\text{sec.}$$

In the case of water level rising, the calculated adjustment had to be subtracted from the measured flow, if measurement was carried out upstream from the gauge. With downstream measurements, adjustments had to be reversed.

2.4. Data processing and evaluation

2.4.1. General

To facilitate evaluation, all data collected were converted to the metric system and tabulated.

2.4.2. Flow data

There was some confusion as to which hydrological year should be used in the tabulation. Originally the Water Department used the period of November 1st - October 31st. The latest hydrological yearbook (1965-1970) [40] uses the period of January 1st - December 31st.

The logic behind a hydrological year is the state of the catchment. The more uniform the state of the catchment at the end of a hydrological year, the more homogeneous the annual data will be, which makes data analysis more reliable. For certain types of analysis, such as water balances, the storage term can be neglected if the state is constant at the end of each period. For this kind of study the hydrological year should end with the end of the dry season, October or November. In October or November, the small rains usually start, having a peak in December. They merge into the large rains, generally from January-May with a peak in April. In this case tabulation was carried out using the November-October hydrological year. If analysis of extreme values is to be carried out, periods from which the extremes will be selected should be independent. The annual low flows occur in the period of October-January. For the hydrological year chosen, the possibility exists that dependent values will be taken. Low flows at the end of October could be related to low flows in November, the beginning of the next hydrological year. No great problems occur in selecting the high flows, because these appear in the February-April period. The flow data were compared with rainfall data, to check their reliability. Annual and monthly means and standard deviations were calculated from reliable records. Low flows were subjected to a thorough analysis.

2.4.3. Rainfall data

Collection of rainfall data in Tanzania was started at the beginning of this century, from which date the network has slowly been expanded. The earliest streamflow measurements started in 1950.

It was decided to collect rainfall data for the majority of the stations starting from this year. Longer series of some specific stations were collected for a time-series analysis.

Annual and monthly means of stations with reliable data were calculated. In some cases area averages were calculated and compared with flows emerging from these areas, in order to estimate the surface water potential of these areas on an annual basis.

2.4.4. Other data

As mentioned in par. 2.2., meteorological data are mainly required for evaporation calculations. Their variation is much less than that of precipitation. Therefore only monthly data of the most recent years were collected, tabulated and used for potential-evaporation calculations. Calculated potential-evaporation of recent years was compared with potential-evaporation estimated by former studies.

2.4.5. Data collected in the field

From published flow data, the relation of rivers with perennial flows to specific source areas, usually mountain ranges with high rainfall and sometimes dense forests, could be detected.
These areas are:

a. Uluguru mountains
b. Nguru mountains
c. Rubeho mountains
d. Kaguru mountains
e. Migomberame mountains

Perennial rivers rise from all these mountains. The regular programme of measurements was concerned with these rivers, because if quality and low flow quantity are sufficient, they may be suitable for gravity supply. More details of the programme have already been given in par. 2.3.
It has to be noted that the sub-areas mentioned in this paragraph are mainly confined to the foothills of abovementioned mountains, where the rivers are easily accessible. An exception are the measurements in the Upper Msowero catchments in which some measurements are carried out far upstream, at a height which is sufficient to design a gravity supply for villages in the Berega catchment.

2.4.6. Statistical methods used in data analysis

The final result of data collection is in many cases a sequence of values arranged in order of their occurrence, so called time-series e.g. annual precipitation, January flows, etc. One may be interested in a mean value of this series but in many cases extreme values as in this study, are of more interest e.g. which annual minimum flow will not be exceeded once every twenty years. Frequency analysis deals with this type of questions.

Other questions that may be posed are: "Is there a relation between streamflow and precipitation" or "Does streamflow in the preceeding year influence stream flow in the present year". The question of correlation comes in here. The statistical methods used are described in Annex 1.

2.4.7. Hydrological models

The origin of the runoff is precipitation, which, after substraction of losses, becomes runoff. The transformation of precipitation into runoff takes place in the drainage basin, which is defined as the area drained by a stream in such a way, that all stream-flow originating in the area is discharged through a single outlet. Figure C 2.4-1 is a diagramme of the processes which are involved.

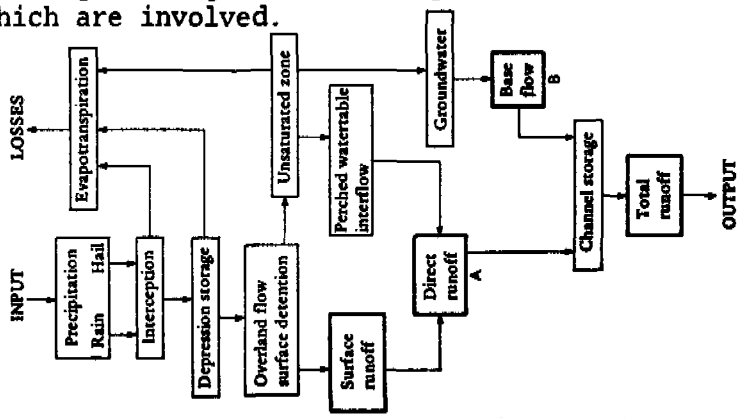


Figure C 2.4-1 Flow chart of the hydrological cycle.

Understanding of these processes can be useful in an optimal management of the water resources. The translation of above diagram into a mathematical formulation is called a hydrological model, or expressed differently: "a hydrological model is a simplified representation of a complex hydrological system".
In a paper presented at the Tanga Hydrological Seminar of 1978 (Msuya and Balaile, 1978) [48], it is even stated that one of the main tasks of a water master plan is to create a hydrological model, though no mention is made of the required complexity. Although models can be useful in assessing the proper management of a drainage basin or in extending flow series, the consultant thinks that at present even simple models cannot replace a proper stream-flow measuring network to assess the water potential of an area. Simple models however can be of great use if applied correctly, but they cannot be better than the initial measurements, which are used for calibration.

For more details see the hydrological handbooks [27] and the Tanga symposium mentioned before.
The hydrological models which are used in this study are described in Annex 2.

2.5. Special studies

Special studies were set up to examine in more detail subjects to which too little attention was paid in the approach outlined above. They are:

a. Detailed study of the Kikundi River
b. Flow analysis of the Ngerengere River

Objectives of the Kikundi River study are:
1. to determine the water resources potential of a mountainous catchment
2. to obtain a better insight into rainfall-runoff-sediment relations of the Kikundi catchment in particular and the Morogoro Region in general
3. to promote hydrology research at University level

The objectives of the Ngerengere River study are:
1. to review and extend surface-hydrology data series of the Ngerengere River in connection with the Mindu dam, to see if there might be a surplus available for water supply of villages below the dam
2. location of water sources to supplement inflow into the dam from other catchments

The reports on the studies are presented in Annex 3 and 4. The results are included in chapters 4 and 5 on the hydrology of the project area and the establishment of the surface water potential.

2.6. Transfer of knowledge

Involving the staff of the hydrology section of the Water Department of Morogoro was considered one way of transferring knowledge. Some flow measurements were also carried out together.

The Kikundi-catchment study was made in co-operation with the University of Dar es Salaam (Morogoro Campus), thus transferring the Consultant's knowledge to local University staff and students.

2.7. References

Meteorology and climatology

1. EAMD (1975)
   Climatological statistics for East Africa, part III
   East African Meteorological Department, Nairobi, Kenya

2. Griffith, J.F. (1962)
   "The climate of East Africa - in E.J. Russel (ed), the Natural Resources of East Africa, East African literature bureau, Nairobi, Kenya

3. Griffith, J.F. (1969)
   Climate - in W.L.W. Morgan (ed), East Africa: its people and resources
   Oxford University Press, Nairobi, Kenya

4. Jackson, I.J. (1977) - Climate, water and Agriculture in the tropics - Longman, New York - London

5. Jackson, I.J. (1971)
   "Climate", in Berry L. (ed), Tanzania in maps
   University of London Press Ltd, London

6. Nieuwolt, S. (1977)
   Tropical Climatology, an introduction to the Climate of the Low latitudes
   John Wiley and Sons, London, New York

Rainfall

7. Desi, F et al. 1965
   On determining the rational density of precipitation measuring networks
   IASH publ. nr. 67 (p.127-130) Symposium, Quebec

8. EAMD (1961)
   10% and 20% - probability maps of annual rainfall of East Africa,
   East African Meteorological Department, Nairobi, Kenya

9. EAMD (1969)
   Average annual and monthly rainfall maps of East Africa. East African Meteorological Department, Nairobi, Kenya

10. East African Meteorological Department
    Observer's Manual - Nairobi, Kenya

11. Jackson, I.J. (1970), Rainfall over the Ruvu Basin and surrounding area
BRALUP research report nr. 9, University of Dar es Salaam, Dar es Salaam.

12. Jackson, I.J. (1970), "Annual rainfall probability and the binomial distribution", E.A. Agric. For. J, 35, nr. 3

13. Jackson, I.J. (1978)
Local differences in the patterns of variability of tropical rainfall: some characteristics and implications
J. of Hydrology 38, 273-278

14. Lumb, F.E. (1965), "Cycles and trends of rainfall over East Africa", Proceedings of 3rd specialist meeting on applied meteorology in East Africa
EAAFRO, Muguga, Kenya

15. Lumb, F.E. (1966), "Synoptic disurbances causing rainy periods along the East African coast", Met. Mag., 95, 150-159

16. Morth, H.T. (1965), "Recent rainfall series studies and their application to agricultural meteorology"
Proceedings of 3rd specialist meeting on applied meteorology in East Afric., EAAFRO, Muguga, Kenya

17. Morth, H.T. (1968), "A study of the areal and temporal variations of rainfall in East Africa", Proceedings of 4th specialist meeting on applied meteorology in East Africa, Nairobi, Kenya

18. Sanson, H.W. (1965), "The maximum possible rainfall in East Africa", EAMD Mem. nr. 3, Nairobi, Kenya

Evaporation
----

19. Doornbos, J. Pruit, W.O. (1975)
Cropwater requirements
Irrigation and drainage paper 24
FAO, Rome, Italy

20. Nieuwolt, S. (1973) Rainfall and evaporation in Tanzania. Bralup Res. paper nr. 24
University of Dar es Salaam, Dar es Salaam, Tanzania

21. Woodhead, T. (1968)
Studies of potential evaporation in Tanzania
Ministry of lands, settlement and water development
Dar es Salaam, Tanzania

Hydrology, sediment, land and water development

22. Agrar und Hydrotecknik GmbH (1976)
Tanga Water Master Plan
Essen, Federal Republic of Germany

23. Balek, J. (1977)
Hydrology and water resources in tropical Africa
Developments in water science 8, Elseviers scientific publishing
Co. Amsterdam, New York

24. Baweja, P.S., Sarma S.V.K. (1978)
The sediment problem in Tanzanian rivers
Uhandisi, Journal of the faculty of engineers
University of Dar es Salaam, Dar es Salaam, Tanzania

25. Bureau of Resource Assessment and Land Use
Planning, University of Dar es Salaam, BRALUP (1973)
Studies of soil erosion and sedimentation in Tanzania
Research Monograph, Number 1, 1973

26. Brokonsult AB (1978)
Water master plan for the Mara, Mwanza and West Lake Regions. Draft
Final Report, volume 4, studies in Hydrology, Taby, Sweden

27. Chow, V.T. (1964)
Handbook of applied hydrology, Mc. Grawhill, New York, London

28. Dagg, M. et al. (1965)
Studies of the effects of changes in land use on the hydrological
cycle in East Africa by means of experimental catchment areas
Bull. IASH Xe année No. 4, 63-75

29. Darabe, N. (1977)
A hydrological study of the Kikundi River Catchment, Morogoro,
Tanzania (unpublished report)
B.Sc. project University of Dar es Salaam, Tanzania

30. DHV (1975)
Mtibwa irrigation project, hydrology and preliminary design
Amersfoort, The Netherlands

31. Dolfi, D. (1963). Water resources potential of the Wami basin
FAO report nr. 1626, Rome, Italy

32. DTH (1975)
Integrated development for Morogoro Region, annex II, water
resources and development
Ministry of foreign affairs, The Hague, The Netherlands

33. Fair et al. (1954)
Water supply and waste water disposal
Wiley, New York, 1954

34. FAO (1961)
An outline plan for the development of the Ruvu basin, report to the Government of Tanganyika, Rome, Italy

35. Fawley, A.P. (1956)
Msalatu Reservoir, Dodoma
Rec. Geological Survey Tanganyika
Vol. III, Dar es Salaam, Tanzania

36. Fiddes, D. 1975
The TRRL East African flood model, flood hydrology symposium - Nairobi 21-24 October 1975
Transport and road research laboratory dept. of the environment, Crownthorne, Berkshire U.K.

37. Finnwater (1977)
Mtwara-Lindi water master plan - Annex A, Hydrology
Finnwater, Helsinki, Finland

38. Gillman, C. (1943)
A reconnaissance survey of the hydrology of Tanganyika territory in its geographical settings
Water Consultant's report nr. 6-1940
Government printer, Tanganyika

39. Heijnen, J.D. (1970)
The river basins in Tanzania, a bibliography
BRALUP, research note nr. 5, University of Dar es Salaam, Dar es Salaam, Tanzania

40. Hydrological yearbook 1950-1959, Tanzania
Hydrological yearbook 1960-1965, Tanzania
Hydrological yearbook 1966-1970, Tanzania

41. Kellerhals, R. (1972)
Hydraulic performance of steep natural channels-in Slaymaker, O.
Mountain Geomorphology
Tantalus Res. Ltd. Vancouver

42. Kobalyenda, J.M. (1978)
Sacramento Model applied to the Ngouo Basin
The 4th hydrological seminar, Tanga
11/9/78 - 19/9/78 Ministry of Water, Energy and Minerals, Tanzania

43. Kovacs, G., Morth, H.T. (1974)
The use of rainfall data in estimating actual and maximum probable river discharge (TANA/KENYA)
Technical memorandum nr. 20 EAMD, Nairobi, Kenya

44. Little, B.G. (1963)
Report on the conditions of rivers rising in the Uluguru mountains and their catchments
Unpublished report WDID, Tanzania

45. Lucas, C.A.F. (1964)
Technical note on the design and construction of small earth dams - Ministry of Agriculture, WDID
Dar es Salaam, Tanzania

46. Malinda, C.K. 1978
The transport and road research, laboratory (TRRL)
East African flood model investigations
Unpublished report (student project) engineering faculty, University of Dar es Salaam, Dar es Salaam, Tanzania

47. Msumba, J.A. (1974)
Morogoro Fisheries Report
25/9/1974

48. Msuya, M.O.Y., Balaile, W. (1978)
The essence/objectives of water master planning
The 4th hydrological seminar, Tanga
11/9/78 - 19/9/78 Ministry of Water, Energy and Minerals, Tanzania

49. NEDECO (1972)
Water resources of the Mkondoa-Wami River basin
NEDECO, The Hague, The Netherlands

50. NEDECO (1974)
Shinyanga water supply survey, water master plan for the Shinyanga Region, technical Annex A Hydrology
NEDECO, The Hague, The Netherlands

51. Ngana, J. (1977)
Preliminary investigation of the hydrology of Rukwa Region
BRALUP research report nr. 22, University of Dar es Salaam, Dar es Salaam, Tanzania

52. Ogrosky, H.O., et al. (1964)
Hydrology of Agricultural Lands
Handbook of Applied Hydrology, Section 21
Chow V.T. Mc Graw Hill, New York, London

53. Paterson, S.L. (1955)
Notes on the hydrological investigation of the Ruvu River, Tanganyika
Informal hydrological conference Lusaka, Zambia

54. Pereira, H.C. et al. (1962), "Hydrological effects of changes in some East African catchment areas
E.A. Agric. For. J. 27 special issue

55. Pereira, H.C. (1965)
"Land use and stream flow"
E.A. Agric. For. J. 30, 395-397

56. Pereira, H.C. (1965)
Suspended sediment and bed load sampling in the Mbeya range catchments
E.A. Agric. For. J. 27, 123-125

57. Rapp, A., et al. (1973)
Soil erosion and sediment transport in the Morogoro River catchment, Tanzania
BRALUP Research Monograph nr. 1, 1973
University of Dar es Salaam, Tanzania

58. Rapp, A., et al. (1973)
Soil erosion and sedimentation in four catchments near Dodoma, Tanzania
BRALUP Research Monograph nr. 1, 1973
University of Dar es Salaam, Tanzania

59. Rensburg, H.J. van (1955)
Run-off and soil erosion tests, Mpwapwa, central Tanganyika
E.A. Agric. For. J., 20, 228-231

60. Riise, U. (1972)
Mkondoa River system, flood frequencies and flow characteristics,
BRALUP research report nr. 41
University of Dar es Salaam, Dar es Salaam, Tanzania

61. Sarma, S.V.K. (1978)
Sediment regression model of the Kizinga basin, Tanzania
Unpublished report, engineering faculty, University of Dar es Salaam, Dar es Salaam, Tanzania

62. Savilc, A.M. (1945)
A study of recent alterations in the flood regimes of three important rivers in Tanganyika
E.A. Agric. For. J., 11, 69-74

63. SWECO 1977
Studies of soil-erosion, vegetation and fluvial transport of Mtera Reservoir Region, Tanzania
Sweden

64. Taylor, C.M., Lawes, E.F. (1978)
Rainfall intensity-duration frequency data for stations in East Africa
EAMD, Technical Memorandum No. 17, Nairobi, Kenya

65. Temple, P.H. (1973)
Landslides in the Mgeta Area, Western Uluguru Mountains, Tanzania
BRALUP Research Monograph nr. 1, 1973
Dar es Salaam, Tanzania

66. Toebes, C., Ouryvaev, V., ed. (1970)
Representative and experimental basin studies and reports in Hydrology 4
UNESCO, Paris, France

67. United States Department of the Interior Bureau of Land Reclamation
Design of small dams
2nd edition, 1973

68. W.M.O., 168 (1970)
Guide to hydrological practices
World Meteorological Organisation, Geneva, Switzerland

69. Zeeuw, J.W. de (1973)
Hydrograph analysis for areas with mainly groundwater runoff - in Drainage principles and applications
chapter 16, ILRI publication 16 Vol. II
P.O.Box 45, Wageningen, the Netherlands, 1973

Domestic water supply
----

70. Gauff, H.P. (1972)
Morogoro town water supply feasibility study, Nairobi, Kenya

71. Gibbs and Partners, Sir A. (1976)
Updated feasibility report Morogoro water supply

72. Kaduma, J. (1970)
Mindu dam, Morogoro
BRALUP research report 21, University of Dar es Salaam, Dar es Salaam, Tanzania

73. Kajulu, S. (1970)
The extension of the Kisitwe-Rubeho pipe line: a planning study
BRALUP research report nr. 15
University of Dar es Salaam, Dar es Salaam, Tanzania

74. N.N. Report on Ngerengere River control; Mindu dam, Ministry
of Water Development, 1956
Library number A 33

75. Shilungushela, J.M.S. (1978)
Design of Natta dam
Unpublished report (student project) engineering faculty
University of Dar es Salaam, Dar es Salaam

76. SOGREAH (1962)
Report of the French technical mission for the development of the
Ruvu basin
Grenoble, France

3. DATA COLLECTION AND EVALUATION

3.1. Precipitation

3.1.1. Available precipitation data

Precipitation observations have been made in the area since the beginning of the century. However, systematic collection and scrutiny was started in 1929, when the East African Meteorological Department (EAMD) was established. Thus the international standard thirty-year period 1931-1960 is the first such period of which systematic rainfall data are available in Tanzania. Regular annual publishing started in 1960 with the summary of rainfall of the year before. From these summaries (last one published in 1974) the Consultant has selected the stations in the area and has obtained all available monthly data from 1950 onwards from the EAMD at Dar es Salaam. All these data up to the end of 1977 are presented in the Data part of this volume. Monthly data of some stations from before 1950 were obtained from NEDECO (1974) [49]. Some stations are run by EAMD itself, many are run by sisal estates, while the Ministry of Water Energy and Minerals also runs 18 stations.

In the 1950-1977 period approximately 150 stations were in operation, many however intermittently. Half the stations were in operation in the year 1977. The stations are shown on map C 1. The data are presented on a monthly basis in the data part of this volume.

The rain gauge used is a model of the EAMD, having a collecting aperture with a 12.7 cm (5") diameter. The rain gauge is installed with the rim 30 cm above the ground level. This model is commonly used in East Africa. Readings are done in the early morning and related to the day before. Besides these manual rain gauges, 10 automatic gauges were installed in the area.
Only monthly and annual data will be discussed. Precipitation fallen over shorter time periods will be touched on in the detailed study of the Kikundi River (annex A3).

3.1.2. Representativeness of the precipitation network

The average network density in the whole project area, counting only the gauges in operation in 1977, is approximately 400 km^2/rain gauge. Although high according to international standards for tropical regions, (the World Meteorological Organisation advises 600-900 km^2/station in flat tropical zones (WMO 1970) [68]), the distribution over the area is very uneven, which makes the network efficiency very low. Many gauges are situated around Kilosa and Morogoro and in the Uluguru Mountains, while the other mountain ranges and the Wami valley have hardly any. This is related to population density and areas of agricultural interest.

The optimal density depends on the need for the data, the error tolerated and on cost of collection. If daily rainfall is of interest, a very dense network is required, because of the patchiness of daily rainfall, to obtain a sufficiently accurate picture of the rainfall distribution. Sugar estates have about 1 gauge per km^2. If longer time intervals are considered, the network can be less dense. Figure C 3.1-1 (after Desi, 1965) [7] relates network density and time interval to percentage error of areal depth of precipitation for zones of mainly convective precipitation. E.g. for areas of 1000 km^2, about 14 gauges are necessary, if on a monthly basis an areal precipitation depth within 10% of the true depth is required. If a season or a year is considered, 2 gauges are sufficient for the same area. If rain is affected very much by difference in exposure and altitude, many more gauges will be required than indicated by Figure C 3.1-1. For most mountainous catchments in the area, five to six rain gauges above the river flow measuring station seem a minimum to obtain a meaningful rainfall-runoff relation. This is usually not the case. Hence, from the hydrological point of view the network is insufficient.

3.1.3. Annual precipitation

The annual precipitation was calculated according to the January-December calender year and the hydrological November-October year.
Annual Isohyetes for the area can be seen on Figure C 3.1-2 copied from the EAMD rainfall map of East Africa and based on all available data in 1966.

Statistical parameters of 10 precipitation stations, of which 8 inside the project area, one coastal town (Bagamoyo) and one station in between, are presented in Table C 3.1-1. The calculation period used is 25 years (1953-1977), except for the Ukaguru forest station, for which only 20 years are available. Note that the means vary considerably, but that the coefficient of variation (Cv) mainly varies between 0.2 and 0.3. The variability of stations with low rainfall and high rainfall is about the same. As was expected the coefficient of skewness (Cs) based on only 25 years of data varies considerably. The average Cs value of the hydrological years is much lower than the Cs value of the calender year. However, this must be so by chance. Most Cs values are positive, indicating that the annual rainfall is slightly skew and that the assumption of normality for these data is only approximately true.

The probability of non-exceedence of the preceeding hydrological year (1977/78), the year in which the Consultant measured flows, is slightly above average for the stations of which the data already could be collected. The hydrological year was wetter than normal with respect to annual total precipitation, as is shown in Table C 3.1-1. This table also shows the lowest three years of the last 25 years. The year 1974, which was con-

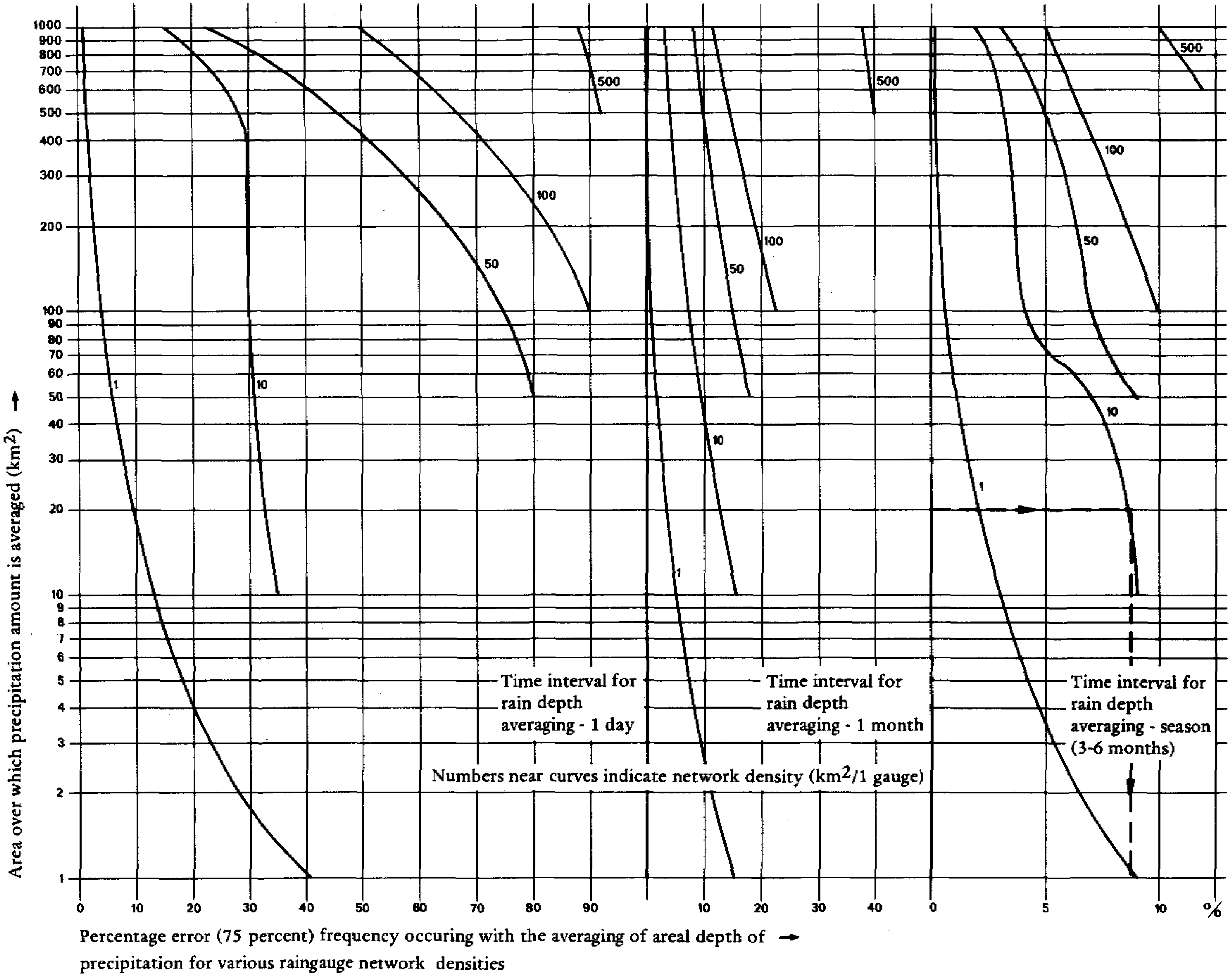


Figure C 3.1-1 **Areal-depth-error-precipitation network density diagram for zones of mainly convective precipitation (after desi, 1965) [7]**

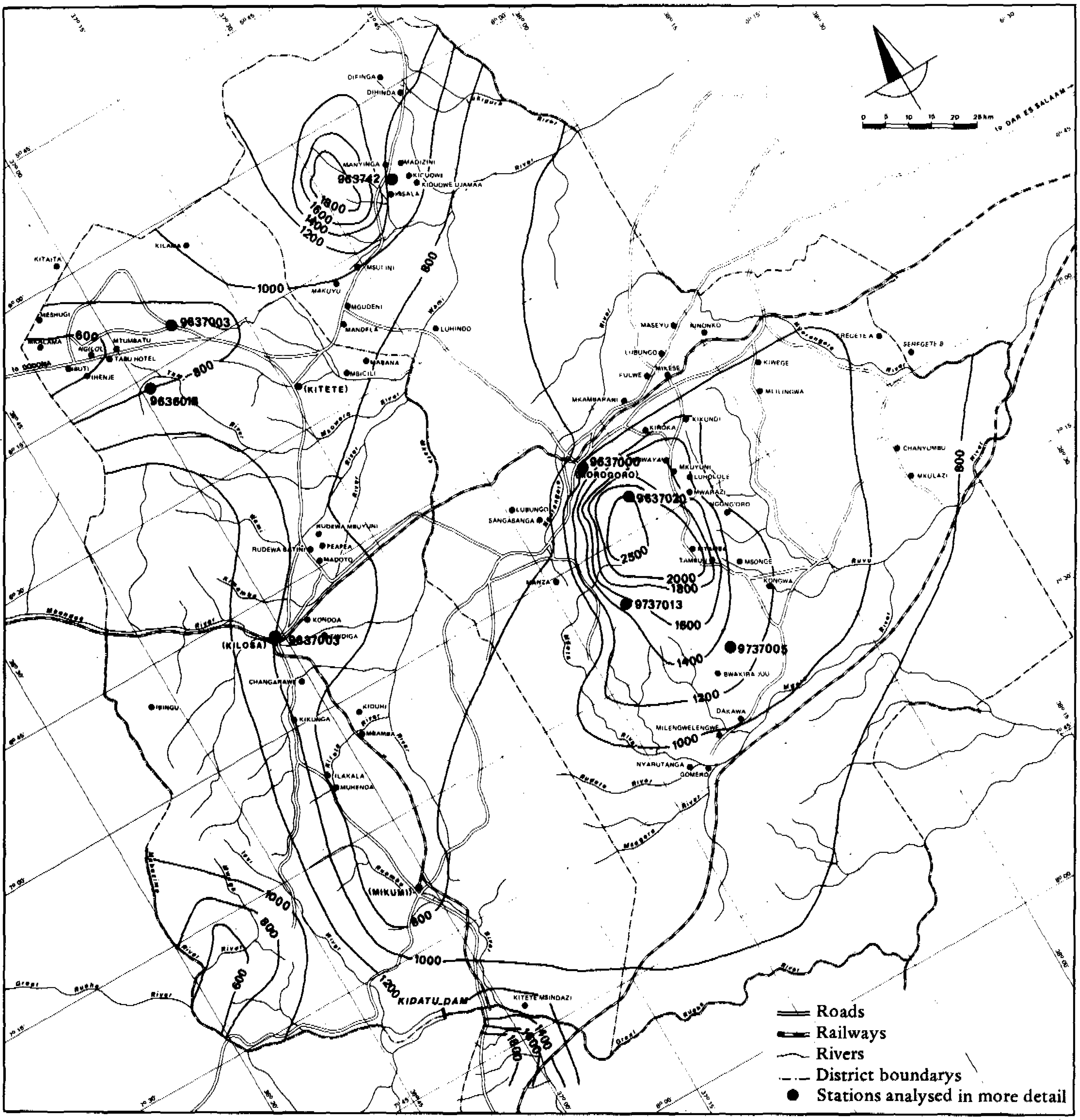


Figure C 3.1-2 Annual rainfall distribution based on all available data at 1966

Table C 3.1-1 Precipitation parameters of 10 selected stations in and near the project area

Station	Number	Distance from coast as the crow flies (km)	Altitude (m)	Mean* (mm)	Standard* deviation (mm)	Coefficient* of variation (–)	Coefficient* of skew (–)	Analysed observation period and number of years	Lowest years* 1st	2st	3st	Rainfall* 1978 or 1977/78	Prob. of non-exceedence of former value
Bagamoyo Agricultural	963800	1	10	1021	298	0,29	+1,68	1953-77	1960	1971	1965	–	–
Office				1021	246	0,24	+0,72	25	64/65	70/71	74/75	–	–
Mandera Mission	963804	55	210	1101	348	0,32	+1,05	1953-77	1958	1973	1976	1106	51%
				1103	315	0,29	+1,26	25	69/70	70/71	54/55	1061	45%
Singiza Mission	973705	160	460	1454	286	0,20	–0,07	1953-77	1964	1966	1969	–	–
				1443	250	0,17	+0,21	25	64/65	76/77	53/54	–	–
Kienzema Mission	973713	170	1680	1351	272	0,20	+0,37	1953-77	1959	1976	1960	–	–
				1340	226	0,17	+0,12	25	76/77	58/59	53/54	–	–
Tegetero Mission	963720	160	990	2619	755	0,29	–0,55	1953-77	1976	1977	1974	–	–
				2616	707	0,27	–1,25	25	75/76	76/77	73/74	–	–
Morogoro Agricutural	963700	160	580	937	218	0,23	+0,77	1953-77	1953	1976	1959	1256	93%
Office				927	175	0,19	+0,16	25	52/53	58/59	75/76	1009	68%
Mtibwa Sugar Estate	963742	130	460	1183	289	0,24	+0,70	1953-77	1954	1958	1975	–	–
				1175	225	0,19	+0,92	25	74/75	57/58	53/54	–	–
Kilosa Agricultural	963701	220	490	1057	226	0,21	+0,44	1953-77	1954	1955	1962	843	97%
Office				1050	208	0,20	+0,82	25	64/65	74/75	55/56	991	61%
Berega Mission	963703	180	850	778	169	0,22	+0,17	1953-77	1974	1960	1966	1087	97%
				773	170	0,22	+0,84	25	73/74	62/63	68/69	875	73%
Ukaguru forest	963618	210	1680	1461	337	0,23	+0,67	1958-77	1974	1975	1970	1800	84%
				1460	333	0,23	–0,09	20	69/70	74/75	64/65	1625	69%
Mean				1297	320	0,24	0,52						
				1291	285	0,22	0,37						

* The first row refers to the January-December year, the second row refers to the November-October year

Table C 3 . 1 - 2 Frequency analysis of annual precipitation

Station	Year / number	Annual precipitation* (mm) equal or less, when return period is in years or %								
	Year	100	20	10	5	2				
	probability / number	1%	5%	10%	20%	50%	80%	90%	95%	99%
Bagamoyo Agricultural Office	963800	326	529	640	771	1021	1271	1402	1513	1715
		448	615	706	814	1021	1218	1336	1427	1594
Mandera Mission	963804	290	527	656	809	1101	1393	1546	1675	1912
		369	583	700	838	1103	1368	1506	1623	1834
Singiza Mission	973705	779	973	1088	1204	1454	1685	1820	1917	2111
		709	923	1123	1178	1443	1708	1763	1963	2177
Kienzema Mission	973713	717	902	1003	1122	1351	1579	1699	1800	1985
		813	967	1051	1150	1340	1530	1629	1713	1867
Tegetero Mission	963720	860	1373	1653	1985	2619	3253	3585	3865	4378
		969	1449	1711	2022	2616	3210	3521	3783	4263
Morogoro Agricultural Office	963700	429	577	658	754	937	1120	1216	1297	1445
		519	638	703	780	927	1074	1151	1215	1335
Mtibwa Sugar Estate	963742	510	706	813	940	1183	1426	1553	1660	1856
		651	804	887	986	1175	1364	1463	1546	1699
Kilosa Agricultural Office	963701	530	684	768	867	1057	1247	1346	1430	1584
		565	707	784	875	1050	1225	1316	1393	1535
Berega Mission	963703	384	499	562	638	778	920	994	1057	1172
		377	493	555	630	773	916	991	1054	1169
Ukaguru forest	963618	676	905	1030	1178	1461	1744	1892	2017	2246
		684	911	1034	1180	1460	1738	1886	2009	2236

* The first row refers to the January-December year, the second row refers to the November-October year

sidered a rather dry year in Tanzania appears as a rather low year in only 3 of the 19 stations. However the distribution over the year has not been considered in these figures. The rain might have fallen in the wrong period, causing the planting and growing period to be too dry.

The distribution of the calender year values of the stations Morogoro-Agricultural Office and Berega Mission are presented on Figure C 3.1-3, while Figure C 3.1-4 shows the graphical frequency analysis of the two stations. Morogoro calender year data seem quite skew on these graphs. Data according to the hydrological year might have given a better graphical representation, judging from the lower Cs value.
An analytical frequency analysis was carried out for all 10 stations. Frequencies of non-exceedence between 1% and 99% are presented in Table C 3.1-2. The differences between calendar year values and hydrological year values are not very large. Values below 5% and above 95% should be considered carefully.

Trend analysis of the normal-year values was carried out for the stations Kilosa Agricultural Office, Morogoro Agricultural Office and Berega Mission. All three stations have records dating back to the 1930's. The first part of the record was compared with the second part and a t-test was carried out on the differences of the means of the two periods (Table C 3.1-3). For all three stations the mean in the second period is somewhat higher, but the differences are not significant.

For the 1946-1977 period 5-year running means are plotted, starting in 1950 with the 1946-1950 mean. (Figure C 3.1-5). All three records show a slightly upward trend, with low-flow periods between 1950-1955 and rather high means between 1964-1970. The last 5-year mean can be considered average. Correlation coefficients r were calculated between year and precipitation in that year.

Table 3.1-3 Data used in trend analysis

	Kilosa Agr. Off. (963701)	Morogoro Agr. Off. (963700)	Berega Mission (963703)	Remarks
PERIOD I	1931-1952	1931-1952	1933-1952	t-tests for testing differences in means did not show any significant difference (5% level) between period I and II for each station
number of observations	22	22	20	
mean (mm)	1003	918	740	
standard deviation (mm)	248	214	200	
Cv	0.25	0.23	0.27	
PERIOD II	1953-1977	1953-1977	1953-1977	
number of observations	25	25	25	
mean (mm)	1057	937	778	
standard deviation (mm)	226	218	169	
Cv	0.20	0.23	0.22	
Correlation coeff. r between year and precipitation in this year (period 1953-1977)	+ 0.30	+ 0.23	+ 0.20	In none of the cases the r is significant at the 5% level

All r values are positive. In none of the 3 cases the r was significant at the 5% level, which indicates that the upward trend in the data can be considered accidental.

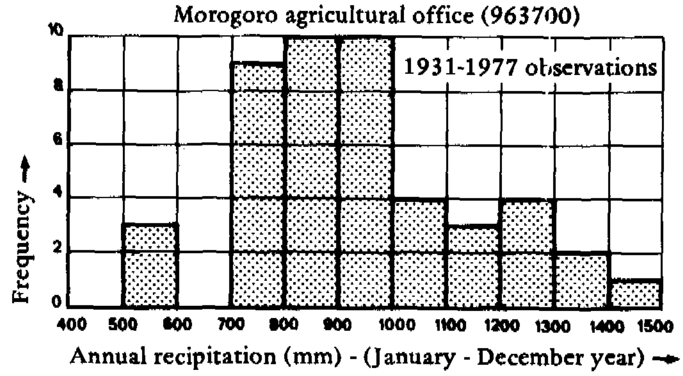
Other tests were carried out to discover cycles of dry and wet years, but none of the tests indicated any.

An analysis of three stations cannot be considered conclusive, but they do indicate that precipitation changes in the project area are not very likely. The results also support the much broader statement of Dalby and Harrison Church (quoted from Jackson, 1978 [13]), that there is no conclusive evidence of cyclic or permanent change in climate on a continental scale.

3.1.4. Monthly precipitation

Monthly precipitation parameters of the same 10 stations as those used in the former section on annual precipitation were calculated and are presented in Table C 3.1-4.

The means clearly reflect the high rainfall peak around April, while a second peak, although less distinct than the former peak, can be distinguished at the end of the year (see Figure C 3.1-6).



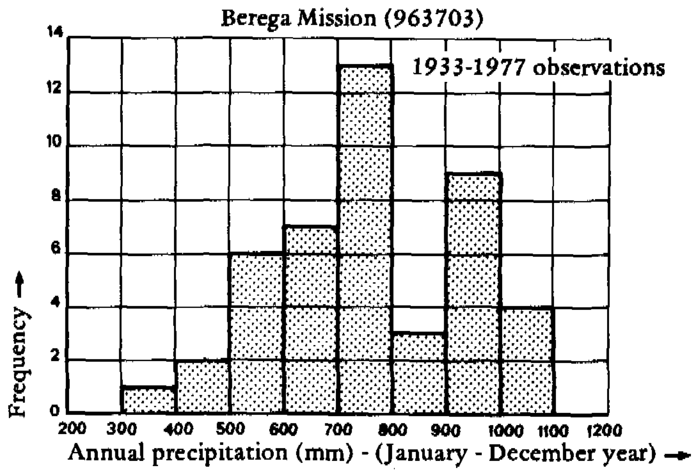


Figure C 3.1-3 Frequency distributions of annual precipitation for Morogoro Agricultural Office and Berega Mission

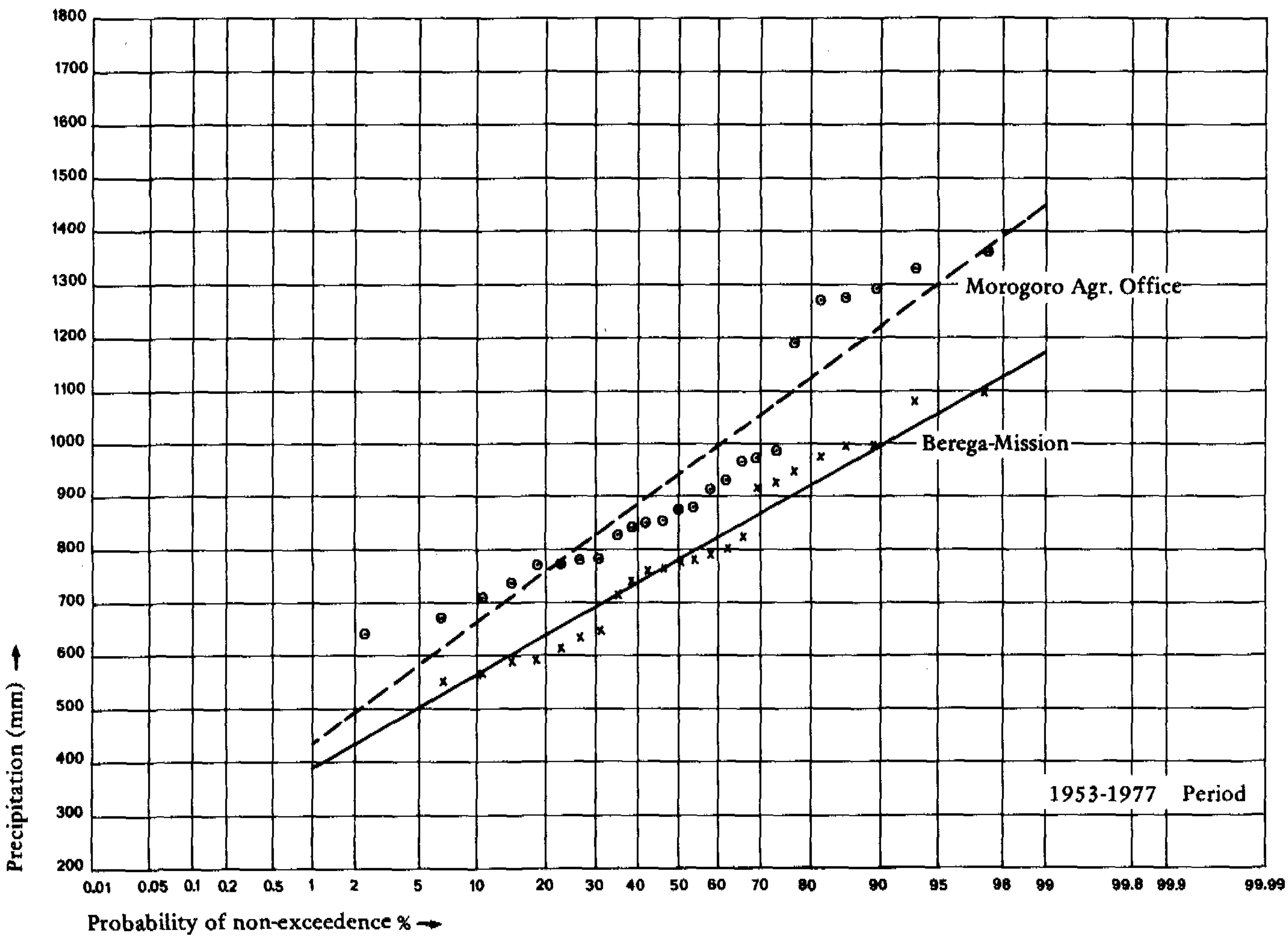


Figure C 3.1-4 Frequency analysis of annual precipitation (calendar year values)

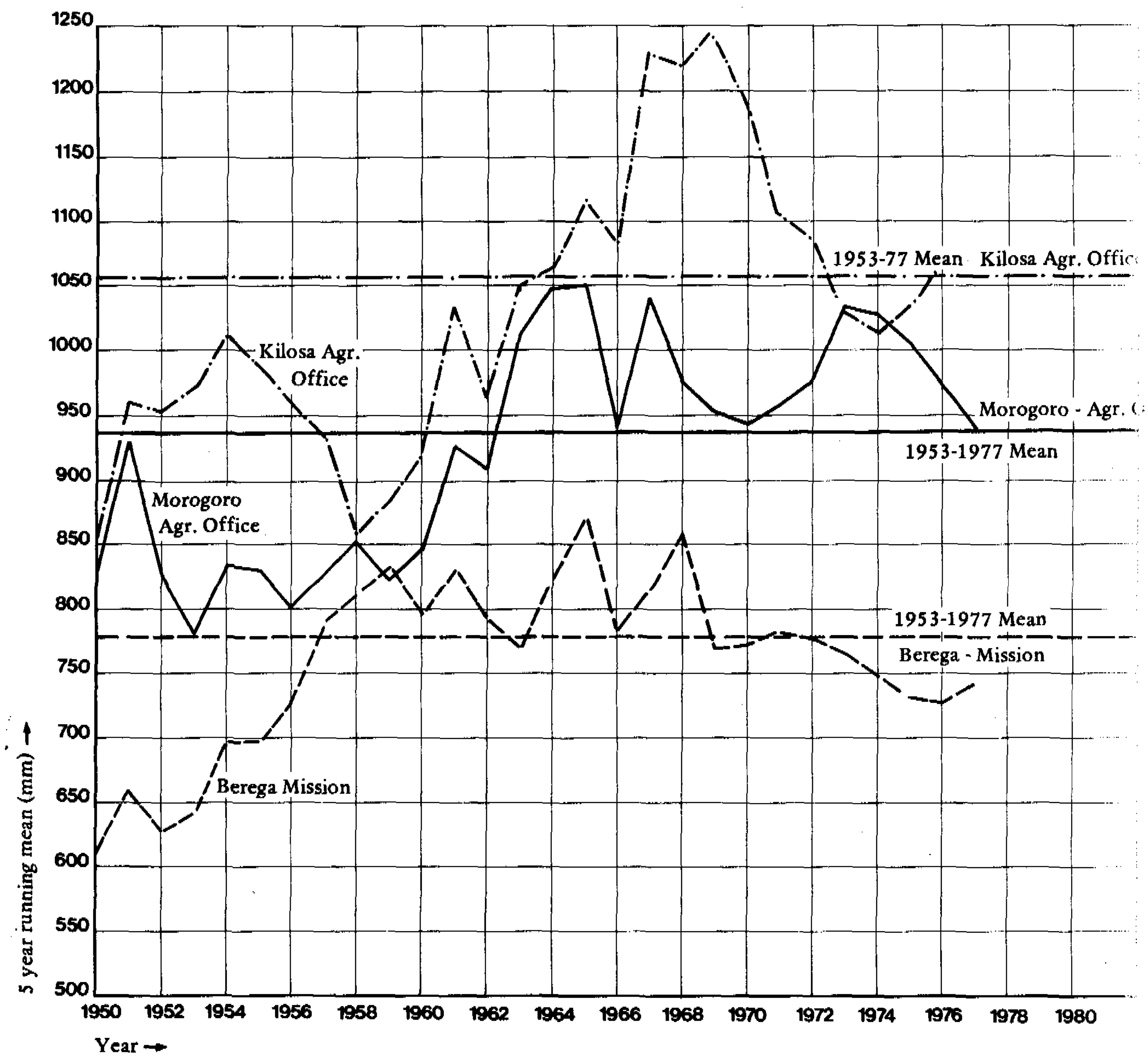


Figure C 3.1-5 Trend of annual precipitation (five year running means)

The coefficient of variation Cv changes in reverse to the rainfall amount, meaning that lower rainfall is much more variable. The high Cv of the months in which the second peak is found, clearly reflects the fact of uncertainty of this second peak, which means that high rainfall cannot always be expected in this period. This is also reflected in the occurrence of lowest annual flows, which usually occur in October or November, but sometimes also occur in January or February.

3.1.5. Spatial variation of precipitation

Because of the lack of sufficient rainfall stations in the northern mountain ranges, isohyetes on Fig. C 3.1-2 are only approximately true, e.g., Ukaguru station, situated on the 800 mm isohyete receives a mean annual precipitation of 1460 mm.
The data however indicate in general, that:

1. rainfall at stations with the same altitude decreases further from the coast
2. rainfall at stations with the same exposure increases with altitude, up to an altitude of 1500 to 2000 metres above MSL after which it decreases again because of less moisture in the air

Due to the very marked influence of exposure (rain shadow effect) general rainfall-altitude relations are not very relevant. The mean annual rainfall at Tegetero Mission is for instance double the amount recorded at Kienzema Mission. Both stations are situated in the Ulugurus, while the former station is 700 m lower. This also means that a rather dense precipitation network is required in the mountainous areas to make a proper estimate of areal-depth of rainfall.

Despite the fact of patchiness of rainfall caused by a convectional type of storms, the whole area is usually influenced by the same air flow pattern, causing a wet season or a dry season throughout the Region. As a result the annual correlation coefficients, based on 17 years of observations, of stations at a distance of up to 100 km, are all significant (Table C 3.1-5). Distance between stations does not affect correlation very much as can be seen in Figure C 3.1-7. However, this does not mean that if at one station the season is very dry, a very dry season will also be experienced at an other station, as clearly appears from Table C 3.1-1, in which the 3 years with the lowest precipitation of the last 25 years are presented. These years are in many cases different for the different stations.

The correlations on a monthly basis are somewhat lower for the months with low rainfall than for the months with high rainfall.However the same tendency is shown as with the annual values.
Except for the nearby station, which can be very highly correlated, again distance does not influence correlation very much, as can be seen in Figure C 3.1-8.

Table C 3 . 1 - 4 Monthly precipitation parameters of some selected stations

Station	Number	*	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total	Analysed period
Bagamoyo Agr. Office	963800	$\bar{m}$	76	75	107	230	166	46	36	25	31	55	66	108	1022	1953-77
		s	53	72	90	82	124	53	33	25	34	64	77	80	298	
		Cv	0,70	0,96	0,84	0,36	0,75	1,15	0,93	1,00	1,08	1,17	1,18	0,74	0,29	
Mandera Mission	963804	$\bar{m}$	98	107	135	224	131	28	26	24	39	82	116	91	1102	1953-77
		s	100	81	80	85	81	28	29	26	53	94	128	63	348	
		Cv	1,01	0,76	0,59	0,38	0,62	1,02	1,09	1,10	1,35	1,15	1,11	0,70	0,32	
Singiza Mission	973705	$\bar{m}$	141	123	267	411	155	38	18	16	32	34	109	111	1454	1953-77
		s	83	82	121	157	120	36	26	25	41	49	111	77	286	
		Cv	0,59	0,67	0,45	0,38	0,77	0,96	1,44	1,59	1,30	1,44	1,02	0,69	0,20	
Kienzema Mission	973713	$\bar{m}$	173	160	217	314	114	28	18	9	27	41	102	149	1351	1953-77
		s	98	92	102	105	64	29	32	16	29	52	79	61	272	
		Cv	0,57	0,57	0,47	0,33	0,56	1,05	1,84	1,79	1,10	1,26	0,77	0,41	0,20	
Tegetero Mission	963720	$\bar{m}$	215	183	346	560	283	108	93	89	123	157	220	238	2619	1953-77
		s	109	117	181	208	160	83	82	86	101	147	222	167	755	
		Cv	0,51	0,64	0,52	0,37	0,57	0,77	0,89	0,98	0,82	0,94	1,01	0,70	0,29	
Morogoro Agr. Office	963700	$\bar{m}$	101	96	141	241	90	22	16	12	20	39	65	95	937	1953-77
		s	63	60	70	93	51	20	25	20	24	41	76	75	219	
		Cv	0,63	0,63	0,50	0,38	0,57	0,92	1,58	1,69	1,21	1,07	1,17	0,79	0,23	
Mtibwa Sugar Estate	963742	$\bar{m}$	122	120	188	238	123	22	21	22	36	69	92	123	1183	1953-77
		s	68	77	89	112	74	19	20	23	36	77	113	86	289	
		Cv	0,55	0,64	0,47	0,47	0,60	0,89	0,97	1,05	1,01	1,12	1,23	0,70	0,24	
Kilosa Agr. Office	963701	$\bar{m}$	127	128	188	226	74	12	8	17	20	36	87	137	1057	1953-77
		s	61	51	75	72	60	13	15	17	27	43	96	106	226	
		Cv	0,48	0,40	0,40	0,32	0,81	1,11	1,87	1,01	1,33	1,21	1,10	0,77	0,21	
Berega Mission	963703	$\bar{m}$	138	137	111	131	70	15	13	3	4	11	36	107	778	1953-77
		s	85	66	67	64	45	16	19	7	10	22	53	64	169	
		Cv	0,61	0,48	0,60	0,49	0,64	1,10	1,40	2,10	2,39	2,00	1,47	0,59	0,22	
Ukaguru forest	963618	$\bar{m}$	141	138	206	282	116	36	27	50	69	75	122	201	1461	1958-77
		s	75	69	89	85	81	33	25	43	54	68	136	122	337	
		Cv	0,54	0,50	0,43	0,30	0,70	0,94	0,93	0,87	0,79	0,91	1,12	0,61	0,23	

* $\bar{m}$ = mean in mm
s = standard deviation in mm
Cv = coefficient of variation

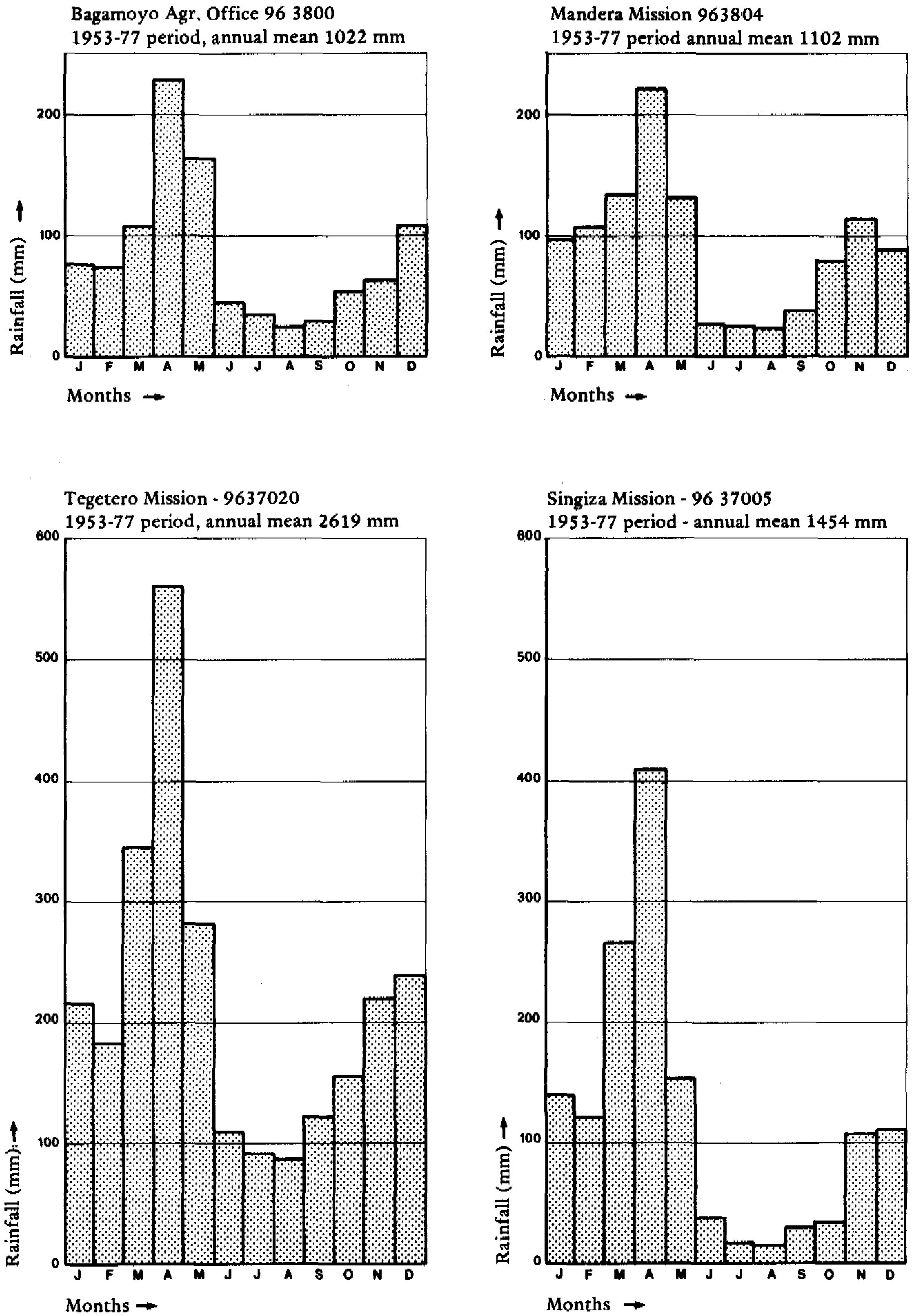


Figure C 3.1-6 Monthly precipitation (mm)

Seven-year annual and monthly precipitation data of three nearby stations (2-3 km distance as the crow flies) near and in Morogoro Town are presented in Table C 3.1-6. From the calculated ratios of the precipitation of the different stations in the same time period, it can be concluded again that yearly and monthly values can differ very much from each other. However, in general the tendency for wet or dry years or months is the same for the three stations.

3.2. Meteorology

3.2.1. Available meteorological data

In the project area four meteorological stations are located (see Map 1). Two stations just outside the Region: Kilombero and Kongwa. Kilombero is just South of the Ruaha River, while Kongwa is located between Gairo and Dodoma. The parameters measured at Kongwa, located at 1021 m above MSL will be more representative for the western parts of the area, especially the Berega catchment, than the other stations which are all located below 550 m above MSL.

In many cases instruments are out of order or charts are out of stock. Selected monthly data of stations run by EAMD and the Department of Agriculture, have been collected from 1970 onwards at the EAMD office. Kongwa and Kilombero data have not been processed yet. The available data are given in the data part of this volume.

3.2.2. Meteorological parameters

The meteorological characteristics of tropical areas, rainfall excepted, do not change very much over the years, as is illustrated by Morogoro-Meteorological Station (Table C 3.2-1). Sudden jumps in records are usually related to observation errors. Note that the radiation figures increased after a different instrument had been installed in 1975. The figures in the last column date from before 1970, when the station was located elsewhere.
The meteorological characteristics of the area itself change only with altitude and exposure, which is illustrated by Table C 3.2-2, presenting monthly parameters of Kongwa, Ilonga and Morogoro. It is noticed that the mean temperature of the latter two stations is the same, while at Kongwa which has a much higher altitude (the difference is approximately 500 m), the mean temperature is 2.2°C lower. However there are more hours of sunshine, which is related to the decrease in cloudiness and rainfall further away from the coast. Except for those in rainfall, monthly differences are not spectacular for any stations . The temperature and humidity are higher during the rainy period. The number of hours of daily sunshine is highest just before the beginning of the short rains, which reflects the fact that the days are at their longest and not many clouds are present. During these months too, the highest evaporation occurs.

Table C 3.1-5 Correlation coefficients of annual precipitation of Morogoro Agricultural Office and Morningside (1961-1977)

	Morogoro Agr. Off. (963700)	Morning Side (963742)	Morogoro Maji (963752)	Tangeni Mission (963725)	Singiza Mission (973705)	Mtibwa Sugar Est. (963742)	Kilosa Agr. Stat. (963701)	Ukaguru forest (963618)
Morogoro Agricultural Office (963700)		0,77 6	0,71 3	0,80 11	0,69 46	0,85 76	0,66 74	0,58 98
Morningside (963742)	0,77 6		0,87 9	0,74 8	0,50 40	0,80 82	0,79 75	0,66 103

* Upper figure is the correlation coëfficient, the lower figure is the distance in km between stations, as the crow flies. All r values are significant at the 5%level.

Figure C 3.1-7 Correlation - distance and annual precipitation

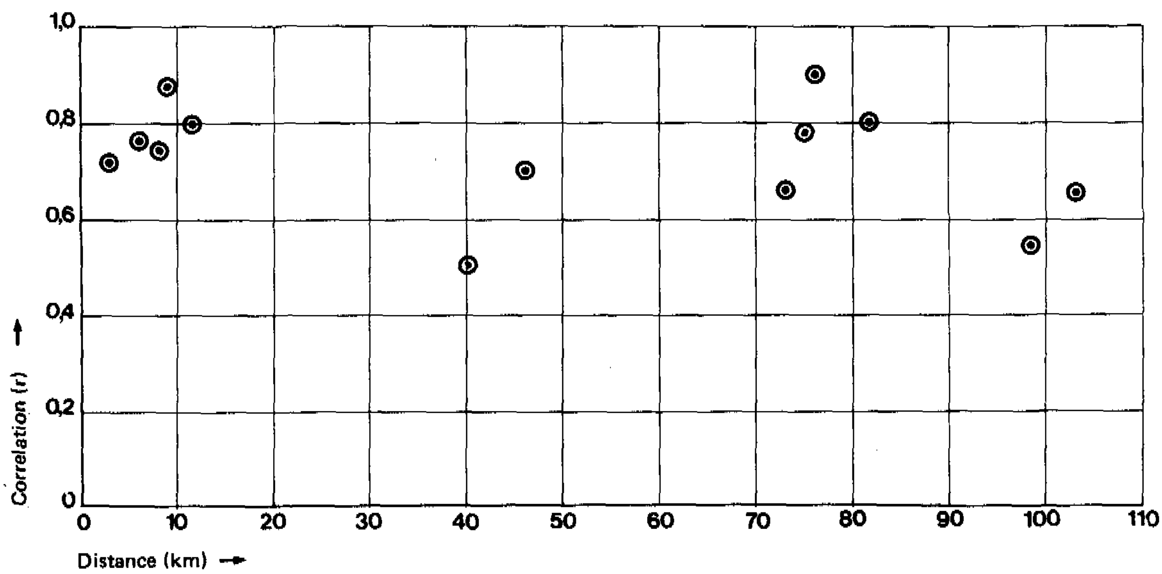


Table C 3. 1-6 Comparison of rainfall at three stations around Morogoro

Period	Morogoro Agricultural Office (963700)	Morogoro Meteorological station (963776)	*	Morogoro Water Department (963752)	*
Year 1971	839	600	0,72	616	1,03
„ 1972	1357	1046	0,77	928	0,89
„ 1973	1276	956	0,75	843	0,88
„ 1974	739	587	0,79	433	0,74
„ 1975	826	774	0,94	681	0,88
„ 1976	671	618	0,92	583	0,94
„ 1977	1186	945	0,80	948	1,00
Mean	985	790	0,80	719	0,91
Jan 1971	120	124	1,03	138	1,11
„ 1972	117	109	0,93	96	0,88
„ 1973	252	248	0,92	219	0,88
„ 1974	36	27	0,75	23	0,85
„ 1975	86	104	1,21	68	0,65
„ 1976	89	106	1,19	54	0,51
„ 1977	152	137	0,90	169	1,23
Mean	122	122	1,00	110	0,90
April 1971	342	227	0,66	161	0,71
„ 1972	230	166	0,72	149	0,90
„ 1973	478	291	0,61	249	0,86
„ 1974	348	279	0,80	227	0,81
„ 1975	218	198	0,91	193	0,97
„ 1976	176	157	0,89	142	0,90
„ 1977	(160)	123	0,77	136	1,11
Mean	279	206	0,74	180	0,87
November 1971	0	4	–	3	0,75
„ 1972	130	71	0,55	48	0,68
„ 1973	94	48	0,51	31	0,65
„ 1974	2	1	0,50	2	2,00
„ 1975	31	29	0,97	10	0,34
„ 1976	7	9	1,29	11	1,22
„ 1977	32	45	1,41	57	1,27
Mean	42	30	0,75	23	0,99

Note: Value in brackets is estimated value.
* Figure indicates ratio of precipitation with precipitation of preceeding station.

Table C 3. 2-1 Climatological parameters of Morogoro Meteorological Station (963776)

	1971	1972	1973	1974	1975	1976	1977	1978	Average	EAMD (1975)* values (1)
Mean Temp. (°C)	23,9	23,9	–	24,4	24,3	24,4	24,4	24,3	24,2	24,5
Rel. Humidity (%)	79	84	82	79	80	79	81	52	77	69
Sunshine (h/day)	7,3	6,6	7,1	7,2	–	7,3	6,9	7,0	7,1	5,1
Radiation** (langleys/day)	–	348	360	–	–	437	423	438	401	–
Wind (km/day)	–	168	183	–	–	215	–	171	184	139
Total A-pan evap. (mm)	2138	1792	1809	2221	2075	–	–	1975	2002	–
Total rainfall (mm)	600	1046	975	587	775	618	945	1166	837	908

* Statistics from publication of the EAMD (1975) [1]

** From 1968 to Oct. 1974 a Gunn Bellani Radiation integrator had been in use. From July 1975 to present a Kipp-solarimeter has been added and only data of the latter instrument are processed.

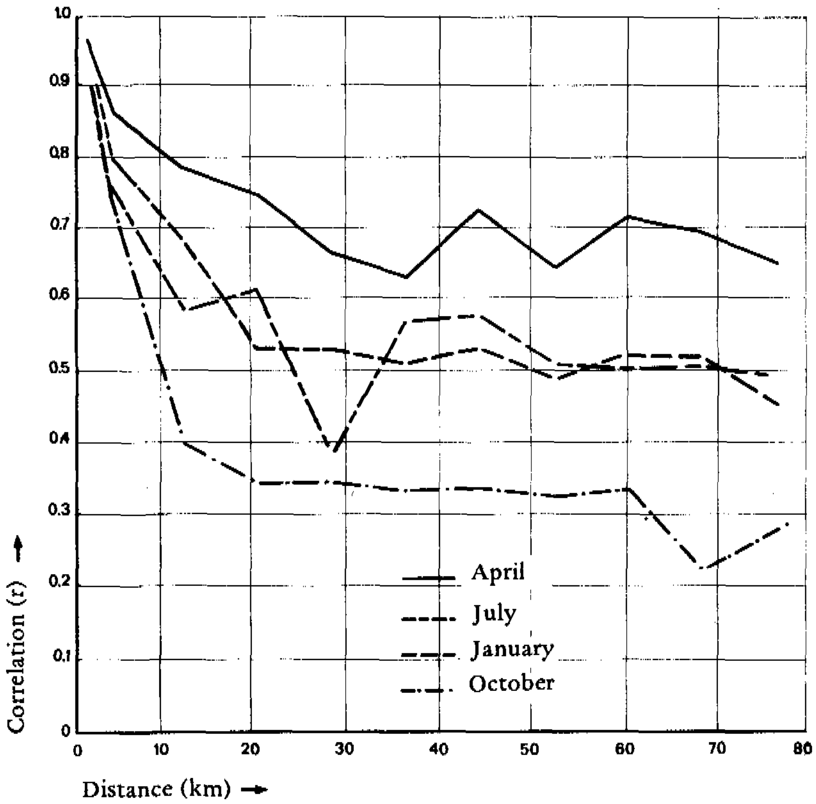


Figure C 3.1-8 Correlation - distance and monthly precipitation

3.2.3. Evaporation

Evapotranspiration is one of the main causes of water losses out of the catchments. It is rather difficult to estimate the evapotranspiration under circumstances of water shortage.One is usually referred to a reference value, which can be calculated from the different climatological parameters or which can be measured directly in an evaporation pan. Crop factors are used to modify this reference value.
The terminology used will be explained below. A full discussion can be found in a F.A.O. paper of 1975 [19].

Eo	=	Open water evaporation
ETo	=	Reference crop evapotranspiration
Epan	=	Pan evaporation
Ecrop or Ep	=	Potential evapotranspiration
Ea	=	Actual evapotranspiration
Kc	=	Crop factor
Kp	=	Pan factor

(E values are expressed in mm over a certain period)

At present the method most often used to calculate ETo (or Eo, which is almost the same), is the Penman method.

This method is based on mean 10-day values or monthly values of radiation or duration of sunshine, air temperature, temperature of dew point or humidity and of wind speed. If not all of the above data are available, more empirical but less reliable formulas can be used. ETcrop can be found out by multiplying ETo by a crop factor Kc, which varies between 0.1 and 1.5 and depends on the type of crop or vegetation and the stage of growth. Epan is measured in Tanzania with a standard A-pan, usually fitted with a screen to prevent animals from drinking out of it. Multiplying Epan by Kp gives ETo. Kp depends on type of pan, month of the year and location. It varies usually between 0,6 and 0,8 for unscreended A-pan's. Hence Epan is higher than ETo. However, a screen can reduce Epan by 10% or more. The most useful factor for a water balance is Ea, the actual evapotranspiration, which is always lower than Ep, in times of water shortage.
Eo values for Tanzania have been calculated by Woodhead (1968) [21] (Table C 3.2-3). Figure C 3.2-1 shows annual Eo contours, also obtained from Woodhead. Mean annual values do not differ very much in the area and vary mainly between the 1800-2000 mm contours. Hence, average daily Eo is slightly above 5 mm/day.
Note from Table C 3.2-3 that at Kongwa which is located west of the project area and which has a much lower temperature than the other stations, a similar Eo is recorded. The lower temperature is compensated by higher incoming radiation.
The low Eo value for Morogoro calculated from data before 1970 (EAMD, 1975 [1]) is suspicious. However before 1968 meteorological parameters were measured at the Agricultural Office. The station was closer to the mountains and close to buildings, so that there was less wind and less incoming

Table C 3 . 2-2 Monthly Meteorological Parameters of three stations in Morogoro Region (after EAMD, 1975 [1])

Kongwa (963603) Ilonga (963732) Morogoro (963776)	Period of observation	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Mean temp. (°C)	1954-70 1947-70 1946-60	23,6 26,2 26,2	23,2 26,0 26,2	23,4 26,0 26,1	22,7 24,9 25,0	21,4 23,5 23,5	19,9 22,0 21,6	19,3 21,7 21,1	20,1 22,5 22,1	21,6 23,6 23,2	23,2 24,8 24,6	24,6 26,0 25,6	24,3 26,8 26,5	22,3 24,5 24,5
Rel. Humidity (%)	1954-70 1947-70 1946-60	67 72 69	71 72 70	69 72 73	67 73 80	62 72 79	56 68 73	55 64 70	52 63 66	51 60 63	46 60 61	48 62 63	59 67 63	59 67 69
Daily Sunshine (hrs)	1954-70 1963-70 1946-61	7,1 6,5 5,7	7,2 7,2 5,9	7,1 7,0 5,9	6,8 5,9 4,3	7,8 6,3 3,9	9,0 6,4 4,3	9,3 6,5 4,1	9,6 6,7 4,2	9,6 6,4 4,7	9,9 7,2 5,7	9,6 7,5 6,2	7,6 7,0 5,8	8,4 6,7 5,1
Daily Radiation (langleys/day)	1967-70 1963-70 —	522 520 —	509 532 —	514 526 —	455 456 —	454 423 —	490 416 —	501 403 —	513 423 —	584 466 —	632 514 —	590 523 —	544 531 —	525 478 —
Daily Windrun (km)	1967-70 1963-70 1947-60*	124 115 128	116 100 120	127 103 120	132 92 104	160 111 112	178 121 128	177 126 128	220 137 128	262 162 160	278 177 192	260 160 176	155 129 176	183 128 139
Monthly Evap. Apan (mm)	1967-70 1964-70 —	132 171 —	119 149 —	138 166 —	104 131 —	133 122 —	134 126 —	148 138 —	166 148 —	193 167 —	235 205 —	218 201 —	153 183 —	1873 1907 —
Rainfall mean (mm)	1953-70 1944-70 1906-70	116 137 95	103 132 102	104 215 167	67 216 215	6 67 91	0 10 26	1 9 15	1 14 11	1 15 18	1 35 29	16 81 61	124 145 78	540 1076 908
Rainfall Highest (mm)	1953-70 1944-70 1906-70	248 322 301	234 254 261	317 486 500	194 402 386	37 219 402	4 35 143	5 41 119	13 75 79	10 68 110	8 160 168	88 314 320	354 379 258	— — —
Rainfall Max. 24 hrs (mm)	1953-70 1944-70 1906-70	105 106 63	57 105 100	82 143 93	57 144 64	9 73 40	2 20 23	4 18 38	12 31 34	10 43 62	6 51 72	42 104 88	96 95 77	— — —

* Daily Windrun from Woodhead (1968) [21]

Table C 3. 2-3 Open water evaporation Eo (after Woodhead, 1968 [21])

Station/number period	Altitude	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec.	ANNUAL Mean	ANNUAL 90% lower	ANNUAL 90% upper
	ma MSL*	mm/day mm/month												mm/day mm/year		
Kilombero 973729 1961-1964	300	5,5 171	6,0 171	5,5 170	4,9 146	4,3 133	4,2 125	4,0 125	4,5 139	5,2 156	5,9 182	6,6 197	6,4 199	5,2 1914	4,9 1803	5,5 2025
Ilonga 963732 1963-1965	500	6,3 194	6,5 185	6,1 189	4,9 147	4,6 142	4,5 136	4,5 140	4,6 144	5,6 167	6,8 210	6,6 199	6,8 210	5,6 2061	5,4 1955	5,9 2167
Morogoro 963776 1947-1960	580	5,6 173	5,6 159	5,4 167	4,2 126	3,6 111	3,5 106	3,6 112	4,1 126	4,9 146	5,8 179	5,9 176	5,8 179	4,8 1760	4,5 1659	5,1 1861
Kongwa 963603 1960-1966	1021	5,3 163	5,3 150	5,0 155	4,4 132	4,3 133	4,4 131	4,5 140	5,1 159	6,4 191	7,2 223	7,0 210	5,8 180	5,4 1967	5,1 859	5,7 2075

* ma MSL = meters above mean sealevel

radiation (see last 2 columns of Table C 3.2-1). Eo for 1978 worked out to be 2188 mm, being 113 mm above Epan of this year.
Besides annual Eo values, Table C 3.2-4 also shows Epan values. Although the figures do not all date from the same periods, one is struck by the fact, that in all cases Epan is lower, which is usually not the case. Some overestimation of Eo is expected, which under certain meteorological conditions is possible (Doornbos, 1975) [19]. From the above figures it can be concluded that annual mean Eo for the plains is about 1900 mm. For the mountainous areas with both longer periods of clouds and lower mean temperatures, this figure will be considerably lower, with a annual mean minimum between 1200 and 1400 mm.

Daily values of the Eo vary between approximately 4 mm in July and 7 mm in October for the plains, while for the higher mountains these values will be 1.0 to 1.5 mm less.
From the above Eo and precipitation values it can be seen that water shortages always occur between June and October. Vegetation cover will evapotranspire less than Ep, which will make it rather difficult to estimate the actual evapotranspiration Ea, without the help of refined hydrological models, which take into account soil moisture storage in different parts of the catchment.

Table C 3.2-4 Annual open water evaporation (Eo) and pan evaporation (Epan) in mm

	Eo and period of observation	Epan and period of observation
Kongwa (963603)	1967 (1960-70)	1873 (1967-70)
Ilonga (963732)	2061 (1963-65)	1907 (1964-70)
Morogoro (963776, agricultural station)	1760 (1947-60)	- -
Morogoro (963776, MET)	2188 (1978)	2002 (1971-78)

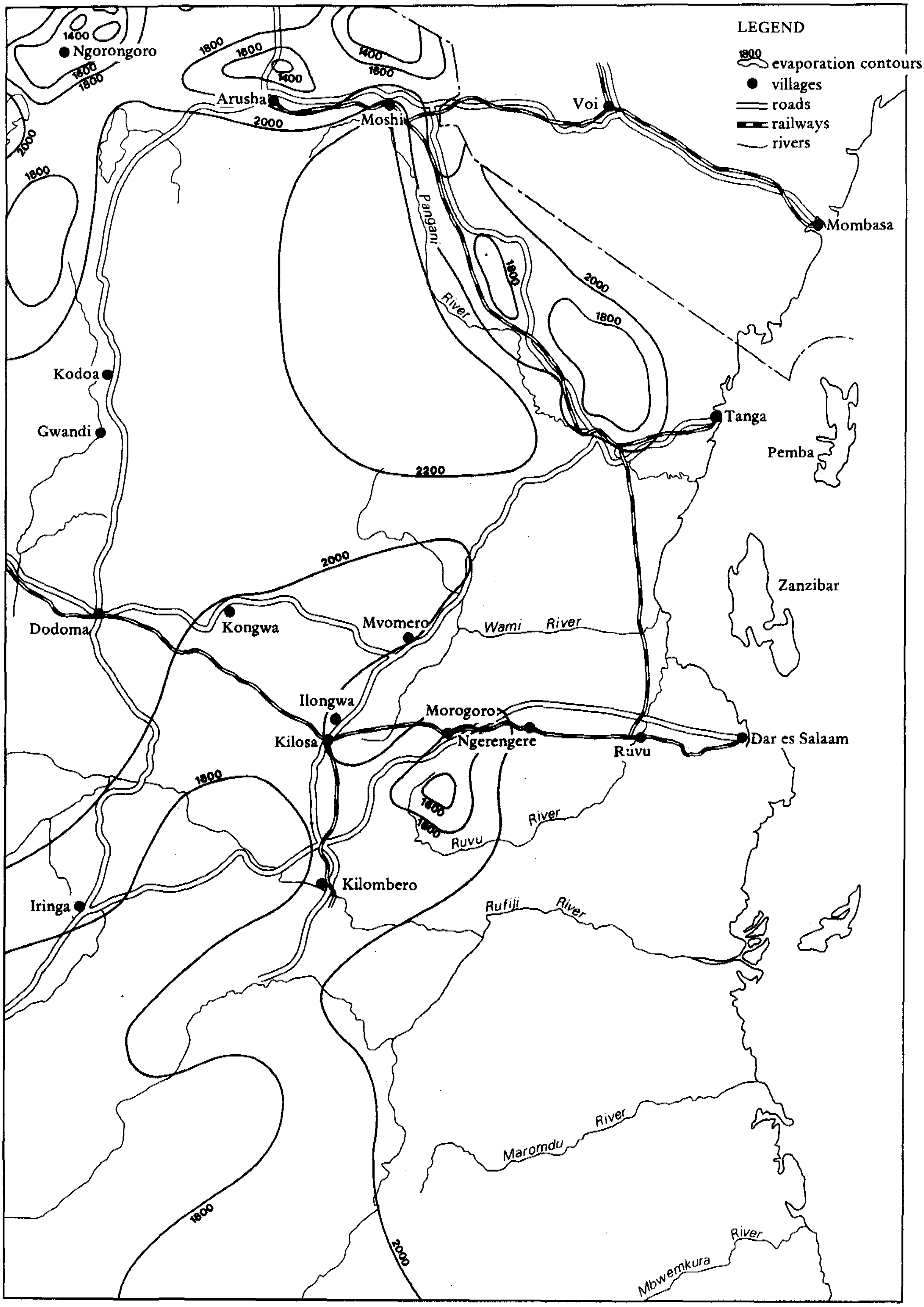


Figure C 3.2-1 Annual open water evaporation distribution (after woodhead 1968 [4])

3.3. Hydrology

3.3.1. General

To assess the surface water potential for domestic water supply of various parts of the project area all available hydrometric data have been collected (sub-par. 3.3.2.). The rating curves, which are used at present, of all hydrometric stations are reviewed and some have been studied in more detail and improved if necessary (sub-par. 3.3.3.).
The analyis of the data has been focused on annual and monthly discharges (sub-par. 3.3.4. and 3.3.5.) to obtain a general picture of the available annual surface water amounts and their distribution over the year.

For domestic water supply only relatively small amounts of water are required*, and perennial streams can be used without storage facilities in the river.
Hence, special attention is paid to the minimum flows (sub-par. 3.3.6).
Some attention is paid to springs as possible sources for domestic water supply (sub-par. 3.3.7.).

* If about one-day-storage is provided in the supply system, a flow of 1 l/s meets a 30 l/day/cap demand of about 2000 people

3.3.2. Available hydrological data

3.3.2.1. Existing data

Stream flows are determined from water level records of hydrometric stations by using stage-discharge relationships (rating curves), which are established for every particular station by a series of current meter measurements. Water levels are obtained by means of reading staff gauges and for some stations also from automatic water level recorders. The water levels by means of staff gauges are collected two to three times a day.

Water level recorders provide continuous data. The observations in the Region are carried out and controlled by the Water Department. Daily discharge data are published by the Ministry of Water Development and Power. At present three Hydrological Yearbooks (1950-1960, 1961-1965, 1966-1970) [40] are available.

Discharge data covering the period 1971-1975 are obtained from the files of the Water Department at Ubungo, where all water level data are processed. On 1/1/1979 no discharge data were available from 1976 onwards, because the processing had not been finished.

In the first and second yearbook a November 1st-October 31st period is used as a hydrological year. In the third yearbook and in recent years, data are presented for the calendar year. (January 1st - December 31st period).

On Map C 1 all existing (26) and closed (21) hydrometric stations are shown. The station numbers consist of up to five numbers and letters, the meaning of which is illustrated by the following example:

Ngerengere River 1 H A 9 A

1 = Indian Ocean drainage
H = Ruvu catchment
A = Ngerengere
9 = Serial number of station on tributary
A = the station replaces an old station

In this way the following rivers are distinguished in the project area:

1H	=	Ruvu
1HA	=	Ngerengere
1HB	=	Mgeta
1HC	=	Mvuha
1G	=	Wami
1GA	=	Lukigura
1GB	=	Diwale
1GC	=	not allocated
1GD	=	Mkondoa
1K	=	Rufiji
1KA	=	Ruaha

All available discharge data are given on a monthly basis in the data part of this volume.

3.3.2.2. Data obtained by the Consultant during the dry season of 1978

Based on the surveys of the different areas a number of rivers and reservoirs were selected and incorporated into a regular measurement programme. The programme started in August 1978 and was carried out monthly up to medio November 1978, when heavy rainfall put an end to the low flows.
The collected data are presented in the data part of this volume.
The altitudes of the measuring site and the catchment area are determined from the topographical maps.
The lowest annual flows which occurred in 1978 are estimated by semi-logarithmical extrapolation.
The method is introduced in sub-par. 3.3.6.2.

3.3.3. Rating curve analysis

3.3.3.1. General

A rating curve gives the relation between water level and discharge at a certain cross-section of the river. If no control is present in the river channel which could create a unique relation, different relations exist during the rising and falling limb of a flood.
Because floods are rather flashy, only few ratings of high flows exist. Hence, no separate rating curves for the rising and falling limb are established.

The existing rating curves for rivers which are at present incorporated in the routine programme of the Water Department cover the 1970-1976 period. Flow data which are collected during the regular measurement programme are compared with the rating curves. Some remarks are made especially on the quality of the lower part of the rating curves: This is the part from which the low flows are derived and which is of the highest importance for the domestic water supply study.
It should be noted, that rating curves are only valid for limited time periods and have to be adapted continuously, especially when the river bed is not very stable.
The remarks collected in Table C 3.3-1 may be out of date, because new rating curves may have been made by the Water Department but were not available on 1/1/1979.

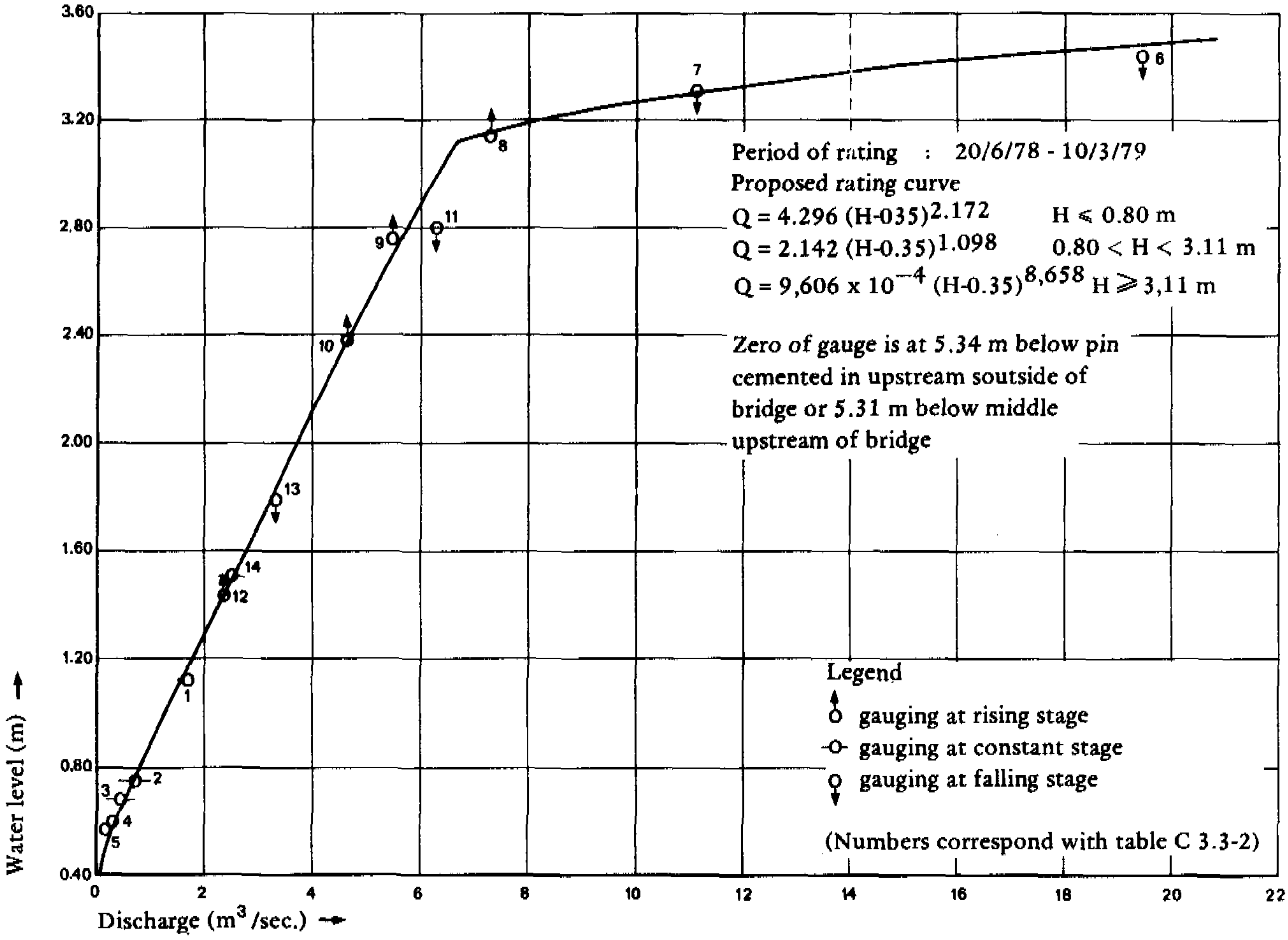


Figure C 3.3-1 Rating curve Ngerengere River at Kihonda (1HA6)

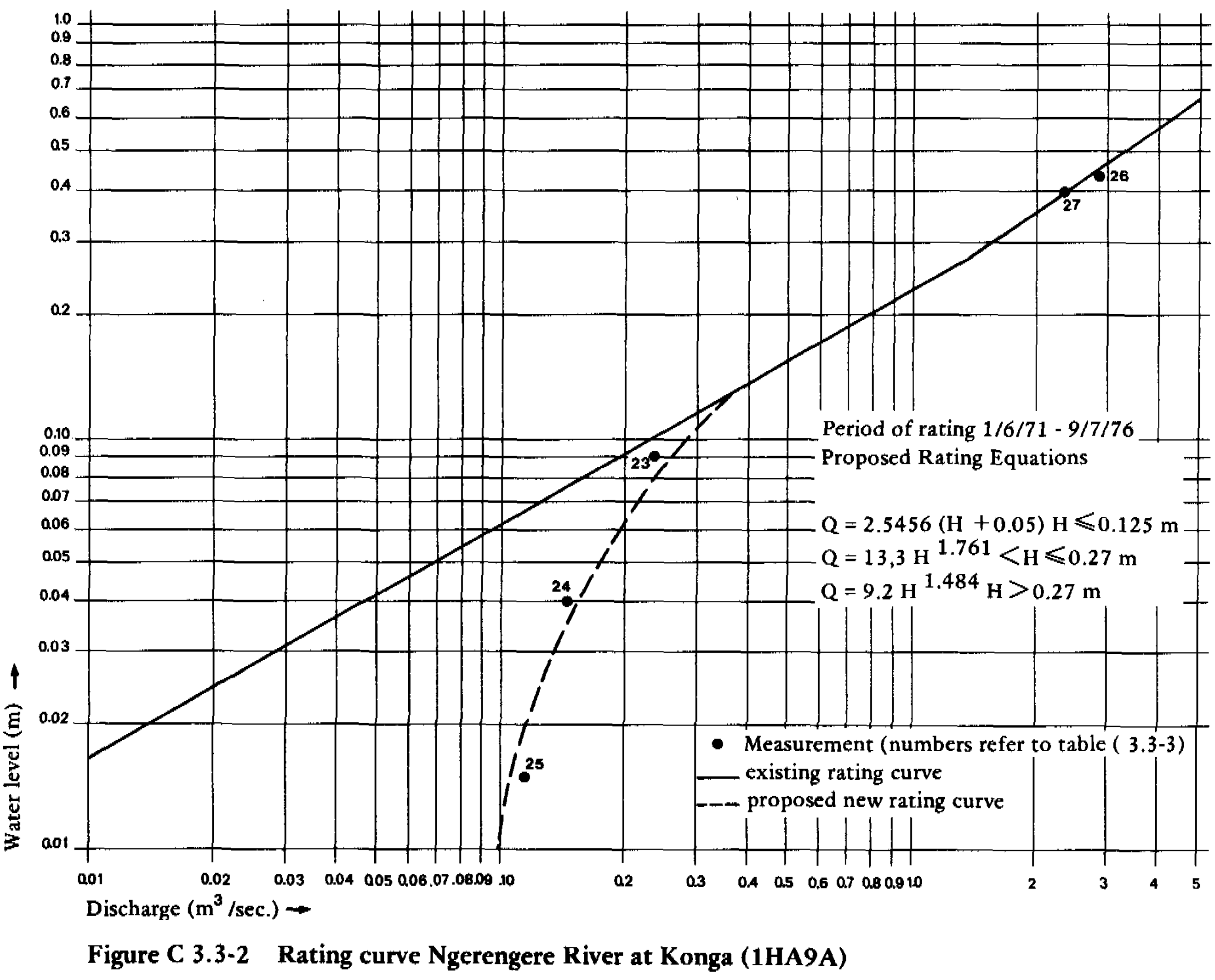


Figure C 3.3-2 Rating curve Ngerengere River at Konga (1HA9A)

Table C 3.3-1 Remarks on rating curves

River	Station number	Remarks
Wami	1G1	data are fitting well
Tami	1G5A	rating curve gives too high values for low flows
Kisangate	1G6	rating curve gives too low values
Mziha	1GA2	good fit of high flows, rating curve gives too low values for low flows
Diwale	1GB1A	data are fitting well
Mkondoa	1GD2	data are fitting well
Mkata	1GD36	data are fitting well
Ruvu	1H5	data are fitting well
Ngerengere	1HA6	new rating curve established
Morogoro	1HA8	new rating curve established
Ngerengere	1HA9A	high flows are fitting well, rating curve gives too low values for low flows, for flows <400 l/s a new rating curve is established
Mgeta	1HB2	large discrepancies between existing rating curve and recently obtained flow data, new rating curve proposed
Mvuha	1HC2	data are fitting well

Some general comments concerning discrepancies between data and rating curves may be made:

a. ratings of very low flows as the Consultant made, have not been carried out and the rating curves in the very low flow part have been obtained by extrapolation (Ngerengere 1HA9A)
b. the accuracy of gauge readings is ~ 1 cm, which can cause relatively large differences with low flows in wide river beds
c. sandy river beds may change due to scouring or sedimentation with a corresponding change of the water level-discharge relationship as a result (Kisangate 1G6)

The rating curves of the Ngerengere at Kihonda (1HA6), the Ngerengere at Konga (1HA9A), the Morogoro (1HA8), the Mgeta (1HB2) and the Tami River (1G5A) are discussed in detail below.

3.3.3.2. Ngerengere River at Kihonda (1HA6)

Gauging at the Ngerengere at Kihonda started in September 1950 and discontinued in 1963 when the network was revised. Because the gauging site is

only 11 km downstream from the proposed Mindu dam site, flows measured at Kihonda are closely related to flows entering the Mindu reservoir. Recently (exact date not known) a 1 m metric gauge was erected just upstream of the bridge on the Morogoro-Dodoma Road. The Consultant installed a pneumatic recorder in August, 1978, which failed in December, 1978, after which twice-a-day readings were carried out up to April,1979. Water levels up to 1 m were measured from the gauge plate. Water levels of above 1 m are measured from the bridge and are recalculated in accordance with the reference level of the gauge plate.
Flow measurements were carried out during the period with high flows (up to 19.35 m^3/s, see Table C 3.3-2). The data are used to establish a new rating curve (see Figure C 3.3-1). The rating curve is used in the detailed study on the Ngerengere River (see Annex 4 Flow analysis of the Ngerengere River).

The following comments can be made about the rating curve:

Table C 3.3-2 Ngerengere River at Kihonda (1HA6), ratings of 1978-1979 (gaugings carried out by Consultant)

nr.	data	gauge reading (m)	discharge (m^3/s)	remarks
1	20/ 6/78	1.120	1.657	water level constant
2	2/ 8/78	0.770	0.649	water level constant
3	28/ 8/78	0.680	0.371	water level constant
4	26/ 9/78	0.600	0.262	water level constant
5	23/10/78	0.580	0.149	water level constant
6	21/11/78	3.440	19.350	water level falling
7	23/11/78	3.360	11.030	water level falling
8	24/11/78	3.140	7.279	water level rising
9	27/11/78	2.760	5.394	water level rising
10	1/12/78	2.390	4.595	water level rising
11	13/12/78	2.840	6.245	water level falling
12	8/ 1/79	1.435	2.304	water level rising
13	2/ 3/79	1.800	3.241	water level falling
14	10/ 3/79	1.505	2.445	water level constant

Table C 3.3-3 Ngerengere River at Kihonda (1HA6) Rating equations (1978/79 gaugings)

Equations (m^3/s)	limits (m)
$Q = 4.296\ (H-0.35)^{2.172}$	$H \leqq 0.80$
$Q = 2.142\ (H-0.35)^{1.098}$	$0.80 < H < 3.11$
$Q = 9.606 \times 10^{-4}\ (H-0.35)^{8.658}$	$H \geqq 3.11$

a. At approximately 0.35 m the river stops flowing.
b. Between 0.80 m and 3.00 m the rating curve is almost a straight line. The rating equation is very reliable in between these limits.
c. After 3.00 m (6.2 m^3/s) the banks of the river start being flooded, which makes the rating very unreliable as can be seen from the very flat curve. A slight change in water level creates a rather large change in discharge. This part of the rating curve is not very reliable.
d. No different rating curve could be distinguished for the rising and falling limb of the hydrograph.

3.3.3.3. Ngerengere River at Konga (1HA9A)

Ratings carried out by the Water Department from 1968 to 1978 and five ratings carried out by the Consultant are given in Table C 3.3-4 and are plotted on Figure C 3.3-2.

Ratings at water levels > 0.2 m seem very consistent, which could be due to the fact that the concrete bottom acts as a control. Below 0.13 m ratings become relatively more erratic, because the concrete bottom has many cracks and little gullies, of which the relative influence becomes larger with smaller flows. Low flows above 100 l/s were measured with corresponding water levels of approximately 0.01 m gauge level. It seems very likely that there will still be some flow below gauge level zero. Hence, it is proposed to use a different rating formula below 0,13 m, which also includes flows below zero gauge level. Table C 3.3-5 shows the present and proposed rating formulas, which are also shown in Figure C 3.3-2. In future the zero level of the gauge should be lowered. Rating 18 has been omitted in calculating the new low flow rating equation. Note that the accuracy of minimum flows will be low, because staff-gauge readings can deviate ± 1 cm (i.e. 140 l/s ± 20 l/s).

Table C 3.3-4 Ngerengere River (1HA9A) at Konga, ratings from 1966 to present

nr.	data	gauge reading (m)	discharge (m^3/s)	remarks
1	7/12/68	0.463	3.000	Water Department
2	15/10/69	0.091	0.273	Water Department
3	8/ 4/71	0.226	0.954	Water Department
4	9/ 4/71	0.305	1.531	Water Department
5	13/ 4/71	0.320	1.612	Water Department
6	14/ 4/71	0.290	1.448	Water Department
7	19/ 4/71	0.387	2.482	Water Department
8	22/ 4/71	0.597	4.276	Water Department
9	23/ 4/71	0.533	4.021	Water Department
10	24/ 4/71	0.427	2.577	Water Department
11	29/ 4/71	0.344	1.863	Water Department
12	3/ 5/71	0.229	1.037	Water Department
13	18/ 5/71	0.244	1.028	Water Department
14	21/ 5/71	0.695	5.224	Water Department
15	3/ 6/71	0.186	0.679	Water Department
16	9/ 8/71	0.110	0.237	Water Department
17	12/ 9/75	0.115	0.367	Water Department
18	16/10/75	0.085	0.130	Water Department
19	9/ 7/76	0.125	0.356	Water Department
20	31/ 7/76	0.090	0.291	Water Department
21	24/ 9/76	0.155	0.570	Water Department
22	8/10/76	0.085	0.289	Water Department
23	2/ 8/78	0.090	0.234	Consultant
24	25/ 9/78	0.040	0.143	Consultant
25	26/10/78	0.015	0.114	Consultant
26	23/11/78	0.440	2.833	Consultant
27	14/12/78	0.400	2.320	Consultant (water level change 0.025 m in 45 min.)

Table C 3.3-5 Ngerengere River at Konga (1HA9A), rating equations

existing rating equations 1/6/71-9/7/76		proposed rating equations 1/6/71-present	
equation (m^3/s)	limit (m)	equation (m^3/s)	limit (m)
		$Q=2.5456(H+0.05)^{1.1545}$	0.125
$Q=13.3\ H^{1.761}$	0.27	same as existing equation	0.125-0.27
$Q=9.2\ H^{1.484}$	0.27-5.0	same as existing equation	0.27 -5.0

Q = Discharge (m^3/s) H = gauge height (m)

3.3.3.4. Morogoro River at Morogoro (1HA8)

A cipoletti weir was erected in March 1954. At a later stage the structure was completed with an automatic recorder.
The edge of the cipoletti weir has been damaged considerably in the course of time, which has changed the rating of the structure. On request of the water department several gaugings were carried out between 4/8/1979 and 19/1/79 (see Table C 3.3-5) and a new rating curve was established.

The following comments can be made:

a. The Crest of the cipoletti weir is badly damaged, hence discharge still takes place below a level of 0 m at the gauge.
b. Gaugings above 0.14 m match the original cipoletti 15 feet (4.57 m) weir formula if actual gauge height is increased by 0,05 m in the formula. (the velocity of approach has not been taken into account)
c. The rating curve was expanded by means of a sharp crested weir formula up to 1.60 m or approximately 22 m^3/s, a discharge which will not be surpassed very often. The dimensions of weir are given in fig. C 3.3-3. Without further gaugings at higher stages the proposed rating curve as given in Table C 3.3-7 and Fig. C 3.3-4 is expected to be good between 0.00 and 0.45 m (0,025-3,000 m^3/s) and fair between 0.45 and 1.50 m (3,000-20,000 m^3/s).
d. Gaugings at the site are carried out by wading. The maximum water level for this procedure is approximately 0.45 m. Gaugings at higher water levels could only be done at the Morogoro bridge in Morogoro, 1.5 km downstream of the gauge. Therefore high water level gaugings may not be very reliable.

Table C 3.3-6 Morogoro River at Morogoro (1HA8), ratings of 1978-1979

nr.	data	gauge reading (m)	discharge (m^3/s)	remarks
1	4/ 8/78	0.050	0.154	Water level constant
2	1/ 9/78	0.020	0.046	Water level constant
3	27/ 9/78	0.000	0.027	Water level constant
4	23/10/78	-0.030	(0.010)	Estimate
5	20/12/78	0.335	2.092	Water level falling
6	5/ 1/79	0.145	0.607	Water level constant
7	15/ 1/79	0.190	1.011	Water level constant
8	19/ 1/79	0.160	0.793	Water level constant

Table C 3.3-7 Morogoro River at Morogoro (1HA8), rating equations

nr.	Equations (m^3/s)	Limits	Derived from
1	$Q = 46.16\ (H+0.05)^{2.52}$	$-0,05<H<0.14$	Derived from 3 lowest gaugings
2	$Q = 8.50\ (H+0.05)^{1.5}$	$0.14 \leqq H \leqq 0.57$	Derived from Cipoletti-weir formula
3	$Q = 8.50\ (H+0.05)^{1.5} + 3.89\ (H-0.57)^{1.5}$	$0.57<H<1.60$	Combination of Cipoletti-weir formula and sharp crested weir formula

3.3.3.5. Mgeta River at Mgeta (1HB2)

The staff gauge was erected on 1/6/54. Twice a day readings take place. In June 1967 an Ott-water level recorder was installed. The highest recorded peak (Temple e.a. 1973)[65] was 4.11 m and the estimated corresponding discharge was 230.5 m^3/s. Usually only very short flash floods surpass the 1.0 m, so the rating curve above 1.0 m will not drastically influence the total annual volume. Downstream from the gauge are a rock bar and rapids which seem to make the rating curve rather stable.

The catchment area above the gauge is 101 km^2 according to the 1965-1970 hydrological yearbook. However, this includes the catchment of the Mzingu River, which joins the Mgeta River just downstream of the gauge. In fact the gauge is above the junction and the catchment area above the gauge is only 85.2 km^2. It is possible that one of the first gauges was installed below the junction before 1967. However, they were washed away several times.

Table C 3.3-8 shows annual flows and low flows from published data up to 1970 and unpublished data for the 1970-1975 period. The sudden change after 1970 is remarkable. Annual flows become much higher, while low flows become much lower. The rainfall has not changed very much after 1970, as can be seen from the rainfall data at Kienzema, a nearby station (see Table C 3.3-9).
A further analysis showed, that a temporary water level change between 1971 and 1975, probably created by human influence, could have been the cause, as will be explained below.

Table C 3.3-8 Mgeta River at Mgeta (1HB2), flow and rainfall data

year (Nov-Oct)	mean annual flow (m^3/s)	daily minimum flow (m^3/s)	total rainfall at Kienzema Mission (9737013) (mm)	remarks
1959-1960	2.33	0.78	1212	
1960-1961	2.33	0.58	1461	
1961-1962	-	1.32	1369	
1962-1963	-	0.66	1574	
1963-1964	2.71	0.66	1791	
1964-1965	1.99	0.72	1209	
1965-1966	-	0.90	1422	
1966-1967	2.53	0.79	1464	
1967-1968	3.57	0.84	1752	
1968-1969	2.66	0.61	1147	
1969-1970	2.60	0.65	1286	
1970-1971	6.19	0.29	1100)	rejected flow data,
1971-1972	5.11	0.00	1506)	reconstruction
1972-1973	9.88	0.23	1614)	seems very
1973-1974	6.95	0.76	1232)	difficult
1974-1975	7.27	0.76	1268)	
1975-1976	-	-	1142)	
1976-1977	-	0.77	936	
1977-1978		0.75		

- = missing values

Table C 3.3-9 shows the ratings carried out between 1966 and 1978, obtained from the files of the Water Department of Morogoro. The table also shows the three ratings carried out by the Consultant in 1978. The rating equations are given in Table C 3.3-10.

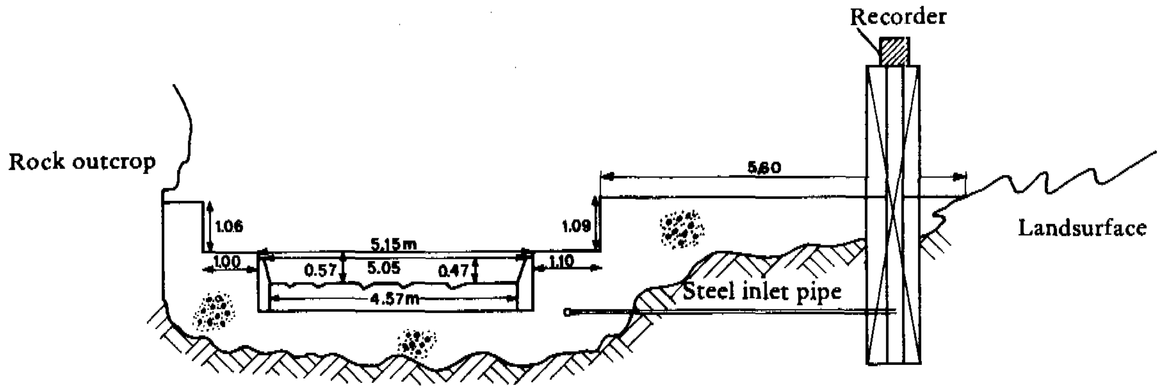


Figure C 3.3-3 Morogoro River (1HA8) cipoletti weir

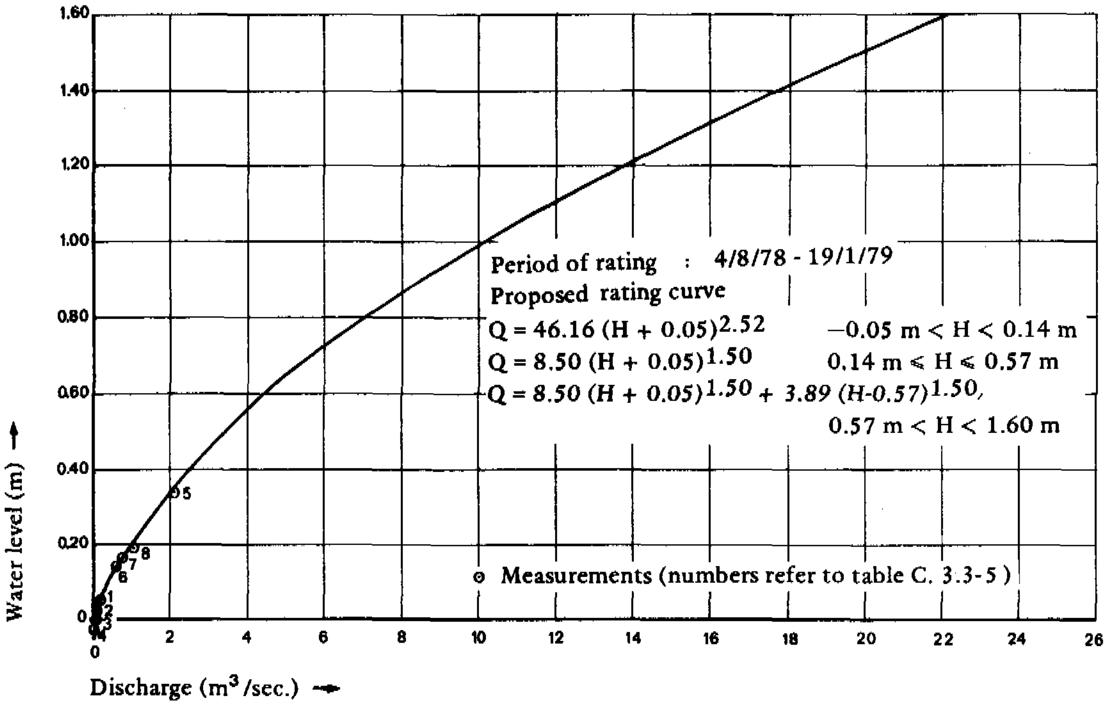


Figure C 3.3-4 Rating curve Morogoro River at Morogoro (1HA8)

Table C 3.3-9 Mgeta River at Mgeta (1HB2), ratings from 1966 to present

nr.	date	gauge reading (m)*	discharge (m^3/s)	remarks
1	20/ 2/66	0.725	5.155	Water Department Morogoro
2	5/11/68	0.330	0.896	Water Department Morogoro
3	7/12/68	0.700	3.998	Water Department Morogoro
4	14/10/69	0.305	0.821	Water Department Morogoro
5	4/ 3/70	0.640	3.722	Water Department Morogoro
6	14/ 7/70	0.410	1.285	Water Department Morogoro
7	5/ 2/71	0.665	4.070	Water Department Morogoro
8	11/ 8/71	0.550	0.662	") metric gauges installed
9	16/10/71	0.510	0.875	")
10	29/ 9/72	0.445	1.211	") period of strange river
11	14/ 8/73	0.570	0.652	") regime
12	29/ 8/74	0.585	0.997	")
13	16/11/74	0.565	0.745	")
14	16/10/75	0.600	0.726	")
15	5/10/76	0.460	1.867	Water Department Morogoro
16	7/10/76	0.445	1.514	Water Department Morogoro
17	4/ 1/78	0.760	5.099	Water Department Morogoro
18	1/ 8/78	0.390	1.289	Consultant
19	1/ 9/78	0.350	0.919	Wat.Dept. Morog.
20	25/ 9/78	0.315	0.904	Consultant
21	26/10/78	0.305	0.754	Consultant

* During the measurements gauge height changed in none of the gaugings

Table C 3.3-10 Mgeta River at Mgeta (1HB2), rating equations

existing rating equations 1/1/71-4/1/78			proposed rating equations 1/1/78-present	
nr.	equation (m^3/s)	limit (m)	equation (m^3/s)	limit (m)
1	$Q = 337.\ H^{10.533}$	0.63	$Q = 5.914\ H^{1.691}$	0.39
2	$Q = 9.43\ H^{2.097}$	0.63-0.89	$Q = 9.681\ H^{2.204}$	0.39-5.0
3	$Q = 10.5\ H^{3.020}$	0.89-4.0		

Rating curves and data for water levels below 0.39 m are shown in fig. C 3.3-5, those for water levels above 0.39 m in fig. C 3.3-6.

The existing rating curve is based on all data over the period of 22/2/66 - 1/9/78. Because the erratic data are also included, the curve obtains a rather flat course. Note also that the existing rating curve is not continuous at 0.63 m, and that the equation for low flows assumes an increase in flow from 0.23 m^3/s to 1.55 m^3/s, if the water level increases from 0.50 to 0.60 m. This seems hardly possible and is caused by the high power of H, which is larger than 10. Normally the coefficient of H should lie between 1 and 3. This abnormality is created by the discharge measurements carried out between 1971 and 1975. Measurements before 1971 and after 1975 can be fitted nicely. Hence a new rating curve is proposed, using only these measurements.
The difference between the 1971-1975 ratings and the proposed rating curve seems so large, that faulty measurements can be excluded.

For some reasons the river level between 1971 and 1975 was 0.20 to 0.40 m higher, however not continuously, which could be explained by a low diversion dam which was washed away every wet season.
From Table C 3.3-10 it can be seen, that equation 2 of the old set of equations and the proposed equation 2 of the new set are nearly the same. Equation 2 of the proposed equations matches the largest flood before 1973 better than equation 3 of the old set. However the influence of the application of equation 3 on the total volume discharge is small, because short flash floods which surpass 1.0 m are rare.

The new rating curve is based on the reliable data only. No rating curve is proposed for the period 1971-1975 with the unreliable data and existing flow volume calculations for this period should be rejected. For flood condition ($Q>3.5$ m^3/s) however the new rating curve may provide sufficiently accurate discharge data for this period.

3.3.3.6. Tami River at Msowero (1G5A)

The ratings of the Tami River at Msowero (1G5A) carried out by the Water Department from 1971 up to 1978 are plotted in Figure C 3.3-7.
In 1974 ratings were carried out frequently between water levels of 0.68 and 1.18 m. These data are fitted well by the rating curve. The ratings below 0.68 m water level are not very consistent, which is probably due to the fact that the sandy riverbed at the gauging site is changed continuously by scouring and sedimentation. Especially changes of the geometry of the river bed affect the reliability of the rating curve in the low range.

Table C 3.3-11 Tami River at Msowero (1G5A), ratings from 1971 to present for water levels below 0.65 m

nr.	date	gauge reading (m)	discharge (m^3/s)	remarks
1	26/10/71	0.52	0.89	Water Department
2	21/ 9/72	0.59	1.58	Water Department
3	23/ 8/73	0.64	1.51	Water Department
4	12/12/73	0.61	0.69	Water Department
5	16/10/74	0.54	(2.04)	Water Department
6	4/12/75	0.44	(2.48)	Water Department
7	19/10/76	0.46	0.45	Water Department
8	17/ 3/77	0.54	1.28	Water Department
9	18/ 3/77	0.53	1.07	Water Department
10	5/ 9/78	0.52	0.67	Water Department
11	12/ 9/78	0.65	2.04	Water Department
12	12/10/78	0.64	0.86	Consultant
13	14/11/78	0.60	0.65	Consultant

The deviation between the discharges which were measured recently and the existing rating curve stresses the need for a new rating curve to be established for water levels below 0.65 m. More ratings are required to obtain a sufficiently accurate new curve.

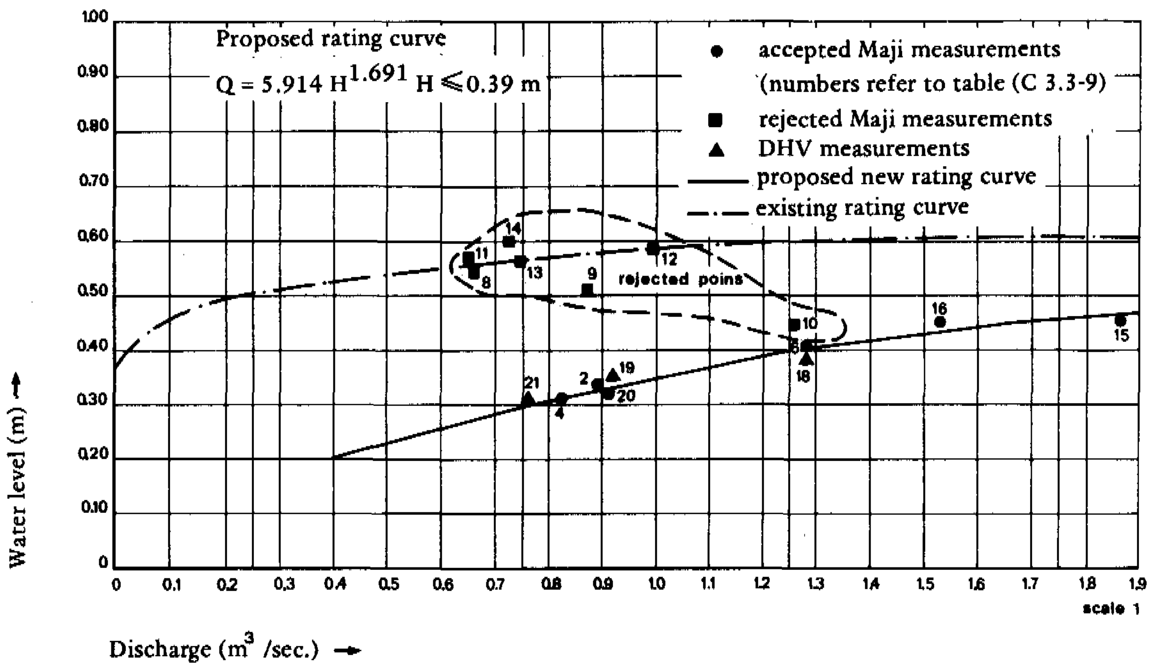


Figure C 3.3-5 Rating curve Mgeta River at Mgeta (1HB2) for water levels equal to or below 0.39 m

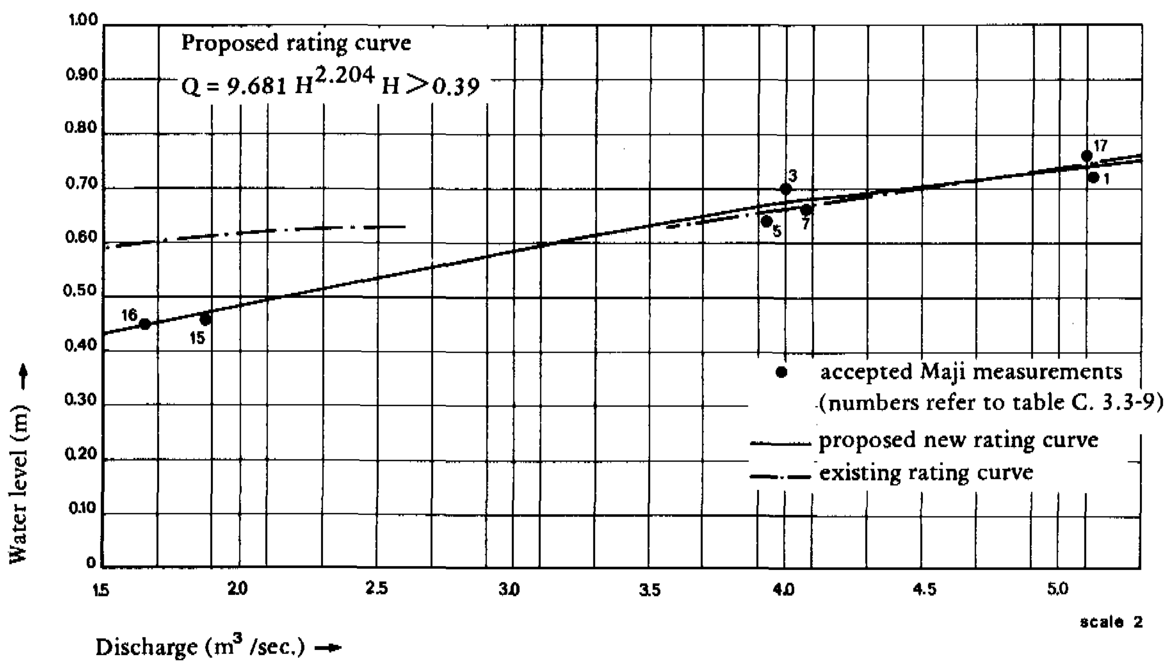


Figure C 3.3-6 Rating curve Mgeta River at Mgeta (1HB2) for water levels above 0.39 m

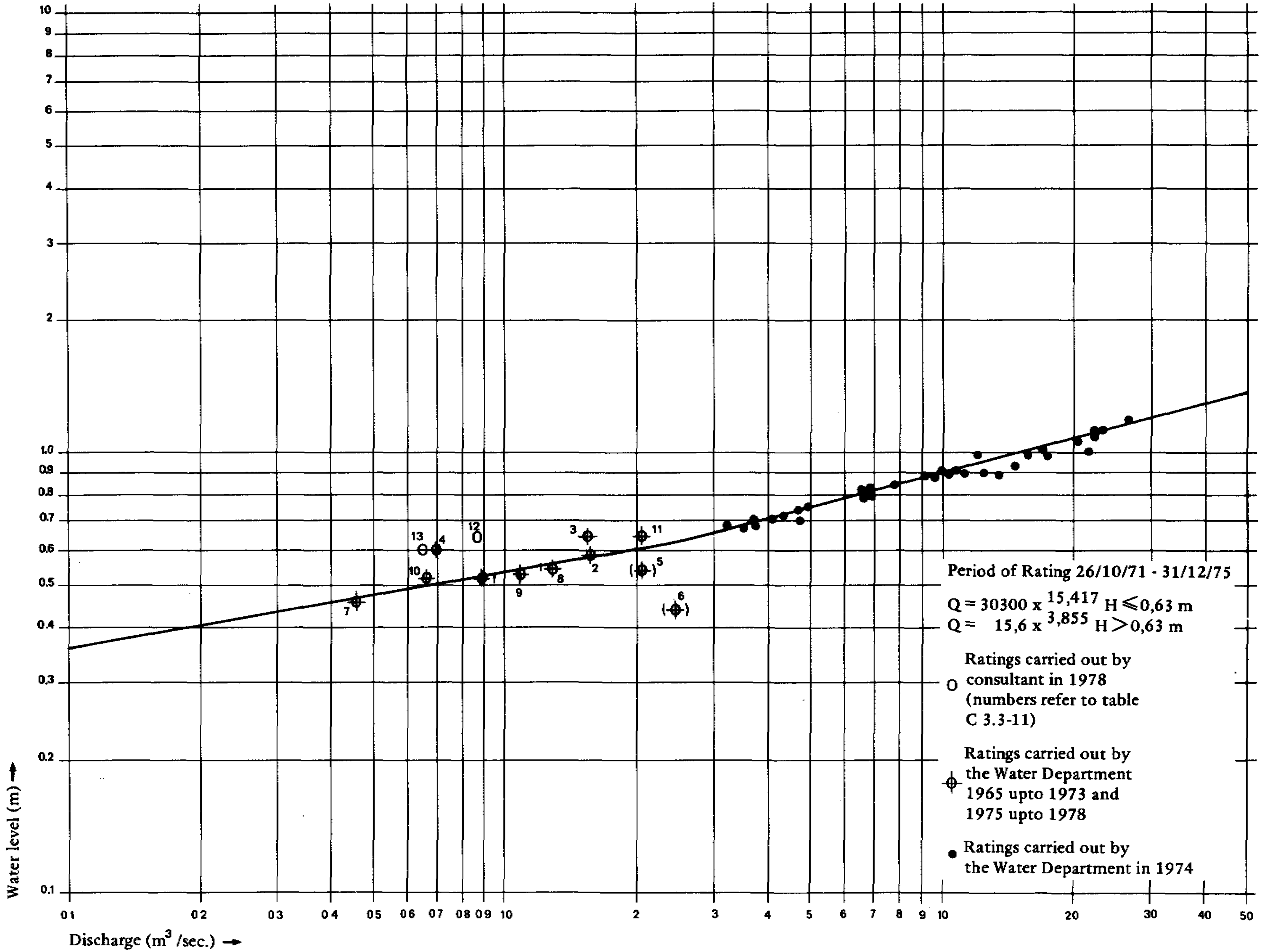


Figure C 3.3-7 Rating curve Tami River at Msowero (1G5A)

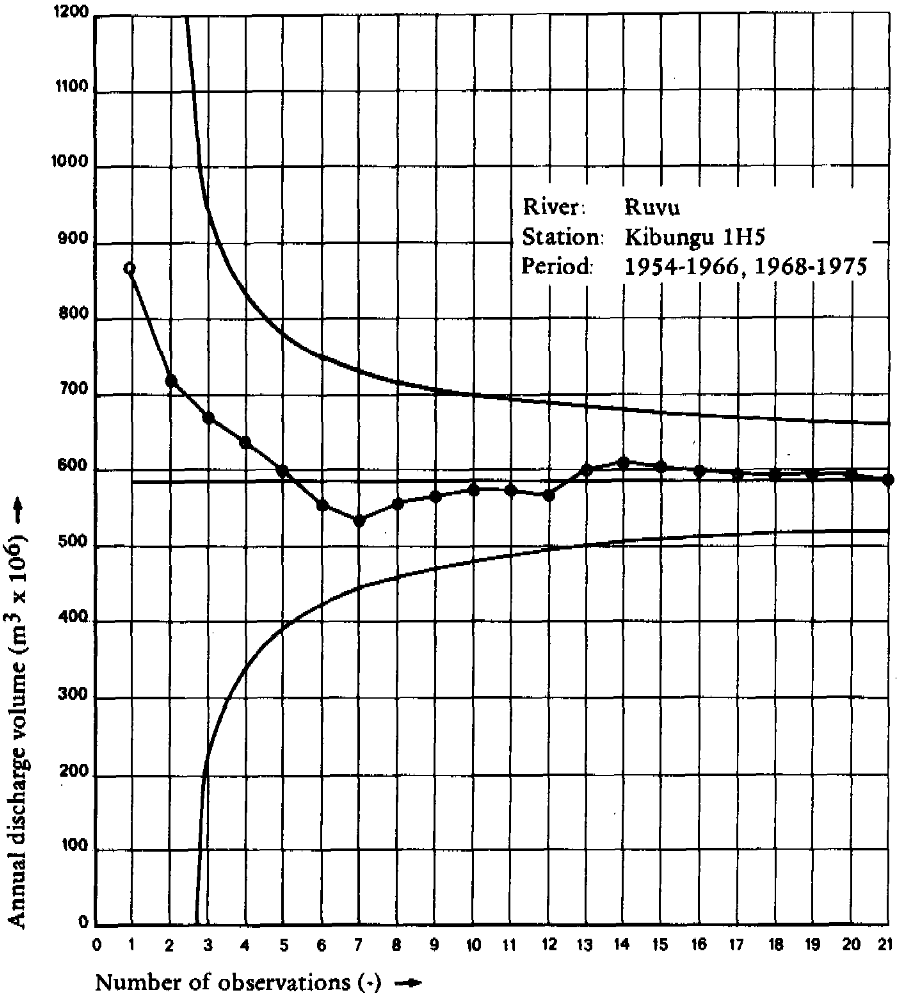


Figure C 3.3-8 Confidence interval of mean annual discharge volume

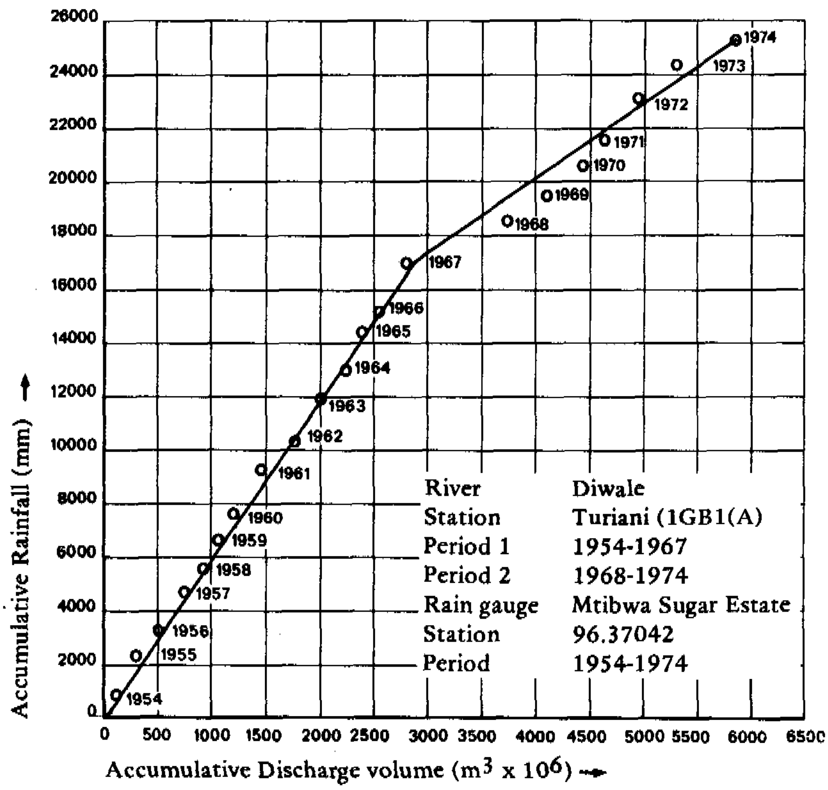


Figure C 3.3-9 Double mass curve of the Diwale River

3.3.4. Annual discharges

3.3.4.1. General

From the monthly discharge data, annual discharge volumes ($m^3 \times 10^6$) are calculated for the calender year period and the hydrological year (November 1st up to October 31st).
The latter data are used to estimate annual discharge volumes during a "very dry" "dry", "median", "wet" and "very wet" (hydrological) year. The definitions of these typical years are related to annual discharge volumes with probabilities of non-exceedence of 5%, 20%, 50%, 80% and 95% respectively.

3.3.4.2. Reliability and number of data

Generally the reliability of an estimation of a probability distribution is smaller as fewer data are available. To determine a criterion on the number of data necessary to obtain sufficient reliability of the estimation, the series of 21 annual discharge volume data of the Ruvu at Kibungo River (1H5) is analysed in detail.
From this series (x_i) a series of 21 means (m_i) is derived according to the following equation:

$$m_i = \frac{\sum_{i=1} 21\ x_i}{n} \qquad (1)$$

where x_i is ranked in chronological order.

The values of m_i are plotted on Figure C 3.3-8.
As expected, the deviation of m_i from the mean of all data (m_{21}) is decreasing with an increasing number of data (n).

Noting that the mean (m_i) is usually almost normally distributed, that the annual discharge volumes (x_i) are independent and that m_{21} is almost equal to the true mean (m_n), the confidence interval which contains the true mean with a probability of (100-α)% can be calculated by the following equation:

$$m_{21} = \pm\ t_{\frac{1}{2}\alpha}\ \frac{S_{21}}{\sqrt{n}} \quad (m^3 \times 10^6) \qquad (2)$$

where $t_{\frac{1}{2}\alpha}$ = a frequency factor which can be obtained from the Student t - distribution for (n-1) degrees of freedom and probability level $\frac{1}{2}\alpha$
S_{21} = sample standard deviation derived from the data x_1, x_2 .... x_{21} ($m^3 \times 10^6$)
n = serial number 1, 2, 3 21

"Independent" means that hardly any carry over of water from one year to the next takes place as is the case in an area with flash floods and near zero low flows.

In Figure C 3.3-8 a confidence interval in relation to a probability of non-exceedence of 95% is shown.
From this figure it becomes obvious, that the more observations are considered, the smaller the confidence interval and the more reliable the estimation of the true mean will be. Five observations and less give a wide and rapidly increasing confidence interval and hence an unreliable estimation; six observations and more show a confidence interval which is decreasing slowly. Consequently records of five years or less are considered unsuitable to establish a sufficiently reliable estimation of the mean. A similar exercise could be carried out for the standard deviation. This being a higher moment, still more data will be required for a reliable estimate.
Probability analyses are carried out for rivers with continuous records of six or more years only.

3.3.4.3. Homogenity of data

Another aspect related to the reliability of data is the instability of the river bed.
Some years are known in which rivers took a completely different course after large floods had changed the river bed. One example is the Mgeta River which, up to 1962, flowed from the escarpment to Nyarutanga and crossed the road to Kisaki close to Kisaki.
From 1963 onwards the main stream has followed a new course over some 10 km, passing Sesenga and crossing the road between Milengwelengwe and Gomero. A recent and similar example is the Mkundi River which changed its course after high floods in November 1978.
In both cases the measurement of the discharge may be influenced to a great extent by the point of observation. Due to a lack of data this assumption cannot be proved to be correct.

In this respect the Diwale River is a better example, because the river has been gauged continuously from 1953 onwards.
In 1967 the Mjonga River, which was flowing directly into the Wami River, joined the Diwale River above the gauging station, probably due to a heavy flood. The effect on the annual discharge is illustrated by Figure C 3.3-9, where the accumulated rainfall of the nearby rain gauge station on the Mtibwa Sugar Estate is plotted against the accumulated discharge volume.
As rainfall and discharge volume are related, accumulated data can be fitted by a straight line, also called double-mass analysis.In Figure C 3.3-9 data from 1954 to 1974 were used.
The data from 1968 and onwards, which include the flow of the Mjonga River, are fitted by a line with a flatter slope. Hence, the record of the Diwale River is split up into two parts, covering the 1953 to 1967 and the 1968 to present period respectively.

This example should demonstrate the necessity of controlling the homogenity of the data before a statistical or other kind of analysis is carried out, when a change of the river bed is expected.

3.3.4.4. Probability analysis of annual discharge volumes

An analysis of seven rivers of which long records exist and which may be considered representative for the project area, shows that the distributions of the annual discharge volumes are not symmetrical.
The asymmetry of a distribution may be characterized by the coefficient of skewness Cs (see Annex 1).
The coefficients of skewness are collected in Table C 3.3-12.

Table C 3.3-12 Coefficients of skewness

River	Station	number of years	coefficient of skewness (Cs)
Wami	1G1	17	+ 0.092
Wami	1G2	18	+ 0.115
Kisangate	1G6	13	+ 0.184
Diwale	1GB1A	14	+ 0.120
Ruvu	1H5	21	+ 0.044
Mgeta	1HB2	13	+ 0.084
Mvuha	1HC2	14	+ 0.062

Although the estimation of Cs from small samples (< 30 observations) is not very reliable, the fact that all Cs-values are positive indicates that the distributions of the annual discharge volumes are asymmetrical with a tail to the right (high values). For this reason an asymmetrical distribution with a lower limit of zero, such as the log-normal distribution, is preferred to a symmetrical distribution such as the normal distribution. However, the samples are too small to make an objective choice between the different asymmetric distributions. In accordance with normal Tanzanian practice (Water Master Plans) the log-normal distribution is used for annual flows.

According to Annex 1 the mean and standard deviations of the distribution are estimated. The distribution and the data are plotted on log-normal probability paper, using the plotting position formulae proposed by Chegodayev (Ven-te-Chow, 1964)[27]. The graphs are presented in paragraph 3.3. of the data part of this volume.
Visually the distributions give a good fit of the plotted data.
From the obtained probability distributions annual discharge volumes which will not be exceeded by probabilities of 5, 20, 50, 80 and 95% are derived and given in Table C 3.3-13. In the third column of this table the coefficients of variation of the obtained distributions are given. This coefficient indicates the variability of the data. As dimensionless numbers the coefficients of variation of different rivers are comparable.

Table C 3. 3-13 Annual Discharge Volumes (x 10^6 m^3)

Rivers	Station		Number of Years	Coefficient of Variation	Probability of Non-Exceedence				
					5%	20%	50%	80%	95%
Wami	Dakawa	IG1	17	0.64	275	467	810	1404	2387
Wami	Mandera	IG2	18	0.69	638	934	1677	2742	4405
Tami	Msowero	IG5A[1)]	6	0.86	51	100	203	410	807
Kisangate	Mvumi	IG6	13	0.46	31	46	71	108	164
Wami	Rudewa	IG8	9	0.36	100	128	186	255	346
Diwale	Turiani	IGB1(A)[2)]	14	0.32	121	151	192	243	306
		[3)]	7	0.63	152	228	348	531	798
Mkindu	Mkindu	IGB2	10	0.32	81	106	141	187	245
Mkondoa	Kilosa	IGD2	16	0.54	126	184	273	406	594
Mkombola	Lukando	IGD5	7	0.20	39	47	56	67	79
Ruvu	Ruvu Sisal Estate	IH2	8	0.23	1198	1451	1770	2160	2616
Ruvu	Kidunda	IH3	11	0.17	761	1050	1461	2033	2795
Ruvu	Kibungo	IH5	21	0.31	347	437	562	723	912
Ruvu	Morogoro Road Bridge	IH8	16	0.52	931	1325	1911	2757	3925
Ngerengere	Utari Bridge	IHA1(A)	18	0.60	61	91	140	213	321
Ngerengere	Kingolwira	IHA3	9	0.21	74	87	104	123	146
Ngerengere	Kilimanjaro	IHA4	6	0.28	38	50	67	89	117
Ngerengere	Kiluwa	IHA5	13	0.51	54	80	119	177	260
Ngerengere	Kihonda	IHA6	9	0.30	36	48	65	88	117
Mlali	Mlali	IHA7	6	0.51	2	4	7	11	18
Morogoro	Morogoro	IHA8[4)]	12	0.33	10	14	18	24	32
Ngerengere	Konga	IHA9(A)	16	0.35	15	20	27	37	49
Mgeta	Kisaki	IHB1	10	0.21	137	165	202	246	298
Mgeta	Mgeta	IHB2	13	0.59	48	75	118	185	287
Mvuha	Mvuha	IHC2	14	0.52	158	238	363	554	832
Great Ruaha	Kidatu	IKA3	11	0.42	1592	2268	3274	4727	6735
Great Ruaha	Yovi	IKA38A	8	0.58	61	95	151	241	377

1) jan. – december year is used
2) up to 1967
3) 1968 and onwards
River Mjonga joined River Diwale in 1968
4) Downstream of intake
Morogoro Town water supply

3.3.5. Monthly discharges

For six records mean monthly discharge volumes are plotted in Figure C 3.3-10.
The records are representative for the following areas:

1.	Wami at Mandera	(1G2)	Nguru, Ukaguru and Rubeho mountains, Mkata and Wami Plains
2.	Kisangate at Mvumi	(1G6)	Ukaguru mountains
3.	Ruvu at Morogoro Road Bridge	(1H8)	Uluguru mountains, Ruvu Plain
4.	Ruvu at Kibungo	(1H5)	East Uluguru mountains
5.	Diwale at Turiani	(1GB1)	Nguru mountains
6.	Ngerengere at Konga	(1HA9A)	West Uluguru mountains

It is remarkable that the six distributions are very similar. In all cases the effect of the short and long rains is obvious. The long rains give a pronounced peak during April and May with a maximum in April. The short rains ending the dry period cause a second but smaller peak during November, December and January, without a well-pronounced maximum. Low flows are reached in February, between the short and long rains, and at the end of the dry period with a minimum in September or October.

From the fact that the distribution of the Wami River at Mandera (1G2) does not have significantly lower peaks or higher low discharges in comparison with the Kisangate River at Mvumi (1G6), it may be concluded that the storage capacity of the Mkata and Wami Plains is small in relation to the monthly discharge volumes of the different rivers entering the plains.
The same conclusion holds true for the Ruvu Plain, when the distributions of the Ruvu River at the Morogoro Road Bridge (1H8) and at Kibungo (1H5) are compared with each other.

For the same six records the coefficients of variation (Cv) for the monthly and annual discharge volumes are given to get an idea of the variability of the discharges (Table C 3.3-14). A high value of Cv implies that the actual discharge may differ relatively much from the given mean discharge. A low value of Cv means that a relatively small deviation from the given mean discharge may be expected.

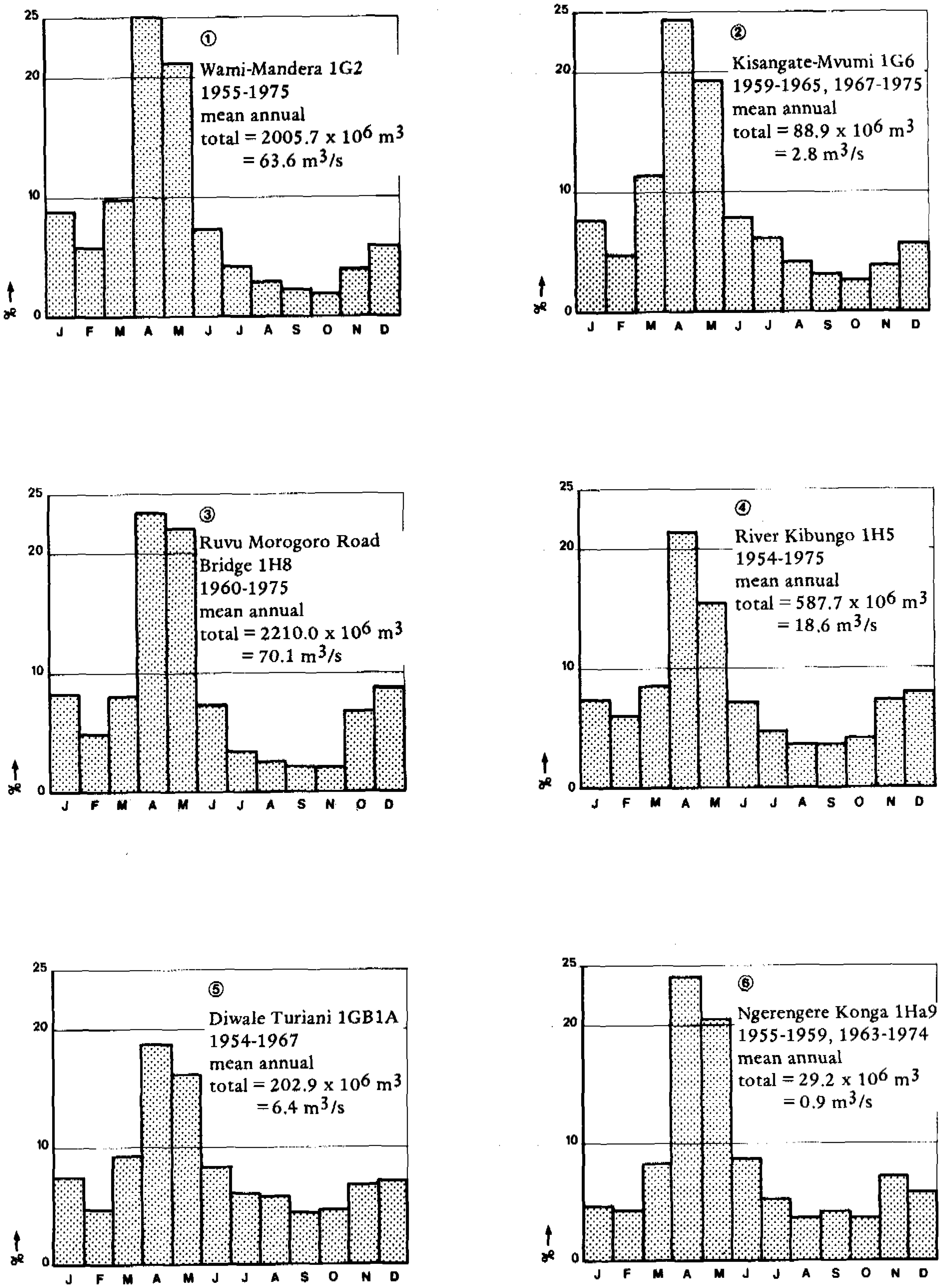


Figure C 3.3-10 Mean annual distribution of monthly discharge volumes (in % of the annual discharge volume)

Table C 3.3-14 Coefficients of variation of discharge volumes of selected rivers

River	Station	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Ruvu	(1H8)	1.28	0.67	0.70	0.81	0.53	0.52	0.36	0.40	0.63	0.62	1.86	1.25	0.44
Ruvu	(1H5)	0.60	0.47	0.40	0.61	0.34	0.39	0.34	0.36	0.65	0.54	1.02	0.85	0.27
Wami	(1G2)	1.48	0.67	0.72	0.98	0.58	0.83	0.45	0.47	0.60	0.74	1.99	1.48	0.69
Kisangate	(1G6)	1.11	0.68	0.79	0.64	0.42	0.36	0.55	0.32	0.32	0.38	0.74	1.01	0.41
Diwale	(1GB1A)	1.10	0.61	0.54	0.33	0.25	0.41	0.43	0.49	0.74	0.64	1.14	0.85	0.27
Ngerengere	(1HA9)	0.94	0.70	0.69	0.38	0.38	0.49	0.67	0.72	0.97	0.78	1.13	0.94	0.33

November, December and January show relatively high values of Cv which is closely related to the high variability of the amount of rainfall during the short rains. The low variability occurs during the months of May up to October.

3.3.6. Minimum flows

3.3.6.1. Probability analysis of existing data

A probability analysis of annual low flows is carried out of records from stations which are located along the escarpments of the Uluguru, Nguru, Ukaguru and Rubeho mountains, which are considered source areas for gravity water supply. No stations are located in rivers in the Migomberame Mountains. Only series with six or more years of complete records are considered. For the shorter series of 6-10 years, estimated low flows below those with probabilities of non-exceedence of 10% are not very reliable.
Several hydrometric stations provide continuous water level data. From these series absolute minimum flows are selected. From other stations only daily minima can be obtained. As daily minima do not differ much from absolute minima, both series are treated as equal values.
Because low flows are limited at low values (≥ 0) but unlimited at high values, skew distributions are obtained. The same approach as the one for annual discharge volumes is used to estimate the probabilities for annual low flows. In both cases the log-normal distribution has been applied.

Data are plotted on log-probability paper and seem to fit well (see data part of this volume).
In Table C 3.3-15 the estimated low flows with probabilities of non-exceedence of 50% (average year), 20% (fairly dry year), 10% (dry year), 5% (very dry year) and 1% (extremely dry year) are given.

The rivers of Table C 3.3-15 are perennial, and even in an extremely dry year they carry remarkable quantities of water considering the amounts needed for domestic water supply.

Table C 3.3-15 Annual low flows (l/s) of gauged rivers

River	Station		Probability of non-exceedence 1%	5%	10%	20%	50%
Wami	Dakawa	1G1	1040	1550	1930	2462	4010
Tami	Msowero	1G5A	48	76	117	190	500
Kisangate	Mvumi	1G6	140	199	238	299	457
Wami	Rudewa	1G8	787	1075	1240	1545	2259
Diwale[1]	Turiani	1GB1(A)	182	271	340	436	713
Diwale[2]	Turiani	1GB1A	140	221	282	382	672
Mkindu	Mkindu	1GB2	252	319	364	421	562
Ruvu	Kibungo	1H5	1811	2163	2400	2660	3304
Ngerengere	Konga	1HA9A	25	39	49	67	116
Mgeta	Kisaki	1HB1	551	690	780	897	1180
Mgeta	Mgeta	1HB2	462	533	575	632	754
Mvuha	Mvuha	1HC2	435	609	730	899	1355

1 1968 and onwards (including Mjonga River). Both the old (1GB1) and the new (1GB1A) gauging site records have been used

2 upto 1967

The distribution of the lowest annual flows over the months of the year is given in Figure C 3.3-11. for the Wami River at Dakawa (1G1), the Diwale River at Turiani (1GB1A), the Ruvu River at Kibungo (1H5) and the Ngerengere River at Konga (1HA9A). The Wami, Diwale and Ngerengere Rivers show the effect of the short rains. The occurrence of the lowest flow in November or December is not very pronounced. The Ruvu river shows less effect of short rains, because at the S.E. part of the Uluguru Mountains the two rainy periods are less pronounced. Due to relatively high rainfall during the short rains and because these short rains merge into the long rains, the lowest annual flows occur in 75% of the years before the end of November. This value amounts to 55% for the Ngerengere River, 70% for the Wami River and 50% for the Diwale.

3.3.6.2. 1978 Field data of gauged and ungauged rivers

Several gauged and ungauged rivers were measured during the dry season in 1978. The first measurements were carried out in June 1978. During the third week of November 1978 heavy rainfall and accompanying floods throughout the region put an end to the dry season and low flows.
The rivers which were measured regularly, are indicated on Map 1. The data are plotted on figures on a semi-logarithmical scale (see data part of this volume).
As soon as surface run off has stopped, the decrease of the flow may be

described by an exponential equation as given below:

$$Q_t = Q_o e^{-\alpha t} \qquad (8)$$

where Q_t = discharge at time t (m^3/s)
Q_o = discharge at time t=o (m^3/s)
α = depletion coefficient, which depends on catchment characteristics (1/day)
t = time (days)

As a result, the data will be more or less fitted by a straight line with slope α on semi-log paper, where the discharge-scale is logarithmic and the time-scale linear.
Deviations from the straight line are mainly caused by occasional rainfall and/or important water losses due to artificial extraction or evaporation in swamps.
The effect of water losses on a depletion curve is illustrated in Figure C 3.3-12. Examples are the Kiroka River (61 and 65), the Mgolole River (58) and the Ngerengere River (55), where the numbers refer to the locations given on Map C 1.

From the depletion curves the lowest flow in the calendar year 1978 was obtained. The lowest flows in 1978 of the gauged rivers are compared with the respective probability distributions, showing that the lowest flows have probabilities of exceedence which are roughly between 40 and 80% (see Table C 3.3-16). With respect to low flows, the calendar year 1978 may be considered an average year for most of the rivers. Only the low flows of the Ruvu, Mvuha and Mkindu Rivers correspond with a wet year. This is in accordance with the findings about rainfall. Due to relatively large, regional differences in rainfall in the same year, some areas received amounts of rainfall above normal.

Table C 3.3-16 Low flows 1978

River	Station		Low flows[1] (l/s)	Probability of non-exceedence (%)
Wami	Dakawa	1G1	3800	46
Tami	Msowereo	1G5A	580	55
Kisangate	Mvumi	1G6	450	50
Wami	Rudewa	1G8	2000	40
Diwale	Turiani	1GB1A	650	43
Mkindu	Mkindu	1GB2	750	80
Ruvu	Kibungo	1H5	4100	80
Ngerengere	Konga	1HA9A	110	47
Mgeta	Kisaki	1HB1	1250	55
Mgeta	Mgeta	1HB2	750	50
Mvuha	Mvuha	1HC2	1700	68

1) estimated from depletion curves (see Data part of this volume)

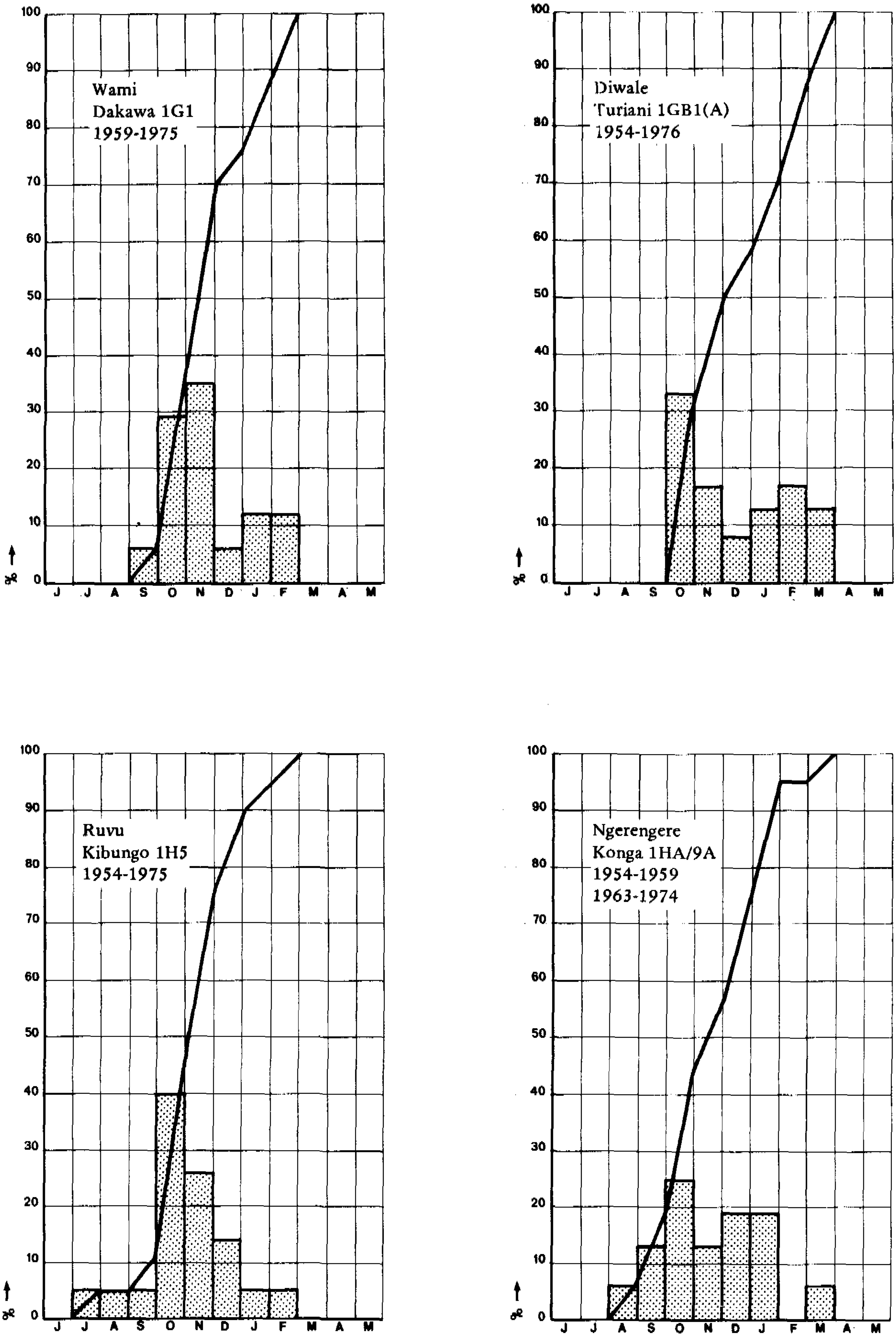


Figure C 3.3-11 Occurrence of lowest annual flows versus the months of the year

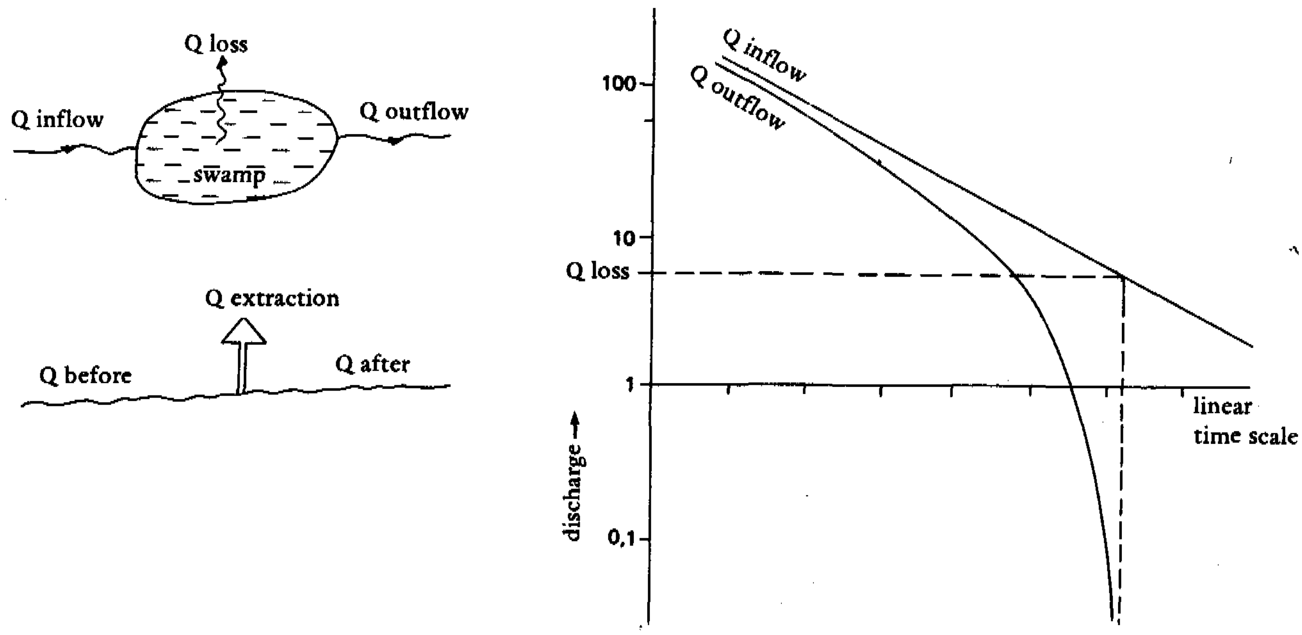


Fig. C 3.3-12 Effect of water losses on depletion curves

3.3.6.3. *Low flows of ungauged rivers*

Probabilities of non-exceedence of low flows of ungauged rivers are estimated by using the following data:

a. the low flow probability distribution of a gauged river nearby the ungauged rivers
b. depletion curves of the gauged and ungauged rivers. (In this case only 1978 depletion curves were known)

The following assumptions are made:

a. the state of the catchments of the gauged and ungauged river at the beginning of the dry period is identical with respect to ground water
b. the pattern of rainfall on both catchments is identical

As length of rainfall season and rainfall amounts vary with altitude and location, the catchments should have the same topography and should not differ too much in size. The remaining catchment characteristics, such as drainage pattern and soil composition, which are incorporated in the depletion coefficient a of equation (8), may be different.

The applied method is based on equation (8) and illustrated in Figure C 3.3-13. The method includes the following steps:

1. First an arbitrary starting point is chosen, t=o and Q_o.
2. From the low flow probability distribution of the gauged river a discharge Q(x%) with a probability of non-exceedence of x% is derived.
3. By means of equation (9) the time period $t_{(x\%)}$ which is required for a decrease of the flow from Q_o to Q(x%) is calculated.

Hence:

$$t_{(x\%)} = \frac{1}{\alpha_1} \ln \frac{Q_o}{Q(x\%)} \qquad \text{(day)} \qquad (9)$$

in which α_1 = depletion coefficient of the gauged river (1/day)

Q_o = discharge of gauged river at starting point (m^3/s)

$Q(x\%)$ = discharge of gauged river with a probability of non-exceedence of x% (m^3/s)

$t_{(x\%)}$ = time required from Q_o at t=o to become $Q(x\%)$ (day)

4. The estimation of the discharge with a probability of non-exceedence of x% of the ungauged river is based on equation (10).

$$q(x\%) = q_o \, e^{-\alpha_2 t_{(x\%)}} \quad (m^3/s) \qquad (10)$$

in which $q(x\%)$ = discharge of ungauged river with a probability of non-exceedence of x% (m^3/s)

q_o = discharge of ungauged river at starting point (m^3/s)

α_2 = depletion coefficient of the ungauged river (1/day)

$t_{(x\%)}$ = time, determined by equation (9) (day)

5. If $\alpha_1=\alpha_2$ equation (9) and (10) may be combined to a simple expression:

$$q(x\%) = \frac{q_o}{Q_o} Q(x\%) \qquad (m^3/s) \qquad (11)$$

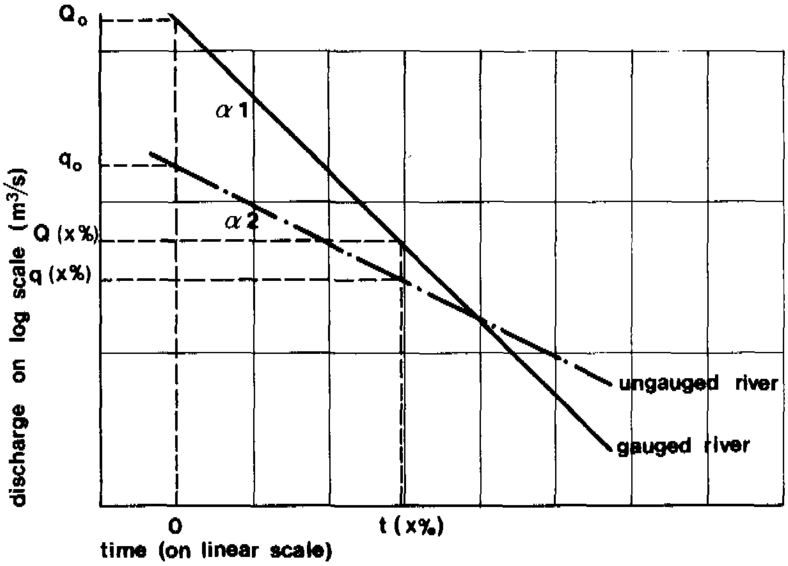


Figure C 3.3-13 Definition sketch of low flow estimation method

The method is tested with two pairs of rivers which have well-defined probability distributions and meet the requirements of similar topography and rainfall pattern.
The rivers used are the Ruvu River at Kibungo and the Mvuha River at Mvuha, both draining the south-eastern part of the Uluguru mountains, and the Kisangate River at Mvumi and the Wami River at Rudewa, which rise from the western slopes of the Ukaguru mountains.
The results of the test are given in Table C 3.3-17.
For each river two values for Q(x%) are given.
The first value is determined by using the method described above. The second value, which is underlined, is derived from the probability distribution which has been established from long records.

Table C 3.3-17 Test results low flow estimation method

River	Station		α (1/day)	Q(1%) (l/s)	Q(5%) (l/s)	Q(20%) (l/s)	Q(50%) (l/s)
Ruvu	Kibungo	1H5	0.0025	1 775 1 811	2 179 2 163	2 763 2 660	3 548 3 304
Mvuha	Mvuha	1HC2	0.0041	450 435	667 609	846 899	1 204 1 355
Wami	Rudew	1G8	0.0066	1 122 787	1 332 1 075	1 634 1 545	2 019 2 259
Kisangate	Mvumi	1G6	0.0133	68 140	129 199	264 299	573 457

The proposed method gives reasonable results between probabilities of non-exceedence of 5% and 50%. As for the Wami-Kisangate example, the results for a probability of non-exceedence of 1% differ much. It should be noted, however, that the probability distribution in this range is obtained by extrapolation and is therefore not very reliable.

The method described above is applied to several ungauged rivers given in Table C 3.3-18 below. The rivers with probability distributions of low flows are underlined. As a starting point the 1st of August, 1978, is used. In Table C 3.3-18 the time to halve the discharge ($T_{0.5}$) is also given.

$T_{0.5}$ indicates the rate of decrease of the flow during depletion.

Table C 3.3-18 Annual low flows of ungauged rivers

River	Station		α (1/day)	$T_{0.5}$ (day)	Q(1%) (l/s)	Q(5%) (l/s)	Q(10%) (l/s)	Q)20%) (l/s)	Q(50%) (l/s)
Ngerengere	Konga 1HA9A	(52)	0.0070	100	25	39	49	67	116
Morogoro	above intake	(53)	0.0062	112	26	38	47	61	100
Kiroka	above Kiroka	(60)	0.0107	65	2	4	6	9	21
Mahembe	Kiroka	(62)	0.0213	33	0	0	1	1	7
Ruvu	Kibungo 1H5	(72)	0.0025	282	1811	2163	2400	2660	3304
Msuazi	Kalundwa	(69)	0.0088	79	3	6	4	13	27
Kisemu	Kilangile	(68)	0.0135	51	0	1	2	3	10
Mvuha	Mvuka 1HC2	(78)	0.0041	168	435	609	730	899	1355
Ditumi	Bonye	(79)	0.0258	27	0	0	0	1	9
Mngazi	Mngazi	(81)	0.0117	59	8	22	87	67	217
Mkindu	Mkindu 19B2	(24)	0.0068	102	252	319	364	421	562
Dihombo	Dihombo	(23)	0.0137	51	5	8	10	14	24
Chazi	Kigugu	(26)	0.0147	47	1	2	2	3	5
Divue	Mbogo	(29)	0.0127	54	16	25	31	41	71
Msengele	Kwamtonga	(30)	0.0211	33	1	1	2	3	6
Lusonge	above Dihinda	(35)	0.0132	52	3	5	6	8	14
Wami	Rudewa 198	(45)	0.0066	105	787	1075	1240	1545	2259
Kisungusi	above Rudewa	(46)	0.0062	112	124	167	191	234	335
Miyombo	Nyameni	(49)	0.0052	132	480	617	688	817	1104
Msowero	Msowero	(93)	0.0054	129	157	204	229	273	373
Tundu	Tundu	(94)	0.0031	223	77	90	96	106	127
Ruembe	Kidogobasi Road	(92)	0.0065	107	253	346	397	491	717
Tami	Msowero 195A	(43)	0.0111	62	48	76	117	190	500
Milindo	Ukaguru Forest Reserve	(9)	0.0080	86	11	15	25	29	59
Masonbowe	Masenge	(7)	0.0078	89	5	7	10	13	25

It should be noted that the Kiroka and Mahembe River do not meet the requirement of being close to the gauged river. Especially the rainfall may be expected to be higher than in the Ngerengere catchment.
The values given in Table C 3.3-18 may therefore be considered to be a conservative estimate.

The applied method does not give zero flows, because a logarithmical equation is used. Zero flows are considered to occur when less than 1 l/s is calculated.

It turns out that several small rivers are not (always) perennial. Rivers for which no estimation of Q(5%) is made or which have been observed only, are considered non-perennial, if zero flow occurred during the dry season of 1978. Perennial and non-perennial rivers are indicated on the hydrological map (Map C2) by full and dashed lines.

3.3.7. Springs

3.3.7.1. General

The low flows discussed above must emerge somewhere. The source areas can be confined to distinct sites, where water is emerging. As has been observed in the field, source areas are usually large depressions, where water seeps out of the bottom at many different places. Sometimes the river acts as a drain and water is seeping out of the embankments of the river. Geomorphologically, four basic types of springs can be distinguished.

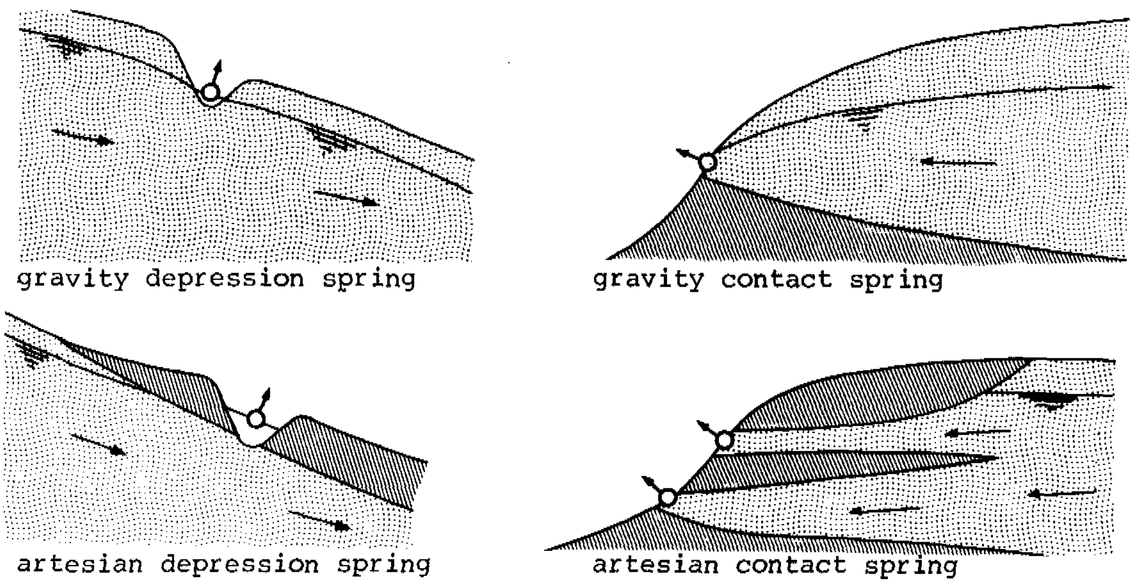


Fig. C 3.3-14 Spring types

Depression springs are rather variable in yield, while in dry periods, when the ground water table is low, they may cease to flow altogether. Gravity contact springs and artesian contact springs are more reliable in this respect, assuming that they are not arising above small perched aquifers. In particular the artesian contact spring with a catchment area at a large distance is a reliable source. This is especially the case for one type of artesian contact spring, the so-called fault spring, in which the artesian water backs up against an impervious bed and rises through the fractures in the fault and finally emerges at the surface. This type of spring is often a hot spring, because it comes from considerable depth.

Climate is the second factor determining the variability of the discharge. Climates with less pronounced wet and dry periods like that of the eastern Uluguru Mountains will have less variable groundwater levels, hence less variable discharges. Minimum spring discharges follow with a certain time-lag, the rainfall minima, where the time-lag depends on the length of the rainy season and the permeability of the aquifer.
In contrast with the low flows of rivers, which end at the beginning of the rainy season, when surface flow and sub-surface flow start adding to the low flows, springs are less affected by these phenomena and minimum flows can occur 1 to 3 months after the beginning of the heavy rains, which also supply the ground water aquifers.
During the fieldwork several small springs were observed emerging along slopes in the different mountain ranges.
These are possibly all gravity contact springs at the outcrop of layers of different permeabilities. Thus they drain all small ground water reservoirs above the spring. Many of these springs dry up after some time. The extended spring areas, the large depressions mentioned earlier, have no extensive amounts of water emerging at one point. However, the areas will be rather well suited for shallow well development, if pumping is used to direct the water to a central point. Under certain circumstances it might be profitable to close part of the whole underground of a valley in order to force the water up and if possible to transport it to demand areas by gravity. The following sub-paragraph will discuss well-defined springs only.
Although during the initial field survey considerable attention was paid to the location of springs, not many viable springs for water development appeared to exist, except for the springs that appear in the limestone area in the south-west Uluguru Mountains.
Springs in two different regions will be discussed in the next section.
The method used to determine low flows of rivers, as discussed in the last section, is also used to determine low flows of springs, although it is done in a conservative way by extending the low flow period by a month.

3.3.7.2. Springs in the SE Uluguru Mountains

<u>Tambuu springs</u>

The largest concentration of springs was found around Tambuu in the Karst area. During a visit on 21-7-78 several springs with estimated discharges of 3-4 l/s (EC 46-48 mS/m) were found in the village, while the largest spring South of Tambuu had a measured discharge of 10.4 l/s on the same date. According to the geological map, this latter spring was located at a Gneiss-limestone transition. The Gneiss could act as an impervious barrier for the ground water to back up against. This particular spring belongs to the head waters of the Msonge River. Assuming a similar type of depletion, the 5% low flow could be approximately 2 l/sec. According to local information discharge always remains much higher.

Mtamba springs

Several kilometres NW of Tambuu, 3 springs were found emerging from a limestone ridge, east of the village Mtamba, presumably gravity contact springs. Each spring is tapped by a small, closed intake structure, which is connected with a reservoir and one tap.

Several measurements were carried out in 1978 (see Table C 3.3-19), which indicate that the southern and northern springs are almost equal in size and that the middle spring produces only about 20% of each of the others.

Table C 3.3-19 Springs near Mtamba, Data

Spring	Site number	Date	Discharge (l/s)	EC (mS/m)
southern	(74)	21-7-78	1.1	-
middle	(74)	21-7-78	0.2	-
northern	(74)	10-8-78	1.0	46
northern	(74)	7-9-78	0.8	47
northern	(74)	5-10-78	0.8	45
northern	(74)	2-11-78	0.5	-

Originally the middle spring had a much higher discharge according to local information. Based on present measurements, the total flow of the three springs together at the end of the dry period is estimated at 1 l/s. The 5% low flow of the three springs together, based on the same depletion as nearby little rivers, is estimated at 0.3 l/s. However, by redeveloping the springs, this figure could possibly be raised to 1 or 2 l/s.

Table C 3.3-20 Springs near Mtamba, potential

altitude supply area	(m a.MSL)	~ 320
altitude springs	(m a.MSL)	~ 340
level difference	(m)	~ 20
5% total low flow	(l/s)	0.25 (before redeveloping)

Mkuyuni spring

About 40 m above Mkuyuni, SW of the village a small spring emerges from below a limestone outcrop. Measured flow in 1978 decreased from approximately 10 l/s to 3 l/s, while the estimated 5% low flow may be roughly estimated at 0.8 l/s. This spring is just large enough to supply the village of Mkuyuni. However, the bacteriological contamination of Karst springs can be severe.

3.3.7.3. Springs in the Berega catchment

Several small springs were observed at the foot of inselbergs in the Berega catchment and at the foot of the amphitheatre-shaped escarpment near Kisitwe. In all cases except two, the discharge was less than 0.5 l/s. The springs below 0.5 l/s are:

a. two small springs on the W and E side of an inselberg W of Yogwe. Many years ago the eastern spring was equipped with a V-notch weir, which was still in a rather good condition. Measured discharge on 6-7-78 was 0,22 l/s. The western spring was tapped and the discharge was just sufficient to supply a nearby mission post
b. one small spring emerging halfway the slope of mountains South of Ihenje. The discharge is estimated at less than 0.3 l/s (28-6-78). The spring is situated in a small valley. Hence a closed wall and collector-well might increase the discharge
c. two small springs emerging at the foot of the escarpment near Kisitwe; the combined discharge on 12-6-78 was less than 0.5 l/s
d. the Kiega spring is emerging at the toe of mountains South of Kiega. The discharge is estimated at less than 0.5 l/s (27-7-78). This particular spring seeps from below big boulders

Unless stated otherwise, an increase of discharge does not seem possible because catchment areas of springs appear very small and the basement is close to the surface.
The two larger springs observed were a spring emerging in a swampy valley near Maguha. This spring was developed for the water supply of this same village. The other larger spring is found 3 km NE of Mamboya and the Water Department is considering development of this spring. The spring consists of two small springs of which the smallest runs dry at the end of the dry season. The springs are located on the slopes of an amphitheatre-shaped mountain, with basement outcropping everywhere. The total discharge measured on 5-7-78 was 3.4 l/s, while at the end of the dry season the discharge of the still flowing spring was only 0.5 l/s. (see Data part 3.5. site number (1)). It is doubtful whether this spring will be perennial during drier years than 1978. Therefore, this spring is not considered suitable for domestic water supply.

The Water Department (Morogoro files) mentions springs near two other villages in the Berega catchment, viz.:

a. Ibuti village (from file K1-15)
Besides 3 very small springs, a spring 2.5 km South of the village (below village level) exists. Estimated discharge on 28-8-1969 was 1.0 l/s.
b. Mtumbatu village (sub.div. Mamboya)
Springs are observed in Mtumbatu River. Early in 1969 a V-notch weir was installed. At the end of the dry period the spring did not flow anymore.

In the Berega catchment water was also observed seeping out of the beds of several dry rivers at places where the underground river bed had barriers. These phenomena are treated in Volume IV - Hydrogeology.

3.4. Sediment

3.4.1 General

In tropical areas with heavy rainfall, erosion of the soil is often an important problem. When at the end of the dry season most of the vegetation has vanished or is destroyed by burning, rainfall and resulting surface run-off may cause heavy erosion.
As vegetation will gradually cover the denudated soils during the wet season, thus providing a natural protection of the soil, the erosional effect of rainstorms will decrease during the course of the wet season.
Other factors which influence erosion rates are catchment slope, soil type and soil conservation measures. As is outlined in subparagraph 4.2.5. - changes in land use and hydrological effects - conservation may bring about significant reductions of erosion rates.
It may be obvious that soil erosion and the resulting sediment concentration in the river are determined by geomorphological and hydrological conditions which vary strongly throughout the country, but also throughout Morogoro Region. Besides soil erosion, silting of surface reservoirs and settling of sediment in intake structures, mains and storage reservoirs of water supply systems are problems related to sediment.
In the case of surface reservoirs, sedimentation causes a steady decrease of the effective reservoir volume. Silting of intakes, mains and storage reservoirs requires continuous maintenance and may affect the reliability of water supply.

Within the project only a few measurements of sediment transport, mainly in connection with the detailed study of the kikundi River (Annex 3), were carried out. Most of the data presented in this paragraph are obtained from studies carried out by others on rivers and reservoirs throughout the country.

As the factors which influence erosion and sediment transport of rivers vary strongly throughout Tanzania but also throughout Morogoro Region, the results derived from these studies cannot be very specific.

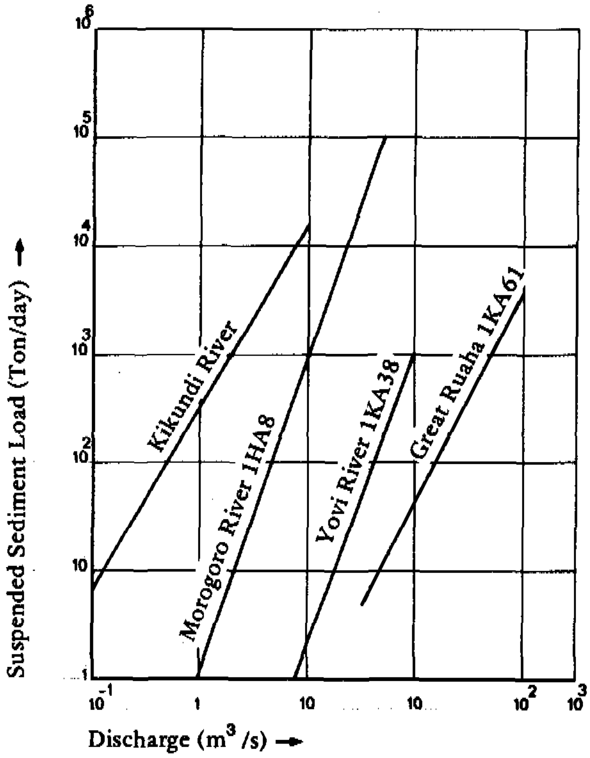
3.4.2. Sediment transport of rivers

The sediment transport of rivers is usually devided into suspended sediment load and bed load.
It is common to measure the suspended sediment load only and derive the bed load from semi-empirical formulas using velocity and grain size distribution of the bed. The bed load may also be taken as a proportion of the suspended sediment load (5-35%).

For several rivers average suspended sediment rating curves, where sediment load is related to discharge, are established. The number of data is too small to establish separate rating curves for the rising and falling flood stages.
The sediment rating curves are usually used in combination with flow duration curves to determine the annual sediment load of rivers. This method is not completely correct, because daily discharge data have to be used, while the sediment rating curves are based on point data. Generally however, there are not enough data available to enable a more detailed determination.
In Figure C 3.4-1 four rating curves for rivers with different catchment areas, geomorphological conditions and vegetation covers, are shown.
For a given discharge, the catchment of the Kikundi River which is steep (24%), small (4.5 km^2) and sparcely covered with vegetation, produces relatively high suspended sediment loads. The rating curve of the Morogoro River with a similar slope, but larger catchment area (19.1 km^2) and more vegetation cover has a position which is well below that of the Kikundi River.
Smaller loads are found for the Yovi River (slope 1.5%, catchment area 610 km^2) and the Great Ruaha River (slope very low, size 78 400 km^2).

The rating curves show very low amounts of suspended sediment at low discharges.
According to the rating curve of the Morogoro River the suspended sediment load at discharges below 1 m^3/s, which may be considered to be base-flow conditions, will not exceed 0.15 g/l on the average. According to the flow duration curve (Fig. C 3.4-2) this situation is present during about 80% of the time. During flood conditions, with high flows, suspended sediment loads range between 0.15 and 2.5 g/l on the average. Flood events which lead to such suspended sediment loads, are short but they occur frequently during the wet seasons. The occurrence may roughly be estimated at 30-50 times/year.
Occasionally suspended sediment loads which are higher than 2.5 g/l occur. The highest load out of 3000 samples collected during the wet seasons in 1969, 1970 and 1971, was 10.6 g/l (Rapp et al. 1973) [57].
According to several measurements carried out by Rapp et al, during floods in the Morogoro River, the sediment concentration of the upper tributaries which drain completely forested parts of the catchment is only about 10-50% of the sediment concentration found at gauge 1HA8. The catchment above the gauge also includes grass, bush and cultivated land.

During different stages of one flood on 30th of March 1970, suspended sediment samples were collected and analysed on their grain-size distribution (Fig. C 3.4-3). The distributions show particle sizes below 1 mm. At rising stage (curve 1) relatively coarse material is transported. At peak and falling stages (curves 2 up to 6) similar distributions are found, which are shifted towards smaller particle sizes.



Kikundi
4.5 km2
80% Bush and grass
20% Cultivated
(see chapter)

Morogoro (1HA8)
19,1 km^2
40% Montane forest
44% Bush and grass
10% Cultivated plots
6% Miyombo woodland and bare soil
(Rapp e.a. 1972)

Yovi (1KA38/
610 km^2
Miyombo woodland
(Water-Department, DSM)

Great Ruaha (1KA61)
78400 km^2
Various Vegetation species
(Water-Department, DSM)

Figure C 3.4-1 Suspended sediment rating curves for three rivers in Morogoro Region

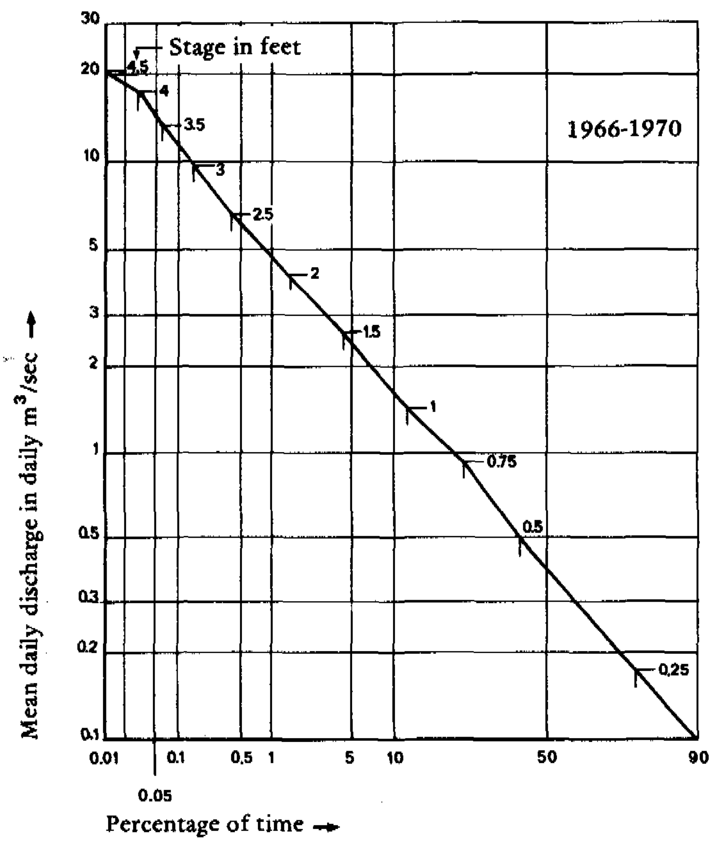


Figure C 3.4-2 Flow duration curve of mean daily discharges of the Morogoro River (Rappetal, 1973 [57]

SUSPENDED SEDIMENT,
MARCH 30, 1970
1. 03,17 rising stage
2. 03.28 peak stage
3. 03.40 peak stage
4. 04.00 peak stage
5. 04.15 peak stage
6. 04.45 falling stage

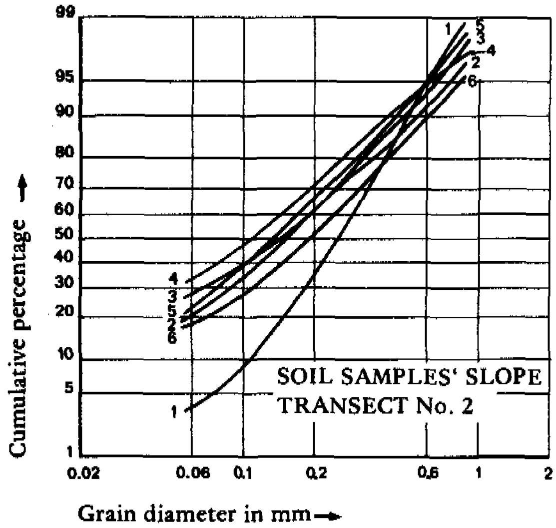


Figure C 3.4-3
Grain size distribution of 6 suspended, sediment samples during a flood on, 30th of March 1970 in the Morogoro, River (Rappetal, 1973 [57]

3.4.3. Sediment yield of reservoirs

Although the sediment yield of reservoirs is directly related to the sediment load of feeding rivers, the estimation based on sediment rating curves and flow duration curves is annually not possible because of lack of data.

From reservoirs in the South-Western United States of America (Fair et al. 1954) [33] the following relationship between catchment area (A) and the volume of sediment (V) which is deposited annually is found:

$$V = C\,A^{0.77} \qquad (1)$$

where:
V = the volume of sediment deposited in m^3/year,
C = a coefficient,
A = the catchment area in km^2,

The value of the coefficient C depends on geomorphological and hydrological factors and also on vegetation cover. As such the coefficient C is similar to the curve numbers (CN) which are used to incorporate these factors into the determination of direct runoff from daily rainfall (see Annex 3).

Sediment yield data for small Tanzanian reservoirs and two rivers are plotted on double-logarithmic paper, together with straight lines which represent equation (1) for different values of C (Fig. C 3.4-4). The data are scattered over a wide range of C values, because of differences in geomorphological and hydrological factors and in vegetation cover. Unfortunately hardly any data of this kind are available. A classification of the coefficient C and an adjustment of the exponent D which is here 0.77 is therefore not possible.

The reservoirs in Dodoma Region are fed by rivers which drain gently sloping catchments (1.5-7%) covered with scarce vegetation such as thicket and some grass. In the catchment high erosion rates are observed. As a result the sediment yield of the reservoirs is fairly high. A C-value of 1000 may be considered representative.

In Morogoro Region similar characteristics are found in the catchment of the Berega River (gently sloping area, scarce vegetation and high erosion rates). The annual sediment yield of reservoirs in this area may hence be predicted by using the same C-value of 1000.

In the gently sloping plains of the Wami, Ruvu and Ngerengere Rivers, which are well covered with grass, miyombo woodland and crops, relatively few traces of erosion are observed. For the prediction of the annual sediment yield of reservoirs in this area a C-value of 250 may be applied as a "safe" estimation.

Reservoirs based on rivers which emerge from steep catchments in mountainous areas such as the Morogoro River will receive higher sediment loads. For the Morogoro River a C-value of about 600 is found. The annual sediment yield is calculated from the mean annual suspended sediment load over the 1966-1970 period, using a ratio between bed load and suspended load of 0.2 and a density after settlement in the reservoir of 1.5 ton/m^3 (Rapp et al.1973) [58].

3.4.4. Recommendations

Gravity and pumped water supply systems should be based on rivers with catchments thickly covered with vegetation to obtain minimum sediment loads and to reduce sedimentation of intakes, mains and storage reservoirs. Sediment loads, which may lead to rapid sedimentation of structures, occur frequently during the wet season. In the design of intakes and mains, sediment concentrations up to 2.5 g/l and occasionally up to about 10 g/l should be taken into consideration.

The annual sediment yield of small reservoirs may be predicted by using equation (1). Provisionally the following C-values may be applied to the Morogoro Region:

Area	Characteristics	C
Berega River catchment	gentle slopes of 0-10%, scarce vegetation cover (high erosion rates)	1000
Mountainous area	steep slopes of 10-30%, well covered with forest, grass and partly cultivated	750
Wami, Ruvu, Negerengere Plains	gentle slopes of 0-10%, well covered with woodland, grass and partly cultivated (low erosion rates)	250

To enable classification of the coefficient C and adjustment of the exponent from equation (1) for the conditions in Morogoro Region and perhaps for Tanzanian conditions in general, the following studies are recommended:

- determination of sedimentation rates in about 20 reservoirs selected from the 350 existing reservoirs in Morogoro Region; the 20 reservoirs should be based on rivers with catchments of different geomorphological characteristics and vegetation;
- collection of catchment characteristics of the reservoirs mentioned in Figure C 3.4-4.

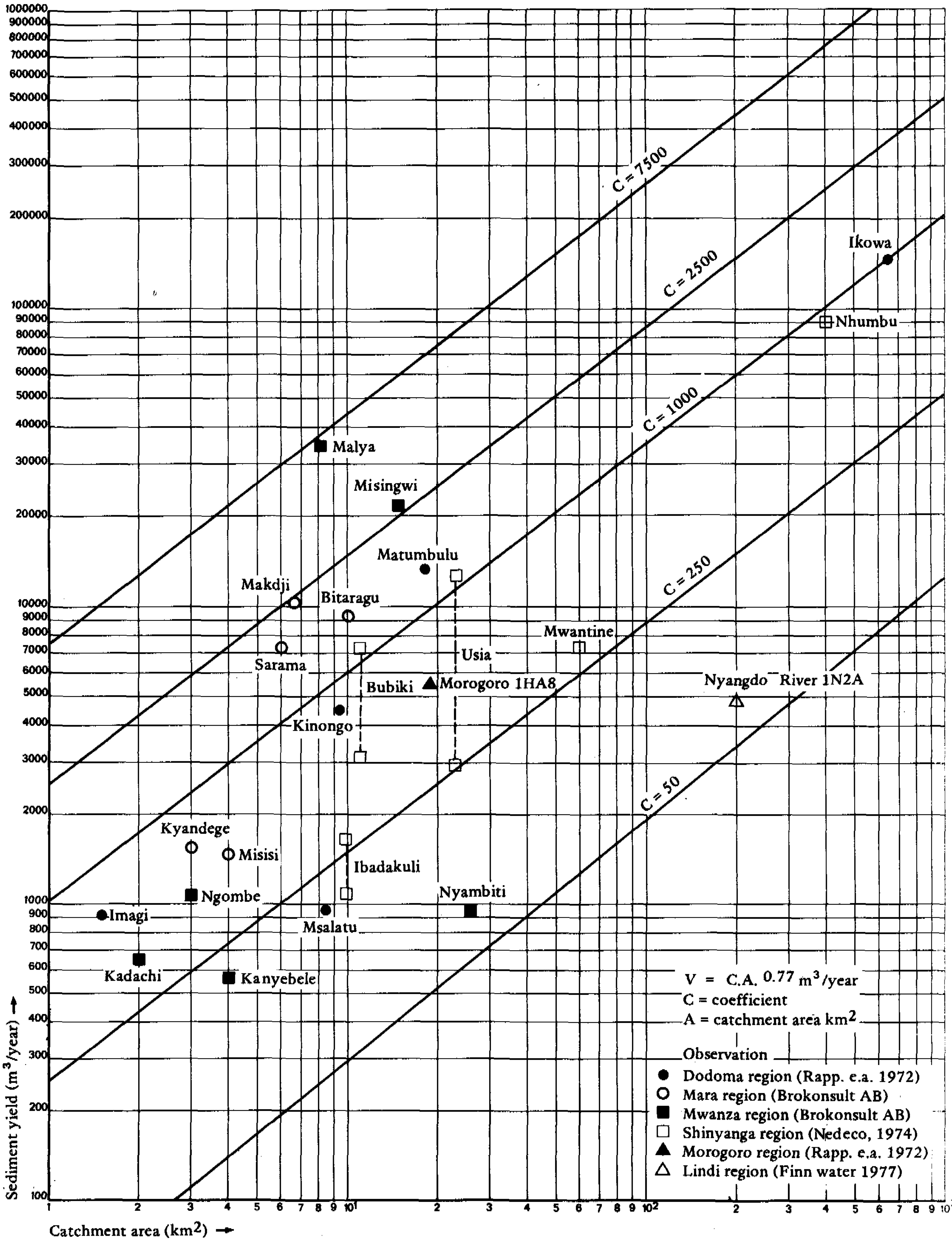


Figure C 3.4-4 Annual sediment yield of small reservoirs in Tanzania versus catchment area

4. HYDROLOGICAL DESCRIPTION OF THE PROJECT AREA

4.1. Description of the project area

4.1.1. Location

The project area lies between Longitudes E 36°30' and 38°30' and Latitudes S 5°45' and 8°00'. The great Ruaha and the Rufiji Rivers form the southern boundary. The northern boundary is formed by the Masai plains and the Lukigura River. The eastern boundary cuts through the alluvial plains of the Ruvu and the Wami Rivers, while the western boundary is formed for a large part by the Upper Wami catchment divide.

4.1.2. Topography

The topography is the final product of geo-morphological processes in the area, which will be discussed in the hydrogeological part of this study (Volume IV). However topography together with soil and vegetation are important factors in transforming rainfall into run-off. Especially vegetation, which can be changed by human interference, can influence low flows to quite an extent, as will be discussed in sub-paragraph 4.2.5.

In the area five mountain ranges can be distinguished, the Uluguru Mountains being the most isolated block, their foothills and several large plains lying in between, and having only isolated hills and mountains protuding them.

These mountain ranges are:

a. Uluguru mountains (SE of Morogoro)
b. Nguru mountains (W of Kilosa)
c. Kaguru mountains (S and SW of Kisitwe)
d. Rubeho mountains (W of Kilosa)
e. Migomberame mountains (S of Mikumi)

The largest plains are the Mkata-Wami plains, which are up to 100 km wide, varying in altitude between 800 m in the upper parts and 400 m in the lower parts of the region. The altitude of the Ruvu plain in the project area varies between 200 m and 300 m, while the altitudes of the Berega valley and surrounding areas in the western part of the project area vary between 800 and 1200 m.

The Uluguru mountains rise from 200 m above MSL in the East and 400 m in the North to an average height of 1800 m up to 2000 m with individual hills or plateau remnants along the western backbone reaching to over 2500 m. The other mountain ranges all rise from the NW of the Mkata-Wami valley, from levels between 400 to 800 m (sometimes in sheer scarp walls, such as the Nguru mountains) up to 2000 m with some mountain peaks reaching to 2500 m.

4.1.3. Climate

The Region belongs to the tropical rain climate. Climatological factors depend on air-movements, which in their turn depend on the Inter Tropical Convergence Zone (ITCZ), a low pressure trough, caused by the warming up of the earth, and in which air converges. The ITCZ follows the sun normally with a time-lag of four to six weeks behind the time of the sun's maximum elevation. The final result is warm north-easterly winds blowing from October to March and cooler south-easterly winds blowing for the remaining part of the year. Both winds are rather dry and are not the main cause of rainfall. Rainfall can be expected near the ITCZ, where decreasing pressure causes the air to rise and to form clouds. Rainfall is far from being always associated with the ITCZ but often occurs elsewhere. During the transitional period around April and October, when pressure and wind conditions are changing, daily rainfall areas show sudden jumps and irregular short term fluctuations (Jackson, 1971) [5], while daily rainfalls are extremely patchy, see also par. 3.1 and 3.2. of this report.

Superimposed on the general air-flow systems are air-flows caused by topography and they also influence the rainfall pattern. Mean annual precipitation of over 2500 mm is measured on the eastern slopes of the Uluguru Mountains. The western Uluguru Mountains lie in the rain shadow and smaller amounts are measured there, while the mean annual precipitation in the plains decreases from 800 mm in the eastern plains to 500 mm in the western plains of the region (Beregera area). Most rain can be expected in April/ May, with smaller amounts in late October/November, although the rain seasons become less distinct as one comes farther from the coast.

All other climatic factors are less variable in time, while variation in space is mainly caused by altitude differences e.g. the mean temperature at 500 m (Morogoro Meteorological Station) is 23°C, but decreases with 0,4 - 0,8°C per 100 m altitude increase. Derived variables like evaporation change likewise with altitude.

4.1.4. Hydrology

As was said before, the project area consists of large mountain ranges and wide plains. Depending on the position and heights of these mountains and their latitudes, rainfall patterns vary widely (see par. 3.1.)

Because of this variation in rainfall and moreover because of the various types of vegetation cover (ranging from rainforest to grassland), and because of the different slopes and permeabilities of the catchments, the run-off pattern varies strongly in place as well as in time.

On most slopes facing the East, the rainfall appears to be high in relation to many other regions and in consequence the run-off abundant. Whereas many streams have a perennial character, there is flooding in most lower parts of the valleys.

The possibility exists that although the upper parts of a river are perennial, the lower parts, often with wide sandy beds, run dry in some years. The flow of the upper river partly evaporates and partly infiltrates into the river bed. Rivers taking their rise in the plains are always intermittent, while duration of flow can vary between a few days to several months, although they often continue flowing underground. Sometimes sub-surface flow of rivers partly emerges over a certain length near underground barriers. Seepage zones, indicating emerging ground water, were found at several places in the Berega-Mkundi River system in the north-western part of the project area.

Some rivers appeared to become intermittent nearer to the source in more recent times because of alteration of the catchment vegetation, as has been the case with the Ngerengere River (Little, 1963) [44].

The three main rivers in the area are the Ruvu River, the Wami River and the Great Ruaha River, the latter being a tributary of the Rufiji River. All the water from these rivers eventually runs into the Indian Ocean.

The Ruvu River and its tributaries, the Ngerengere, Mgeta and Mvuha Rivers, receive their water from the Uluguru mountains and surrounding areas. The Wami River has its source in the Kaguru and Rubeho mountains and receives substantial amounts of water from the Nguru mountains too. Another main tributary of the Wami River, the Mkondoa River, receives water from the Kinyasungwe River, which drains an area of 1500 km^2 west of the project area. The water enters the Mkondoa River as an overflow from Lake Gombo. Due to the aridity of the catchment and the retention of the flow by a string of lakes and depressions, overflow at this point occurs very seldom. The above mentioned, intermittent Berega-Mkundi Rivers also drain into the Wami River.

The Great Ruaha River also enters the Region from the West and then follows the boundary of the project area, thus receiving all the water from the southern part of the area. A large dam, the Kidatu dam, built for power purposes, is located 10 km upstream from the village of Ruaha. Water development schemes in the area, in different stages of execution, are the Kidatu dam-stage II just upstream from Ruaha for hydropower purposes, the Mindu dam for industrial and town water supply and a 2000 ha rice project near Dakawa, using low flows only.
There are plans for a dam in the Ruvu River at Kidunda, to store water for irrigation purposes, while there are also plans for dams in the lower Wami river outside the project area.

An extensive analysis of available river flow data can be found in par. 3.3.

4.2. Surface water resources

4.2.1. General

By surface water resources of the project area the total runoff of the rivers is understood. The total runoff can be split up into direct runoff (A) and base-flow (B). Most of the groundwater that emerges as base-flow in rivers will be counted as surface water runoff. The base-flow is usually the largest part of the total runoff in the rivers of the Morogoro Region. The Kikundi special study e.g. found 82% base-flow and 18% direct runoff over the October 1978 - March 1979 period. Pumping from groundwater storage could mean a depletion of the surface water resources. However this is not true in all cases. By pumping, water tables could be lowered, and evapotranspiration could decrease. Hence, part of the pumped water could come from decreasing evapotranspiration. In some cases the water which is pumped out of the groundwater storage is put back into the river, usually somewhat reduced in quality.

The next paragraph discusses hydrological regions. Rainfall-runoff coefficients have been calculated for selected catchments in the different regions. These coefficients represent the proportion of the rainfall, which is converted into runoff. Calculated figures, especially for the western part of the regions, should be considered indicative only, because the density of the precipitation-gauge network is not dense enough to allow estimates within 10% of the true values.
For some areas simple relationships between rainfall and runoff have been established. A general discussion of this type of models is given in sub-paragraph 2.4.7.

The last sub-paragraph discusses depletion-characteristics of the region.

4.2.2. Hydrological regions

In the project area several hydrological regions are distinguished, based on a classification of the runoff-rainfall ratio. The following ranges are applied: 0 - 10, 10 - 30 and 30 - 60%.
In an area within a range of 10 - 30% for example, the mean annual runoff will be between 10 and 30% of the mean annual rainfall, while the runoff includes base-flow and direct runoff and the rainfall is averaged over the area. The November-October hydrological year is used for the analysis. As is outlined in paragraph 2.4., the difference between the groundwater storage at the beginning and the end of this hydrological year will then be small compared with runoff and evapotranspiration components of the water balance. Hence for instance for the area within the 10 - 30% range, the remaining 70 - 90% may roughly be allocated to evapotranspiration.
The runoff-rainfall ratio is strongly related to geomorphological characteristics, such as slope of the basin, drainage pattern, vegetation, altitude.

Table C 4. 2-1 Runoff-rainfall-ratio Ruvu River at Kibungo (1H5)-Uluguru Mountains

(1) Year	(2) Rainfall Matombo Mission 973706 (390 m a.s.l.) (mm)	(3) Rainfall Kibungo Mission 973724 (980 m a.s.l.) (mm)	(4) Rainfall Kibungo 973726 (270 m a.s.l.) (mm)	(5) Rainfall Tawa Health Centre 973728 (460 m a.s.l.) (mm)	(6) Rainfall Tegetero Mission 963720 (990 m. a.s.l.) (mm)	(7) Rainfall Weighted Mean 1) (mm)	(8) Runoff Kibungo 1H5 (420 km^2 473 m a.s.l.) (mm)	(9) $\frac{\text{Runoff}}{\text{Rainfall}} \times 100$ (%)	(10) Remarks
53/54	1610	(2430)	(1758)	(1987)	2750	2369	1380	58,2	–
54/55	(1628)	(2493)	(1662)	(2084)	3071	2528	1316	52,1	–
55/56	1859	(2420)	(1769)	(2036)	2711	2378	1476	62,1	–
56/57	1328	(2484)	(1672)	(2002)	3038	2479	1262	50,9	
57/58	2126	2612	2101	(2034)	2477	2378	1121	47,1	–
58/59	1853	2298	1539	(1856)	2086	2028	758	35,7	–
59/60	2195	2292	1834	(2073)	2557	2319	1078	46,5	–
60/61	(1997)	2869	1557	(2039)	2603	2427	995	41,0	–
61/62	(2604)	2780	1517	(2450)	3527	2907	1980	68,1	–
62/63	2584	2235	2150	(2112)	2366	2292	1352	59,0	–
63/64	3858	2479	1533	2772	2632	2596	1674	64,5	–
64/65	3198	2048	1776	1964	2915	2467	985	40,0	–
65/66	(2961)	(2503)	1362	2609	3196	2735	2424	88,6	–
66/67	(1923)	(2548)	1774	2335	3360	2738	1410	51;5	–
67/68	2736	(2626)	1546	2711	3788	3035	2394	78,9	–
68/69	1572	2443	2772	1865	3068	2594	1422	54,8	–
69/70	1784	2399	1313	1858	2794	2323	1287	55,4	–
70/71	1445	2136	1440	2350	2887	2368	1140	48,1	–
71/72	1631	2447	1237	2048	2932	2408	1211	50,3	–
72/73	(2014)	2595	1574	2040	2594	2361	1891	80,1	–
73/74	1892	2283	2519	(1785)	1808	2000	1415	70,7	–
74/75	1818	2109	2053	1883	2507	2026	908	44,8	–
Mean								56,8	

1) P 17 = 0,075 P(2) + 0,238 P(3) + 0,105 P(4) + 0,154 P(5) + 0,429 P(6) (Thiessen method)

Note: values in brackets estimated

Table C 4. 2-2 Runoff-rainfall-ratio Ngengere River at Konga (1HA9A) Uluguru Mountains

(1) Year	(2) Rainfall Tangeni Mission 963725 (640 m a.s.l.) (mm)	(3) Rainfall Mondo 963745 (1120 m a.s.l.) (mm)	(4) Rainfall Weighted Mean[1] (mm)	(5) Runoff Konga 1HA9A (20,5 km^2, 530 m a.s.l.) (mm)	(6) $\frac{\text{Runoff}}{\text{Rainfall}} \times 100$ (%)	(7) Remarks
54/55	1224	2337	1825	1195	65,5	–
55/56	1228	2690	2017	1351	67,0	–
56/57	1174	3263	2304	1171	50,8	–
57/58	1099	2584	1904	1137	59,7	–
58/59	1048	3046	2127	620	29,1	–
62/63	1249	3004	2197	2537	(115,5)	> 100?
63/64	1404	2760	2136	2302	(107,8)	> 100?
64/65	1336	2302	1858	1420	76,4	–
65/66	1410	3095	(2320)	(1585)	(68,0)	–
66/67	1451	2952	2262	1259	55,6	–
67/68	1452	2717	2135	1702	80,3	–
68/69	1413	2588	2048	1478	72,2	–
69/70	1166	1958	1594	990	64,3	–
70/71	1605	1978	1806	859	47,5	–
71/72	1551	2876	2267	1307	57,7	–
72/73	1633	2825	2277	1605	73,9	–
73/74	1024	2365	1748	(966)	(55,3)	–
74/75	858	2286	1629	(873)	(53,6)	–
75/76	851	1882	1379	(678)	(49,2)	–
76/77	1217	2250	1775	(888)	(50,0)	–
77/78	1120	2680	1862	(1405)	(75,4)	–
Mean					62,4 (excluding 62/63, 63/64)	

1) P(4) = 0,46 x P(2) + 0,54 x R(3) (Thiessen Method)

Note: values in brackets estimated

Table C 4. 2-3 Runoff-rainfall-ratio Mgeta River at Mgeta (1HB2) Uluguru Mountains

(1) Year	(2) Rainfall Bunduki 973715 (1280 m a.s.l.) (mm)	(3) Rainfall Kienzema 973713 (1680 m a.s.l.) (mm)	(4) Rainfall Mizugu 973716 (1100 m a.s.l.) (mm)	(5) Rainfall Weighted Mean[1] (mm)	(6) Runoff Mgeta 1HB2 (85,2 km^2, 975 m a.s.l.) (mm)	(7) $\frac{\text{Runoff}}{\text{Rainfall}} \times 100$ (%)	(8) Remarks
59/60	1993	1213	1131	1663	867	52,2	
60/61	2824	1461	1049	2216	859	38,8	
63/64	1598	1791	1081	1592	1006	63,2	
64/65	1349	1209	911	1256	735	58,5	
66/67	1716	1464	1062	1564	981	62,7	
67/68	1878	1752	1040	1741	1295	74,4	
68/69	2003	1147	948	1628	965	59,3	
69/70	1574	1286	1186	1444	960	66,5	
Mean						59,5	

1) P(15) = 0,59 P(2) + 0,29 P(3) + 0,12 P(4) (Thiessen Method)

The distinguished, hydrological regions coincide with areas with more or less homogeneous geomorphological features. These are:

- the Uluguru, Nguru, Rubeho and Migomberame Mountains,
- the foothills of these mountains,
- the Ruvu, Wami and Berega Plains.

In most of these regions gauged rivers or sections of rivers exist and in most of the regions rain-gauges are located, which enables the determination of runoff-rainfall ratios. If necessary data are missing, a runoff-rainfall ratio is selected from other regions based on geomorphological similarity.
The distinguished regions are presented on the Runoff-Rainfall-Ratio Map C 3.

The Uluguru Mountains

More than half of the Uluguru Mountains is drained by rivers which are well-gauged and of which the catchments are covered with a sufficient number of rain-gauges to ensure a reliable estimation of the runoff-rainfall ratio. The Ruvu, Ngerengere, Mgeta and Mvuha Rivers are studied in detail. The used data and derived runoff-rainfall ratios are given in Tables C 4.2-1, C 4.2-2 and C 4.2-3.
The ratio seems to vary roughly between 30 and 80%, and is on the average about 60%. Of the Mvuha River the ratios are improbably large, which is probably due to an underestimation of the average rainfall over the catchment.
For the Ruvu and the Ngerengere a usefull correlation could be established between the average annual rainfall (x) and the annual runoff (y). In both cases the correlation coefficient (r) is significant at the 5% level. The equations derived are given below. Data and curves are shown in figures C 4.2-1 and C 4.2-2.

Table C 4.2-4 Runoff-rainfall relations (mm) - Uluguru Mountains

River	Station	n [1]	$r_{n,5\%}$ [2]	r	Equation
Ruvu	Kibungo	22	0.42	0.74	$y = 2.50 \times 10^{-4} x^2 - 106.9$
Ngerengere	Konga	18	0.47	0.76	$y = 0.80 x - 348.7$

1) n = number of observations
2) $r_{n,5\%}$ = correlation coefficient significant at 5% level, taken from statistical tables.

The annual open-water evaporation (Eo) of an average year amounts to 1400 - 1600 mm in the higher and 1600 - 1800 mm in the lower parts of the Uluguru Mountains. The average value for the Ruvu, Ngerengere and Mgeta catchments may be estimated at 1600 mm. The annual, actual evapotranspiration which is derived from a simplified water balance (Ea = Annual Rainfall - Annual Runoff) seems to be about half of the open-water evaporation (Table C 4.2-5). Note that the potential evaporation (Ep) of short vegetation, covering most of the ground in the area is about 80% of Eo.

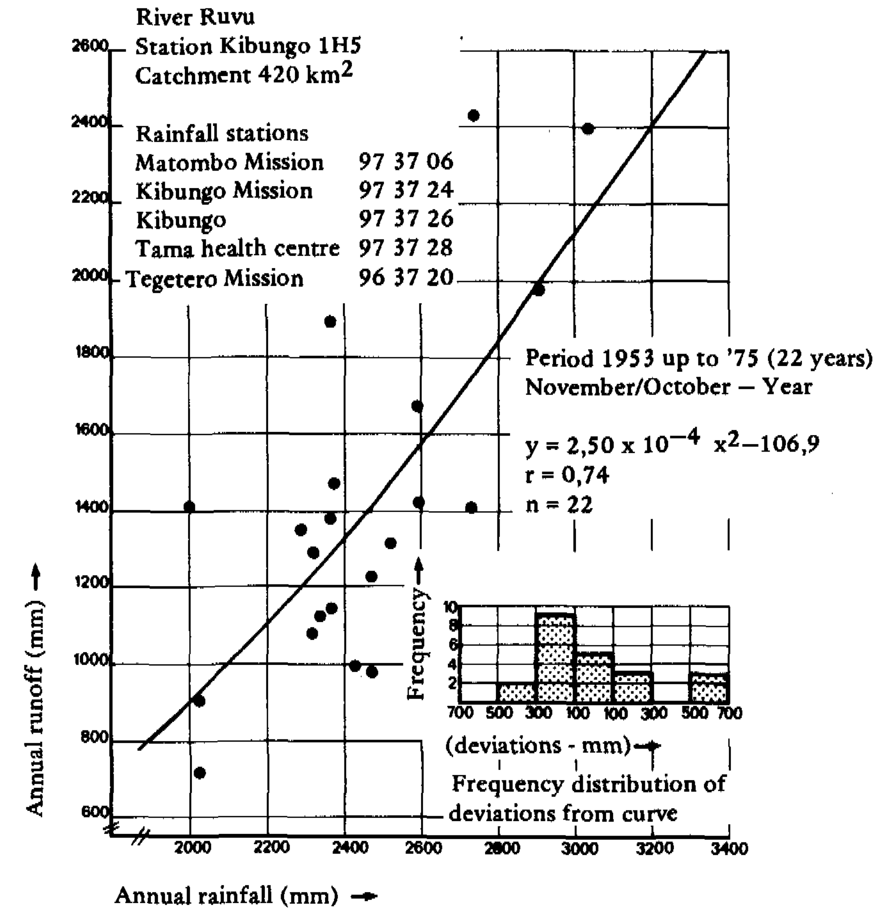


Figure C 4.2-1 Runoff-rainfal relation Ruvu River at Kibungo (1H5) - Uluguru Mountains

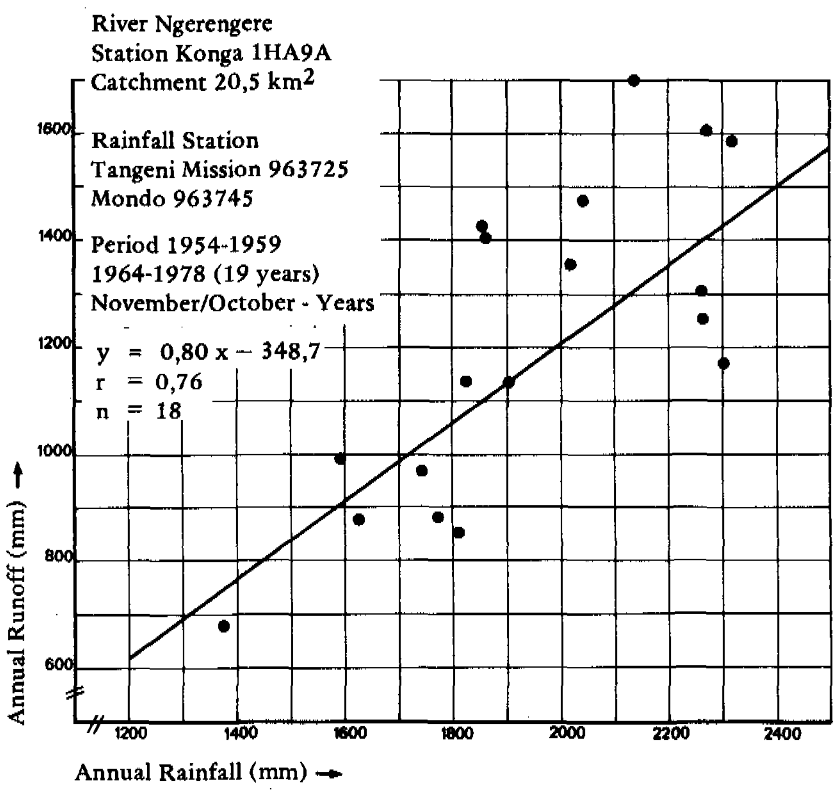


Figure C 4.2-2 Runoff-rainfall relation Ngerengere River at Konga (1HA9A) - Uluguru Mountains

Table C 4.2-5 Water balance of an average year (mm) - Uluguru Mountains

River	Station	Rain-fall	Run-off	Actual evapo-ration	Open-water evapo-ration	$\frac{Ea}{Eo}$ x 100%
Ruvu	Kibungo	2470	1400	1070	1600	67
Ngerengere	Konga	1900	1180	720	1600	45
Mgeta	Mgeta	1610	960	650	1600	41

The Nguru Mountains

Two important rivers, the Diwale and Mkindu, have suitable flow records. However especially in the mountains, the density of the rain-gauge network is too small to provide a sound basis for the estimation of the average rainfall over the catchments.
For both rivers the analysis shows runoff values which are higher than the corresponding rainfall values. This discrepancy is due to an under-estimation of the average rainfall over the catchments, and perhaps also to wrongly defined catchment boundaries in the case of the Diwale River. As is outlined in sub-paragraph 3.3.4.3., the riverbed of the Diwale is not stable. As a result it is not known to which extent the Mjonga River contributes to the flow of the Diwale.
In view of the geomorphological similarity of the higher parts of the Nguru Mountains to the Uluguru Mountains, a runoff-rainfall ratio of 30 - 60% may be expected.

The Rubeho Mountains

In the Rubeho Mountains several rivers with suitable flow records exist. Again the number of rain-gauges in the mountains is small. The isoheytal method is applied to determine the average rainfall over the catchments. Although with this method all available information is used in the determination of the rainfall distribution, the derived values should still be considered rough estimates. The Wami River, which mainly drains the higher and steeper parts of the Rubeho Mountains, shows runoff-rainfall ratios of the same magnitude as is found for the Uluguru Mountains. The actual mean ratio found is slightly more than 50% (Table C 4.2-6). Lower ratios, within the range of 10 - 30% are found for the Mkondoa (31%), the Mdukwe (26%), the Kisangate (18%), the Yovi (17%) and the Tami (26%). Especially in the case of the Tami-catchment the ratio has to be considered a composite of high values related to the steep parts and of low values for the flat parts of the catchment. Low runoff-rainfall ratios between 0 - 10% are derived for the Lumuma (6%) and Chali River (5%).
The data are given in Tables C 4.2-7, C 4.2-8 and C 4.2-9.

Table C 4.2-6 Runoff-Rainfall-Ratios - Wami River at Rudewa (1G8) - Rubeho Mountains

(1) Year	(2) Rainfall (Isoheytal Method) (mm)	(3) Runoff Rudewa 1G8 (320 km^2, 466 m a. MSL) (mm)	(4) $\frac{\text{Runoff}}{\text{Rainfall}} \times 100$ (%)	(5) Remarks
58/59	1 150	307	26.7	-
59/60	1 090	483	44.3	-
60/61	1 145	429	37.5	-
61/62	1 385	803	58.0	-
62/63	1 055	827	78.4	-
64/65	700	597	85.3	-
65/66	1 450	485	33.5	-
66/67	1 485	985	69.1	-
67/68	1 675	683	40.8	-
Mean			52.6	

Table C 4.2-7 Runoff-Rainfall-Ratios - Tami River at Msowero (1G5A) - Rubeho Mountains

(1) Year	(2) Rainfall (Isoheytal Method) (mm)	(3) Runoff Msowero 1G5A (907 km^2, 457 m a. MSL) (mm)	(4) $\frac{\text{Runoff}}{\text{Rainfall}} \times 100$ (%)	(5) Remarks
65/66	1 180	150	12.7	-
66/67	1 480	324	21.9	-
67/68	1 635	891	54.5	-
68/69	1 145	192	16.8	-
69/70	715	171	23.9	-
Mean			26.0	

Table C 4. 2-8 Runoff-rainfall-ratios at Mkondoa (1GD29), Lumuwa (1GD30), Mdukwe (1GD31), Yovi (1KA38A) and Chabi (1KA58A) - Rubeho Mountains

(1) River	(2) Station	(3) Catchment (km^2)	(4) Altitude (m a.s.l.)	(5) Year	(6) Rainfall (mm)	(7) Runoff (mm)	(8) $\frac{\text{Runoff}}{\text{Rainfall}} \times 100$ (%)	(9) Remarks
Mkondoa	1GD29	290	1520	70/71	930	303	32,6	Isoheytal Meth.
				71/72	1210	317	26,2	" "
				72/73	1510	482	31,9	" "
				73/74	800	254	31,8	" "
				Mean			30,6	
Lumuma	1GD30	502	1050	69/70	777	50	6,4	Thiessen Method
Mdukwe	1GD31	516	767	69/70	950	247	26,0	Isoheytal Meth.
Yovi	1KA38A	630	610	58/59	598	102	17,0	Thiessen Method
Chabi	1KA58A	559	1294	65/66	765	42	5,5	Thiessen Method
				66/67	898	42	4,7	" "
				69/70	550	27	4,8	Thiessen Method
				Mean			5,0	

Table C 4.2-9 Runoff-Rainfall-Ratios - Kisangate River at Mvumi (1G6) - Rubeho Mountains

(1) Year	(2) Rainfall (Isoheytal Method) (mm)	(3) Runoff Mvumi 1G6 ($404\ km^2$, ? m a. MSL) (mm)	(4) $\frac{Runoff}{Rainfall}$ x 100 (%)	(5) Remarks
58/59	1 160	80	6.9	-
59/60	1 120	110	9.8	-
60/61	1 165	125	10.7	-
61/62	1 500	334	22.3	-
62/63	1 100	196	17.8	-
63/64	1 190	305	25.6	-
64/65	750	137	18.3	-
68/69	1 240	239	19.3	-
69/70	930	293	31,5	-
70/71	935	150	16.0	-
71/72	1 320	206	16.5	-
72/73	1 320	292	22.1	-
74/75	700	76	10.9	-
Mean			17.5	

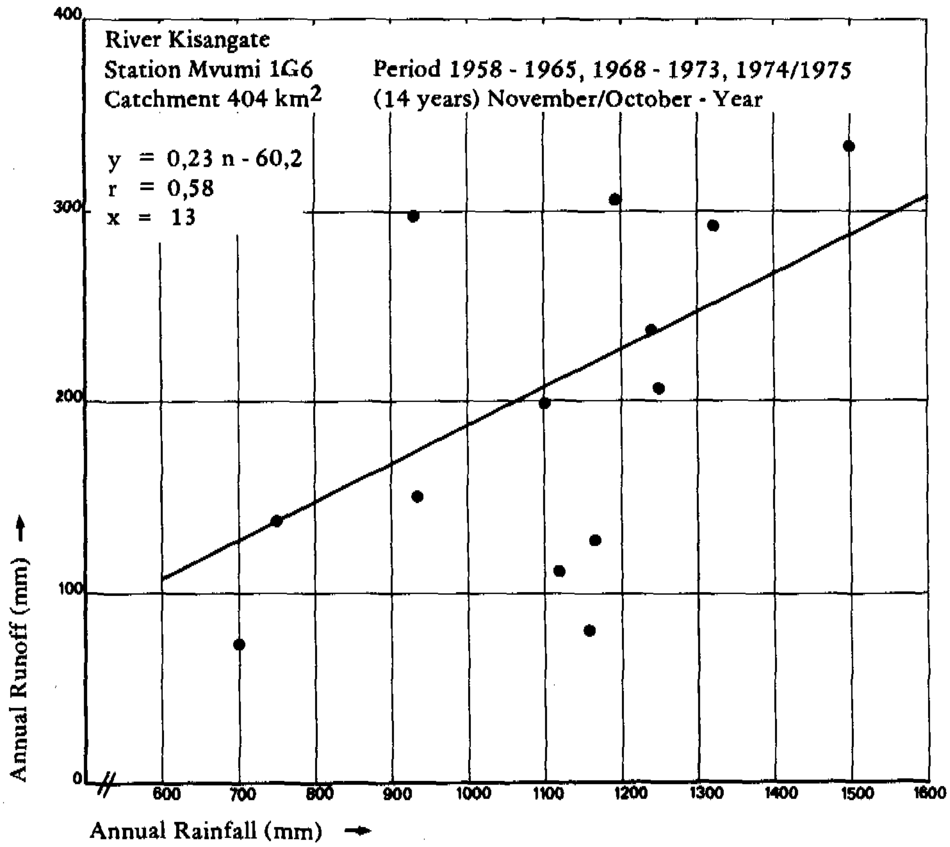


Figure C 4.2-3 Runoff-rainfall relation Kisangate River at Mvumi (1G6) - Rubeho Mountains

Only for the Kisangate River a usefull correlation could be found between rainfall (x) and runoff (y). It is presented below.

Table C 4.2-10 Runoff-rainfall relations (mm) - Rubeho Mountains

River	Station	n [1)]	$r_{n,5\%}$ [2)]	r	Equation
Kisangate	Mvumi	13	0.55	0.58	y = 0.23 x - 60.2

[1)] [2)] see Table C 4.2-4 for explanation

The data and curve are shown in figure C 4.2-3.

All over the Rubeho Mountains the annual open-water evaporation (Eo) of an average year lies between 1800 and 2000 mm. Just as in the Uluguru Mountains, the actual evapotranspiration is lower and is approximately 40% of the open-water evaporation on the average.

Table C 4.2-11 Water balances of average years (mm) - Rubeho Mountains

River	Station	Rain-fall	Run-off	Actual evapo-ration	Open-water evapo-ration	$\frac{Ea}{Eo}$ x 100%
Wami	Rudewa	1180	620	560	1900	30
Mkondoa		1110	340	770	1900	41
Tami	Msowero	1330	350	980	1900	52
Mdukwe		950	250	700	1900	37
Kisangate		1110	190	920	1900	48
Lumuma		780	50	730	1900	38
Chali		740	40	700	1900	37

The Migomberame Mountains

No flow data and hardly any rainfall data have been collected in this area. For the higher parts of these mountains the figures may be expected to be similar to those for the lower parts of the Uluguru, Nguru and Rubeho Mountains.

Ruvu, Ngerengere and Wami Plains

The Ruvu, Ngerengere and Wami Rivers are gauged at several successive sites along their courses through the plains. Thus the amounts of water which enter and leave the plain situated between the gauging stations are calculated by taking the difference between the total inflow and outflow. Furthermore the number of rain-gauges is sufficient to estimate the average rainfall.

For the Ngerengere River a suitable section is found between Kingolwira (1HA3) and Kiluwa (1HA5). No rivers from the Uluguru Mountains join the Ngerengere River between these stations. Therefore the increase of the flow is due to runoff from the plain only. The runoff-rainfall ratios are below 10% with a mean value of about 4% (Table C 4.2-12).

Downstream of Kiluwa the flow seems to decrease. The annual flows of the Ngerengere River at the downstream site at Utari Bridge (1HA1A) are lower than the corresponding flows at Kiluwa (Table 4.2-13). From Kiluwa onwards the river flows through Karst area. Probably the flow decrease is related to water losses into the underground, which is a common Karst phenomenon. When a runoff-rainfall ratio is taken which is equal to the one found for the upstream section of the river, the total waterloss between Kiluwa and Utari Bridge can be estimated at approximately 30 x 10^6 m^3 annually.

For the Ruvu Plain between the Morogoro Road Bridge (1H8) and Kidunda (1H3) or Mikula (1H10) and Utari Bridge (1HA1A) again a low runoff-rainfall ratio of 1.5% is derived (Table C 4.2-14). It is likely that also in this part of the plain water losses may occur due to Karst phenomena, and that the actual ratio may be slightly higher than the established value.

Out of 16 years of records the runoff-rainfall ratio is established as a mean value of 8% for the Wami Plain between the gauge sites at Dakawa (1G1) and Mandera (1G2) and the Nguru Mountains (Table C 4.2-15). The inflow at Dakawa and the outflow at Mandera are well known. From the Nguru Mountains however many rivers emerge, from which only the biggest - the Diwale (1GB1A) and the Mkindu (1GB2) - are measured regularly. The total flow from the remaining rivers is estimated, based on some short records of the Chazi (1GB3), the Mziha (1GA2) and the Lukigura (1GA1A) River.

Just downstream of Dakawa the Wami River flows through a flat area where its course is not very well defined. During high flows this area is inundated, which causes considerable evaporation losses.
The same situation is found regarding the tributaries which emerge from the Nguru Mountains and enter the Wami River between Dakawa and Mandera. Although it is difficult to determine the total, flooded area and the duration of inundation, the average annual evaporation losses may be estimated at approximately 3 - 5 m^3/s (300 km^2 flooded during 3 months of the year). These losses reduce the annual runoff-rainfall ratio by 1.5 to 3% and may cause negative ratios when the annual runoff is exceeded by evaporation losses. According to the data in Table C 4.2-15 this situation may occur in 2 out of 16 years. The results should be treated with caution, because the flow of ungauged rivers had to be estimated and included in the analysis. However it is obvious, that the runoff of the Wami Plain is slightly higher than suggested by the figures in Table C 4.2-15.

Table C 4. 2-12 Runoff-rainfall-ratios of Ngerengere River between Kingolwira (1HA3) and Kiluwa (1HA5), Ngerengere Plain

(1) Year	(2) Inflow Ngerengere Kingolwira 1HA3	(3) Outflow Ngerengere Kiluwa 1HA5	(4) Runoff (= Outflow-Inflow)	(5) Plain Area	(6) Runoff	(7) Rainfall Kingolwira Sisal Estate 963715 (460 m a.s.l.)	(8) Rainfall Ngerengere Sisal Estate 963801 (210 m a.s.l.)	(9) Rainfall Weighted Mean 1)	(10) $\frac{\text{Runoff}}{\text{Rainfall}} \times 100$	(11) Remarks
	$(10^6\ m^3)$	$(10^6\ m^3)$	$(10^6\ m^3)$	(km^2)	(mm)	(mm)	(mm)	(mm)	(1%)	
53/54	93,4	114,3	20,9	955	22	872	847	866	2,5	–
54/55	108,0	127,6	19,6	955	21	753	715	744	2,8	–
55/56	107,8	149,6	41,8	955	44	879	512	790	5,5	–
56/57	81,2	115,7	34,5	955	36	837	686	781	4,6	–
57/58	77,9	115,8	37,9	955	40	938	775	899	4,4	–
58/59	37,1	61,9	24,8	955	26	811	870	825	3,2	–
Mean									3,8	

1) P(9) = 0,76 x P(7) + 0,24 x P(8) (Thiessen Method)

Table C 4. 2-13 Annual water losses of the Ngerengere river in the Karst and between Kiluwa (1HA5) and Utari Bridge (1HA1A) (1255 km²)

(1) Year	(2) Rainfall Weighted Mean (mm)	(3) Runoff Estimated[1] (10^6 m^3)	(4) Inflow Ngerengere Kiluwa (1HA5) (10^6 m^3)	(5) Inflow Ngerengere + Runoff (10^6 m^3)	(6) Outflow Ngerengere Utari Bridge (1HA1A) (10^6 m^3)	(7) Water loss between Kiluwa and Utari Bridge (10^6 m^3)	(8) Remarks
53/54	856	26,9	114,3	141,2	96,5	44,7	–
54/55	881	31,0	127,6	158,6	147,9	10,7	–
55/56	512	35,4	149,6	185,0	161,3	23,7	–
56/57	686	39,7	115,7	155,4	139,9	15,5	–
57/58	754	41,7	115,8	157,5	100,4	57,1	–
58/59	811	32,6	61,9	94,5	58,1	36,4	–
Mean						31,4	

1) based on runoff-rainfall-ratio derived for the plain between Kingolwira and Kiluwa

Table C 4. 2-14 Runoff-rainfall-ratios of Ruvu Plain between station 1H8, 1H3 (1H10) and 1HA1A.

(1) Year	(2) Inflow	(3) Inflow	(4) Inflow	(5) Outflow	(6) Runoff (= Outflow-Inflow)	(7) Catchment Plain	(8) Runoff	(9) Rainfall	(10) Rainfall	(11) Rainfall	(12) $\frac{\text{Runoff}}{\text{Rainfall}} \times 100$	(13) Remarks
	Ngerengere at Utari Bridge 1HA1A (10^6 m^3)	Ruvu Kidunda 1H3 (10^6 m^3)	Ruvu Mikula 1H10 (10^6 m^3)	Ruvu Morog. Road Bridge 1H8 (10^6 m^3)	(10^6 m^3)	(km^2)	(mm)	Kidunda 973808 (90 m a.s.l.) (mm)	Nghesse 973809 (90 m a.s.l.) (mm)	Weighted Mean 1) (mm)	(mm)	(%)
59/60	116,1	1365,7	–	1552,6	70,8	5577	13	806	856	831	1 5	
60/61	74,4	981,6	–	1070,2	14,2	5577	3	747	891	801	0,3	–
61/62	372,9	2955,2	–	3406,1	78,0	5577	14	1073	1202	1138	1,2	–
66/67	208,0	–	1504,8	1913,5	200,7	6480	31	1020	1018	1019	3,0	–
Mean											1,5	

1) P(4) = 0,5 x P(8) + 0,5 x P(9) (Thiessen Method)

Table C 4. 2-15 Runoff-rainfall-ratio of Wami Plain between stations 1G2 and 1G1 (area 4700 km²)

(1) Year	(2) Inflow Wami Dakawa 1G1 (10^6 m^3)	(3) Diwale Turiani 1GB1A (10^6 m^3)	(4) Mkindu Mkindu 1GB2 (10^6 m^3)	(5) Remaining Rivers1) (10^6 m^3)	(6) Outflow Wami Mandera 1G2 (10^6 m^3)	(7) Runoff (= Outflow-Inflow) (10^6 m^3)	(8) (mm)	(9) Rainfall Kingolwira Prison Farm 963711 (mm)	(10) Mtibwa S. Estate 963742 (mm)	(11) Wami Prison Farm 963756 (mm)	(12) Lugoba Mission 963805 (mm)	(13) Kwaru-hombo 963812 (mm)	(14) Weighted Mean2) (mm)	(15) $\frac{\text{Runoff}}{\text{Rainfall}} \times 100$ (%)	(16) Remarks
58/59	331,4	126,3	94,0	(247)	840,2	135,5	29	719	1110	(905)	1016	901	973	3,0	–
59/60	679,6	159,1	111,5	(293)	1320,5	188,8	40	741	1083	(894)	818	817	910	4,4	–
60/61	334,9	164,7	(118)	(310)	761,9	-47,7	-10	1046	1139	(926)	999	1005	1041	–	–
61/62	2049,0	375,3	(191)	(501)	4033,8	108,5	236	1151	1466	(1002)	1151	1394	1318	17,4	–
62/63	1153,2	242,7	(145)	(381)	1972,1	195,2	42	840	1132	(935)	832	918	974	4,3	–
63/64	1817,1	249,6	175,1	(460)	2812,9	286,2	61	928	1411	(1011)	980	(1108)	1166	5,2	–
64/65	500,4	134,6	108,5	(286)	957,6	36,6	8	764	1091	713	866	(1024)	967	0,8	–
65/66	956,3	203,2	163,8	(430)	2175,8	586,3	125	1104	1284	(937)	1201	(1240)	1201	10,4	–
66/67	910,1	195,6	157,7	(414)	2026,0	506,3	108	1228	1294	1187	948	(1159)	1185	9,1	–
67/68	2774,3	928,9	228,7	(600)	6332,0	2028,8	432	843	1844	1313	1316	(1232)	1428	30,3	–
68/69	850,4	412,7	177,5	(466)	1814,4	85,3	18	693	1096	743	1025	(1076)	1006	1,8	–
69/70	883,0	318,2	(140)	(368)	1760,9	191,7	41	882	1177	1039	721	(988)	1015	4,0	–
70/71	537,7	198,6	(124)	(326)	1054,6	-7,7	- 2	454	1020	1046	663	659	815	–	–
71/72	887,2	286,7	(136)	(357)	1570,9	40,0	9	1079	1341	810	901	1103	1116	0,8	–
72/73	1259,1	380,5	(165)	(433)	2868,7	796,1	169	737	1279	1115	770	1260	1147	14,7	–
73/74	629,2	233,2	(134)	(352)	1475,4	263,0	56	(600)	1067	829	838	1049	967	5,8	
Mean														8,0.	

1) Estimation is based on flow data of the Mkindu, Chazi, Mziha, Lukigura rivers.

2) P(14) = 0,07 x P(9) + 0,33 x P(10) + 0,13 x P(11) + 0,13 P(12) + 0,34 P(13) (Thiessen Method)

Note: values in brackets estimated

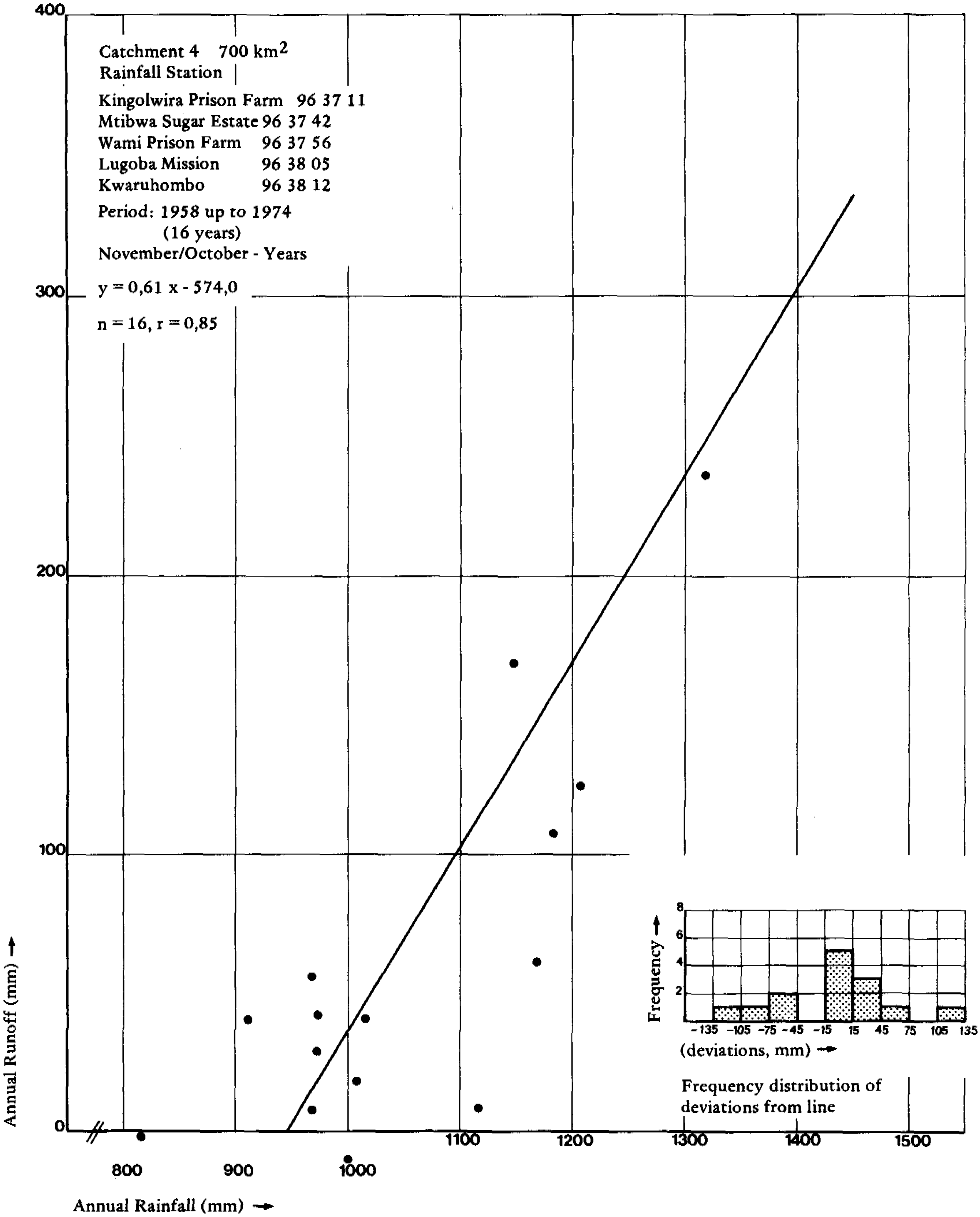


Figure C 4.2-4 Runoff-rainfall relation Wami plain between stations 1G2 and 1G1

Between the annual average rainfall (x) and the annual runoff (y) from the plain a linear relationship is established as best fitting the data.

Table C 4.2-16 Runoff-rainfall relation (mm) - Wami Plain

River	Station	n [1]	$r_{n,5\%}$ [2]	r	Equation
Wami	Wami Plain	16	0.50	0.85	$y = 0.61\,x - 574.0$

[1] [2] see Table C 4.2-4 for explanation

The data and best fit are given in figure C 4.2-4.

In the plains the annual open-water evaporation (Eo) of an average year ranges from 2000 to 2200 mm.
The actual evapotranspiration (Ea) is again about 40 - 50% of Eo (Table C 4.2-17), as is also found for the mountainous hydrological regions.

Table C 4.2-17 Water balances of average years (mm) of Ruvu, Ngerengere and Wami Plains

River	Station	Rain-fall	Run-off	Actual evapo-ration	Open-water evapo-ration	$\frac{Ea}{Eo} \times 100\%$
Ruvu	1H8, 1H3 or 1H10, 1HA1A	950	15	935	2100	45
Ngerengere	1H3, 1H5	820	30	790	2100	38
Wami	1G1, 1G2, 1GB2, 1GB1A	1100	90	1010	2100	48

4.2.3. Depletion characteristics

4.2.3.1. General

Sub-paragraph 3.3.6 discusses minimum flows. It is stated that the depletion curve or the hydrograph of the base-flow can be represented by a straight line on semi-log paper, as follows:

$$Q_t = Q_o e^{-\alpha t} \qquad (1)$$

where the symbols have the same meaning as in sub-paragraph 3.3.6.

The depletion factor (α) is a parameter for the drainage characteristics of the area. If only one extensive aquifer would have been involved, it can be reasoned out (De Zeeuw, 1973) [69], that the depletion factor (α) can be calculated in the following way:

$$\alpha = \frac{10\ KD}{\mu\ L^2}$$

where:	K =	hydraulic conductivity of aquifer	(m/day)
	D =	thickness of aquifer	(m)
	μ =	effective porosity	
	L =	drainspacing	(m)

A denser drainage network and more permeable soil of shallow depth causes α to be large, which results in very low flows at the end of the dry season. The opposite is true for a small α.
The diversions of a straight line on semi-log paper can be explained in the following way:

a. The base-flow is the sum of the contributions of different aquifers. If all of them discharge according to formula (1), flows will plot on a straight line, only if α is the same, otherwise aquifers with smaller α will dominate at the end of the dry season. Usually depletion curves will curve slightly upward.
b. In case a river enters a low-lying swampy area, much water evaporates and the opposite will happen of what was mentioned before. The swampy area reacts as a river-diversion, taking water away.
   In this case the depletion curve dips downward on semi-log paper, as has already been explained in paragraph 3.3.
c. A third possibility is that the lower lying areas act as a reservoir which is constantly filled up at a decreasing rate in the low-flow period. In case there is a very extensive reservoir and a slow draining of this reservoir, the depletion curve will follow the depletion of the lower lying areas again in the long run. And in this case, just as in case a, the curve will turn upward on semi-log paper.

The different cases will be discussed in the next section. All depletion curves are based on 1978 flow measurements. Rainfall at the end of the dry season complicated matters to some extent. Depletion curves start turning upward, not only because of the causes mentioned above, but also because of rainfall. As far as possible the rainfall effect has been eliminated from the α-determination; hence the slope of the recession curve between August and October seemed the most reliable estimate for α, because some precipitation actually occurred already at the end of October and the beginning of November, especially East of the Uluguru Mountains, before the heavy rains after the middle of November started.

4.2.3.2. Results

Depletion curves are shown in figures C D3.6-1, C.D3.6-5. Depletion factors (α) can be found in Table C 4.2-18. No α-values have been determined of rivers that have zero flows. The following comments can be made:

a. Most depletion curves of the flows just leaving mountains and foot-hills, without being affected by swamps, turn slightly upward.
b. α-Values of flows, measured at rivers just leaving the mountains and not affected by swamps, are between 0.0050 and 0.0100.
Lower values can be found for the larger, deeply incised rivers (e.g. Ruvu at Kibungo: α = 0.0025), while higher values can be found for steeper and smaller rivers (e.g. Chazi: α = 0.0147).
c. Flows measured at a distance from the mountains have α-values larger than 0.0100, partly because flows infiltrate into riverbeds and because water is used for industrial purposes, hence the depletion curve dips downward. E.g. compare the Ngerengere River at Konga, Mindu-dam site, Kihonda and Ubena. While at Konga the Ngerengere is perennial, further downstream α increases and finally the river becomes intermittent.
d. Mkata at Mkata Ranch and the Wami at Dakawa are examples of rivers, where the depletion is largely determined by the storage in the swamps. The rivers flow into swampy areas and only come out of the swamp after heavy losses. Table 4.2-19 shows water-losses at selected dates in the low-flow season of 1978. Note that at the end of the season water-losses above Mkata Ranch and above Dakawa may be both approximately 2 m^3/s.
e. It can be concluded that there is no simple method to obtain α, because riverflow at a certain point in space is an integrated value of the catchment propertie above the point of observation. Hence dividing the area in regions of the same riverflow depletion characteristics can not be done.
If an α-estimate is required at a certain point in a river, measured α-values up or downstream of this point, and α-values of nearby rivers with similar catchment characteristics should be taken as a guideline.

Table C 4.2-18 Depletion coefficient of rivers in the northern Morogoro region, measured in the August - November 1978 low-flow period

River	Site [1] code	Site location	Lowest flow 1978 estimate	α
Ikonde	1	Spring near Mamboya	0	N.A. [2]
Kitange	2	Kitange I	6	0.0412
Mahero	3	Masenge	7	-
Mnibule	4	Masenge	9	0.0092
Mnyera	5	Masenge	-	-
Maboto	6	Masenge	-	-
Masonbowe	7	Masenge	21	0.0078
Manga	8	Masenge	1.5	0.0143
Milindo	9	Mvumi road	65	0.0080
Milindo	a	Kaguru Mountain	-	-
Milindo	b	Kaguru Mountain	-	-
Milindo	c	Kaguru Mountain	-	-
Milindo	d	Kaguru Mountain	-	-
Milindo	e	Kaguru Mountain	-	-
Milindo	f	Kaguru Mountain	-	-
Milindo	g	Kaguru Mountain	-	-
Milindo	h	Kaguru Mountain	-	-
Mvomero	21	Mvomero	0	N.A.
Modenho	22	Msufini	-	-
Dihombo	23	Kwadihombo	43	0.0137
Mkindu	24	Mkindu	750	0.0068
Kigugu	25	-	-	-
Miazi	26	Kigugu	9	0.0147
Kikwane	27	Mbogo	-	-
Mahuvuge	28	Mbogo	0	N.A.
Divue	29	Kwamtonga	330	0.0127
Msengele	30	Kwamtonga	15	0.0211
Mvaji	31	Kwamtonga	-	-
Diwale	32	Turiani	650	0.0133
Mjonga	33	Turiani	120	0.0143
Mjonga	34	Kisanga	0	N.A.
Lusonge	35	Dihinda	25	0.0132
Kanga Creek	36	Kanga	0	N.A.
Mziha	37	Mziha	6.5	0.0232
Mukundi	40	Dumila	0	N.A.
Chogowale	41	Nguru Mountains	-	-
Kitete	42	Kitete	0	N.A.
Tami	43	Msowero	580	0.0111
Kisangate	44	Mvumi	450	0.0133
Wami	45	Rudewa	2000	0.0069
Kisungusi	46	Rudewa	300	0.0062
Ilonga	47	Ilonga	140	-
Mkondoa	48	Kilosa	2500	0.100

Table C 4.2-18 (continued)

River	Site code [1])	Site location	Lowest flow 1978 estimate	α
Miyombo	49	Ulaya Kibaoi	1000	0.0052
Mgeta	50	Mgeta	750	0.0067
Mtali	51	Mzumbe	-	-
Ngerengere	52	Konga	110	0.0070
Morogoro	53	Morogoro	40 - 60	0.0062
Ngerengere	54	Mindu damsite	170	0.0166
Ngerengere	55	Kihonda	140	0.0193
Ngerengere	56	DSM road	0	N.A.
Mgolole	57	Magole	12	0.0092
Mgolole	58	DSM road	0	N.A.
Kikundi	59	Morogoro	0,8	0.0412
Kiroka	60	Upstream Kiroka	19	0.0107
Kiroka	61	Kiroka	0	N.A.
Mahembe	62	Kiroka	6	0.0213
Mahembe	63	Confluence Ndege	-	-
Ndege	64	Confluence Mahembe	-	-
Kiroka	65	Msumbisi	0	N.A.
Isumbisi	66	Kibwaya	0	N.A.
Maduma	67	Kibwaya	0	N.A.
Mkalazi	68	Kalundwa	25	-
Msuazi	69	Kalundwa	58	0.0088
Mkungazi	70	Tandai	-	-
Mkuyuni springs	71	Mkuyuni	2.2	0.0133
Ruvu	72	Kibungo	4100	0.0025
Kibangili	73	Kibangili	25	0.0135
Mtamba springs	74	Mtambai	0.4	-
Tambuu spring	75	Tambuu	-	-
Msonge springs	76	Msonge	-	-
Msonge	77	Msonge	30	0.0131
Mvuha	78	Mvuha	1700	0.0041
Ditumi	79	Bonye	38	0.0258
Bwakira	80	Bwakirachini	0	N.A.
Mngazi	81	Mngazi	420	0.0117
Mgeta	82	Gomero	1250	0.0074
Ruembe	90	Mikumi	0	N.A.
Ruembe	91	Last bridge from Kidata	45	-

Table C 4.2-18 (continued)

River	Site code [1]	Site location	Lowest flow 1978 estimate	α
Ruembe	92	Kidogobasi	650	0.0065
Msowero	93	Msowero	350	0.0054
Tundu	94	Tundu	120	0.0031
Tundu	95	Tundu	0	N.A.
Iwembe	96	Iwembe	-	-
Kidodi	97	Kidodi	-	-
Kifinga	98	Kifinga	-	-
Nyambisi	99	Ruaha	-	-
Wami	100	Dakawa	3800	0.0066
Mkata	101	Mkata range	1100	0.0152

1) For site code see Map G
2) N.A. = not applicable, because river is not perennial

Table C 4.2-19 Waterlosses (l/s) in the Mkata and Wami plains at selected dates in 1978

River and site code	Flows in l/s 13 - 14 September	14 - 15 November	River and site code	Flows in l/s 13 - 14 September	14 - 15 November
Mkata - 101	2540	(1700)	Myombo - 49	1840	1093
Mkundi - 4	150	0	Mkondoa - 48	(5400)	2600
Kitete - 42	0	0			
Tami - 43	1124	646			
Kisangate - 44	(1100)	770			
Wami - 45	3371	2441			
Ilonga - 47	(250)	154			
Total	8535	5711	Total	7240	3693
Wami - 100	(6200)	(3800)	Mkata - 101	2540	1700
Losses*	2335	1911		4700	1993

( ) Flow from rating curve or estimate
* Difference between Wami or Mkata and totals

4.2.4. Surface water reservoirs

4.2.4.1. General

This paragraph discusses small reservoirs, which can be an alternative for rural water supply.
Large reservoirs, such as Kidatu dam stage I and II, Mindu dam and the proposed dam in the Mgeta at Kidunda, are excluded from discussion.

Small ponds and artificial reservoirs are no new phenomena in the project area, but they are only occasionally used for rural water supply. Small scale irrigation, cattle watering, wild life and fishing purposes, are the main reason for their construction.
Msumba (1974) [47] mentions the existence of 450 small reservoirs in the Morogoro district and about 100 in the Kilosa district. The main objection against using small reservoirs for water supply is their quality. In most circumstances, it is almost impossible to keep the water free from pollution and for this reason other solutions are preferred. In combination with some treatment however, they can be an acceptable alternative.

Within the project area, as alternatives small reservoirs will be considered in the lower Ngerengere and Berega catchments. Although a gravity system has been planned for the Berega catchment, small reservoirs for cattlewater supply should complement the system to prevent overloading of the gravity system.

The Water Department in Morogoro has designed and constructed several reservoirs. The directives for designing are given in a Technical note (Lucas, 1964) [45], which is available in every regional office. Hydrological criteria mentioned in the above note will be related to observations made during the course of this study and elsewhere. Some attention will also be paid to rainwater collection from impervious areas.

4.2.4.2. Rainwater collection

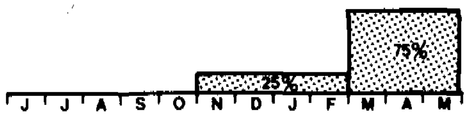
Rainwater can be collected efficiently, if large impermeable areas are available e.g. corrugated iron roofs or large outcrops of bare rocks. They have to be supplemented with devices such as gutters to guide the water to a storage tank or cistern. Because of the rather large impervious areas required, rainwater collection seems only suitable for small communities. Table C 4.2-20 shows the monthly distribution of precipitation of two selected stations and an imaginary station, representative for the dryest part of the project area. The rainfall-runoff coefficient can be taken as 80%, while the remaining 20% will evaporate. From Table C 4.2-20 it can be concluded that for Morogoro town an annual yield of at least 510 mm for 9 out of 10 years can be expected. The same figure for the dryest part of the project area is 260 mm. For other areas the 9 out of 10 year figure can be approximated by taking 70% of the mean annual precipitation.

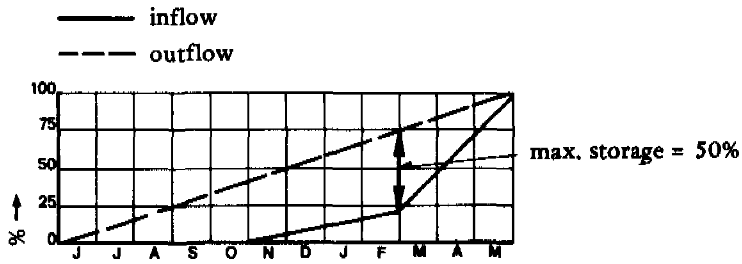
The size of the cistern for storage depends on the distribution of the rainfall over the year. The distribution of the average rainfall does not necessarily have to correspond with the distributions of an average year (see Table C 4.2-20). Low annual rainfall can be caused by absence of the

Table C 4. 2-20 Relative distributions of rainfall over the year of two selected stations (%)
Use has been made of 1950-77 records.

Station and Number	Year (Nov.-Oct.)	N.	D.	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	Rainfall (mm) Year	10%	5%
Mor. Agri. Office 963700	Average year	6,9	10,1	10,8	10,2	15,0	25,7	9,6	2,3	1,7	1,3	2,1	4,1	927	703	638
	1st lowest year	4,4	1,3	7,1	0,6	14,0	35,9	22,7	0,4	3,4	0,1	2,0	4,8	586		
	2nd Lowest year	4,8	13,4	12,1	10,9	14,5	17,1	7,1	2,1	1,5	9,1	2,4	5,1	727		
Berega Mission 963703	Average year	4,5	14,5	19,0	18,8	15,3	18,1	9,6	2,1	1,8	0,5	0,6	1,5	773	555	493
	1st Lowest year	0,3	15,9	8,9	7,6	4,0	38,3	10,4	0,4	1,9	0,0	0,0	2,4	572		
	2nd Lowest year	0,5	25,2	17,1	23,2	16,9	12,2	2,6	2,2	0,0	0,0	0,0	0,0	588		
Imaginary Station N.W. of Gairo	Average year	4,5	14,0	15,0	15,0	15,0	22,0	10,0	2,0	0,0	0,0	0,5	2,0	450	306	264
	10% year	6,0	6,0	5,0	5,0	20,0	45,0	10,0	0,0	0,0	0,0	0,0	3,0	322		

Design Rainfall Distribution





Balance of storage tank →

Berega 10% rainfall =		= 555 mm
Effective 10% rainfall =		= 444 mm
Annual demand per capita	= 0,03 x 365	= 11 m^3
Required impervious area per capita	= 11/0,444	= 25 m^2
Required storage volume per capita	= 11 x 0,5	= 5,5 m^3

Figure C 4.2-5 Rainwater collection, design example short rains and/or not very heavy long rains. Visual inspection of monthly rainfall figures reveals that a conservative design of the volume of a cistern can be based upon 75% of the precipitation occurring in March, April and May and the remaining 25% is evenly distributed over the months of November up to February.

A design example is given in figure C 4.2-5 for an area with a 9 out of 10 year annual rainfall amount of 555 mm e.g. Berega Mission.

4.2.4.3. River flow collection

If large reservoirs are designed, a gauging station will be installed several years before construction or a nearby gauging station will be used for yield calculations. This is however not the case for small reservoirs and one has to rely mainly on precipitation data of nearby stations, which have to be transformed in one way or other to discharge volumes.
Brokonsult AB (1978) [26] for the Water Master plan of the Mara, Mwanza and West Lake regions used a computer model based on monthly data including many different catchment and climatic characteristics for randomly sampled areas to obtain the water potential of the different regions. The reliability of the method however is not known and the method is difficult to apply without proper computer facilities. For this reason the more lucid rainfall-runoff percentages mentioned in several reports will be examined and used in this report.

Lucas (1964) [45] mentions the use of Head Office note nr. 24, from which Table C 4.2-21 is taken (after conversion to the S.I. system).

Table C 4.2-21 Rainfall-Yield relation (after Lucas 1964) [45]

Rainfall	Yield per km^2 ($10^3 m^3$)	Yield as percentage of rainfall (%)
508	23.8	4.7
635	47.6	7.5
762	81.0	10.6
889	114.3	12.9
1016	154.8	15.2
1143	195.3	17.1
1270	242.9	19.1
1524	338.1	22.2

No catchment characteristics are given. As a shortcoming of this table Lucas mentions the fact that the size of the catchment area is not included, because he expects a lower percentage of yield from larger areas. This is true if the yield consists for the largest part out of surface runoff, which can infiltrate or evaporate in the lower parts of the catchment. He also quotes some data from the Mwanza area, with a mean rainfall between 600 - 1000 mm.
They are shown on next page (converted to the S.I. system):

Table C 4.2-22	Range of catchment area (A) km^2	Yield (%)
Yield-catchment relation (after Lucas, 1964 [45])	$A \leqq 2.6$ $2.6 < A < 13$ $A \geqq 13$	15 - 20 7 - 10 5 - 7

For the Shinyanga area Nedeco (1974) [50] has developed the following relations, based on observed discharges and monthly precipitation for catchment areas of 10 km^2 (called one drainage-unit in the report in question)

Table C 4.2-23 Runoff-Rainfall-Ratio for Shinyanga Region (after Nedeco 1974 [50])

Precipitation range (mm)	Runoff-Rainfall relation (mm)
$P \leqq 90$	$R = 0$
$90 < P < 285$	$R = 0.01\ (P-90)^{1.77}$
$P \geqq 285$	$R = (P-158)$

where P = the monthly precipitation at a specific raingauge
R = the monthly surface runoff from the surrounding 10 km^2

Only surface runoff is considered, because base-flow is negligible in the Shinyanga area. Larger catchments can be thought to consist of several 10 km^2 of drainage units. From the equations it is clear that the monthly precipitation has to exceed 90 mm, before surface runoff starts.
Based on 6 raingauges, hence for an area of 6 x 10 = 60 km^2, the following results were obtained:

Table C 4.2-24 Runoff-Rainfall-Ratio for an area of 60 km^2 with 6 raingauges for Shinyanga Region (after Nedeco 1974 [50])

Rainfall (mm)	Return Period (years)	Runoff-Rainfall Ratio (%)	Runoff (mm)
775	2	11	85
580	10	3	17
530	20	1.5	8

For catchments between 200 and 11000 km^2 Finnwater (1977) [37], in charge of the Mtwara-Lindi water master plan, obtained annual runoff coefficients between 1 and 45%, with an average value of 6%. Minimum values corresponding with approximately a 5-year return-period varied between 1 and 2%, while the percentage yield decreased with the increase of the catchment area. For small catchments (< 1000 km^2), the minimum yield is above 20 mm, while the minimum yield decreases to 10 mm for catchments larger than 15000 km^2. The mean annual precipitation in the area in question varied between 900 and 1200 mm.

Rapp et al. (1973) [58] studying small catchments near Dodoma concluded, that storm-flow, which constituted the whole of the stream-flow, was directly proportional to the amount of effective rainfall i.e. rainfall in excess of the amount needed to satisfy the storage capacities of the catchments. The runoff averaged 40% of the effective rainfall.
However the first rains of the wet season appear to fill the groundwater storage in the coarse sand of the river-beds, since they yield little stream-flow in spite of previous wetting of the soil surface. Rapp et al. (1973) [58] also quotes Fawley (1956) [35], who found that for five years out of nine the runoff percentage in December is above 20% for the Msalatu reservoir near Dodoma. From these data and his own data Pratt quoted by Rapp et al. (1973) [58] concluded that runoff from semi-arid foothill areas in East Africa with poor vegetation cover can reach 30 - 40% of the precipitation of a rainy season for catchment areas of the size of only a few km^2. However in larger catchments more of the precipitation infiltrates into the large areas of sandy rivers, sand fans and mbugas (swamps). From there it is partly lost by evapotranspiration during the dry season, which reduces the percentage of runoff that reaches the reservoir.

The above conclusions correspond with observations made by the Consultant. In sub-paragraph 4.2.1 on surface water resources, yearly runoff-rainfall-ratios are deduced for the project area (see Map C 4 and Tables in sub-paragraph 4.2.1). Both the lower Ngerengere and Berega catchments where the construction of small reservoirs is under consideration lie in 0 - 10% areas. In some years some stretches of the Ngerengere River even loose water because of passing through Karst area between Kiluwa (1HA5) and Utari Bridge (1HA1A). In other parts of the lower Ngerengere catchment, runoff coefficients between 2.5 and 5.5% have been measured. This means however that runoff coefficients of the intermittent (seasonal) streams feeding the Ngerengere River have rainfall-runoff coefficients above 5% in the gently sloping and hilly upper catchments and below 5% in the flatter, partly swampy areas.

In the Karst areas different values can be expected. The geological map should be consulted for the extent of the Karst area. Observations of some selected reservoirs in the lower Ngerengere catchment confirm these assumptions. Table C 4.2-25 shows some details of 4 reservoirs in the Ngerengere catchment and one former reservoir in the Berega catchment.

Water levels of reservoir 1 at Ubena were regularly observed (see figure C 4.2-6). From June to the middle of November, 1978, the water level decreased steadily, after which it started to rise. On the 5th of December it started to overflow. The inflow in November was 4,1% of the rainfall, while for the first four days of December, this was 19,1%.

Some of the runoff in December however is base-flow, so it is related to rain in November. Base-flow plays an important part in the Ngerengere catchment, because in the case of the Ubena reservoir, it kept the reservoir overflowing a long time after the end of the short rains.

For the Kikundu River (see Annex 3) base-flow consisted of 82% of the flow over the October 1978 - March 1979 period.

From the above observations, an annual runoff-rainfall-ratio of 7 - 8% for gently sloping to hilly areas in years of low rainfall does not seem unreasonable for the lower Ngerengere catchment. For design purposes it can be assumed that this runoff takes place during the months of March, April and May, the months of the long rains. If a reservoir fails to supply water, this is usually not caused by lack of inflow but by leakage out of the dam, as is the case with one of the two reservoirs at Kingolowira Prison (reservoir 4 of the Table C 4.2-25).

Assessment of runoff in the Berega catchment is much more difficult, because no regular flow observations exist. One reservoir built near Gairo in the Upper Berega catchment never dried up, but the dam broke several years ago. Another dam built at Ibuti never held water because of leakage. In conformity with other semi-arid areas, runoff during low rainfall years can be estimated at 5% for well-vegetated and gently sloping or hilly areas. This figure increases to above 10% if vegetation is decreased and signs of erosion can be observed. However it becomes much lower than 5% if the reservoir is built below areas with sand fans, sandy river beds or swamps.

From the above observations it is clear that catchment characteristics and antecedent precipitation play an important part and only models which take all these factors into account could solve this problem. As said in the beginning of this paragraph, mathematical modelling for small reservoirs does not seem feasible yet, while use of a rainfall-runoff coefficient seems quite rough. As a temporary solution a multiple regression method or Curve-Number (CN) Method which is used by the Tanga Water Master Plan [22] could be applied, Specially the CN Method was encouraged by the participants of Tanga Hydrological seminar 1978. More details on Curve-Number Method can be found in Annex 3.
The Curve-Number Method has not been thoroughly tested yet in Tanzania, and application of the method to the Kikundi catchment did not produce very good results. Hence the use of a properly selected rainfall-runoff coefficient seems the best available technique so far.

After having calculated the runoff with the help of rainfall-runoff coefficients in combination with the 10% or 5% annual rainfall the yield has to be corrected because of seepage out of the reservoir and evaporation. If a proper site is chosen for the dam and the dam is properly constructed, seepage should not be more than 2 to 3 mm a day. Larger values however can be found for the Karst area. For evaporation of an open water surface see sub-paragraph 3.2.3. For the lower Ngerengere and the Berega catchment a mean daily evaporation of 5 mm or a total annual evaporation of 1800 mm is a fair estimate. For reservoir calculations it can be assumed that total inflow takes place in March, April and May, supposing that in this particular year the contribution of short rains to the runoff can be neglected.

Table C 4. 3-25 Details of some selected small reservoirs

Nr.	Location	Coordinates dam Latit. Longitude	Year finished	Level at damsite (m.a.m.s.)	Catchment area (km sq.)	Average slope of catchment (%)	Vegetation	Water use	EC (mS/m)	Mean annual precipitation (mm) and coëfficient of variation	Remarks
1	Ubena prison	S6°39',E38°07	1964	270	2,3	4,2	95% grass and scattered trees, 5% shamba	some irrigation	90	900* 0,23	Never dries up Reservoir area at full supply level 2,6 ha
2	Fulwe	S6°43',E37°52'	before 1964	510	0,4	8,8	Heavy bush	Wildlife watering	10	839 0,23	Never dries up
3	Kingolwira prison	S6°44',E37°48'	1947	450	5,2	5,0	Grass and light shrubs	Ducks and fish irrigation	110	839 0,23	Never dries up
4	Kingolwira prison	S6°44',E37°48'	1968	450	2,2	5,0	Grass and light shrubs	Irrigation	NA	839 0,23	Dries up 1 to 2 months after end of long rains
5	Gairo	S6°10',E36°52'	1963	1270	8,0	3,5	Grass and light shrubs	Cattle watering	NA	500* 0,25	Dam broken, Never dried up

* Estimated value

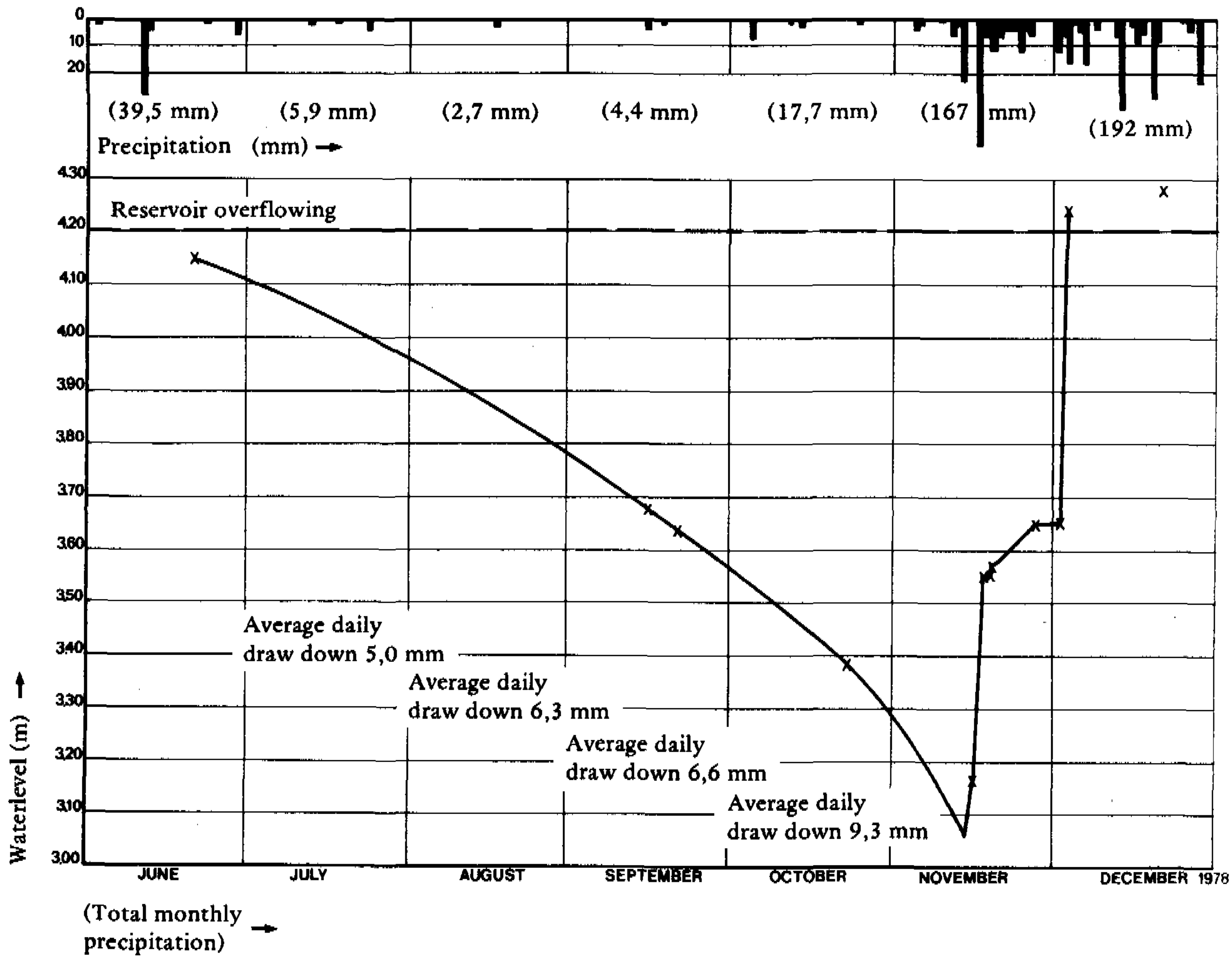


Figure C 4.2-6 Water level observations, Ubena Reservoir June-December 1978

To obtain an idea of the size of the catchment areas required to fill a reservoir for a community of 5000 people which needs 40 l/day per capita at the source, some rough calculations have been made and presented in Table C 4.2-26. Reservoirs are assumed to be located in the gently sloping or hilly parts of either the lower Ngerengere catchment or the Upper Berega catchment. No swampy areas or extensive flat sand bodies are considered to be present in the catchment area above the reservoirs.

Table C 4.2-26 Catchment area calculations for small reservoirs supplying 5000 people

Assumption	Lower Ngerengere catchment	Upper Berega catchment
Mean precipitation	800 mm	500 mm
Precipitation exceeded in 9 out of 10 years	0.7 x 800 = 560 mm	0.7 x 500 = 350 mm
Annual seepage and evaporation losses (8 mm/day)	365 x 8 = 2920 mm	365 x 8 = 2920 mm
Net annual losses	2920 - 560 = 2360 mm	2920 - 350 = 2570 mm
Net annual losses in m^3, (assuming average reservoir area of 2.5 ha for the Ngerengere and 4.0 ha for the Berega area. (Reservoirs in the Berega area need more space allocated for water storage and sediment.))	59.0×10^3 m^3	102.8×10^3 m^3
Spill (not applicable for dry years)	0.0 m^3	0.0 m^3
Consumption	73.0×10^3 m^3	73.0×10^3 m^3
Total amount of water required	132.0×10^3 m^3	175.8×10^3 m^3
Runoff-Rainfall-Ratio	7%	5%
Required catchment area	3.4 km^2	10.0 km^2

From the above calculations it can be seen that for the same net yield the required catchment areas in the Upper Berega catchment have to be approximately 3 times larger than the catchment areas in the Ngerengere area. The effective capacity of the reservoir has to be sufficient for the consumption between June and February, a period of no or not sufficient inflow, while the total capacity has to allow for dead storage and sediment.

In the above calculations consumption and losses do not differ very much in magnitude, which is usually so with water impoundment by small earth dams. A more favourable ratio between useable water and losses can be obtained by using charcos. A charco is a sub-surface reservoir. Construction of a charco is only possible where the depth of impervious material below groundlevel is considerable (preferably up to 6 m). More details about the construction of earth dams and charcos, and a comparison between the two can be found in the technical note written by Lucas (1964) [45].

From field surveys and inspection of the 1 : 50000 maps it is concluded that small reservoirs are possible in the area in question, which is also indicated by the many small reservoirs present in the Ngerengere catchment and the two dams in the Upper Berega catchment. The construction of these two dams in the Berega catchment was a failure because of technical reasons and not because the amounts of water coming out of the catchment were insufficient.

Floods

Usually no flood records are available of small catchments and empirical formulas have to be used. Lucas (1964) advises the Dickens formula and the Head Office Sketch no. 200. Both methods provide a so-called maximum flood, while a flood occurring once every ten years may be of course sufficient as design criterion. No references could be found about the applicability of the two methods in the project area. The use of the so-called TRRL East African Flood Model method, which takes more catchment characteristics into account than either of the two methods above is encouraged by the Engineering Department of the University of Dar Es Salaam. For the time being the use of the TRRL method is advised for calculating design floods of catchments without any records. (see also Annex 3).

If a saddle with crest level below crest of dam can be found as a spillway section to handle large floods, the exact magnitude of the design flood is not very crucial. It has to be prevented in all cases that water spills over the earth dam.

Sediment

The annual sediment yield is a function of climate and catchment-characteristics, such as vegetation cover, slope, soil type and catchment size, and is thoroughly discussed in paragraph 3.4. and which also gives the following formula for the relation between annual sediment yield V in m^3/year and catchment area A in km^2:

$$V = C\ A^{0,77}$$

where C is a factor which depends on catchment characteristics. For the lower Ngerengere catchment it is approximately 250, while in the Upper Berega catchment it can be as high as 1000.

The sediment trap efficiency depends on the sediment characteristics and the rate of flow through the reservoir. For reservoirs that do not spill too frequently it may be roughly between 70 and 90%. Using figures of 250 and 600 for C of the above formula, a lifetime of 30 years and a trap efficiency of 80%, volumes that have to be allocated to sediment in the given example can be calculated. For the reservoir of 3,4 km^2 in the lower

Ngerengere catchment (Table C 4.2-26) this is 15 x 10^3 m^3, while for a less vegetated catchment in the Berega of 10,0 km^2, this figure is 106 x 10^3 m^3, the latter figure being higher than the combined annual consumption and losses. However, if the reservoir only receives diverted low flows, (so-called off-channel storage) as is the case with some reservoirs in the foot-hills of the Uluguru Mountains, sediment inflow can be almost neglected. Some sediment load figures of base-flow can be found in Annex 3.

If under certain circumstances the reservoir is being filled up with rather coarse sediment with a good permeability an artificial aquifer is built up, from which shallow groundwater can be extracted.
The useful storage of the sediment filled reservoir is approximately 30% of the original storage capacity. However the loss of storage will be partly compensated by a considerably reduced evaporation loss.

4.2.5. Changes in land-use and hydrological effects

4.2.5.1. General

Land-use has become one of the more important items in soil conservation policies and surface- and groundwater management in Tanzania, since the large-scale deforestation of mainly mountainous areas has led to disastrous erosion rates, high peak-flows and low-flow reductions in some parts of the country. The problems are related to the important role of the vegetation cover in the hydrological cycle and soil conservation. The vegetation cover influences infiltration rates, evapotranspiration, retention of groundwater and controls erosion. Evapotranspiration determines the annual yield of the catchment, infiltration and retention of the low-flows and peak-flows. Excessive erosion may lead to high sediment loads and a continuous decrease of the groundwater storage capacity of the soil, which finally leads to a reduction of the low-flows.
Several studies have been carried out to quantify the effects of changes in land-use on these factors in order to provide a sound basis for management decisions in this field. However the number of data is rather limited so far. It is obvious that further exploitation of the remaining forests should be avoided and that in several areas soil conservation measures should be taken.

In this sub-paragraph some data from research projects in Tanzania are presented and the TRRL East African Flood Model is applied to illustrate the effect of land-use on peak-flows of the Morogoro River.

4.2.5.2. Forest

Some characteristic properties of forests related to the hydrological cycle may be summarized as follows:

- the annual evapotranspiration is relatively high and as a result the annual surface water yield from forested catchments is relatively small;
- forest cover favours infiltration and hence groundwater recharge; depletion of the groundwater storage is strongly reduced, resulting in a slow decrease of the base-flow during the dry season;
- the capability of forests to absorb large quantities of rain leads to small peak-flows;
- consequently forests provide an optimal prevention against erosion, sediment loads of rivers from forested catchments are consequently low.

In the mountainous areas, where the annual rainfall (> 1250 mm) exceeds the high evapotranspiration losses, the forested parts provide a reliable source for storage and supply of clean water throughout the year.

4.2.5.3. Grassland and cultivation

Compared with forest, grassland and cultivated land give smaller evapotranspiration losses and hence higher annual runoff volumes.
Groundwater storage and retention are less, causing more rapid depletion and lower low-flows as well as higher peak-flows. Especially after burning of grass and cultivated land high intensity rain and subsequent peak-flows may cause severe erosion and high sediment loads.

4.2.5.4. Waterbalance

The effect of changes in land-use on the evapotranspiration losses and annual runoff of six experimental catchments areas is investigated by the East African Agriculture and Forestry Research Organization (Dagg et al. 1965) [28]. Three comparisons are made, the first between high montane forest and tea estates at Kericho (2200 m altitude) the second between bamboo forest and softwood plantations at Kimakia (1500 m altitude). The catchments are located in the Western part of Kenya with evergreen, continuously growing vegetation. The third comparison is made between two catchments in Mbeya Range in the Southern Highland area of Tanzania (2500 m altitude). This area shows a rainfall pattern with heavy rain from December to May and extreme drought for the remainder of the year. Some results are summarized in Table C 4.2-27 which are self-explanatory.

Table C 4.2-27 Evaporation tests of catchments with different vegetation cover (after Dagg et al., 1965 [28])

Site	Catchment vegetation cover	Annual runoff (mm)	Annual evapo-transpi-ration Et (mm)	Open-water evapor-ation Eo (mm)	$\frac{Et}{Eo}$ (-)
Kericho[1]	1. high forest	698	1503	1667	0.90
	2. tea estate	813	1338	1656	0.81
Kimakia[2]	1. bamboo forest	1428	1080	1434	0.75
	2. vegetables and pine	1405	948	1417	0.66
Mbeya[3]	1. forest	348	1280	1701	0.75
	2. peasant	589	627	1701	0.37

1 6-year average
2 7-year average
3 4-year average

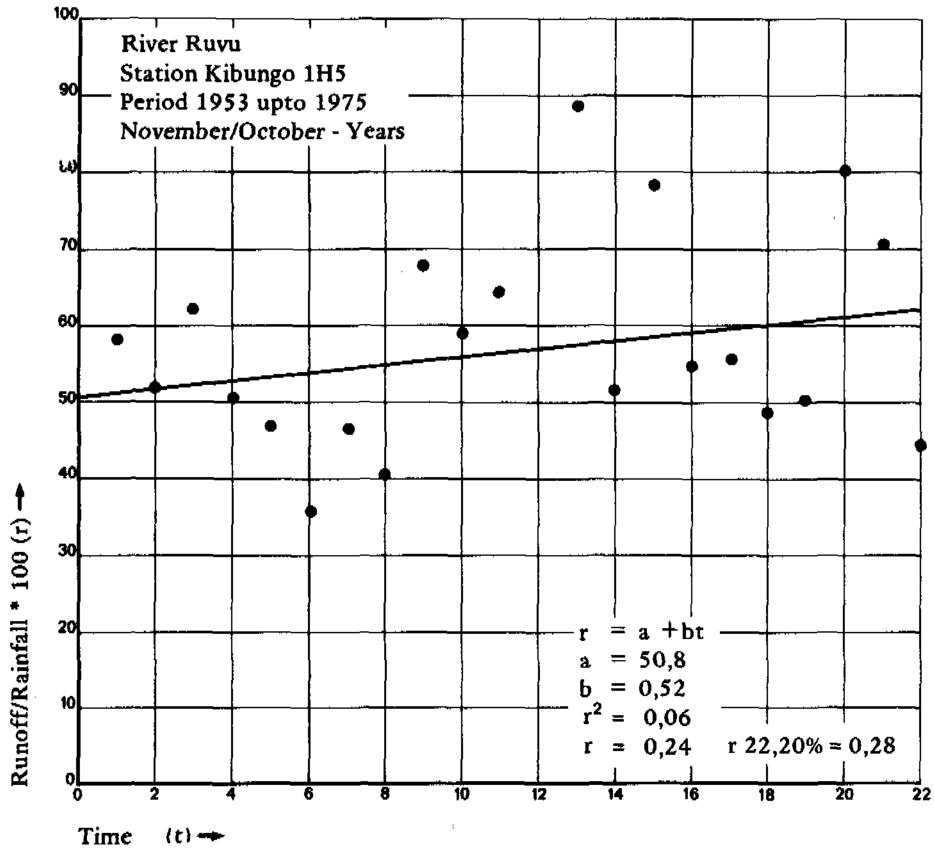


Figure C 4.2-7 Change of the Runoff-rainfall-ratio over the 1953 up to 1975 period for the Ruvu River at Kibungo (1H5)

Using the 22-year flow record of the Ruvu River at Kibungo and the rain-gauges in the catchment the effect of the deforestation of the original rain forest in the Uluguru Mountains on the ratio between annual runoff and annual precipitation is studied .

Although the correlation between the runoff-rainfall ratio and time is not significant (20% significance level), the ratio shows an increasing tendency, which indicates the same tendency of increasing runoffs as found by the investigations mentioned before (see figure C 4.2-7).

4.2.5.5. Peak-flows

The effect of changes in land-use on peak-flows is also investigated by the East African Agriculture and Forestry Research Organization (Dagg et al., 1965) [28]. The response of the experimental catchment at Kericho before and after cultivation with different rainfall intensities is shown in Table C 4.2-28. The cultivated catchment produces peak-flows which are at low rainfall intensities almost twice and at high rainfall intensities almost four times the peak-flows from the forested catchment.

Table C 4.2-28 Kericho, experimental catchment investigations (after Dagg et al., 1965 [28]). Peak-flows as % of incident rainfall

Catchment	Rainfall intensities (mm/h)				
	0-12.5	12.5-25.0	25.0-38.0	38.0-51.0	51.0-63.5
1. forested 1957-1958	0.57	0.81	0.81	1.05	1.25
2. tea plantation 1961-1963	0.90 ± 0.09	2.14 ± 0.18	2.71 ± 0.36	2.71 ± 0.43	5.58 ± 0.56

Because no such data exist for catchments in the Morogoro region, the effect of changes in land-use on peak-flow response is studied by using the TRRL East African Flood Model. The Morogoro River catchment is taken as an example. The results may be considered typical of similar catchments in the Uluguru Mountains. The maximum peak-discharge occurring once every ten years is determined at 32 m^3/s, if the catchment area is completely covered with forest, and increases as more area is being covered with grass or cultivated. A maximum of 146 m^3/s is reached when the whole catchment is cultivated (see figure C 4.2-8).
At present the Morogoro River catchment is covered with 39.8% of rainforest, 44.0% of grassland and riverine forest (Rapp et al., 1927) [57].
According to the model the present 1 out of 10 year maximum peak-flow may be estimated at about 80 m^3/s.

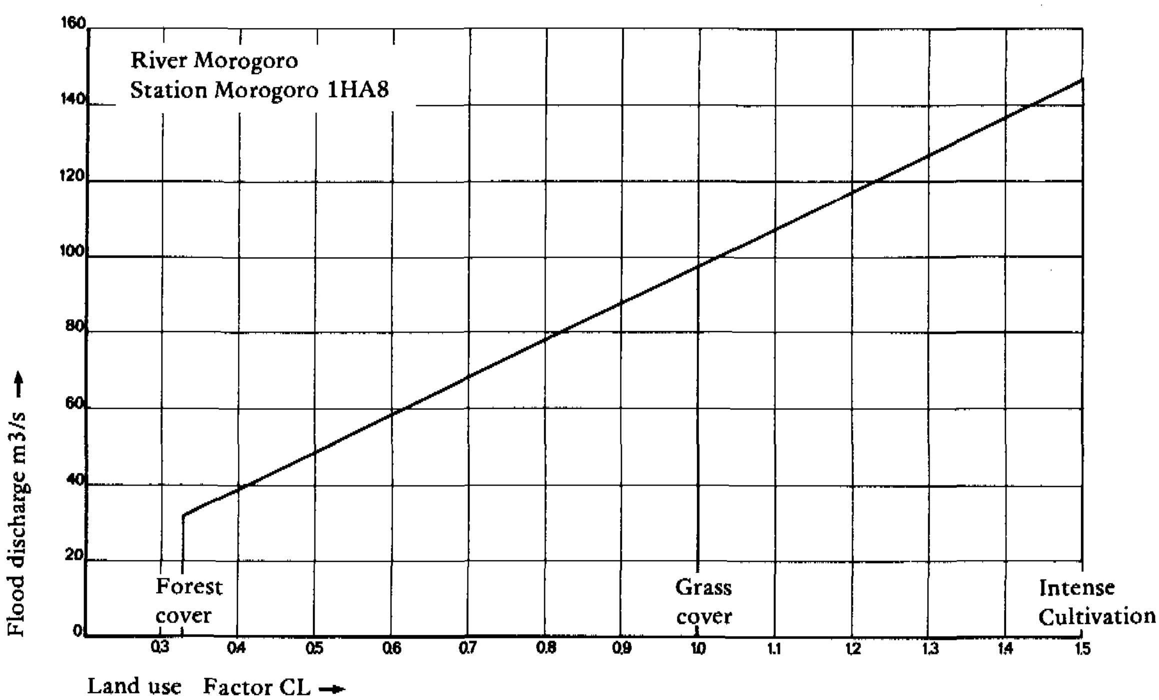


Figure C 4.2-8 Influence of change in land-use on the design flood discharge of the Morogoro River according to TRRL East African Flood Model.

4.2.6. Low-flows

The effect of land-use changes on low-flows has not been quantified yet. Generally after clearance of forest a rise of the whole annual hydrograph including peak-flows and low-flows may be expected initially (Dagg et al., 1965) [28].

If no proper soil conservation methods are applied and if annual burning of the natural vegetation is not prevented, the groundwater-bearing soils may be steadily eroded. Peak-flows will increase and low-flows will be reduced, until originally perennial rivers may stop flowing during the dry season. According to an analysis of the flow data of the Ngerengere River (Temple, 1972 [65] referring to Little, 1963 [44]), the river seems to dry up completely in the dry season with increasing frequency. First recorded in 1930, this phenomenon recurred in 1934, 1943, 1949, 1953, 1955, 1958 and 1960. It is not mentioned however from which section the data are obtained, and no observation was possible after 1963. At the gauging sites downstream of Kihonda the increasing zero-flow frequency may also be caused by increasing withdrawal of river water for sisal production. No other rivers with sufficiently long records are available in the Morogoro region to prove the correctness of the results published by Temple.

4.2.6.7. Erosion and sedimentation

The problem of erosion and sediment load of rivers caused by land-use in Tanzania is thoroughly studied by various authors. The results are published in Research Monograph no 1, 1973, of the Bureau of Resource Assessment and Land Use Planning (BRALUP).

Attention in particular is paid to the Uluguru Mountains as one of the major stream source areas in Tanzania. Large areas of the mountains have been deforested over the last one and a half century for the sake of small-scale agriculture. The crops offer little protection to steep slopes against heavy rainfall. Landslides and mudflows are identified as a most serious, erosional threat. After a very heavy rainfall recorded in February 1970 in the Mgeta catchment 1000 landslides and mudflows occurred of which about 47% originated from cultivated area, about 46% from grassland, about 6% from bare soils, while less than 1% was found in forested area.

The effect of land-use on sediment yield of rivers was investigated by the Department of Veterinary Science and Animal Husbandry (Rensburg 1955) [59]. Five experimental plots at Mpwapwa with the same morphological characteristics but different vegetation cover (n2 1 is entirely cultivated, n2 2 is half cultivated - half grass covered, n2 3 is entirely grass covered) were studied during eight years. The average erosion in tons of soil lost per ha. annually was respectively 55.6, 3.2 and 0.7 for the three plots. The average erosion from forest cover may be expected to be below the amount of 0.7 tons/ha/annum.

4.2.6.8 Land-use in relation to domestic water supply, conservation measures

It may be obvious that domestic water supply systems such as gravity supply and pumped supply systems based on low-flows of perennial rivers from mountainous areas are extremely dependent on the conservation of vegetation and soil cover of the catchment. It should be stressed that the present mountain forests, which were identified as sources of water of sufficient quantity and quality, should be protected against continuing destruction. According to the study of Temple [65], reforestation which would help to reduce and control the present soil erosion, is only possible to a limited extent in order to prevent disruption of the agricultural economy. For areas like the Uluguru Mountains the most feasible conservation measures would be to encourage tree-planting below ridge crests, along roads, above villages and along river banks in combination with a change towards perennial tree crops instead of annual cropping. Planting of trees would also meet the demand for firewood, thus preventing deforestation of the remaining rain forests.

Bench terracing to change slope angles has proved to be less acceptable in the steep parts of the Uluguru Mountains. This method favours conditions for landslides, as water storage raises pore water pressure, which reduces the shear strength of the soil (Temple 1972) [65].
Besides conservation of the remaining rain forests, no general recommendations for soil conservation can be made for the other mountainous areas without detailed studies of the local conditions.

4.2.6.9. Recommendation

More attention should be paid to the collection of low-flow data, in order to obtain a basis for quantifying the effect of deforestation on low-flows.

5. SURFACE WATER POTENTIAL

5.1. General

The surface water potential is a function of the total annual and seasonal distribution of the runoff, which is related to the distribution of the rainfall.
Roughly 80% of the total annual runoff occurs from November up to the end of May. The remaining 20% is accounted for by the runoff during the dry months. From June up to the end of October there is hardly any rain and the river flows are decreasing steadily. Some rivers run dry before it starts raining again. Others stop flowing during a very dry year with a long lasting dry period and small amounts of groundwater recharge during the preceding rainy season. However throughout the project area several large perennial streams emerge from the mountainous areas which carry substantial quantities of water even during very dry years (see Hydrological Map C 2).

If water is to be used to the fullest extent, water storage is a prerequisite. For this reason several large dams are built or planned to be built. Examples in the project area are Kidatu dam stage I and stage II in the Great Ruaha River and the Mindu dam in the Ngerengere River near Morogoro. For financial reasons, the building of storage facilities, which cover the water demand during part of the dry season, is usually not feasible for domestic water supply. The surface water potential is therefore generally determined by the lowest annual flows.

Small earth dams and charcos based on perennial or non-perennial rivers however are feasible in most parts of the project area and may be used for cattle watering and possibly for domestic water supply.
The hydrological study has emphasized low-flows, while only minor attention has been paid to a combination of runoff and storage.

The principal results are listed below and if necessary discussed in more detail in the following paragraphs:

a. To evaluate trend in rainfall 3 long rainfall series were analysed. No trend was discovered, which means that in general the project area neither becomes dryer nor wetter.

b. Rainfall and runoff have been compared in several areas with different rainfall-runoff percentages. This resulted in Map C 3. where areas with mean annual runoff-rainfall ratios between 0 - 10%, 10 - 30% and 30 - 60% are shown. Areas with a rainfall-runoff coefficient larger than 10% also have a rather high rainfall. Building small reservoirs in these areas will be no problem from a hydrological point of view. Even in the 0 - 10% area proper catchments may be selected, as will be explained in paragraph 5.4. Several existing empirical methods relating surface-runoff, peak floods, base-flow and sediment loads have been checked, by using data of the small Kikundi catchment (see Annex 3). The Curve Number method to assess surface runoff did not yield very good results. The TRRL East African Flood model to convert rainfall into flood hydrographs performed better. More effort is required to adapt these methods to local circumstances.

In the detailed flow analysis of the Upper Ngerengere River (see Annex 4) a regression analysis has been used to link rainfall and runoff. The relation has been used to extend the flow series which enable a more reliable estimation of the yield of the proposed Mindu Reservoir.

Because computer facilities were not available and no extensively measured catchments are present in the project area either, no attempts have been made to use detailed mathematical models which differentiate between surface runoff, infiltration, actual evaporation, groundwater-recharge and base-flow.

c. Assessment of low-flows of rivers and springs in the project area has been based on existing flow data, and a low-flow measurement programme was carried out between August and December, 1978, by the Consultant on a monthly basis. A summary of the results is given in paragraphs 5.2 and 5.3. The surface water potential in respect to domestic water supply is shown on map C 4.

d. Land-use in the project is still liable to change and this has also its impact on the water potential in so far as the total runoff tends to increase, but the low-flows become lower. The results of the study are presented in paragraph 5.5.

5.2. Supply from rivers

5.2.1. General

Even during extremely dry years the larger (gauged) rivers in the project area carry amounts of water which are abundant, if compared with the amounts required for domestic water supply.

Table C 5.2-1 Annual low-flows (l/s) of gauged rivers.

River	Station		Probability of non-exceedence				
			1%	5%	10%	20%	50%
Wami	Dakawa	1G1	1040	1550	1930	2462	4010
Tami	Msowero	1G5A	48	76	117	190	500
Kisangate	Mvumi	1G6	140	199	238	299	457
Wami	Rudewa	1G8	787	1075	1240	1545	2259
Diwale[1]	Turiani	1GB1(A)	182	271	340	436	713
Diwale[2]	Turiani	1GB1(A)	140	221	282	382	672
Mkindu	Mkindu	1GB2	252	319	364	421	562
Ruvu	Kibungo	1H5	1811	2163	2400	2660	3304
Ngerengere	Konga	1HA9A	25	39	49	67	116
Mgeta	Kisaki	1HB1	551	690	780	897	1180
Mgeta	Mgeta	1HB2	462	533	575	632	754
Mvuha	Mvuha	1HC2	435	609	730	899	1355

1 1968 and onwards (including Mjonga River)
2 up to 1967

If 40 l/day per capita is allocated at the source, a flow of 1 l/s may supply approximately 2000 people. The total demand of all villages in the project area in 1982 is estimated at 549 l/s (17.3 10^6 m^3/year).
With the assessment of the surface water potential a number of aspects are involved. The main points concerning pumped supply systems are:

1. sufficient amounts of water at reasonable distance from the supply area;
2. a good quality of water is preferred;
3. downstream effects have to be acceptable.

In the case of gravity supply systems the water has to be found at sufficient altitude above the supply area.

On the surface water potential map C 4 the lowest annual flows are indicated which will not be exceeded once every 10 and once every 20 years. These flows are taken as a design criterion for domestic water supply systems. The flows are given for possible intake sites, which are in the case of pumped supply systems as close as possible to the supply area and in the case of gravity water supply at the nearest location of sufficient altitude. When average conditions are present the required level difference may roughly be put at 50 m.

Water quality aspects are dealt with in part B (volume II) of this report.

The acceptability of downstream effects depend on the amounts of water which are demanded in relation to the available low-flow and the downstream use of the river for water supply or irrigation. Generally downstream effects seem to be negligible.

The low-flows given in this chapter are mainly based on the results of the low-flow analysis presented in sub-paragraph 3.3.6. As these flows are mostly given for sites which do not coincide with possible intake sites either for pumped or for gravity systems, the values are adjusted linearly with the difference in catchment area. If no low-flows are established because data are lacking, a rough estimate is made based on data of nearby catchments.

Favourable intake sites are selected from topographical maps (scale 1 : 50000), aerial photographs (scale 1 : 20000 up to 1 : 48000) and in several cases from field surveys.

Possibilities for gravity supply systems are generally found in mountainous areas and also along the escarpments of mountainous areas. In the steep parts of the mountainous areas gravity supply systems offer better opportunities than pumped supply systems. Villages along the escarpments require relatively long gravity supply mains and pumped supply systems become competitive. Most of the villages in the Ruvu and Wami plain are situated too far from mountains to be supplied by gravity.
Possibilities for pumped supply systems are found along most of the big perennial rivers, such as the Wami, Mkata, Ruvu and Mgeta. These systems are therefore not discussed in detail.

The potential for gravity supply however depends on specific topographical conditions. The most favourable areas, which are shown in figure C 5.2-1, are discussed below (par. 5.2.2).

5.2.2. Areas with possibilities for gravity supply

Uluguru mountains

Area 1, Ngerengere River

The Ngerengere River above Konga rises from the steep north-western slopes of the Uluguru mountains. Sufficient altitude is reached close to the supply area. At present a total of about 1.6 l/s is extracted at two intakes. The oldest intake is situated in the Tangeni River which is a tributary of the Ngerengere River. This intake is situated at a level of 640 m above MSL. The second intake is built at a level of 550 m above MSL, about 2 km above the present gauging station at Konga.

The low-flows with 5 and 10% probability of non-exceedence are 39 and 49 l/s for the nearby station at Konga. This indicates that more water could be withdrawn, as is already proposed by the Water Department.

Table C 5.2-2 Ngerengere River, water potential

altitude supply area	(m a. MSL)	520 - 550
altitude possible intake	(m a. MSL)	600
5% low-flow	(l/s)	39
10% low-flow	(l/s)	49
present use	(l/s)	1.6
maximum extension of supply	(l/s)	37

Although many consumers depend at present on the Ngerengere River downstream from Konga, no problems will be caused by an increase of water withdrawal for gravity supply, because the planned Mindu dam in the Ngerengere valley will provide a considerable increase of the water potential and low-flows during the dry period.

Area 2, Mgolole River

The Mgolole River is draining a catchment which is similar to that of the Ngerengere River above Konga. In this case too, the altitude close to the supply area is sufficient.
However, the potential of the river is almost exhausted due to gravity supply systems for several villages and institutions (estimated capacity = 10 l/s). The low-flows with 5 and 10% probability of non-exceedence are estimated at 14 and 17 l/s, based on the 5 and 10% low-flows of the Ngerengere River at Konga and the ratio between the catchment areas (Mgolole catchment above possible intake = 7.2 km^2, Ngerengere catchment above Konga = 20.5 km^2).

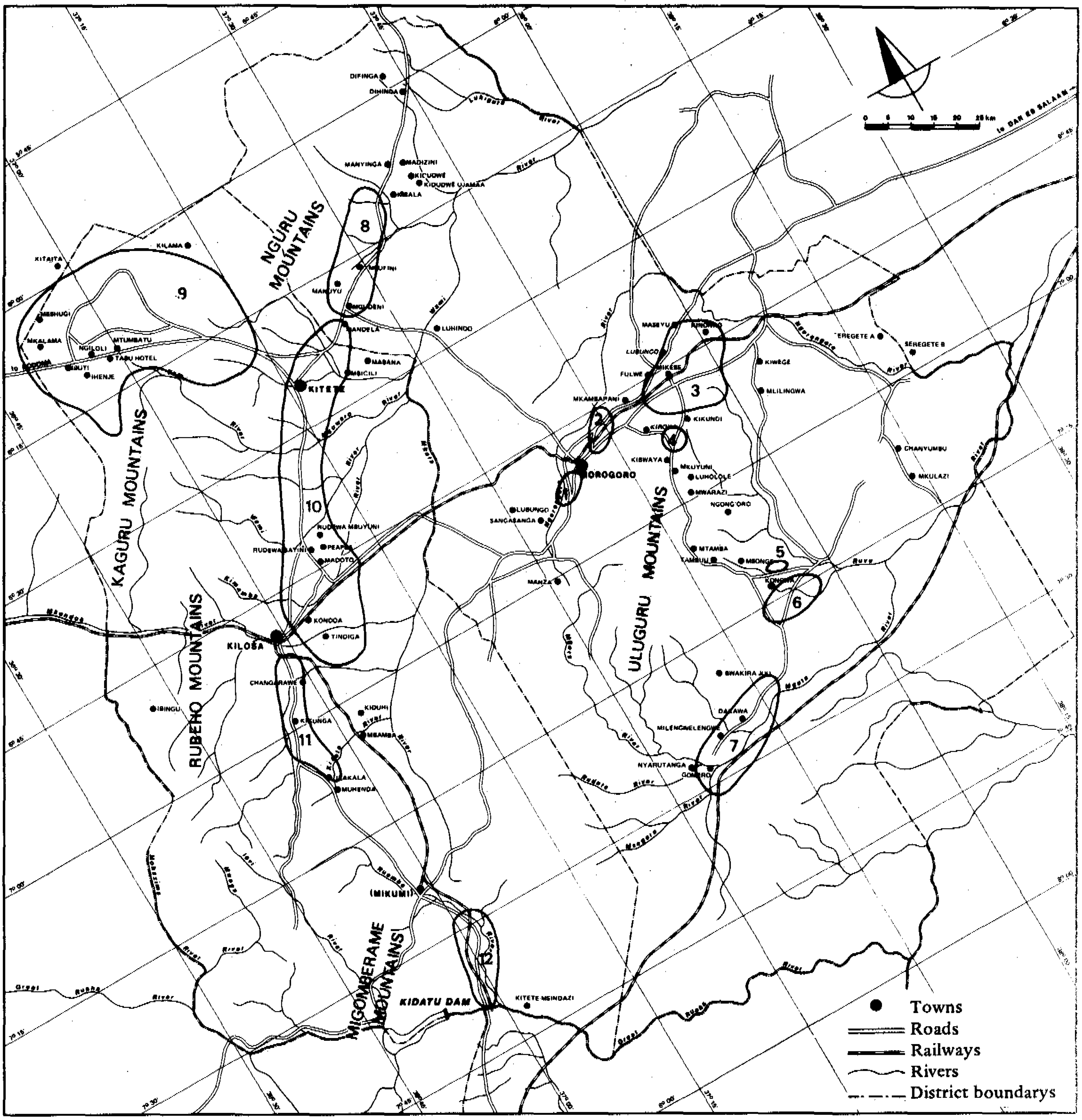


Figure C 5.2-1 Areas with possibilities for gravity supply

The table below shows that some extension of the gravity supply system is possible.

Table C 5.2-3 Mgolole River, water potential

altitude supply area	(m a. MSL)	450 - 510
altitude possible intake	(m a. MSL)	550 - 600
5% low-flow	(l/s)	14
10% low-flow	(l/s)	17
present use	(l/s)	10
maximum extension of supply	(l/s)	4

No downstream extraction was observed.

Area 3, Mindu reservoir

The part of the Ngerengere valley roughly between Mkambarani and Kinonko may be supplied by gravity from the planned Mindu reservoir.
The reservoir is designed for a continuous supply of 720 l/s throughout the year. According to the feasibility study carried out in Annex 4 there is still storage left. Therefore sufficient amounts of water are available for the supply of villages in this area.

Area 4, Kiroka River

The Kiroka River is a small river which is perennial before it enters a swampy area of about 0.3 km^2. The river drains a steep catchment at the northern part of the Uluguru mountains.
The low-flows with 5 and 10% probability of non-exceedence are estimated at 4 and 6 l/s, for a site close to a possible intake site (see figure C 5.2-2). The losses in the swamp were observed to be 22 l/s at the end of the dry season (see Table C 5.2-4).

Table C 5.2-4 Kiroka River, flow data

date	discharge above swamp (l/s)	discharge below swamp (l/s)	loss (l/s)
5 - 10 - 78	50	28	22
2 - 11 - 78	22	0	22

Compared with the losses in the swampy area, tapping of the whole 5% low-flow (4 l/s) of the river will have no important effect in inhabited area.

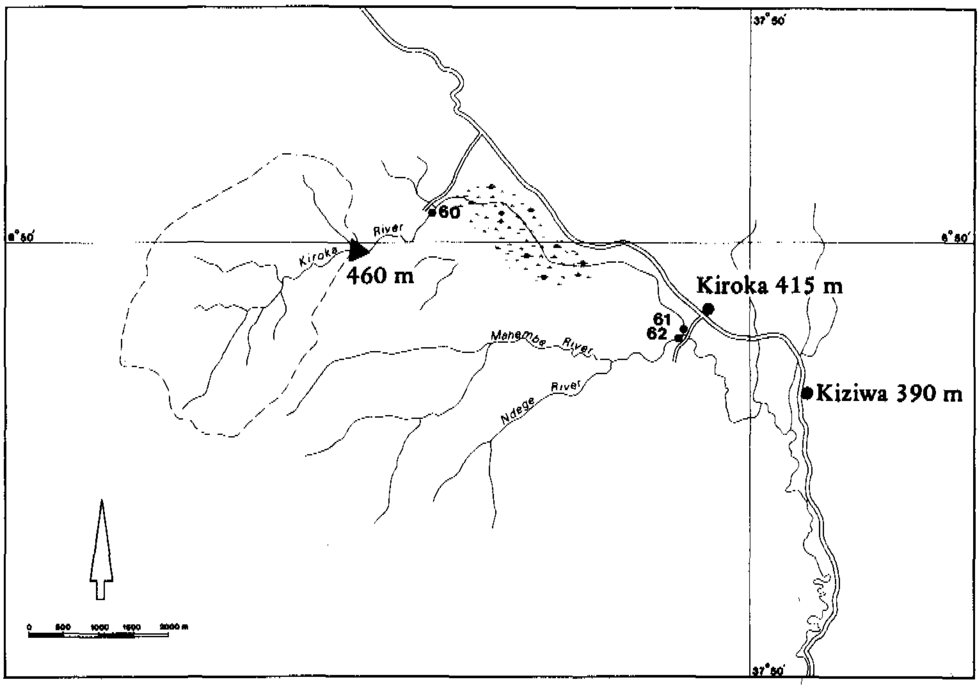


Figure C 5.2-2 Area 4, Kiroka River, Uluguru Mountains

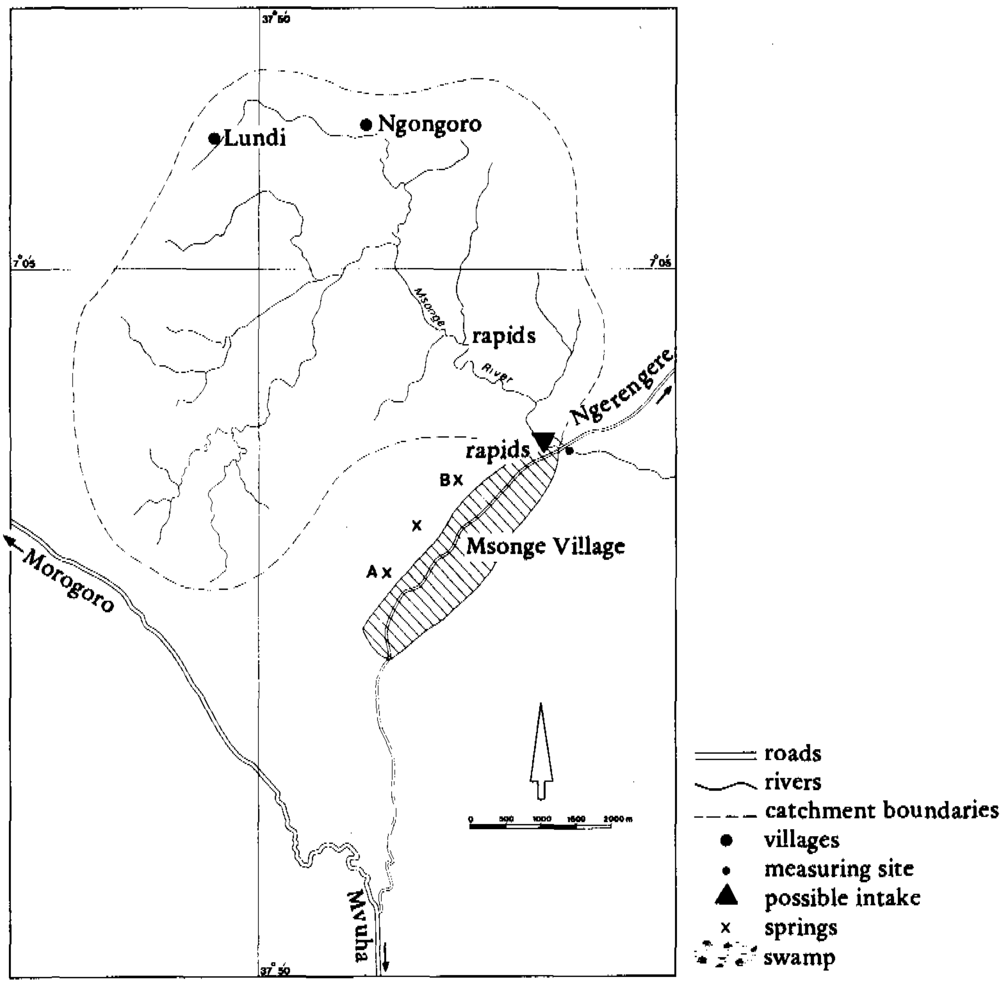


Figure C 5.2-3 Area 5, Msonge River and Springs, Uluguru Mountains

Table C 5.2-5 Kiroka River, water potential

altitude supply area	(m a. MSL)	390 - 420
altitude possible intake	(m a. MSL)	460
5% low-flow	(l/s)	4
10% low-flow	(l/s)	6

Area 5, Msonge River and springs

The Msonge River and several springs emerge from the foothills of the eastern part of the Uluguru mountains. According to local information the river and the springs are perennial, and therefore suitable for gravity supply to Msonge village (see figure C 5.2-3).
As data on low-flows of similar rivers and springs are missing, only a very rough estimate of the water potential can be made based on the measurements carried out in 1978 and on local experience.

Table C 5.2-6 Msonge River and springs, water potential

altitude supply area	(m a. MSL)	not known
altitude possible intake	(m a. MSL)	not known
estimated level difference:		
Msonge River	(m)	15
spring A	(m)	15
spring B	(m)	20
5% low-flows:		
Msonge River	(l/s)	10
spring A	(l/s)	0.04
spring B	(l/s)	0.08
10% low-flows:		
Msonge River	(l/s)	15
Spring A	(l/s)	0.05
Spring B	(l/s)	0.10

Area 6, Mvuha River and area 7, Mngazi River

Although considerable amounts of water are running down from the south-eastern part of the Uluguru mountains by way of the Mngazi and the Mvuha River, the flat slopes of the river beds make it necessary to tap the smaller upper tributaries in order to obtain sufficient level difference between intake and supply area. As a result, relatively long supply mains are required. The Mngazi and Mvuha River drain the central and higher part of the Uluguru mountains. Due to more rainfall, these rivers are more suitable for the gravity supply than the Bwakira and Ditumi River, of which the catchments cover a lower part of the Uluguru mountains (see figure C 5.2-4). On 9-8-1978 one of the main upper reaches of the Mngazi River was measured at roughly 150 - 200 m above the supply area, close to a possible intake site. As is shown in Table C 5.2-7 the yield (l/s/km^2) of the upper Mngazi is about twice the yield of the Mngazi at Mngazi.

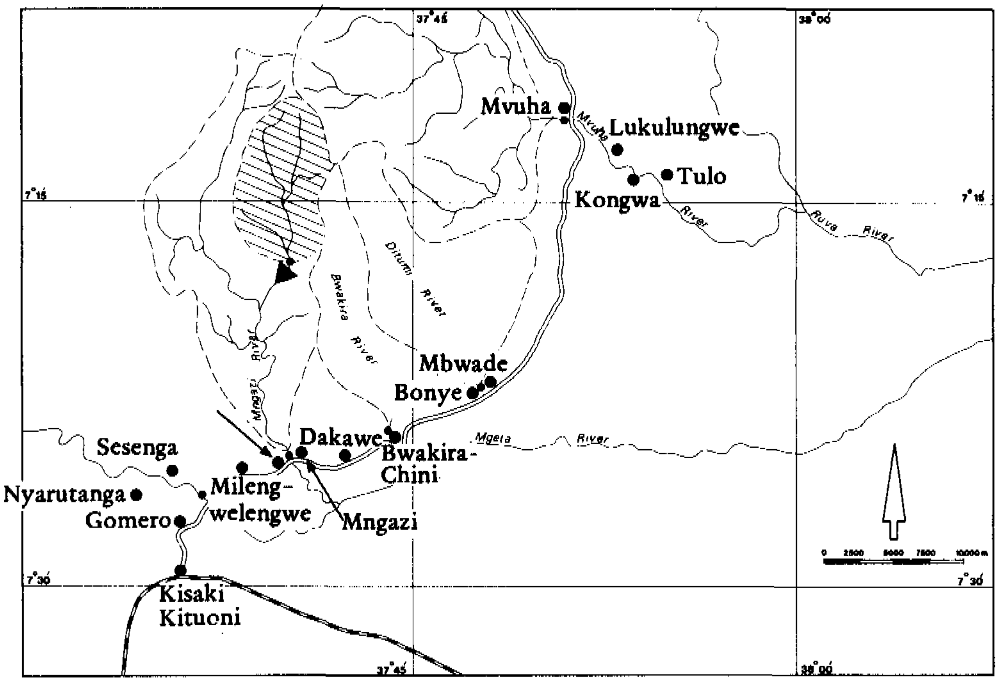
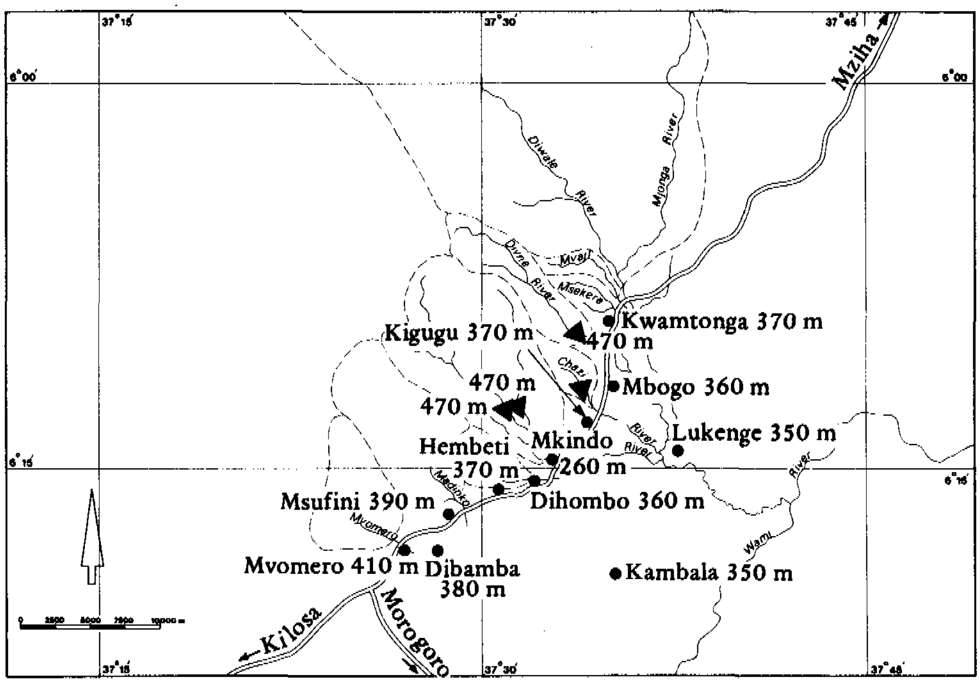


Figure C 5.2-4 Areas 6 and 7, Mvuha and Mngazi Rivers, Uluguru Mountains



roads
railway
rivers
catchment boundaries
villages
measuring sites
possible intakes

Figure C 5.2-5 Area 8, Mkindu River, Nguru Mountains

Table C 5.2-7 Mngazi River, flow data

date	site	discharge (l/s)	catchment area (km^2)	yield ($l/s/km^2$)
9-8-78	Mngazi near Mngazi below Escarpment	1250	215	5.8
9-8-78	Mngazi between Bwakira Juu and Singisa (possible intake)	646	55	11.8
9-8-78	ratio	0.52	0.26	2.03

Based on the data of Table C 5.2-7 and the low-flows with 5 and 10% probability of non-exceedence of 22 and 37 l/s at Mngazi, the 5 and 10% flows near the possible intake may be estimated at 12 l/s (= 2.03 x 0.26 x 22 l/s) and 20 l/s.
It is assumed that the ratio between the yield of the river at both sites does not change very much.
No measurements of the upper tributaries of the Mvuha River were carried out, because of the inaccessibility of the catchment area. In view of the high low-flow of 609 l/s for the station at the escarpment, which has a 5% probability of non-exceedence, and in view of the fact that the catchment is similar to that of the Mngazi River, the upper tributaries will also have considerable 5 and 10% low-flows (300 l/s and more).

Table C 5.2-8 Mvuha and Mngazi River, water potential

altitude supply area	(m a. MSL)	not known
altitude possible intakes	(m a. MSL)	not known
estimated level difference	(m)	150
<u>5% low-flows</u>:		
Mngazi River near Singisa	(l/s)	12
Mvuha tributaries above escarpment	(l/s)	300
<u>10% low-flows</u>:		
Mngazi River near Singisa	(l/s)	20
Mvuhu tributaries above escarpment	(l/s)	350

Except for domestic water supply no downstream use of the rivers was observed.

Nguru mountains

Area 8, Mkindu River

Several perennial rivers are running down from the western slopes of the Nguru mountains between Mvomero and Turiani. Steep river beds provide nearby locations for possible intakes (see figure C 5.2-5).

Even in a very dry year (5% probability) one of the main rivers - the Mikindu River - carries abundant amounts of water, considering the possible water demand of the population living along the lower slopes. Therefore downstream effects due to water extraction for domestic water supply will be negligible.

Table C 5.2-9 Mkindu River, water potential

altitude supply area	(m a. MSL)	350 - 380
altitude possible intakes	(m a. MSL)	470
<u>5% low-flows:</u>		
Mkindu River	(l/s)	319
Divue River	(l/s)	25
<u>10% low-flows:</u>		
Mkindu River	(l/s)	364
Divue River	(l/s)	31

<u>Kaguru mountains</u>

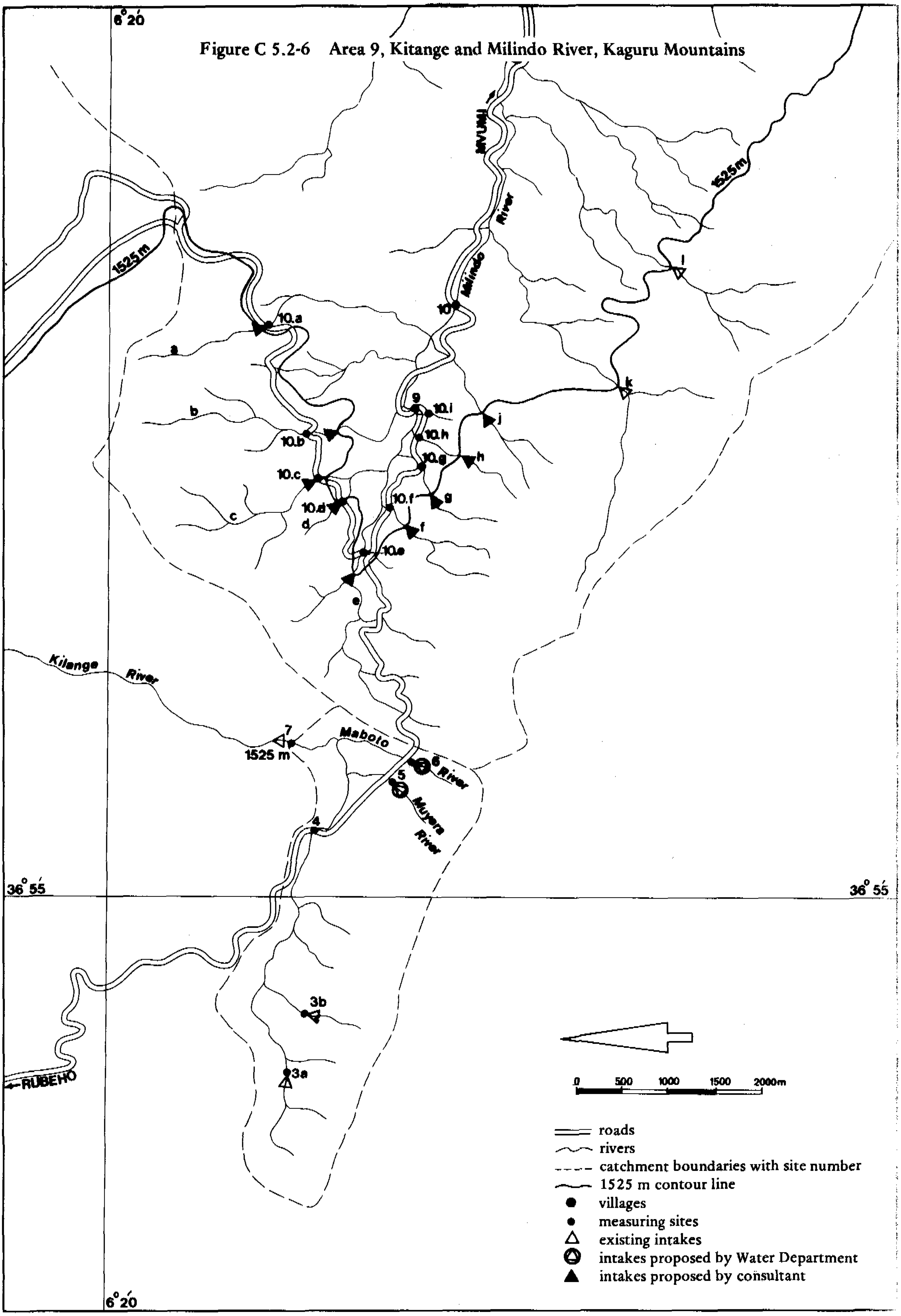
Area 9, Upper Kitange and Milindo River

The Kaguru mountains form the only area with perennial streams in the vicinity of Gairo and Mamboya area. The streams are tributaries of the Kitange and Milindo River which both empty themselves into the Tami River (also called Msowero River).
The supply area is mainly situated in the catchment of the Berega River. The high level watershed between the two catchments requires intakes at a high altitude to enable gravity transport (see figure C 5.2-6).
At present two small tributaries of the Kitange River are tapped at an altitude of 1920 m a. MSL. The capacity of the system is too small to meet the present demand because of the small potential of the streams. Measurements are carried out at both intakes (3a, 3b) and at a downstream location (7) (Table C 5.2-10).
For the downstream site low-flows with 5 and 10% probability of non-exceedence of 7 and 10 l/s are found.

Table C 5.2-10 Tributaries of the Kitange River, flow data at existing intakes

date	discharge at intakes 3a and 3b (1.3 km^2) (l/s)	yield at intakes 3a and 3b ($l/s/km^2$)	discharge at downstream location 7 (7.6 km^2) (l/s)	yield at downstream location 7 ($l/s/km^2$)
26-7-78	7.5	5.8	68	8.9
23-8-78	7.3	5.6	58	7.6
19-9-78	9.1	7.0	47	6.2
19-10-78	7.2	5.5	50	6.6
mean		6.0		7.3

Figure C 5.2-6 Area 9, Kitange and Milindo River, Kaguru Mountains



In view of the yield and catchment area ratios, the 5 and 10% low-flows at the existing intakes may be roughly estimated at 1 l/s (= $\frac{6.0}{7.3}$ x $\frac{1.3}{7.6}$ x 7 l/s) and 1.4 l/s.

Two new intake sites are planned by the Water Department at 1700 and 1750 m a. MSL in the Mnyera and Maboto streams. According to measurements carried out in 1978 at locations 5 and 6, the potential of these streams is not much more than that of the presently tapped streams (see Table C 5.2-11).

Table C 5.2-11 Tributaries of the Kitange River flow data at existing intakes (3a, 3b) compared with those of the Mnyera and Maboto streams (5, 6)

date	discharge at present intakes (l/s)	discharge Mnyera stream (l/s)	discharge Maboto stream (l/s)
26- 7-78	7.5	3.3	4.5
23- 8-78	7.3	4.1	3.2
19- 9-78	9.1	2.9	3.5
19-10-78	7.2	6.2	4.5

Better opportunities are found in the catchment of the Milindo River. Possible intakes have to be situated above the lowest, nearby point of the watershed (1525 m a MSL) to enable transport to the supply area by gravity. The catchment area above the possible intakes is situated in the completely uninhabited part of the Ukaguru Forest Reserve.
In September and October 1978 measurements were carried out in the Milindo River (9, 10) and in the tributaries close to possible intakes (10a up to 10i). The data are given in Table C 5.2-12 on next page. The tributaries are ranked from a up to i, starting with the tributary closest to the lowest point of the watershed.

Table C 5.2-12 Milindo River and tributaries, flow data

river or tributary	catchment (km2)	discharge 20 and 21-9-78 (l/s)	yield (l/s/km^2)	discharge 20-10-78 (l/s)	yield (l/s/km^2)
trib.a	0.6	5.8	9.7	4.2	7.0
trib.b	1.6	16.9	10.6	18.3	11.4
trib.c	2.1	29.4	14.0	23.9	11.4
trib.d	0.4	5.0	12.5	0	0
trib.e	3.7	32.0	8.7	34.0	9.2
trib.f	1.3	13.5	10.4	12.1	9.3
trib.g	0.9	7.9	8.8	8.8	9.8
trib.h	0.9	13.0	14.4	6.4	7.1
trib.i	0.2	2.9	14.5	3.0	15.0
total	11.7	126.4	10.8	110.7	9.5
Milindo (9)	10.8	106.1*	9.8	85.9	8.0
Ratio			1.1		1.2

* The Milindo River at measuring site 9 includes tributaries c up to i only.

As the catchments of the tributaries are very similar with respect to slope, drainage pattern and vegetation, the differences in yield (l/s/km^2) are expected to be caused by inaccuracies in the flow measurements (no ideal cross sections, small amounts) and in the determination of the catchment areas. The average yield (l/s/km^2) of the tributaries is slightly higher than that of the Milindo River at measuring site 9, as was expected.
Beside most of the tributaries mentioned in Table C 5.2-12, the catchment of the Milindo River above the measuring site comprises relatively flat parts which are expected to have a relatively small yield.
In Table C 5.2-13 the low-flows with 5 and 10% probability of non-exceedence are given for the measured tributaries a up to i and three remaining tributaries j up to l, which have not been measured.
Based on the 5 and 10% low-flow of 15 and 25 l/s established for the Milindo River at site 9 and taking account of the relevant area of the catchments above possible intake sites, and a ratio of 1.15 between the yield of the tributaries and the Milindo River the flows are estimated.
The tributaries are ranked again starting with the tributary closest to the lowest point of the watershed, which is the passage of the intake main. Hence tributary "a" will be tapped first, after which the capacity of the system may be increased by extending the intake main to the next tributary, number "b", and so on.

Some additional water may be obtained from the Kitange River, which has a 5 and 10% low-flow of 7 and 10 l/s at measuring site 7, close to the possible intake.

Table C 5.1-13 Tributaries Milindo and Kitange River, water potential

River or tributary	catchment area above possible intakes	discharge with 5% probability of non-exceedence		discharge with 10% probability of non-exceedence	
			accumulative		accumulative
	(km2)	(l/s)	l/s	(l/s)	l/s
trib.a	0.6	1.0	1.0	1.6	1.6
trib.b	1.6	2.6	3.6	4.3	5.9
trib.c	2.1	3.4	7.0	5.6	11.5
trib.d	0.4	0.6	7.6	1.1	12.6
trib.e	3.7	5.9	13.5	9.8	22.4
trib.f	1.2	1.9	15.4	3.2	25.6
trib.g	0.8	1.3	16.7	2.1	27.7
trib.h	0.6	1.0	17.7	1.6	29.3
trib.i	-	0	17.7	0	29.3
trib.j	0.9	1.4	19.1	2.4	31.7
trib.k	2.7	4.3	23.4	7.2	38.9
trib.l	1.6	2.6	26.0	4.3	43.2
Kitange	7.6	7.0 [1])	33.0	10.0 [2])	53.2

[1]) Including 1 l/s tapped at existing intakes.
[2]) Including 2 l/s tapped at existing intakes.

The total area of the Milindo catchment covered by forest may be estimated at about 80 km^2. Considering the fact that the catchment area above the possible intakes is 16.2 km^2 and considering the constant yield over the whole catchment, the flow at the border of the forest may be expected to be 5 times the total flow of tributaries "a" up to "l" at the possible intakes. Hence, even if the total 10% low-flow will be tapped, the resulting decrease of the flow during the dry months of a 10%-year will be small.

As the catchment area above the possible intake in the Kitange River is the only source area during a dry period, tapping of the whole low-flow will cause zero-flow at inhabited areas during the dry months of a 5 or 10%-year.

A summary of the results is given in Table C 5.2-14.

Table C 5.2-14 Tributaries Milindo and Kitange River, water potential

altitude supply area	(m a. MSL)	< 1325
altitude possible intakes	(m a. MSL)	1525
5% low-flow:		
tributaries Milindo River	(l/s)	26.0
Kitange River including 1 l/s at existing intakes	(l/s)	7.0
10% low-flow:		
tributaries Milindo River	(l/s)	43.2
Kitange River including 2 l/s at existing intakes	(l/s)	10.0

Rubeho mountains

Area 10, Kisungusi River

Several perennial rivers are running down the south-western escarpment of the Rubeho mountains between Kilosa and Mvomero (see figure C 5.2-7). Hence, abundant amounts of water are available even during a very dry period. Important perennial rivers are, going from the South to the North, the Wami, Kisangate and Tami Rivers with respectively 5% low-flows of 1550, 76 and 199 l/s.

The Kisungusi River, which is a tributary of the Wami River, seems to be very useful for gravity supply, in comparison with the other rivers. Firstly, the river has a relatively steep bed. As a result the level above the supply area is of sufficient altitude and at short distance.

Secondly, the mica-content of the Kisungusi River water is relatively low, according to reports of the Water Department. Mica is considered to be a source for water-related deseases (see Part E, Volume V).

For these reasons the Kisungusi River is already used to feed a small gravity system of the Kisungusi Agricultural School. Additionally, the Water Department has planned a large gravity scheme for villages along the lower slopes from Rudewa to Mandela based on the Kisungusi River.

The low-flows with a probability of non-exceedence of 5 and 10% are estimated at 167 and 191 l/s, which is abundant, considering the amounts which are usually needed for domestic water supply.

Table C 5.2-15 Kisungusi River, water potential

altitude supply area	(m a. MSL)	430 - 450
altitude possible intake	(m a. MSL)	600
5% low-flow Kisungusi River	(l/s)	167
10% low-flow Kisungusi River	(l/s)	191

About 2 km downstream from the existing and possible intakes the Kisungusi River empties itself into the Wami River, with a low-flow almost ten times higher. Downstream effects due to water extraction may therefore be considered negligible.

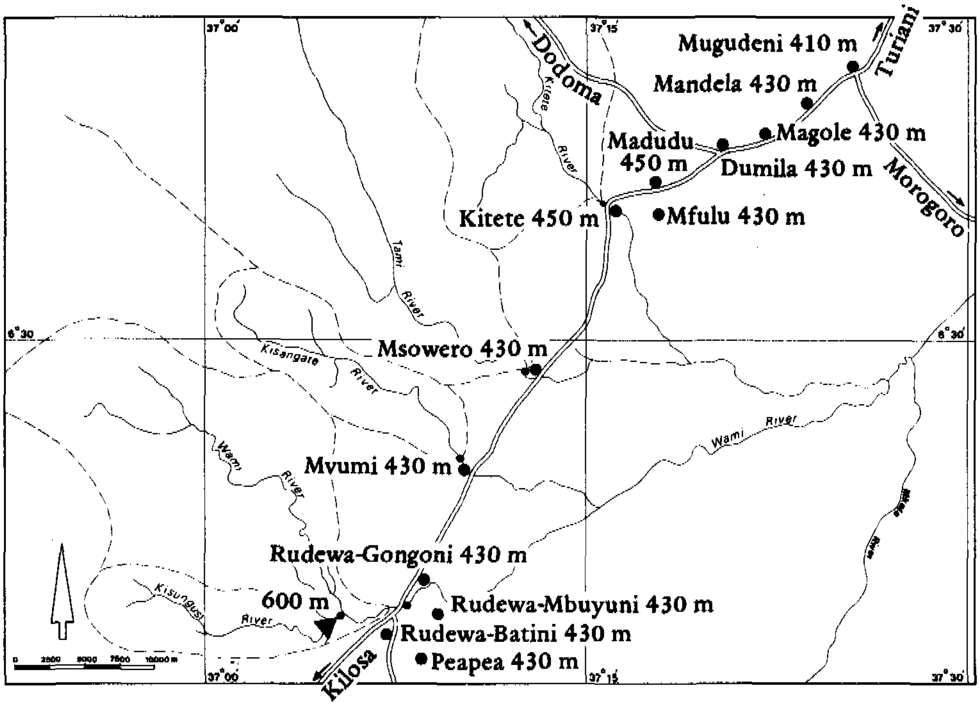
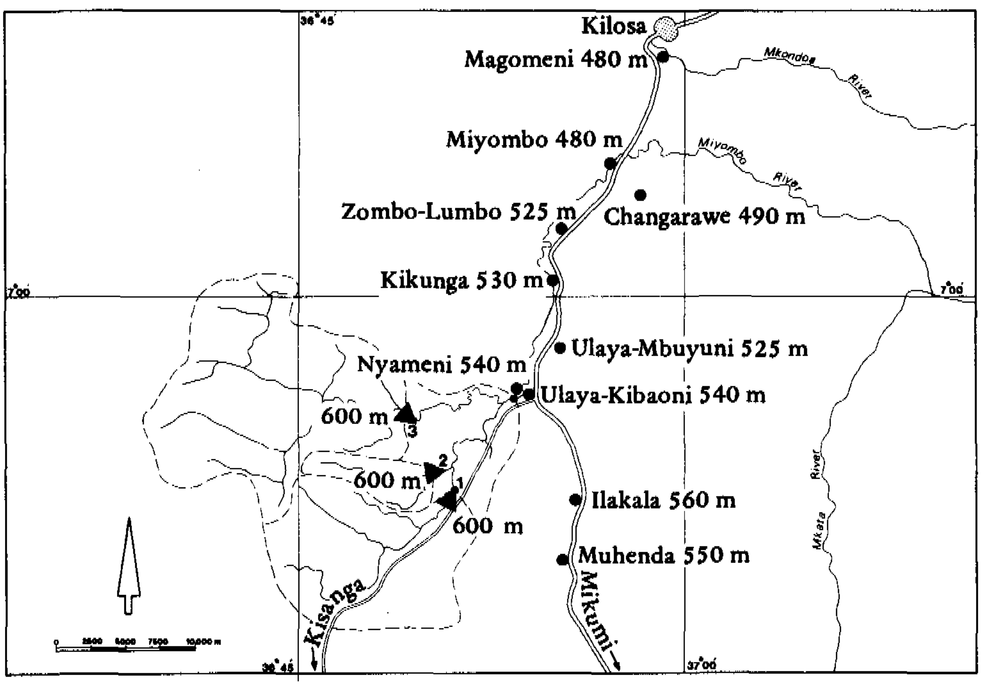


Figure C 5.2-7 Area 10, Kisungusi River, Rubeho Mountains



roads
rivers
catchment boundaries
villages
measuring sites
possible intakes
town

Figure C 5.2-8 Area 11, Miyombo River, Rubeho Mountains

Area 11, Miyombo River

Between Muhenda and Kilosa only the Miyombo River is running down from the Rubeho mountains (see figure C 5.2-8). Measurements carried out in 1978 indicate that the river is perennial and carries abundant amounts of water. The low-flows with 5 and 10% probability of non-exceedence are estimated at 617 and 688 l/s.
Most of this water originates from the northern tributary which drains a relatively high and forested part of the Rubeho mountains.
The measurements of 1978 have been carried out at a site near Ulaya village. In November, 1978, an additional measurement at a possible intake site in the southern tributary was carried out.
The flows at a second possible intake in a small tributary and at a third possible intake in the northern tributary are estimated. The results are shown in Table C 5.2-16.

Table C 5.2-16 Miyombo River, flow data of 15-11-78

River or tributary	site	catchment area (km^2)	discharge (l/s)	(%)	yield ($l/s/km^2$)
Miyombo	Ulaya village	362.2	1093	100	3.0
southern trib.	poss. intake 1	142.0	174	16	1.2
middle trib.	poss. intake 2	21.7	(27)*	(2)	(1.2)
northern trib.	poss. intake 3	138.8	(892)*	(82)	(6.4)

* Values estimated

The estimates of the flow of the middle tributary are based on the same yield as the one found for the southern tributary (1.2 $l/s/km^2$). According to topographical maps and aerial photographs the two tributaries have the same catchment characteristics.
As the flow measured near Ulaya village is determined by the flow from the three tributaries, the flow of the northern tributary is obtained by a water balance (1093 - 174 - 27 = 892 l/s).
The ratios between the flows of the tributaries and the flow near Ulaya village are considered typical of a situation without direct surface runoff, in this case of low-flows.

Table C 5.2-17 Miyombo River, water potential

altitude supply area	(m a. MSL)	480 - 560
altitude possible intakes	(m a. MSL)	600
<u>5% low-flows</u>:		
southern tributary	(l/s)	99
middle tributary	(l/s)	12
northern tributary	(l/s)	506
<u>10% low-flows</u>:		
southern tributary	(l/s)	110
middle tributary	(l/s)	14
northern tributary	(l/s)	564

Because of the large amounts of water compared to the amounts generally needed for domestic water supply, downstream effects will be small.

Migomberame mountains

Area 12, Msowero and Tundu Rivers

Conditions for gravity supply to villages between Ruaha and Lomango along the escarpment of the Migomberame mountains seem to be very favourable. Several perennial rivers, of which the Msowero and Tundu Rivers are the biggest, are running down the relatively steep escarpment. Possible intakes may be situated close to the supply area (see figure C 5.2-9).

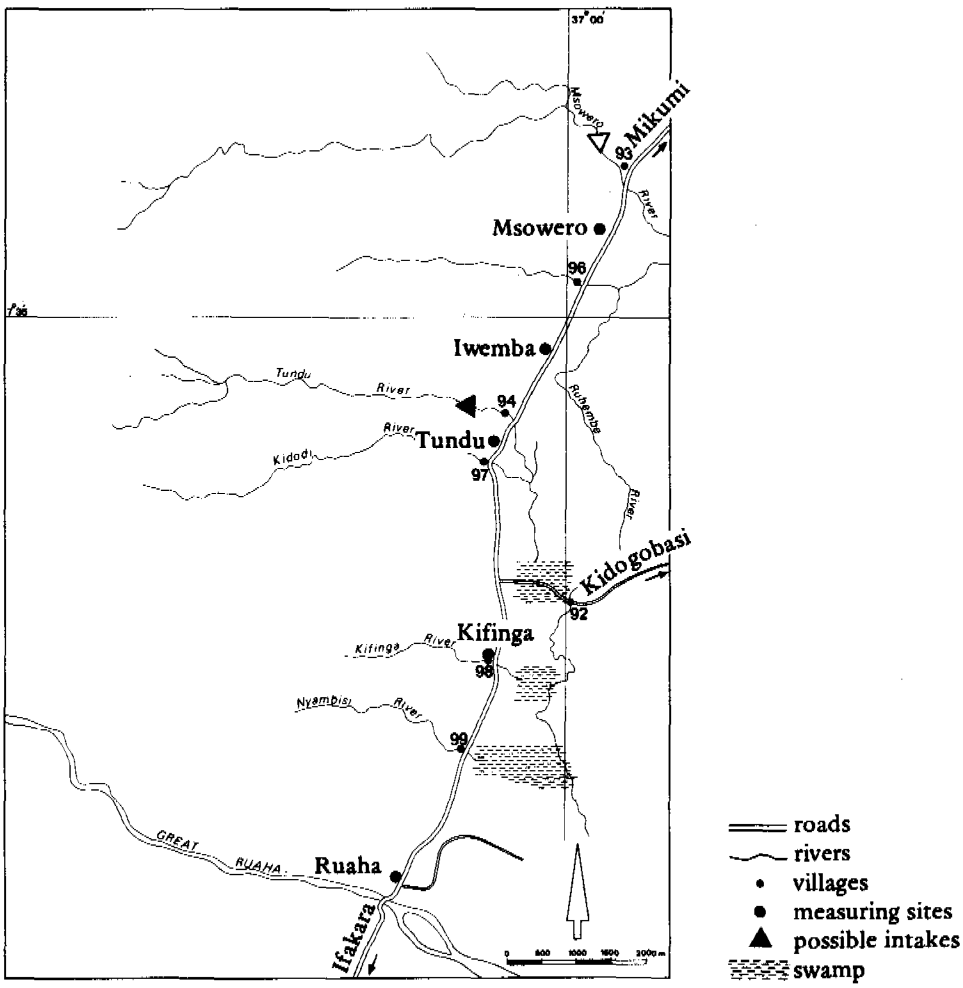


Figure C-5.2-9 Area 12, Msowero and Tundu River, Migomberame Mountains

The low-flows with 5 and 10% probability of non-exceedence of 204 and 299 l/s for the Msowero and 90 and 96 l/s for the Tundu River also apply to the possible intake sites.

Table C 5.2-18 Msowero and Tundu River, water potential

altitude supply area	(m a. MSL)	--
altitude possible intakes	(m a. MSL)	--
estimated level difference intake-supply area	(m)	> 100
5% low-flows:		
Msowero River	(l/s)	204
Tundu River	(l/s)	90
10% low-flows:		
Msowero River	(l/s)	299
Tundu River	(l/s)	96

The rivers flow through part of the Kilombero Sugar Estate. No water is extracted for irrigation yet. Amounts needed for domestic water supply are small compared to the amounts of water available or to the amounts that may be used for irrigation purposes in the future.

5.3. Supply from springs

In general, springs are discussed in sub-paragraph 3.3.7. The results were not very promising. The only springs that could still be developed are situated in the Karst area of the SE Ulugurus. They are:

a. Springs in Tambuu
The springs lie below village level so that the smaller springs can be enclosed and covered. They could be considered free-flowing shallow wells. As an alternative, the largest spring could serve as a water supply source for the whole village. The minimum flow with a probability of non-exceedence of 5% is conservatively estimated at 2 l/sec.

b. Springs in Mtamba
Three small springs East of Mtamba are already developed. However, the discharge has been decreasing over the years, especially the discharge of the middle one (local information). However, 5% low-flows estimated at present at 0.3 l/sec, could increase to perhaps 1 l/sec by cleaning up the discharge area, and subsequent horizontal drilling.

c. Spring South of Mkuyuni
The 5% low-flow of this Karst spring emerging 40 m above village level is 0.8 l/sec.

All springs are in the Karst area, which means that with these springs there is more chance of bacteriological contamination than with springs emerging from other areas, (see Part E on this subject).

5.4 Reservoirs

As stated in paragraph 5.1 only small storage facilities are feasible for domestic water supply, and then only if other alternatives are difficult to realize, as is the case in the Berega catchment and the lower Ngerengere catchment. Map C 3 indicates areas where the mean annual runoff is between 0 - 10%, 10 - 30% and 60% of the mean annual rainfall. The areas with high runoff potential, in this case the areas within the 10 - 30 and 30 - 60%-ranges, also lie in the areas of higher rainfall. No hydrological difficulties exist and sufficient quantities of water are available to fill up potential reservoirs. Geo-technical problems however have still to be investigated. For the areas designated on map C 3 as having rainfall-runoff coefficients between 0 - 10%, too problems may exist from a hydrological point of view. However reservoirs in this area are still possible, where the landscape is at least gently sloping, where the basement is not of Karstic origin (limestone or dolomite) and where no swampy areas or large flat sand bodies are found above the site of the dam. Hydrological design criteria and some rough calculations concerning the yield of reservoirs and required catchment-areas can be found in sub-paragraph 4.2.4. The possibility of harvesting rainfall from impervious areas in combination with storage tanks seems to be a rather unattractive one, because large surface areas and big storage are required. The rainfall in the project area is too low and too seasonal for this method to be used.

During the field survey some small reservoirs that failed have also been visited. From the survey it was deduced that the fact that these reservoirs failed can be attributed to insufficient geological siting or faulty construction.

5.5. The influence of changes in land-use on surface water potential

Land-use has become one of the more important issues of soil conservation policies and surface- and groundwater management in Tanzania, since the large-scale deforestation of mainly mountainous areas has led to disastrous erosion rates, high peak-flows and low-flow reductions in some parts of the country.
Data to study hydrological effects of changes in land-use in the project area are scarce, so conclusions are mainly be based on literature.

A dense forest cover is preferred especially in hilly or mountainous areas, because high low-flows are sustained and soil erosion is minimal. Continuous deforestation in the project area lowers the low-flows due to a steady decrease of the groundwater storage capacity of the soil. Rivers which were originally perennial may finally dry up completely as observed by Little (1963) [44] in the Ngerengere. Quantifying the effects of deforestation on low-flows is difficult, because not enough reliable, long low-flow series are available. However it is obvious that conservation of soil by protecting the remaining forests is of vital importance for water supply systems based on low-flows.

Because of the high evapotranspiration of forests, the total annual runoff is less, then that of catchments without forest cover.
Based on Ruvu data at Kibungu, the annual rainfall-runoff ratio has increased annually by more than 0.5% on the average over the last 22 years. This means that with a mean annual rainfall of approximately 2400 mm, runoff has increased by 12 mm every year. Hence if storage is not a limiting factor, more water can be obtained by alternative land-uses.
Besides an increasing average flow after deforestation, higher peak-flows also occur. No data are available to show changes in peak-flows, but based on the TRRL East African flood model, the once every 10 year peak discharge of a mountainous catchment in the Uluguru Mountains could increase 4 to 5 times, if a complete forest cover would be changed by alternative land-use. The influence of land-use is less drastic on peak-flows in rather flat areas, as is the case in the Mkata and Wami valley.
Plans exist and are partly carried out at Dakawa on the river Wami to convert low-lying swampy areas covered with grass and reed into rice-fields. A partly draining of the lower areas will also decrease sub-surface storage, and low-flows. The influence on the total runoff will be minor because evapotranspiration of swamps will be replaced by evapotranspiration of irrigated crops. This could even mean a net gain of the total runoff.

ANNEX CA1

STATISTICAL METHODS USED IN DATA ANALYSIS

CA 1 STATISTICAL METHODS USED IN DATA ANALYSIS

The following paragraphs give a short description of the basic statistical methods which are used in this study. For a detailed description see Chapter 8 in Chow: Handbook of Applied Hydrology [27].

Frequency analysis:

Probabilities of time-series can be estimated analytically or graphically. In both cases an assumption has to be made about the distribution function. Table C A1-1 shows a hypothetical time-series of 25 values, which could be considered as 25 years of annual rainfall.
The distribution is shown in figure C A1-1a. The area under the curve for a certain class is an estimate of the probability of occurrence of values in this class. Note that values smaller than 400 or larger than 2400 have a very small chance of appearing.

Certain statistical parameters can be calculated from the time-series. Those used in this report are:

Measures of central tendency:

The arithmetic mean (m_x) is the value most often used.
It is defined by:

$$m_x = \frac{\sum_{i=1}^{n} x_i}{N}$$

where:

x_i = value of time series at time i

N = total number of values in series

Σ = summation sign

Sometimes the median will be used, which is the middle value or the variate which divides the frequencies of a distribution into two equal portions.

Measures of variability:

The standard deviation (s_x) is a measure of the variability of the data.

It is the square root of the mean-squared deviation of individual measurements from their mean and is defined by:

$$s_x = \frac{\sum_{i=1}^{N} (x_i - m_x)^2}{N - 1}$$

(Notation as before)

The coefficient of variation (c_v) is the standard deviation divided by the mean, hence:

$$c_v = \frac{s_x}{m_x}$$

Both s_x and m_x have the dimension of the observation. Hence, c_v is a dimension-less coefficient, which makes comparison of variabilities of time-series with different means and standard deviations possible.

Measures of skewness:

Some distributions are symmetrical around the mean, others have a long tail to the right or left (compare figures C A1-1a and b). The skewness (∂), which is a measure for non-symmetry, is defined by:

$$\partial = \frac{N}{(N - 1)(N - 2)} \sum_{i=1}^{N} (x_i - m_x)^3$$

(Notation as before)

The measure used in this report is again a dimensionless coefficient - the coefficient of skewness (c_s), where:

$$c_s = \frac{\partial}{s_x^{\,3}}$$

Above parameters will be calculated from the given time-series of size N. They can be considered as estimates of the true parameters, which could only be calculated if an infinite number of values of the series would be available. Shorter time-series give less reliable results.

If above parameters are known and the type of distribution is also known, frequencies can often be calculated by means of the following frequency formula, (Chow, 1964):

$$x_\alpha = m_x + k_\alpha s_x$$

where α refers to the probability of exceedence or non-exceedence. E.g. a non-exceedence of 10% means that values lower than $x_{10\%}$ have only a 10% probability of showing up or will occur once every 10 years. k_α is the frequency factor that belongs to a certain distribution.

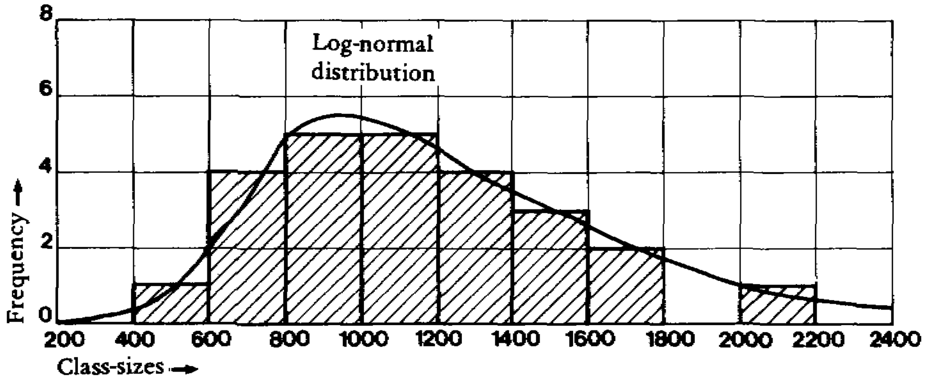
Frequency factors for the normal distribution are given in table C A1-2. The normal, bell-shaped distribution is symmetrical around the mean (see figure C A1-1b). Hence the coefficient of skewness c_s should be zero.

Annual precipitation with mean values of 750 mm or more in tropical regions are assumed to be normal (WMO 1970 [68]).

TABLE C A1-1 SERIES OF HYPOTHETICAL DATA

Nr:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Hypothetical Series:	735	800	1087	870	1123	1423	1231	905	1576	1096	1216	1660	701	829	715	612	1444	1276	1694	1155	1096	565	2126	931	1312
Transformed Series:	2,87	2,90	3,04	2,94	3,05	3,16	3,09	2,96	3,20	3,04	3,09	3,22	2,85	2,92	2,85	2,79	3,16	3,11	3,23	3.06	3,04	2,75	3,33	2,97	3,12

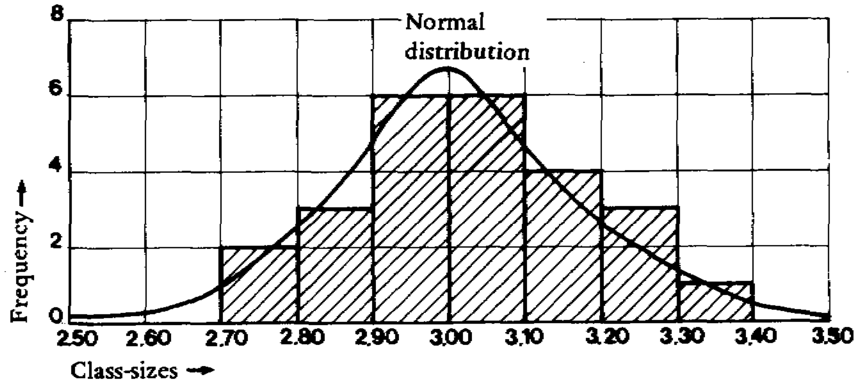
Figure C A1-1 Frequency distribution of hypothetical and transformed series



a

Hypothetical Series

mean	m =	1127
standard deviation	s =	382
coefficient of variation	c_V =	0,34
coefficient of skewness	c_S =	0,71
median	=	109,6



b

Transformed Series

m = 3,03 (.................................)
s = 0,15
c_V = 0,05
c_S = 0,04

Median = 3,04, retransformed to 1076
(Note median and mean may not differ very much)

Annual flows in tropical regions are almost always skew with a long right-tail. There are many skewed distribution functions. The one which is often used for annual streamflows in Tanzania and which will also be used in this study is the log-normal distribution, with the left boundary at zero.

If the logarithmic values of the log-normally distributed time-series are taken, the transformed values are normally distributed, and data can be treated as such to calculate values with various probabilities, after which they have to be transformed back.

Table C A1-2: Extreme values of hypothetical series assuming a normal and a log-normal distribution.

	Probability of non-exceedence								
	1%	5%	10%	20%	50%	80%	90%	95%	99%
Frequency factor - k	-2.33	-1.65	-1.34	-0.84	0	+0.84	+1.34	+1.65	+2.33
Normal assumption	237	497	615	806	1127	1448	1639	1757	2017
Log-normal assumption	479	606	674	802	1071	1432	1702	1894	2396
Difference	- 242	- 109	- 59	+ 4	+ 56	+ 16	- 63	- 137	- 379

The hypothetical series given in table C A1-1 originates from a log-normal distribution. The transformed values of this series are normally distributed. Figures C A1-1a and b show both the graphs of the original distribution and the transformed distribution.

In reality it is often rather difficult to differentiate between different distributions. Table C A1-2 shows what happens to the hypothetical series of Table C A1-1, if the original series is assumed to be a normal distribution instead of a log-normal one. The less extreme values (values between 10% and 90%) are reasonably well estimated, while the lower and higher values differ considerably.

In this report all frequencies for annual flows, low flows and annual rainfall are calculated with the above-mentioned frequency formula.
The specific flows are assumed to be log-normally distributed while the annual rainfall is considered to have a normal distribution. Sometimes graphical plots will be made on probability paper, specially designed for normally or log-normally distributed values. If the right paper is chosen for the right distribution, data should be plotted on a straight line. However this will only be true for the hypothetical case. Usually data deviate

slightly. If deviations become too large, a wrong distribution has been chosen. The absciss on the paper gives probabilities, while the ordinate gives the size of the values. In the case of normal and log-normal probability paper the abscisses have the same scale, while the ordinate of the latter paper has a log-scale. To plot data, they are first ranked in order of magnitude and then given a plotting position.

The best plotting position for the normal or log-normal probability distribution is the one developed on a theoretical basis by Chegodayew (see Chow [27]):

$$\text{Plotting position} = \frac{m - 0.3}{N + 0.4} \times 100\%$$

where m = rank number of value, which is sorted out according to increasing or decreasing values

N = total number of data

Figure C A1-2 shows a plot of the hypothetical data on log-normal probability paper.

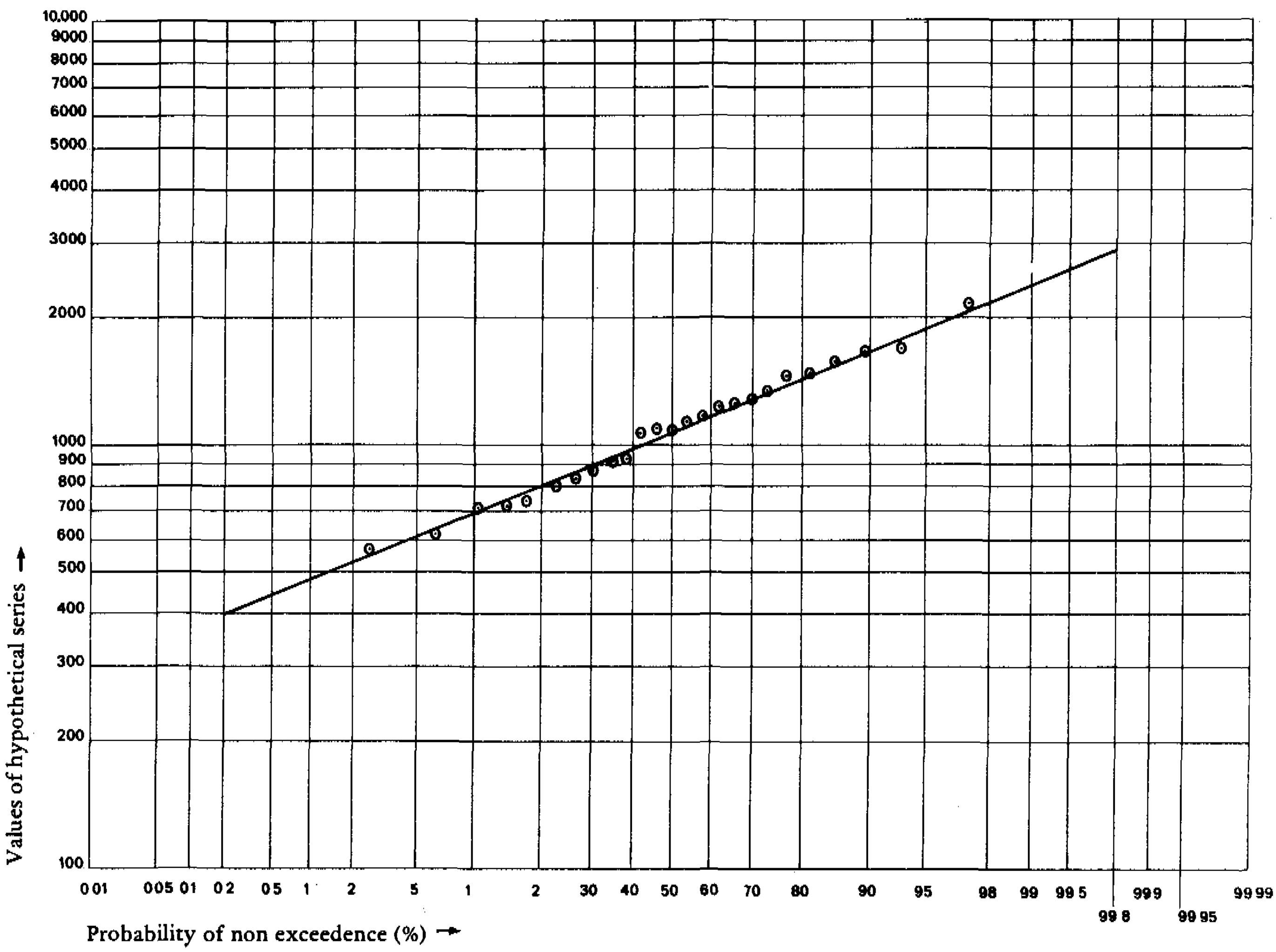


Figure C A1-2 Frequency analysis of hypothetical series

In Tanzania the Weibull plotting position is generally used.

$$\text{Plotting position} = \frac{m}{N + 1} \times 100\%$$

(Notation as before)

This plotting position is more adapted to extreme distributions which are not used in this study.

Instead of "probability of exceedence or non-exceedence", the "return period" will also be used. "Return period" is the reverse of the plotting position. An annual probability of non-exceedence of 5% corresponds with a return period of once every twenty years.

For the above analysis homogeneous data are required. Causes of heterogeneity could be:

- a change of the location of a raingauge which results in a higher or lower rainfall amount,
- a change in the course of the river, which sometimes occurs after heavy floods. The river discharge may be higher or lower after the change

Only in those cases where a change was anticipated tests for homogeneity have been carried out.

Correlation analysis:

To make a statement about the association of two different time-series x and y, the linear correlation coefficient r is used [27]. r is a dimensionless measure, and can vary between +1 and -1, while r = +1 expresses perfect sympathy between x and y. In that case x and y have a perfect linear relationship. r = -1 expresses perfect antipathy between x and y, while r = 0 means that there is no linear relationship between x and y. Whether r is significant or not depends on the number of data in the series. For a larger number of data a small absolute r value can already be a sign of association, as can also be seen in table C A1-3. In comparing r's of different time-series, it has been tried to use series with the same number of data to facilitate comparisons of r's.

Table C A1-3: Critical values r_α of the linear correlation coefficient

n \ α	10%	5%	2%	1%
5	0.81	0.88	0.93	0.96
10	0.55	0.63	0.72	0.85
15	0.44	0.51	0.59	0.73
20	0.38	0.44	0.52	0.65
25	0.34	0.44	0.46	0.59
30	0.31	0.36	0.42	0.54

n = number of paired observations
α = level of significance

Testing a hypothesis:

In this study different tests will be used to examine a hypothesis. E.g. - "Is the correlation coefficient significant or is the particular value obtained by chance". The 95% probability criterion will be used. There is a 5% probability that the value originated by chance.

The presence or absence of trends in time-series was also important for this study. E.g. "Does the rainfall or streamflow increase or decrease significantly in the course of time". Different tests were also used to answer these questions, together with the plotting of running means. Running means are a series of consecutive averages over a predetermined number of years, e.g. consecutive means of 5 or 10 years. In this way the annual peaks are very much flattened, which makes possible trends more visible on graph paper.

All the tests used are normal statistical tests of which more details can be found in the usual textbooks on statistics. No further explanation will be given in this study.

ANNEX CA2

HYDROLOGICAL MODELS

CA 2 HYDROLOGICAL MODELS

Models can be classified in two main groups:

a. deterministic and
b. stochastic models.

In the first type of model all variables are free from random variation. In the second type one or more random variables are involved, which are defined by probability distributions.
A sub-classification could be made by considering whether the used formulas are empirical (based on experience) or conceptual (following true laws of nature).
In many cases a stochastic model has a deterministic and a stochastic part, e.g. one of the most useful stochastic (empirical) models in hydrology has the following form:

$$Q_i = a + bP_i + \varepsilon_i \tag{1}$$

where:

Q_i = runoff in period i,

P_i = precipitation or a transformed value of the precipitation in period i,

a, b = constants, e.g. obtained by a least square method,

ε_i = a random variable having zero mean and constant variance (random component),

Q_i' = $a + bP_i$ is the equation of fitted curve (deterministic component).

ε_i makes the model stochastic. In this case, ε_i is the variation around the fitted line. This variation is usually assumed to be normally distributed, with mean zero and a variance S_ε^2 calculated from the deviations from the fitted curve. This variance can be calculated in the following way:

$$S_\varepsilon^2 = \frac{\Sigma(Q_i - Q_i')^2}{n - 2} \cong S_{Q_i}^2 \, (1 - r^2) \tag{2}$$

where:

Q_i = observed value,

Q_i' = calculated value from $Q_i' = a + bP_i$,

r = correlation coefficient between Q_i and P_i,

$S_{Q_i}^2$ = variance of Q_i. (= square power of the standard deviation).

(see also Annex 1 on statistical methods)

Model (1) is useful for the extension of data series and the estimation of missing data. When only a few data are missing, the deterministic part of the equation may be applied only. In case of many missing data or if extension of the data is required, the variation of the data has to be taken into account. The newly created data have a perfect correlation and their range is diminished considerably, if only Q_i' should be taken. Hence ε_i has to be included. The following method is proposed:

$$\varepsilon_i = t_i \cdot S_\varepsilon \tag{3}$$

where ε_i and S_ε are defined before and t_i is a normal random variate with zero mean and one as variance and can be taken from random tables or generated by computer or suitable pocket calculators.

The normality assumptions are sometimes only approximately true, as can be seen from the frequency distribution graphs in figures C 4.2-1 and C 4.2-4 of chapter 4. Only the latter of these graphs looks normally distributed.

Above models are valid for runoff values where no carry-over takes place, e.e. annual runoff values, and also for a limited range of rainfall.
The carry-over effect can be checked by correlating the present runoff with that of the year before.
This excercise has been carried out in table C A2-1 for November - October hydrological years of selected stations. Only the Ngerengere at Konga shows an above normal correlation.

Table C A2-1: Lag-one correlation of Nov - Oct runoff totals of selected stations.

Station	number of observations	correlation coefficient r	remarks
1G1 Wami at Dakawa	15	- 0.14	not significant
1G6 Kisangate at Mvumi	10	- 0.02	not significant
1H5 Ruvu at Kibungo	22	- 0.06	not significant
1HA9A Ngerengere at Konga	17	+ 0.37	two very high, doubtful years were excluded. Significant at the 20% level
1HA6 Ngerengere at Kihonda	8	+ 0.20	not significant
1HA1A Ngerengere at Utari Bridge	18	- 0.05	not significant

The precipitation range limit can be explained as follows:

The equation $Q_i' = a + bP_i$ can be rewritten as:

$$Q_i' = b' \ (P_i - a') \tag{4}$$

where:

$b = b'$

$a = - a'b'$

a' = the initial rain that falls before any runoff occurs.

If all losses are compensated for, and enough water is present for evapotranspiration, all remaining precipitation will become runoff. The latter case only occurs in very limited time periods in the Morogoro Region. In the first case, if not enough rain falls to meet initial losses, equation (4) gives a negative value, while in the actual case zero runoff will be measured.
Figure C A2-1 gives a graphical representation of model described above.

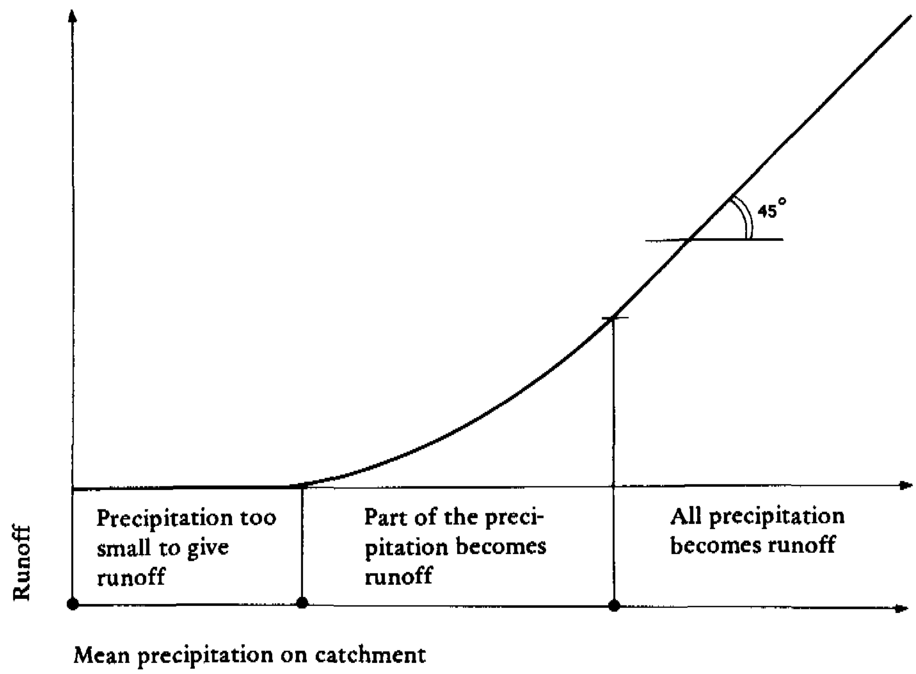


Figure C A2-1: A simple rainfall runoff model.

This relation will of course be modified by the intensity of rain, distribution of rain in time and space, etc. The carry-over effect becomes important when short periods are considered. In that case the following model becomes useful:

$$Q_i = a + bQ_{i-1} + cP_i + \varepsilon_i \qquad (5)$$

where the notation is the same as before and Q_{i-1} refers to the runoff in the period before.

This type of model will be more fully discussed in the detailed study on the Ngerengere River.

By including more and more processes that determine the actual runoff and by improving the actual relationships, all the processes shown in figure C 2.4-1 (chapter 2) combined will provide a rather complicated model, such as the Sacramento-model described in the Tanga Seminar of 1978 (Kobalyenda, 1978 [42]).
This model does not include a stochastic term anymore. These types of models can be useful to study the influence of parameters related to a specific property of a catchment, e.g. percentages of different type of vegetations. Very well-instrumented catchments are required for testing these models.

On the other hand it is possible to consider runoff as a random variable coming from an assumed distribution with parameters derived from the measured runoff series. In this case input in the model is not rainfall anymore, but a generated random variable, having the same properties as the actual measured runoff. In this way very long series can be created, which are useful for studying proposed reservoir systems for irrigation or hydropower.

Often only sub-models are required for specific purposes. A sub-model is for instance the Unit-hydrograph method, which transforms excess rainfall into a hydrograph. The unit-hydrograph can be seen as part of a larger model which first calculates excess rainfall.

Three models will be discussed in the detailed study of the Kikundi River (Annex 3):

a. the curve number method to transform daily rainfall into direct runoff (= excess rainfall),
b. the TRRL East African Flood model used for calculating floods from ungauged catchments, and
c. the Unit-hydrograph method.

The first model is frequently mentioned in the Tanga Seminar, while the TRRL East African Flood model is extensively studied at the University of Dar-es-Salaam. The model is more complicated, but more reliable than the well-known rational method, the Kenya flood formula and the Tanzania flood formula to calculate floods.

Depletion curves, which were discussed in paragraphs 3.3 (chapter 3) and 4.2 (chapter 4), can also be considered as sub-models, describing the tail end of a flood-hydrograph. They characterize the low flow properties of a drainage basin.

ANNEX CA3

DETAILED STUDY OF THE KIKUNDI RIVER

CONTENTS PAGE

CA 3 DETAILED STUDY OF THE KIKUNDI RIVER

A 3.1 General

The Kikundi River drains a small and steep mountainous catchment on the north-western slopes of the Uluguru Mountains close to Morogoro Town. From September 1978 up to March 1979 detailed rainfall-, flow- and sediment-data have been collected to obtain a basis for the analysis of:

a. the magnitude of the components which are involved in the water balance (rainfall, direct runoff, base-flow, evapotranspiration, groundwater storage),
b. the flood characteristics,
c. the sediment load characteristics.

The results may be considered as representative for similar catchments in the Uluguru Mountains.
The data were also used to investigate the applicability of the TRRL East African Flood model and the Unit-hydrograph method in combination with the Curve Number method for flood prediction of small mountainous catchments in the Uluguru Mountains.

The Kikundi River was selected for this study because of the following reasons:

a. the small catchment requires a limited number of rain-gauges in order to provide a sufficiently accurate determination of the areal distribution of precipitation,
b. the Kikundi River is equipped with a compound crump weir combined with an automatic Ott-water level recorder, providing continuous flow data,
c. the Agricultural engineering Department of the University of Dar-es-Salaam, Morogoro Campus, was interested in the study and provided valuable support during the execution of the study.

Acknowledgement is made to Dr. Tiwari and Mr. Kimboka (University of Dar-es-Salaam) for their general support of the study and Mr. Materu (University of Dar-es-Salaam) for his analysis of sediment samples.

A 3.2. Catchment characteristics

The catchment of the Kikundi River is situated south of Morogoro (figure C A3-1). It covers a steep part of the lower slopes of the north-west Uluguru Mountains. The catchment is long-shaped with one pronounced main stream and four minor tributaries. The most important data are given in Table C A3-1.

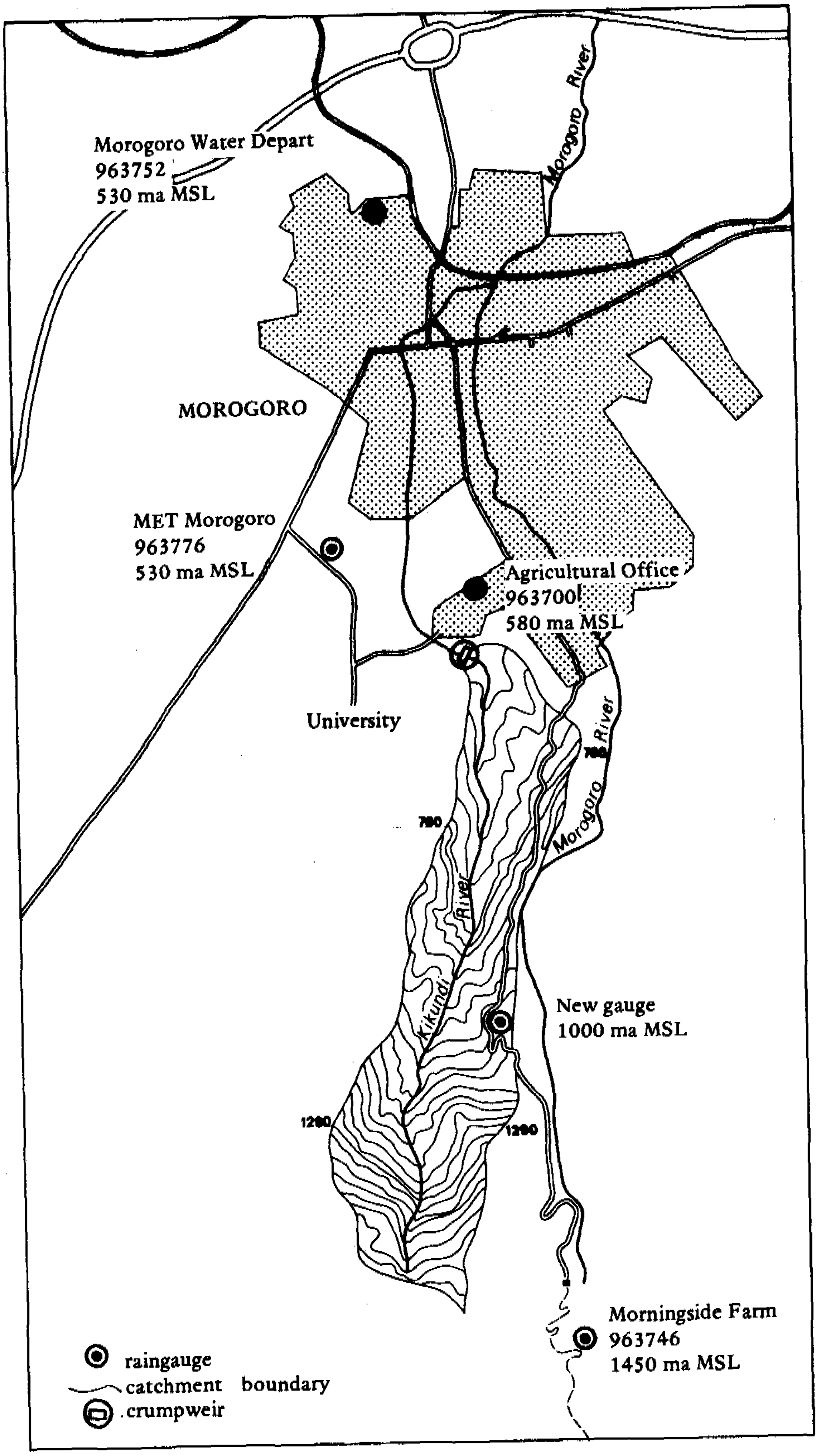


Figure C A3-1 Kikundi River

Table C A3-1: Catchment characteristics Kikundi River

catchment area	4.4 km^2
highest point	1710 m a MSL
level at weir	535 m a MSL
length of main stream	5 km
slope of main stream	7 - 40 %
average slope	24 %
average land slope	46 %

The slopes are covered with relatively thin, sandy loams with a reddish colour. The dark top-soil layer, which is found in forested parts and which most probably also covered the Kikundi catchment in the past, is missing. The lower part of the catchment is covered with so-called Miombo woodland, which is a result of often burning the area (about 60% of the catchment area). The higher slopes are cultivated with vegetables and maize. A few scattered trees offer some protection for the thin soil layers against landslides in this part of the catchment.

A 3.3. Measuring methods

Precipitation

Originally three precipitation stations were located close to the catchment:

a. MET Morogoro (963776, 530 m a MSL),
b. Agricultural Office (963700, 580 m a MSL), and
c. Morningside Farm (963746, 1450 m a MSL).

The MET station is operated by the Meteorological Department, the Agricultural Office by KILIMO and the station at Morningside Farm by the Water Department. From the MET and Morningside Farm stations continuous 1-day precipitation records are available, from which start, end and intensity of individual storms can be derived. The data collected at the Agricultural Office are on a daily basis only. Therefore and because of its location close to the MET station these data are not used.

To obtain a more accurate determination of the average precipitation over the catchment a third automatic rain-gauge was installed by the Consultant on the 18th of October 1978.
This gauge is located close to the boundary of the Kikundi and Morogoro River at an altitude of 1000 m a MSL. This gauge provides continuous 7-day records. The time scale is too rough to determine the intensity distribution, but sufficient to identify the start and end of the storm.
The gauge is used in combination with a standard manual control gauge.
On the 1st of April 1979 maintenance and operation were taken over by the Water Department under gauge name "Morningside" (963746A).

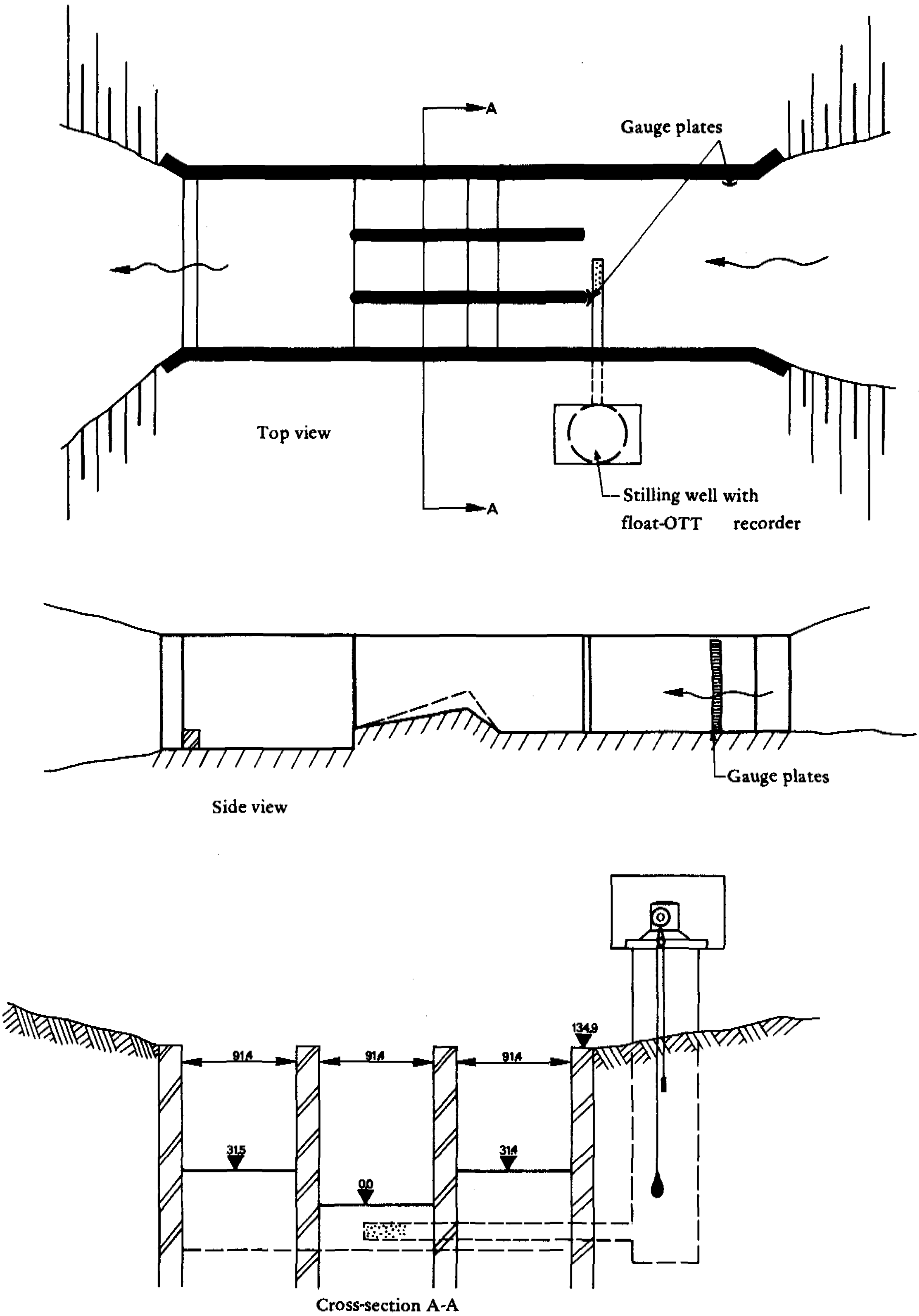


Figure C A3-2 Compound crump weir, Kikundi River

Discharge

The discharge is measured with a compound crump weir installed by the University in 1973.
The water level is recorded continuously by a floating type Ott-recorder (see figure C A3-2). A rating curve is obtained from the University. The curves have been approximated by the following equations:

$$Q = 3.53\ H^{1.59} \quad m^3/s \qquad H < 0.23\ m \tag{1}$$

$$Q = 7.18\ H^{2.07} \quad m^3/s \qquad 0.23 < H < 1.35\ m \tag{2}$$

(H refers to crest of middle weir. At $H = 1.35$ m, $Q = 13.4$ m^3/s)

Unfortunately the intake section of the weir acts as a sediment trap, causing high siltation rates. Due to the high sediment load of the Kikundi River one fully employed person was necessary to prevent clogging of the weir after several floods.
From the point of view of maintenance and operation the compound crump weir may be considered to be less suitable for rivers with high sediment loads. In this respect a flat-V-type weir may provide a better solution.

The accuracy of the compound crump weir in the Kikundi River is small for low-flows (< 0.15 m^3/s). For this range the Consultant installed a temporary 90°-V-notch below the existing weir.
The notch was used during the low-flow period at the end of the dry season from the 26th of October up to the 18th of November 1978. Weekly reading of the upstream water level was sufficient to record the slowly decreasing flow. After the first big flood on the 19th of November 1978 the notch was washed away.
The flow was calculated from the upstream water level with equation:

$$Q = 140\ H^{2.5} \quad m^3/s \qquad H < 0.45\ m \tag{3}$$

(H lowest point of notch = 0 m)

Sediment

Suspended sediment load samples were taken with two types of point-integrating hand-operated samplers. The Nilsson-type was borrowed from the Agricultural engineering Department of the University of Dar-es-Salaam, Morogoro campus. The USDH 48-type was obtained from the Water Department in Morogoro.
Four measurements at different sediment loads were carried out for comparison. It turned out that the Nilsson-sampler gives higher suspended sediment concentrations.
As the USDH 48-sampler is well standardized and widely used, the data obtained with the Nilsson-sampler have been corrected.

$$S_{(USDH\ 48)} = 0.75\ S_{(Nilsson)} \tag{4}$$

The bed load is considered to be a relatively small proportion (< 20%) of the total sediment load and is therefore not measured.

The suspended sediment load samples were analysed at the laboratory of the University. The samples were filtered through Whatman filter paper, numbers 42 and 41. The amount of suspended sediment that passed through the paper was found to be negligible. After drying the filter paper (air dry, 24 h at 100 °C in Mammert oven) the concentration of the suspended sediment was found to be the difference in filter paper weight after and before filtration related to the sample volume.

Meteorological data

The meteorological data necessary for the determination of the reference crop evapotranspiration are obtained from the MET station in Morogoro. According to sub-paragraph 3.2.2 (chapter 3) the modified Penman-method is used.

A 3.4. Data collection

Discharge data are collected from 23/9/78 up to 31/3/79. From 17/11/78 continuous records are available from the crump weir.
In Table C A3-2 the flow data are presented on a daily basis. The recorder sheets are not included in the report.
Rainfall data from MET Morogoro (963776), Morningside Farm (963746) and the new rain-gauge are given in Table C A3-3 on a daily basis for the months of October 1978 up to March 1979. The data are collected at 9.00 a.m. Therefore the recorded rainfall concerns mostly the previous day. As usually, monthly totals are determined on the basis of the sum of rainfall from the second day of the month up to the first day of the following month. The average rainfall over the catchment is taken as a weighted mean of the three rainfall records, based on the assumption that the stations are representative for those parts of the catchment, which are bounded by the contours halfway the stations (see figure C A3-1).

$$P = 0.29\ P_1 + 0.51\ P_2 + 0.20\ P_3 \tag{5}$$

where:

P = the average rainfall over the catchment,
P_i = rainfall recorded in station i, where 1, 2 and 3 refer resp. to the lower, the middle and the higher station.

Meteorological data concerning evaporation are presented on a monthly basis in Table C A3-4. According to the modified Penman-method (Doornbos, 1975) [19] the reference crop evapotranspiration is determined. Sediment data derived from samples taken mostly upstream of the crump weir in the Kikundi River are given in Table C A3-5.

Table C A3-2: Kikundi River, flow data derived from current meter measurement, V-notch and crump weir. (× 10^3 m^3)
1 = Base flow 2 = Direct Runoff 3 = Total Runoff

Month	September 1978			October 1978			November 1978			December 1978			January 1979			February 1979			March 1979		
Day	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
1				0.53	0	0.53	0.20	0	0.20	15.53	1.23	16.76	9.76	0	9.76	3.58	0	3.58	8.47	0	8.47
2				0.49	0	0.49	0.05	0	0.05	14.75	0	14.75	9.07	0	9.07	3.12	1.56	4.68	7.86	0	7.86
3				0.47	0	0.47	0.05	0	0.05	14.55	0	14.55	8.47	0	8.47	4.45	0	4.45	6.65	0	6.65
4				0.44	0	0.44	0.13	0	0.13	13.77	0	13.77	9.07	0	9.07	10.51	4.48	14.99	5.53	0	5.53
5				0.41	0	0.41	0.13	0	0.13	14.26	19.96	34.22	8.47	0	8.47	7.26	0	7.26	5.53	0	5.53
6				0.38	0	0.38	0.16	0	0.16	18.26	3.18	21.44	7.86	0	7.86	5.69	3.13	8.82	4.92	0	4.92
7				0.35	0	0.35	0.26	0	0.26	12.53	0	12.53	7.26	0	7.26	6.51	0	6.51	4.92	0	4.92
8				(0.35)	0	(0.35)	0.21	0	0.21	13.42	0	13.42	7.26	0	7.26	5.53	0	5.53	4.92	0	4.92
9				(0.35)	0	(0.35)	0.16	0	0.16	11.54	0	11.54	6.65	0	6.65	3.97	0	3.97	4.92	0	4.92
10				(0.35)	0	(0.35)	0.10	0	0.10	9.76	0	9.76	6.65	0	6.65	6.05	0	6.05	3.46	0	3.46
11				(0.35)	0	(0.35)	0.07	0	0.07	8.47	0	8.47	6.65	0	6.65	5.69	2.79	8.48	3.02	0	3.02
12				(0.23)	0	(0.23)	0.07	0	0.07	9.54	0	9.54	6.05	0	6.05	7.41	0	7.41	4.65	3.11	7.76
13				(0.23)	0	(0.23)	0.07	0	0.07	8.17	0	8.17	7.26	0	7.26	7.26	0	7.26	8.06	6.21	14.27
14				(0.23)	0	(0.23)	0.07	0	0.07	12.57	11.28	23.85	9.23	0.44	9.67	5.94	0	5.94	12.43	4.14	16.57
15				(0.23)	0	(0.23)	0.07	0	0.07	12.27	3.01	15.28	10.08	2.51	12.59	7.76	0	7.76	14.04	0	14.04
16				0.23	0	0.23	0.07	0	0.07	13.94	0	13.94	8.94	0	8.94	5.27	0	5.27	12.19	1.02	13.21
17				(0.23)	0	(0.23)	0.30	1.00	1.30	18.10	13.81	31.91	7.86	0	7.86	25.60	19.42	45.02	11.51	0	11.51
18				(0.23)	0	(0.23)	0.85	0.60	1.45	8.49	0	8.49	6.65	0	6.65	21.84	0	21.84	9.07	0	9.07
19				(0.23)	0	(0.23)	(0.65)	(41.52)	(42.17)	21.54	7.85	29.39	6.05	0	6.05	18.23	0	18.23	7.86	0	7.86
20				(0.23)	0	(0.23)	(8.64)	(102.59)	(111.23)	22.73	0	22.73	6.05	0	6.05	14.95	0	14.95	7.86	0	7.86
21				(0.23)	0	(0.23)	(19.44)	(18.28)	(37.72)	27.60	11.84	39.44	5.53	0	5.53	16.50	0	16.50	7.86	0	7.86
22				(0.13)	0	(0.13)	(44.60)	(4.74)	(49.34)	25.73	0	25.73	5.53	0	5.53	14.02	0.55	14.57	7.26	0	7.26
23	0.6	0	0.6	(0.13)	0	(0.13)	26.18	0	26.18	22.64	0	22.64	4.92	0	4.92	18.08	2.73	20.81	7.26	0	7.26
24				(0.13)	0	(0.13)	17.50	0	17.50	19.96	0	19.96	4.92	0	4.92	13.39	0	13.39	7.23	0	7.23
25				(0.13)	0	(0.13)	14.30	1.07	15.37	17.68	1.10	18.78	3.97	0	3.97	11.92	0	11.92	6.63	0	6.63
26				0.13	0	0.13	31.72	0.53	32.25	19.81	0	19.81	4.41	0	4.41	10.45	0	10.45	7.23	0	7.23
27				(0.13)	0	(0.13)	14.20	0	14.20	16.51	0	16.51	3.13	0	3.13	9.76	0	9.76	7.23	0	7.23
28				(0.13)	0	(0.13)	12.41	1.71	14.12	15.60	0.71	16.31	4.84	0	4.84	9.07	0	9.07	6.05	0	6.05
29				(0.16)	0	(0.16)	14.77	0	14.77	10.04	0	10.04	5.06	1.83	6.89	-	-	-	5.50	0	5.50
30	0.5	0	0.5	0.16	0	0.16	8.10	4.76	12.86	11.92	0	11.92	3.24	0	3.24	-	-	-	5.50	0	5.50
31	-	-	-	0.16	0	0.16	-	-	-	10.45	0	10.45	3.97	0	3.97	-	-	-	4.96	0	4.96
Total				8.16	0	8.16	215.53	176.80	392.33	472.13	73.97	546.10	204.86	4.78	209.64	279.81	34.66	314.47	220.58	14.48	235.06

Table C A3-3: Daily precipitation data in mm, October 1978 - March 1979, collected at 9.00 a.m.
1 = MET Morogoro (963776)
2 = new gauge
3 = Morningside Farm (963746)
4 = average rainfall = $0.29\ P_1 + 0.51\ P_2 + 0.2\ P_3$ or = $0.38\ P_1 + 0.62\ P_3$

Month	October				November				December				January				February				March			
Day	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
1	0	-	0	0.0	0	0	0	0.0	16.0	22.5	39.8	24.1	0	0.0	0.0	0.0	0.7	1.5	2.1	1.4	0	0.0	2.0	0.4
2	1.4	-	4.3	3.2	0	0	0	0.0	4.9	6.0	10.0	6.5	0	0.0	0.0	0.0	20.6	20.5	25.0	21.4	0	0.0	0.0	0.0
3	TR*	-	2.4	1.5	0	0	0	0.0	0.3	2.0	5.5	2.2	0.6	0.2	0.3	0.3	1.7	1.5	1.2	1.5	0	0.0	0.0	0.0
4	0	-	8.1	5.0	0	0	0	0.0	2.3	9.0	21.2	9.5	0	0.2	4.0	0.9	20.3	28.0	31.5	26.5	0	0.0	0.0	0.0
5	TR*	-	4.3	2.7	0	0	0	0.0	1.2	6.0	16.0	6.6	0	0.0	0.0	0.0	0	0.0	0.5	0.1	0	0.0	1.0	0.2
6	0	-	0	0.0	0	0.5	18.7	0.3	13.8	13.0	33.3	17.3	0	0.0	0.0	0.0	0.2	0.5	1.8	0.7	0	0.0	8.0	1.6
7	0	-	0	0.0	0	0	1.0	3.7	17.8	8.0	2.5	9.7	TR*	1.0	2.7	1.1	28.7	19.0	7.4	19.5	0	0.0	1.0	0.2
8	0	-	0	0.0	0	0	0.1	0.2	0	4.0	26.5	7.3	7.0	6.0	13.5	7.8	TR*	0.0	0.5	0.1	0	0.0	0.0	0.0
9	0	-	0	0.0	0	0	1.2	0.0	0	3.5	13.5	4.5	0.1	0.0	0.3	0.1	0.0	0.0	0.0	0.0	TR*	0.5	1.0	0.5
10	0	-	0	0.0	0	0	1.0	0.2	4.9	5.5	30.4	10.3	0	0.0	0.0	0.0	11.5	2.0	0.0	4.4	21.0	0.0	1.0	6.3
11	0	-	0	0.0	0	0	0	0.0	0	0.0	0.0	0.0	0	0.5	5.0	1.3	7.7	3.5	1.0	4.2	0	0.0	45.8	9.2
12	0	-	0	0.0	0	0	0	0.0	1.8	1.5	7.7	2.8	1.7	8.0	6.5	5.9	4.2	23.0	39.8	20.9	0	0.0	0.0	0.0
13	0	-	0	0.0	0	0	0	0.0	6.0	1.0	18.2	5.9	9.0	19.0	19.5	16.2	0.8	2.5	5.5	2.6	44.9	38.0	31.0	38.6
14	0	-	0	0.0	1.6	6.0	6.9	4.9	72.1	35.5	90.0	57.0	2.4	8.5	25.0	10.0	0	0.0	0.0	0.0	4.2	31.0	41.3	25.3
15	0	-	0	0.0	0	TR*	0.5	0.1	0.8	3.0	2.0	2.2	10.2	14.5	21.5	14.7	13.9	9.5	16.0	12.1	29.0	18.0	12.3	20.1
16	0	-	1.8	1.1	0	0	0	0.0	17.6	17.5	26.0	19.2	15.0	14.5	20.1	15.8	0	0.0	0.0	0.0	19.8	5.0	15.0	11.3
17	0	-	0	0.0	1.0	0	31.5	6.6	38.2	23.5	28.0	28.7	1.1	0.5	5.1	1.6	95.0	60.0	50.0	68.2	4.4	14.0	11.8	10.8
18	0	-	0	0.0	24.7	35.0	34.5	31.9	6.0	5.5	6.2	5.8	6.8	4.5	11.0	6.5	1.8	0.5	1.0	0.7	TR*	2.0	9.0	2.8
19	0	0	0	0.0	5.4	1.0	23.8	6.8	18.2	27.5	34.0	26.1	0	0.0	0.0	0.0	8.2	9.0	10.8	9.3	0	0.0	1.5	0.1
20	0	0	0	0.0	60.3	(190)	275.0	169.4	10.7	10.0	14.0	11.0	0	0.0	0.0	0.0	0	0.0	0.0	0.0	4.7	12.0	10.8	6.6
21	0	0	0	0.0	29.4	(43)	63.0	43.1	24.2	21.5	27.7	23.5	0	0.0	1.3	0.3	0.6	0.5	0.3	0.5	1.6		10.3	5.6
22	0	0	0	0.0	5.1	(49)	71.0	40.7	0	0.5	0.5	0.4	3.2	0.0	0.8	1.1	0.8	9.0	29.5	10.7	8.1	1.0	1.5	3.2
23	0	0	0	0.0	6.5	(22)	32.2	19.5	0	0.0	0.0	0.0	0	0.0	0.0	0.0	16.9	15.0	28.0	18.2	0	2.0	6.6	2.3
24	0	0	0	0.0	4.0	(6)	8.4	5.9	0	0.0	0.0	0.0	0	0.5	4.5	1.2	2.1	3.0	5.1	3.2	0.1	1.0	4.8	1.5
25	0	0	0	0.0	0.3	(1)	1.2	0.8	0.5	0.5	1.0	0.6	0	0.0	0.4	0.1	0	0.0	0.0	0.0	8.4	1.5	4.0	4.0
26	0	0	0	0.0	1.9	7.0	16.0	7.3	2.3	7.5	15.5	7.6	11.8	4.0	3.0	6.1	22.9	4.0	0.0	8.7	30.3	9.5	6.0	14.8
27	0.2	0	2.5	0.6	10.8	18.5	22.2	17.0	TR*	0.0	0.0	0.0	12.5	0.5	0.0	3.9	0	0.0	0.0	0.0	0	0.0	0.0	0.0
28	0	0	0	0.0	0.3	3.5	9.0	3.7	0	0.0	0.0	0.0	18.0	10.0	8.0	10.9	0	0.0	0.0	0.0	0	1.2	8.0	2.2
29	0	1.0	3.0	1.1	6.3	9.5	31.2	12.9	12.1	17.0	0.5	12.3	1.7	22.0	1.2	12.0	-	-	-	-	0	0	0.0	0.0
30	3.4	1.0	4.5	2.4	0	0	2.2	0.4	0	0.0	0.0	0.0	TR*	0.5	25.0	0.5	-	-	-	-	0.6	1.4	1.5	1.2
31	0	0	0.8	0.2	-	-	-	-	0	0.0	0.0	0.0	0.7	0.0	0.0	0.2	-	-	-	-	0.1	0.0	0.5	0.1
Total	5.0	-	31.7	17.8	173.6	414.5	664.9	399.5	255.7	229.0	430.2	277.0	101.8	116.4	180.8	119.9	257.9	211.0	257.3	233.9	177.1	137.1	235.7	168.5

* TR = TRACE

Table C A3-4: Monthly meteorological data; September 1978 - March 1979, Station MET Morogoro 963776

		September	October	November	December	January	February	March
Mean maximum temperature	°C	31.0	32.5	31.7	27.1	30.6	30.9	30.6
Mean minimum temperature	°C	16.5	18.4	20.1	20.7	20.6	20.8	20.8
Dew point temperature	°C	12.7	15.1	18.2	21.2	20.6	20.3	21.9
Relative humidity	%	36	37	52	66	61	58	67
Sunshine	h	8.3	8.7	7.2	5.3	-	-	6.1
Radiation	$cal/cm^2/day$	468	504	446	428	498	439	421
Wind run	km/day	225.5	210.7	190.3	187.4	169.4	123.7	104.0
A-pan evaporation	mm	198.6	232.5	199.3	140.1	-	-	-
Reference crop evapotranspiration according to modified Penman method	mm	228	251	201	164	242	194	194

Table C A3-5: Suspended sediment data collected above the crump weir in the Kikundi River

Sample Number	Date	Hour	Discharge l/s	Sediment (measured) g/l	Concentration (corrected) g/l	Sediment load kg/s	Type of sampler	Remarks
A1	22/11/78	9.00	534	1.09	0.82	0.437	Nilsson	Falling limb
A2	22/11/78	21.20	515	0.05	0.04	0.019	Nilsson	Base flow
A3	23/11/78	8.15	329	0.52	0.39	0.128	Nilsson	Falling limb
A4	23/11/78	18.45	241	0.20	0.15	0.036	Nilsson	Base flow
A5	24/11/78	12.30	201	0.03	0.03	0.006	USDH 48	Base flow
A6	25/11/78	9.30	164	1.16	1.16	0.190	USDH 48	Falling limb
B1	28/11/78	19.20	191	2.31	1.73	0.331	Nilsson	Rising limb
B2	28/11/78	19.45	230	0.58	0.44	0.100	Nilsson	Rising limb
B3	28/11/78	20.05	252	0.97	0.73	0.183	Nilsson	Rising limb
B4	28/11/78	20.35	273	(9.77)	(7.33)	-	Nilsson	Rising limb
B5	28/11/78	20.50	295	1.03	0.77	0.228	Nilsson	Peak flow
C1	15/12/78	10.00	129	2.66	2.00	0.257	Nilsson	Rising limb
C2	15/12/78	17.15	318	7.21	5.41	1.720	Nilsson	Rising limb
C3	15/12/78	17.45	917	9.55	7.16	6.568	Nilsson	Peak flow
C4	15/12/78	18.15	636	5.64	4.23	2.690	Nilsson	Falling limb
C5	16/12/78	9.00	164	0.68	0.51	0.084	Nilsson	Base flow
C6	22/12/78	10.00	284	0.37	0.28	0.079	Nilsson	Base flow
D1	15/01/79	17.05	98	0.77	0.77	0.075	USDH 48	Base flow
D2	15/01/79	17.45	121	0.99	0.99	0.120	USDH 48	Base flow
E1	24/02/79	10.15	146	0.48	0.48	0.070	USDH 48	Base flow
E2	24/02/79	10.15	146	0.17	0.13	0.019	Nilsson	Base flow
F1	9/02/79	17.15	64	0.18	0.14	0.009	Nilsson	Base flow
F2	10/02/79	9.15	64	0.21	0.16	0.010	Nilsson	Base flow
F3	11/02/79	17.00	554	(15.29)	(11.47)	-	Nilsson	Falling limb
F4	17/02/79	8.30	969	1.81	1.81	1.754	USDH 48	Falling limb
F5	17/02/79	9.30	769	1.05	1.05	0.807	USDH 48	Falling limb
F6	18/02/79	9.30	173	0.05	0.04	0.006	Nilsson	Base flow
G1	10/03/79	8.15	57	0.39	0.29	0.017	Nilsson	Base flow
G2	12/03/79	14.30	105	1.79	1.34	0.141	Nilsson	Peak flow
G3	12/03/79	16.30	57	0.39	0.29	0.017	Nilsson	Base flow
H1	13/03/79	16.45	817	5.74	4.31	3.517	Nilsson	Rising limb
H2	13/03/79	17.10	969	5.61	5.61	5.436	USDH 48	Peak flow
H3	13/03/79	17.30	817	2.99	2.99	2.443	USDH 48	Falling limb
H4	13/03/79	17.45	636	3.30	2.48	1.574	Nilsson	Falling limb
H5	13/03/79	17.45	636	2.39	2.39	1.520	USDH 48	Falling limb
H6	13/03/79	18.15	554	1.79	1.34	0.744	Nilsson	Falling limb
H7	13/03/79	18.15	554	1.38	1.38	0.765	USDH 48	Falling limb
H8	13/03/79	18.45	477	(2.17)	1.63	-	Nilsson	Falling limb
H9	13/03/79	18.45	477	1.15	1.15	0.549	USDH 48	Falling limb
H10	14/03/79	8.30	77	0.08	0.06	0.005	Nilsson	Base flow
I1	14/03/79	17.10	679	8.51	8.51	5.778	USDH 48	Rising limb
I2	14/03/79	17.25	817	6.09	6.09	4.976	USDH 48	Peak flow
I3	14/03/79	17.40	636	5.35	5.35	3.403	USDH 48	Falling limb
I4	14/03/79	17.55	636	6.02	6.02	3.829	USDH 48	Falling limb
I5	14/03/79	18.10	554	2.87	2.87	1.590	USDH 48	Falling limb
I6	14/03/79	18.25	477	2.83	2.83	1.350	USDH 48	Falling limb
I7	14/03/79	18.40	442	2.25	2.25	0.995	USDH 48	Falling limb

A 3.5. Rainfall

When annual rainfalls recorded at MET, 530 m a MSL, and Morningside, 1450 m a MSL, are compared, the positive effect of altitude on rainfall amount is obvious (see Table C A3-6).

Table C A3-6: Annual rainfall MET Morogoro and Morningside (Nov-Oct year)

year	MET Morogoro (963776)	Morningside Farm (963746)
1970/71	711.3	2072.2
1971/72	905.7	2474.1
1972/73	961.7	2699.1
1973/74	750.2	1822.8
1974/75	677.7	1893.1
1975/76	655.0	1786.9
1976/77	819.0	2127.8
1977/78	933.9	2267.4

The same tendency can be observed regarding the monthly precipitation. On a daily basis however a large variation appears. According to the data from October 1978 up to March 1979 maximum daily totals occur also at low altitude. Sometimes one of the stations records high rainfall amounts while the adjacent station does not receive any rainfall at all. Storms sometimes are very local. For a sufficiently accurate estimation of the average rainfall over the catchment during a storm, a dense rain-gauge network is required in such an area. Therefore the additional rain-gauge at 1000 m a MSL was installed.

The effect on the linear correlation coefficient (r) is illustrated by the correlation matrix in Table C A3-7. The correlations are based on the data of all days during the months October 1978 up to March 1979 on which rainfall is recorded in at least one of the two stations concerned.

The low correlation coefficient of 0.54 for the MET and Morningside stations indicates that the original gauge network was insufficient to determine the average rainfall over the catchment on a daily basis. The newly installed gauge is better correlated with MET station (r = 0.64) and highly correlated with Morningside station (r = 0.93).

The accuracy of the determination of average daily rainfall over the catchment may be expected to be within a ± 10% range of the true value.

Table C A3-7: Correlation matrix daily rainfall

	MET Morogoro (963776)		New gauge (963746A)		Morningside Farm (963746)	
	r *	n **	r *	n **	r *	n **
MET Morogoro	1	-	0.65	99	0.54	121
New gauge			1	-	0.93	115
Morningside Farm					1	-

* r = correlation coefficient
** n = number of observations

The rainfall amounts recorded during the observation period differ strongly from the average conditions, as is illustrated by the distributions of monthly rainfall of Morningside Farm and MET Morogoro (see figure C A3-3). In particular in November and December 1978 both stations recorded exceptionally high rainfall amounts.

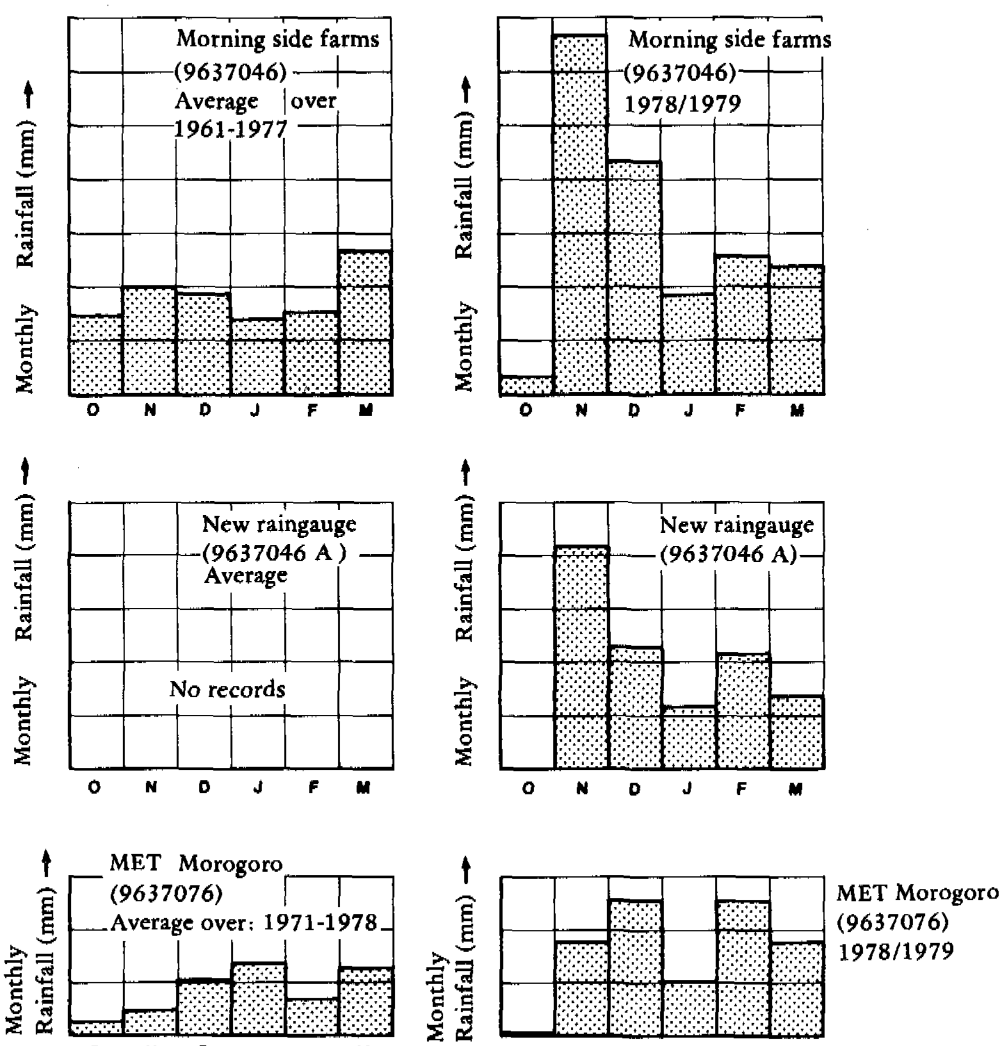


Figure C A3-3 Average and October 1978 up to March 1979 monthly rainfall distributions

A 3.6. Water balance

From the available data a simplified water balance for the October 1978 - March 1979 period is established. The components which are taken into account are given by the following equation:

$$P = R + ka \cdot kc \cdot ETo + \Delta G \tag{6}$$

where:

P	= average precipitation over the catchment in mm,
R	= runoff in mm, measured at the weir (underground outflow can be neglected),
ETo	= reference crop evapotranspiration in mm,
kc	= crop or vegetation factor,
kc·ETo	= potential evapotranspiration in mm,
ka	= ratio between actual evapotranspiration and potential evapotranspiration,
ka·kc·ETo	= actual evapotranspiration in mm,
Δ G	= change in groundwater and soil moisture storage in mm.

The water balance is established on a monthly basis. P and R are derived directly from precipitation and flow data. ETo is determined by the modified Penman-method based on meteorological data from the MET Morogoro station, as shown in Table C A3-4. As the catchment has a higher altitude and is less exposed to wind, the ETo obtained from the MET Morogoro station is probably a little bit too high.
According to the guide lines for crop water requirements issued by the FAO [19], kc varies strongly with growth stage, rate of crop development and other crop characteristics. For the vegetation in the Kikundi catchment the range of kc is given in Table C A3-8. The low values occur in the beginning of the wet season (October, November), when grass and crops start growing; kc increases during the following months (December, January) and is assumed to reach its maximum during the long rainy period.

Table C A3-8: Vegetation factor for Kikundi catchment

Vegetation	% area	kc
grass	60	0.50 - 1.00
maize	40	0.30 - 0.45
vegetables		0.15 - 0.30
weighted mean	100	0.39 - 0.75

The coefficient ka is more difficult to determine accurately. In fact ka takes the effect of watershortage on evapotranspiration into account, which not only depends on precipitation, but also on the infiltration and storage capacity of the soil and root systems. On these factors no data have been collected. It is however obvious that water shortage has occurred during the dry season up to the middle of November 1978, when heavy rains started.

For the end of the dry season a ka of 0.2 is taken into account. For the following months ka = 1.0 has been used, based on the assumption, that the November and December rains provided sufficient groundwater recharge to cover the crop water demand during the relatively dry months of January and February.

Δ G has not been measured, but is obtained from the balance equation (6) and therefore also incorporates measuring and determination errors. The results are summarized in Table C A3-9.

Table C A3-9: Water balance Kikundi River.

month	P mm	R mm	ka -	kc -	ETo mm	ka·kc·ETo mm	Δ G (+error) mm	Σ Δ G (+error) mm
October	17.8	1.9	0.5	0.39	251	49	- 33	- 33
November	399.5	89.2	0.75	0.57	201	86	224	191
December	277.0	124.1	1.0	0.75	164	123	30	221
January	119.9	47.7	1.0	0.75	242	182	- 110	111
February	233.9	71.5	1.0	0.75	194	146	16	127
March	168.5	53.4	1.0	0.75	194	146	- 81	96

During October, before heavy rains were present, the losses (runoff and evapotranspiration) were higher than the rainfall, which results in a further decrease of the groundwater table.
During the wet months November, December, February and March, rainfall exceeds runoff plus evapotranspiration, and soil moisture storage and groundwater is recharged. January received a relatively small amount of rainfall, while evapotranspiration was high causing a large decrease of the soil moisture and groundwater storage.

A 3.7. Runoff

The runoff measured at the crump weir incorporates base-flow and direct runoff, where the latter is determined by surface runoff and interflow. The daily runoff from the catchment during the study period (see figure C A3-4) is strongly related to the rainfall (see Table C A3-3 and figure C A3-3). Up to medio November hardly any rainfall was recorded, resulting in very low flows of 0.8 l/s only. On the 20th of November 1978 an exceptionally high amount of rainfall (average over the catchment = 170 mm) was recorded, resulting in a high mean daily discharge of about 1.3 m^3/s and most probably a peak flow of above 2.5 m^3/s.

A typical, single peaked hydrograph is shown in figure C A3-5 to illustrate the procedure to separate base-flow and direct runoff. Up to the point A there is only base-flow. Between A and B direct runoff also occurs due to rainfall. From B onwards again only base-flow is present, but at a higher level because groundwater is recharged. According to sub-paragraph 3.3.6. base-flow decreases exponentially. Plotted on semi-logarithmical paper this part of the hydrograph is represented by a straight line. The moment at which direct runoff stops can therefore be determined as the point at which the curved part of the hydrograph changes into a straight line.

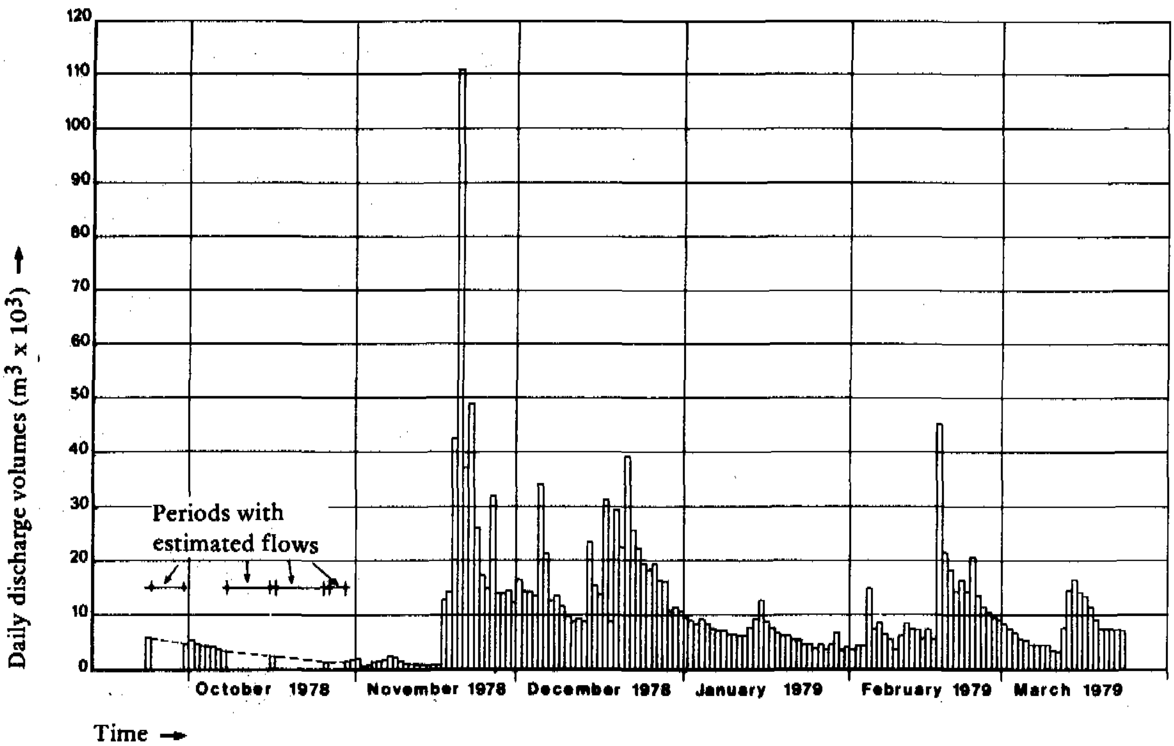


Figure C A3-4: Distribution of daily discharge volumes.

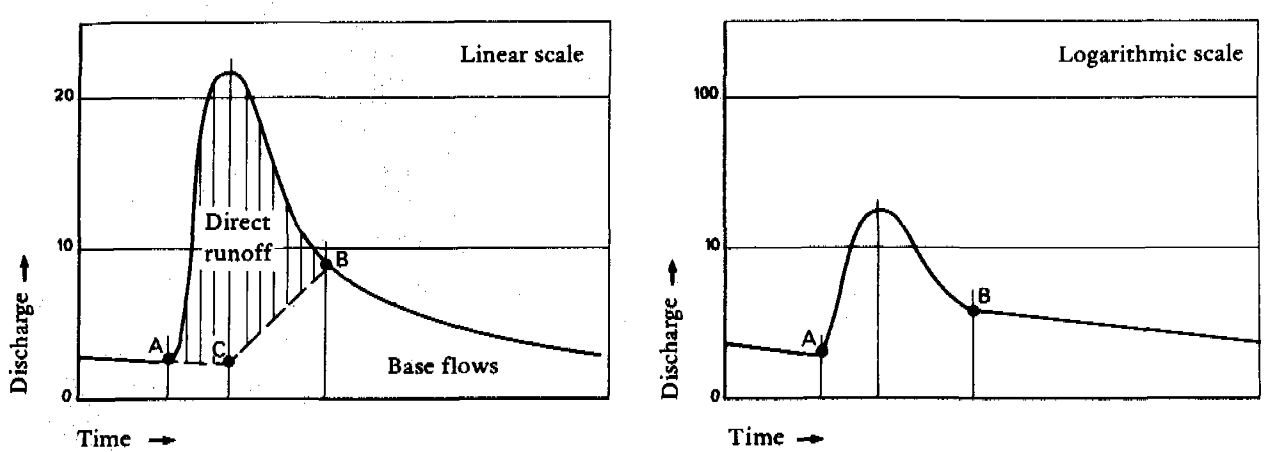


Figure C A3-5: Separation of base-flow and direct runoff, definition sketch.

Between A and B the course of the base-flow has to be estimated. Because sub-surface flow is slower than direct runoff, the increase of base-flow lags behind the increase of direct runoff. More or less arbitrarily the moment of base-flow increase is taken at peak time. Between A, B and C a linear change of base-flow is assumed.
The shaded area above ACB represents the direct runoff volume. The area below ACB is the volume of base-flow during the flood.
The monthly base-flow and direct runoff amounts are given in Table C A3-10.

Even during the wet month of November base-flow exceeds direct runoff:

Table C A3-10: Base-flow and direct runoff Kikundi River, October 1978 up to March 1979

month	base flow		direct runoff		runoff
	$m^3 \times 10^3$	%	$m^3 \times 10^3$	%	$m^3 \times 10^3$
October	8.16	100	0	0	8.16
November	215.53	55	176.80	45	392.33
December	472.13	86	73.97	14	546.10
January	204.86	98	4.78	2	209.64
February	279.81	89	34.66	11	314.47
March	220.58	94	14.48	6	235.06
Total	1,401.07	82	304.69	18	1,705.76

Base-flow

During the observation period two periods without any rain of importance are available to estimate the depletion coefficient α and the time to halve the discharge $T_{0.5}$ as defined in sub-paragraph 3.3.6 of chapter 3.

Table C A3-11: α and $T_{0.5}$ of the Kikundi River

period	range of flow (l/s)	α (1/day)	$T_{0.5}$ (days)
23/9/78 - 30/10/78	< 20	0.052	13
26/2/79 - 6/03/79	> 20	0.094	7

The calculated α- and $T_{0.5}$-values indicate that the catchment contains aquifers with relatively high permeability, which are depleted at high rate. When these aquifers are empty, base-flow is determined by the depletion of less permeable aquifers.

Direct runoff

Although direct runoff is usually only a relatively small portion of total runoff, several methods are developed to determine direct runoff from rainfall data and catchment characteristics. This is because the direct runoff volume is a basic magnitude for flood prediction (see next sub-paragraph).
The most widely used method is the Curve Number Method [27], which has been elaborated by the US Soil Conservation Service. The method is based on the concept of a limited recharge capacity of the soil, which is determined by antecedent moisture conditions and by physical characteristics of the drainage basin. The method may be classified as a preconceived multiple correlation model.
The method is based on the following two equations for $P \geqq 0.2\ S$:

$$CN = \frac{25400}{254 + S} \qquad (7)$$

$$D = \frac{(P - 0.2\ S)^2}{P + 0.8\ S} \qquad (8)$$

where:

CN = curve number,
D = direct runoff in mm,
P = rainfall in mm,
S = recharge capacity of the soil in mm.

If $P < 0.2\ S$ no direct runoff occurs ($D = 0$).

The one- up to five-day totals of rainfall can be used.
The CN is not a mysterious number, but a convenient transformation of S to obtain numbers from 1 to 100. The validity of equation (8) is rather doubtful, see the relevant literature [27, 67].

For the United States the method is much refined and the large number of different soils and vegetation covers is classified.

In the Tanga Water Master Plan [22] the Curve Number Method has been applied. A simplified soil and vegetation classification for Tanzanian conditions based on the original method is proposed.
Furthermore the effect of slope on direct runoff is introduced, whereas the original method was developed for gently sloping areas (0 - 5%).
The method is applied to the Kikundi River using the daily rainfall data from November up to February. According to the Tanga Water Master Plan the catchment is classified as follows:

a. slope > 20%;
b. soil group B, which represents soils with moderate infiltration rates;
c. vegetation group C, which includes African cultivation, estates and grassland;
d. for the three antecedent moisture correlation groups I, II and III, curve numbers of 47, 67 and 83 are given, where I, II and III resp. refer to a dry, a moist and a wet condition.

With these curve numbers the daily rainfall data are converted into direct runoff. The monthly totals found by adding the daily values are presented in the table below (Table C A3-12), and compared with the direct runoff diverted from the hydrograph from the crump weir.

Table C A3-12: Montly direct runoff in mm, comparison of Curve Number Method with measurements

month	CN Method	Hydrograph
November 1978	638.5	(172.0)
December 1978	74.4	74.0
January 1979	3.6	4.8
February 1979	54.5	34.7

The deviation appears to be very big for the month of November which may partly be caused by an under-estimation of the badly recorded big flood on the 20th, 21th and 22nd of that month. However for the month of February the method also gives too high a value.
In Table C A3-13 daily values of direct runoff are compared.

Also on a daily basis the deviation between direct runoff values determined by the CN Method and derived from the hydrograph is remarkable. Small storms seem to be under-estimated. Probably the amount of rain which is considered to produce no direct runoff (0.2 S) is too high and should be adjusted at least for areas similar to that of the Kikundi River. The direct runoff from rainfall above 0.2 S is evidently over-estimated. Therefore the similarity between the estimated and measured direct runoff totals for December 1978 and January 1979 has to be considered accidental.

It may be concluded, that the application of curve numbers proposed in the Tanga Water Master Plan is questionable at least for drainage basins which are similar to that of the Kikundi River.
More test data for the revaluation and refinement of the method are required before general application to Tanzanian conditions can be recommended.

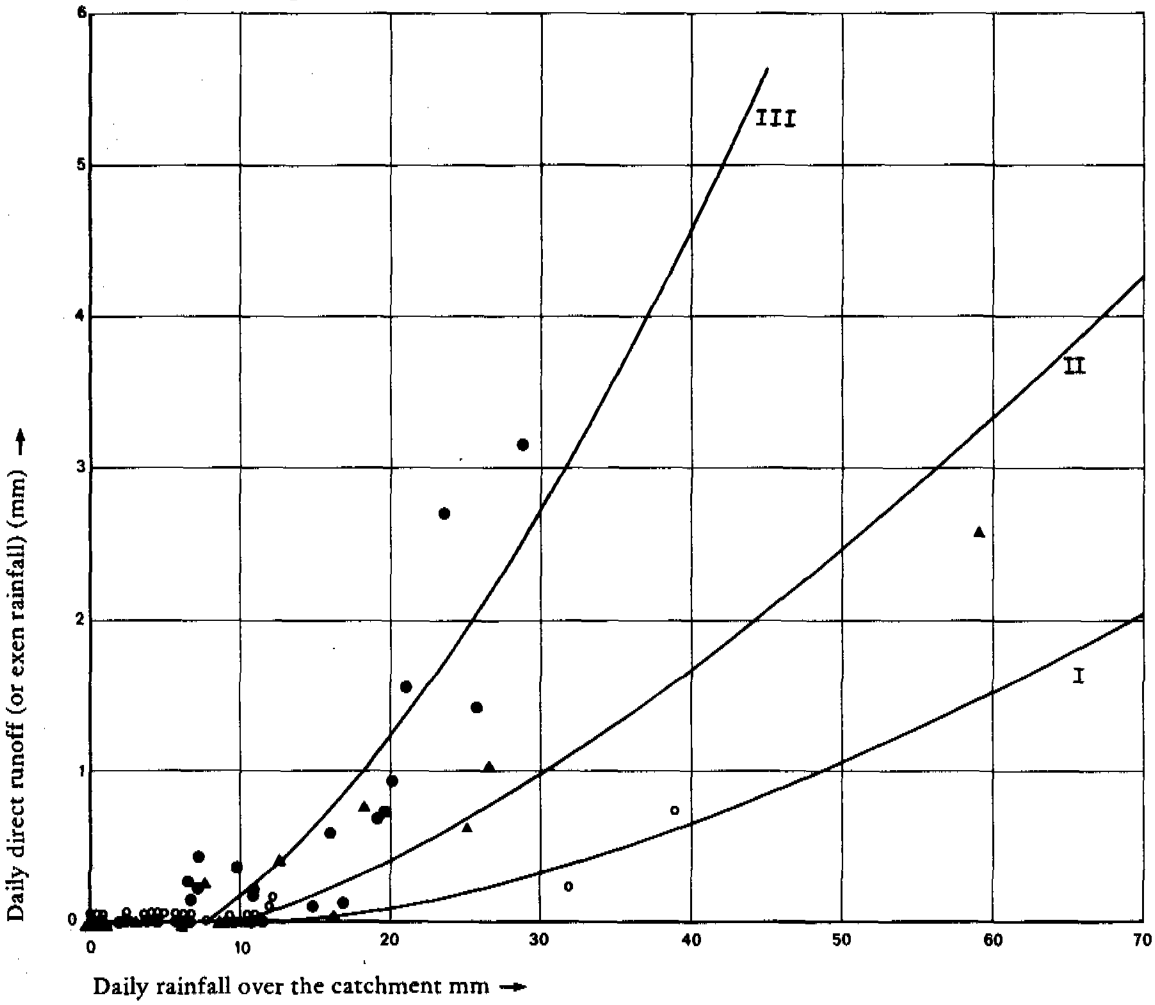
As a substitute for the CN Method for the drainage basin of the Kikundi River a relationship between daily rainfall and direct runoff is established based on all available data collected during the months of November 1978 up to March 1979.
According to the CN Method the data are classified, for antecedent moisture conditions and plotted in figure C A3-6.

AMC	5-day antecedent rainfall (mm)
I	< 23
II	23 - 40
III	> 40

Table C A3-13: Daily direct runoff in mm, comparison of Curve Number Method with measurements

Date	Antecedent moisture condition	Precipitation (mm)	Direct runoff	
			CN Method	Hydrograph
18/11	I	31.9	0	1.0
29/12	I	12.3	0	0.7
8/01	I	7.8	0	0
28/01	I	10.9	0	0
29/01	I	12.0	0	1.8
22/02	I	10.7	0	0
29/11	II	12.9	0	1.7
14/12	II	59.2	32.2	11.3
26/12	II	7.6	0	1.1
13/01	II	16.2	0	0
14/01	II	10.0	0	0
2/02	II	21.4	0	1.6
4/02	II	26.5	0	4.5
12/02	II	20.9	0	2.8
15/02	II	12.1	0	0
17/02	II	68.2	48.6	19.4
23/02	II	18.2	0	3.3
19/11	III	6.8	0	0.6
26/11	III	7.3	0	1.1
27/11	III	17.0	3.3	0.5
1/12	III	24.1	12.5	4.8
2/12	III	6.5	0	1.2
7/12	III	9.7	0	1.5
8/12	III	7.3	0	1.7
9/12	III	4.5	0	0
16/12	III	19.2	5.6	3.0
17/12	III	28.7	20.9	13.8
19/12	III	21.0	7.9	7.2
21/12	III	23.5	11.5	11.8
15/01	III	14.7	1.4	0.4
16/01	III	15.8	2.2	2.5
7/02	III	19.5	5.9	3.1

The curves, which are fitted by eye, are used for flood prediction with the Unit Hydrograph Method.



Antecedent moisture condition I $y = 0.10\ (x - 12.5)^{0.57}$

Antecedent moisture condition II $y = 0.20\ (x - 10)^{0.67}$

Antecedent moisture condition III $y = 0.05(x - 7.5)^{1.3}$

Figure C A3-6: Rainfall - direct runoff relations for different antecedent moisture conditions for the Kikundi River

A 3.8. Flood flow

Flood flow is an important phenomenon, which is a design criterion for the construction of spillways of reservoirs and culverts in roads. Continuous flow records from which design floods with a 10 or 20% probability of non-exceedence may be derived by statistical methods are seldom available. Therefore much effort has been devoted to develop a model for flood flow prediction of rivers with some flood data or of ungauged rivers.

Two methods will be applied to the Kikundi River:

a. the Unit Hydrograph Method,
b. the TRRL East African Flood Model.

Unit Hydrograph Method

The starting point of the Unit Hydrograph Method is direct runoff, which is converted into a flood hydrograph from which peak flow can be derived. The basic assumption is that the drainage has a linear and time-invariant response to excess rainfall. The response in fact reflects all combined drainage characteristics of the basin such as slope, drainage pattern, soil and vegetation. The characteristic response of a present amount of rain, here taken as 1 mm, of excess rainfall of specified duration and uniform distribution is called the unit-hydrograph of the drainage basin.
Unit-hydrographs for other rainfall durations can be deduced with the S-Hydrograph Method.
A detailed description of both methods can be found in the Handbook of Applied Hydrology (Chow) [27].

Two single peaked floods are selected from the hydrograph of the crump weir in the Kikundi River, with different duration of excess rainfall and uniform distribution in time (see figure C A3-7).
For both floods a unit- and S-hydrograph are established, from which a relationship between unit peak-flow (l/s/mm of excess rainfall) and duration of excess rainfall is derived (see figure C A3-8).
The two curves do not coincide mainly because the requirement of uniformity of rainfall over the catchment is not met.
The data of nine other floods with less uniform shapes are plotted in figure C A3-8 for comparison.

With the relationships presented in figure C A3-6 and C A3-8 peak-flows can be predicted if rainfall data are available. From figure C A3-6 the direct runoff volume (which equals excess rainfall) is taken for a given rainfall amount. This amount is multiplied by the unit peak-flow obtained from figure C A3-8 for a given rainfall duration to obtain the peak-flow response in l/s.

For various rainfall stations in Tanzania the Meteorological Department has established rainfall amount-duration-frequency data [64].
The Dar-es-Salaam station is considered to be most representative for the Kikundi catchment.

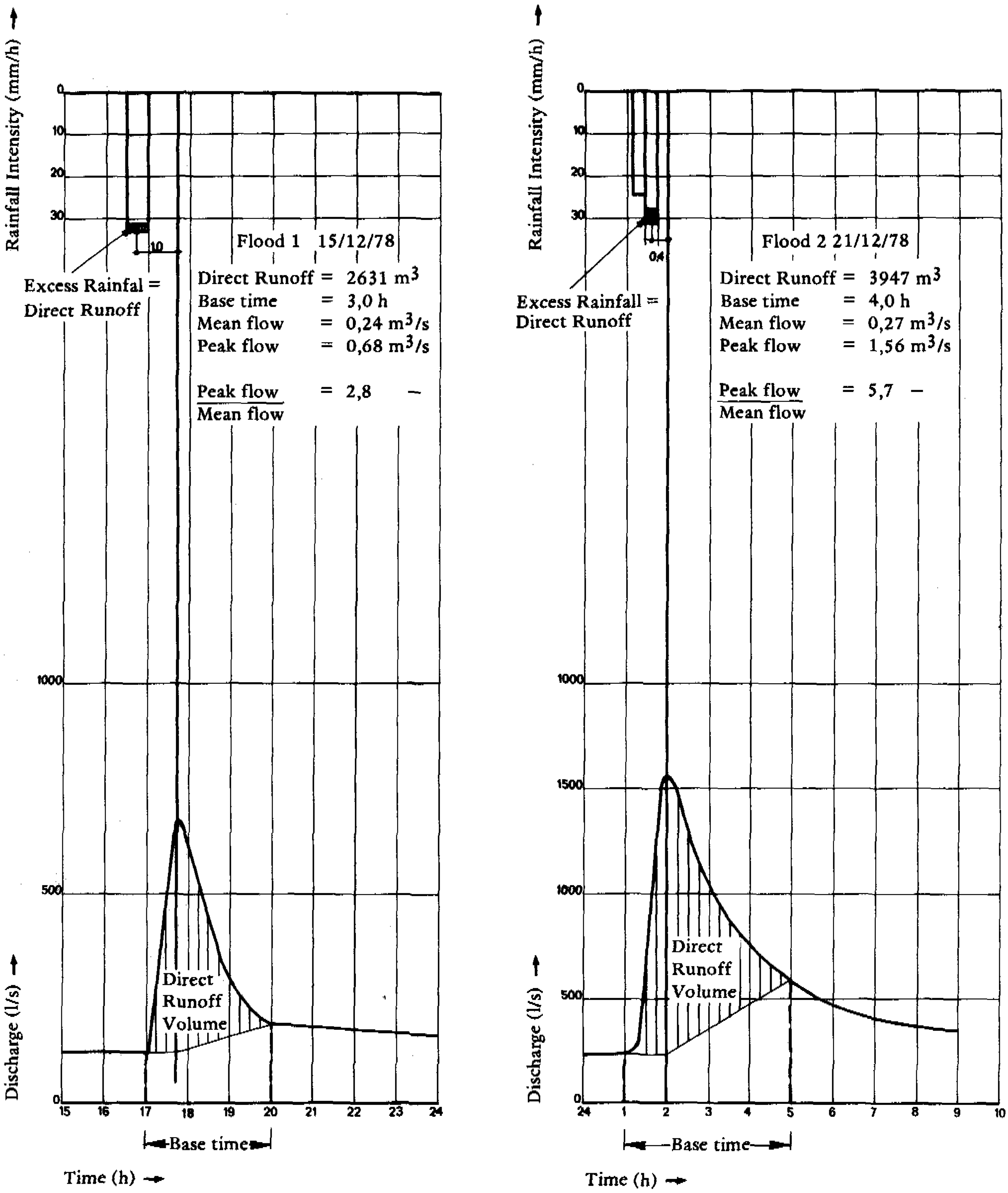


Figure C A3-7: Average rainfall over the catchment and resulting single peaked floods recorded at the crump weir in the Kikundi River.

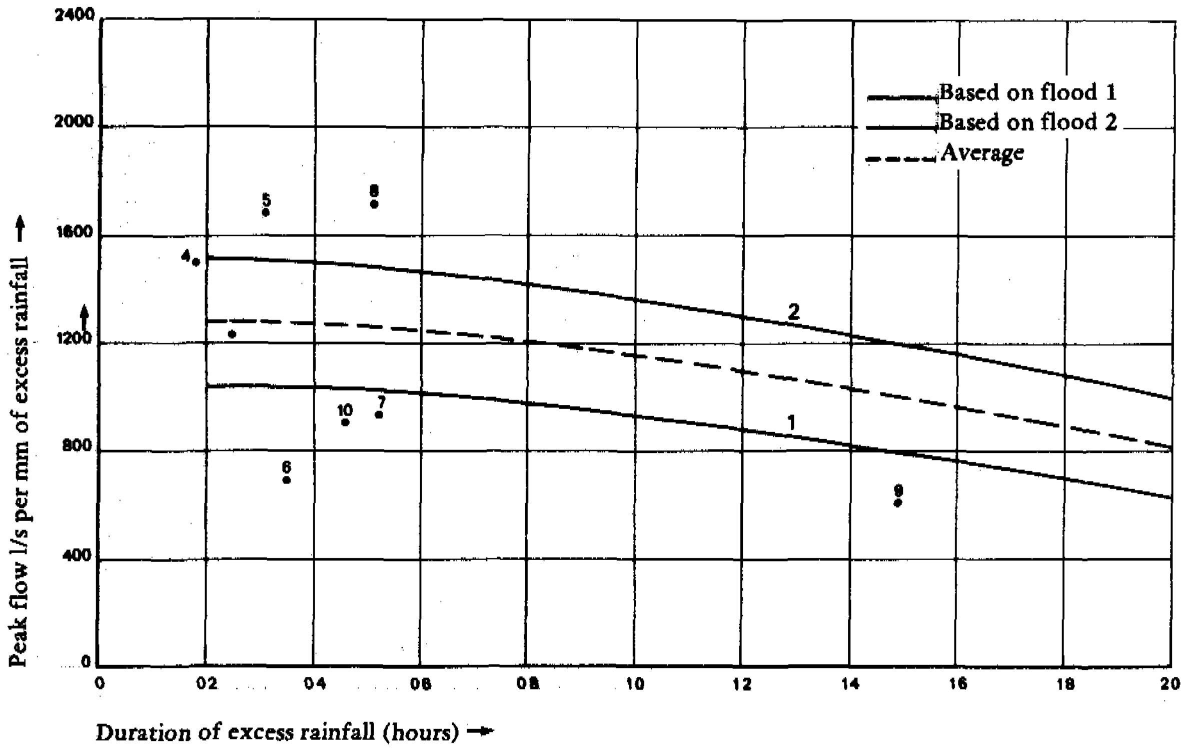


Figure C A3-8: Peak-flow - excess rainfall - duration - relationship.

The Dar-es-Salaam data are fitted by the following equations:

$$P_{10} = 55.3 \; t^{0.36} \quad \text{mm} \tag{9}$$

$$P_{20} = 60.7 \; t^{0.38} \quad \text{mm} \tag{10}$$

where:

P_{10} = rainfall with duration t which is exceeded once in 10 years (mm),
P_{20} = rainfall with duration t which is exceeded once in 20 years (mm),
t = rainfall duration (h).

Antecedent moisture condition group III is used for the flood prediction. It is assumed that the highest peak-flows occur during the wettest part of the year.

According to Table C A3-14 the maximum peak-flow occurs at a rainfall duration of 1.5 h and appears to be about 9 m^3/s, exceeded once every 10 years, and about 11 m^3/s exceeded once in every 20 years.

Table C A3-14: Design peak-flows exceeded once every 10 and once every 20 years, based on the Unit Hydrograph Method

rainfall duration	exceeded once every 10 years				exceeded once every 20 years			
	rainfall	excess rainfall	peakflow		rainfall	excess rainfall	peakflow	
h	mm	mm	l/s/mm	l/s	mm	mm	l/s/mm	l/s
0.5	43	5.2	1260	6550	47	6.0	1260	7560
1.0	55	7.6	1150	8740	61	8.8	1150	10120
1.5	64	9.5	980	9310	71	11.0	980	10780
2.0	71	11.0	800	8800	79	12.9	800	10320

A more reliable and accurate estimation of the maximum peak-flow based on the Unit Hydrograph Method could be achieved with a rainfall amount-duration-frequency distribution of MET Morogoro and Morningside stations. Within the scope of MDWSP this time-consuming work cannot be carried out. Additionally more unit hydrographs could be established from the flow record of the crump weir and combined to an average unit hydrograph to smooth out the non-uniformity of rainfall distribution in space and time.

TRRL East African Flood Model

The TRRL East African Flood Model was developed in 1966 by the Transport and Road Research Laboratory in co-operation with the Ugandan and Kenyan Governments. Twelve representative catchments with areas between 0.45 and 171 km^2 were studied in detail providing the basis for the model design. The model is built up out of two sub-models, of which the first simulates the runoff from the catchment using a linear reservoir analogue. This part of the model incorporates catchment slope, soil type in respect to drainage capacity, catchment wetness and land use.
The second sub-model translates this runoff to average outflow of the catchment during a specified base-time. This sub-model is based on a finite difference routing technique. It incorporates the rainfall time and the channel characteristics. The model generates an average outflow which is finally transformed in peak-flow by a fixed ratio (peak-flow/average flow) which is 2.8 for catchments with short lag times.
The model can be used to calculate peak-flows which are related to the return period of the precipitation. Usually the one every 10 years return period is taken, being a reasonable design criterion for small structures. The method has been tested for this return period.
Except rainfall all required input data can be derived from a topographical map and some additional field survey. The maximum rainfall during base-time which is exceeded once every 10 years is needed. Generally no such data are

available for an arbitrary catchment and no approach to this problem is proposed in the publications on the model (see publications [36, 46] and also some papers of the Tanga Hydrology Seminar of 1978).
As rainfall is one of the most important factors in the model, the accuracy of the peak-flow prediction is affected strongly at this point. For the Kikundi River equation (9) is used as the most representative estimation.

With the data of Table C A3-15 the model gives a peak-flow of 21 m^3/s, which is exceeded once every 10 years.

Table C A3-15: Catchment data of the Kikundi River used in the TRRL East African Flood Model

catchment area	4.4 km^2
average slope	24 %
catchment type	steep and small
soil type	well drained
"rainfall zone"	wet
land-use	grass cover, small trees (60%) cultivated area (40%)
channel length	5 km
Mannings coefficient	0.05 for mountainous stream, cobbles with large boulders

Evaluation of peak-flow estimation

Of the peak-flow of the Kikundi River, which will be exceeded once every 10 years, the estimations with the Unit Hydrograph Method and the TRRL East African Flood Model differ much: 9 and 21 m^3/s respectively. Generally the Unit Hydrograph Method will give more reliable results, because all catchment characteristics are included in the shape of the unit hydrograph which is derived directly from the flow records, while for the TRRL East African Flood Model the catchment factors have to be estimated separately. A crucial point which determines the reliability of the Unit Hydrograph Method however is the representativeness of the flood from which the unit hydrograph is derived. The estimation will be more accurate as the storm which produces the considered flood is more uniformly distributed in time and space and has such an intensity and duration that the magnitude of the peak-flow is closer to that which has to be determined.

In our example the average unit hydrograph is obtained from two floods with peak-flows of 0.68 and 1.56 m^3/s, while the estimated peak-flow which is exceeded once every 10 years is 9 m^3/s. This implies that an extrapolation with at least a factor 8 is involved. Therefore the true peak-flow may well be higher (or lower) than 9 m^3/s.

According to local information the heavy storm of 8/2/77, which flooded the market place and damaged the weir, caused a flood which washed over the edges of the weir. Overtopping was partly due to a big log that jammed the entrance of the weir which decreased the maximum weir capacity of 14 m^3/sec.

A similar flood occurred in February 1961.
The peak-flow of 21 m^3/s determined by the TRRL method is at present considered a conservative estimate. Practically the design peak-flow with a return period of once every 10 years may be expected to be between 15 and 20 m^3/s.

A 3.9. Sediment load

Suspended sediment samples were taken during several floods and during base-flow conditions (see Table C A3-5). The measured suspended sediment concentrations during base-flow conditions are relatively low: 0.03 - 0.99 g/l. This sediment originates from scouring and washing out of small particles of deposited material from the river bed. Contrary to expectations, no positive relation could be established between base-flow discharge and sediment concentration, which is probably due to strongly varying composition of the bed deposits.

Naturally, during periods with floods much higher suspended sediment concentrations occur, because the scouring effect is much higher and the flood-producing rainfall causes surface runoff which carries large amounts of eroded material into the main channel. The measured concentrations are generally between 0.5 and 10 g/l.

Four series of samples during floods are shown in figure C A3-9. The series show identical sequences of events:

a. during base-flow conditions, preceding the flood, the suspended sediment concentrations are low;
b. the suspended sediment concentration shows a sharp increase simultaneously with the rise of discharge; according to Kellerhals, 1972 [41], this sediment probably originates from eroded streambed material and incorporates a relatively high content of course particles;
c. during or after peak-flow the suspended sediment concentration drops; it is observed that at the falling stage the flow shows a gradual change to darker coloured, brownish suspension; most likely this sediment represents newly eroded material from the catchment slopes [57].

For flood conditions a usable relation is found between discharge and suspended sediment load. The number of data was too small to establish separate relationships for the rising and falling limbs of the flood. The curve shown in figure C A3-10 therefore represents an average suspended sediment-discharge rating curve. A linear regression by the method of least squares between the log-transformed variables is carried out.
The correlation coefficient r = 0.84 is high, considering the number of data n = 31. After transforming bach the following equation is obtained:

$$L = 3.62\ Q^{1.69} \qquad (kg/s) \qquad (11)$$

where:

L = suspended sediment load in kg/s,
Q = discharge in m^3/s.

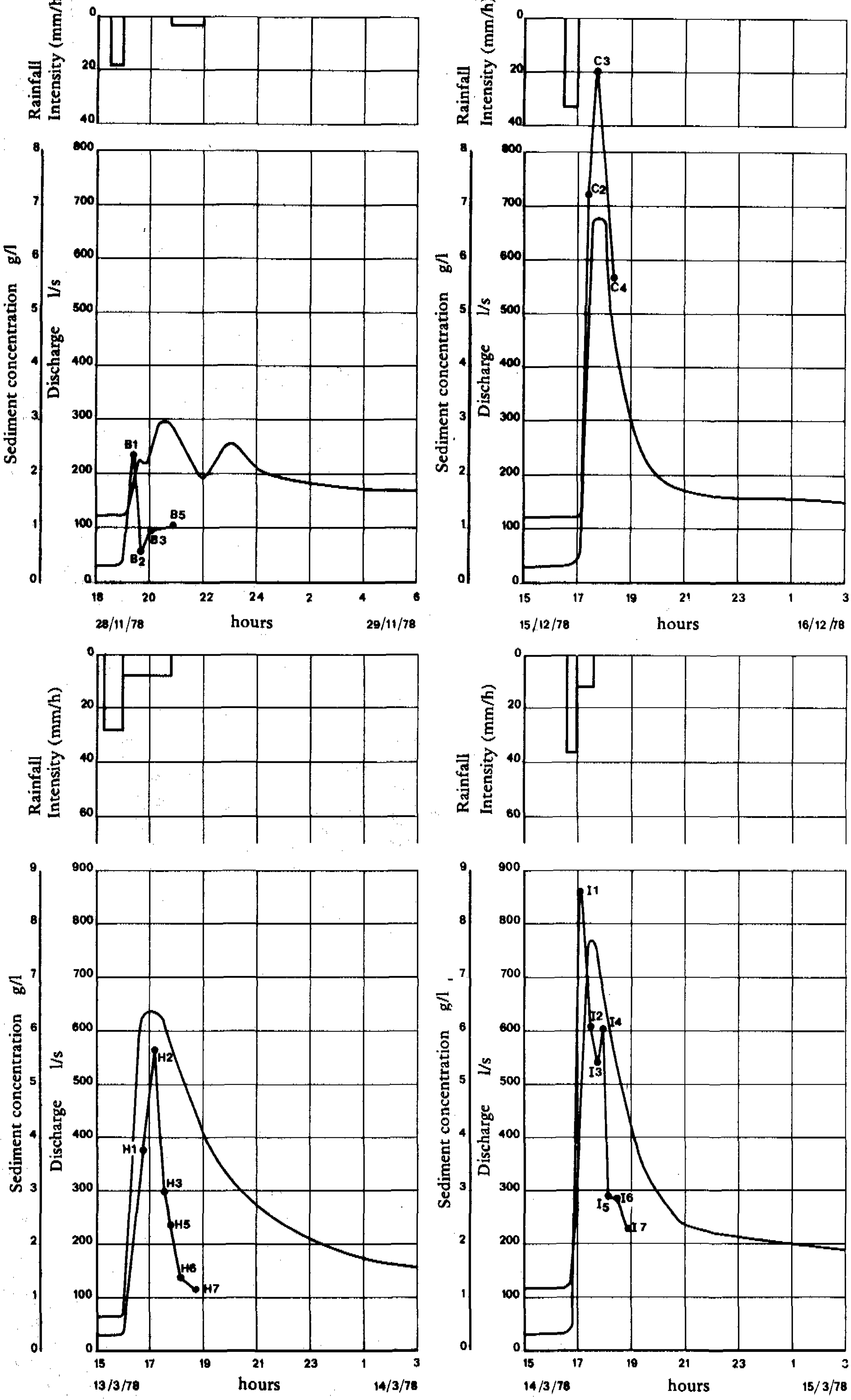


Figure C A3-9 Average rainfall, discharge and suspended sediment concentration in the Kikundi River

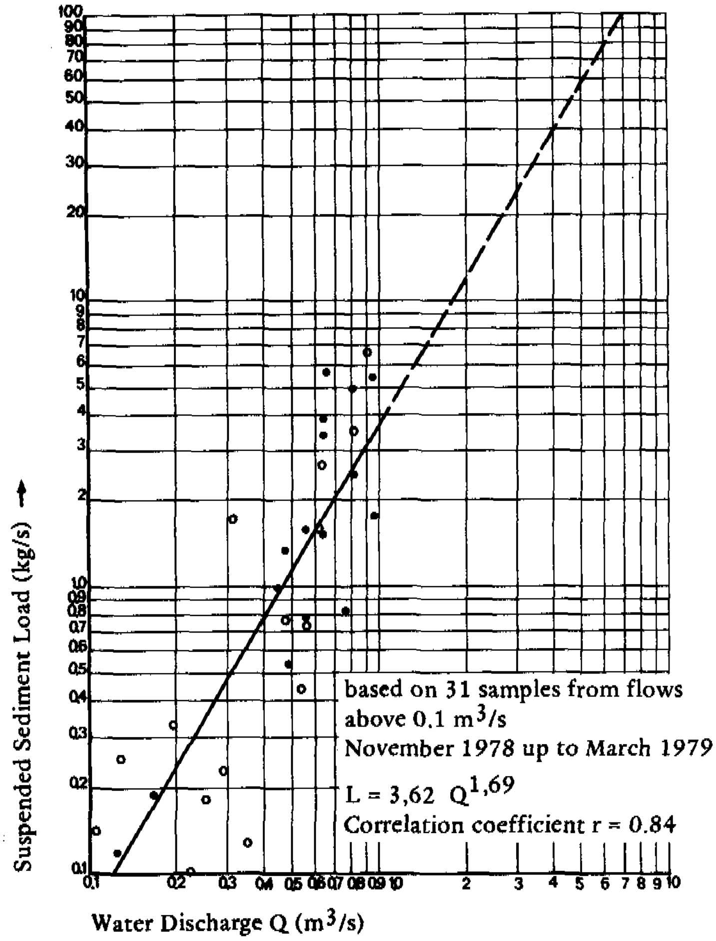


Figure C A3-10 *Average suspended sediment discharge rating curve for the Kikundi River at the crump weir*

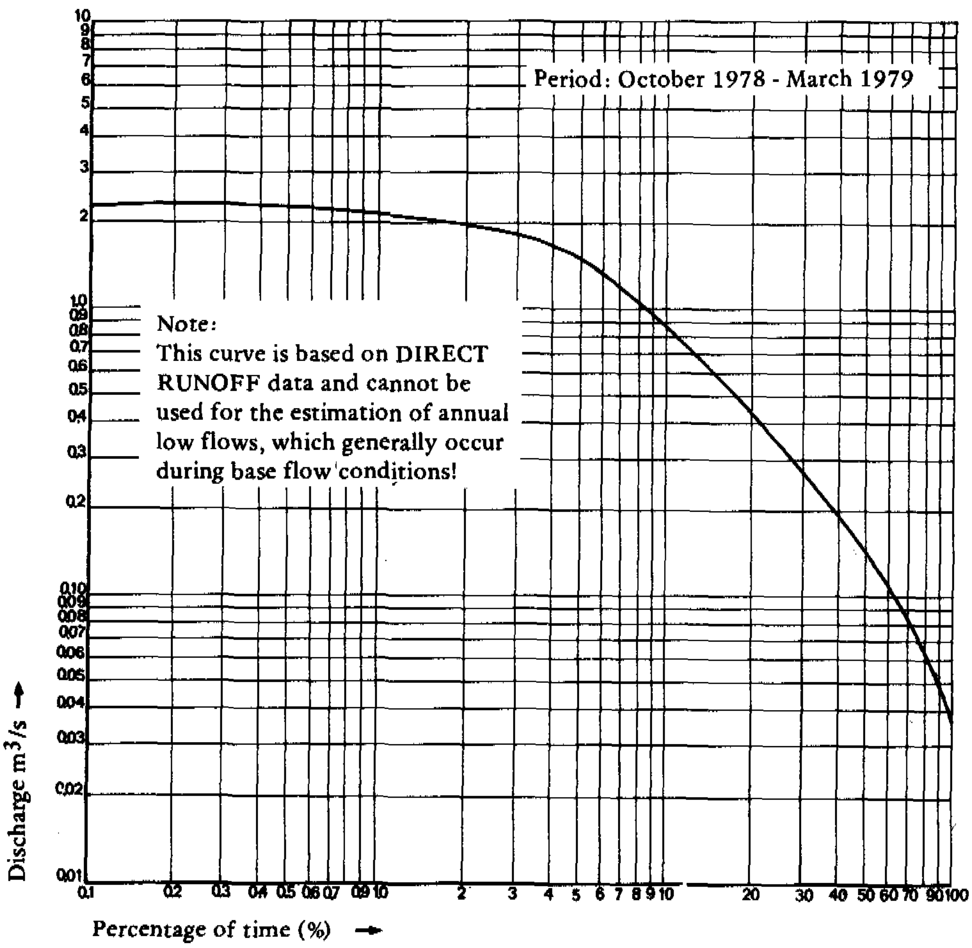


Figure C A3-11 Flow duration curve for 0,5 hour periods with direct runoff for the Kikundi River at the crump weir

The rating curve is used in combination with a flow-duration curve for direct runoff conditions (see figure C A3-11) to estimate the total amount of sediment which is transported by floods during the six month measuring period (October 1978 up to March 1979). The flow duration curve is based on half-hour-discharge observations.
The base-flow suspended sediment load during the period is estimated with the average concentration of 0.3 g/l derived from the samples. The bed load is taken as 20% of the suspended sediment load on the average.
The results of the calculations are presented in Table C A3-16.
During 6.3% of the period, direct runoff occurred, discharging only 18% of the total water volume but 72% of the total sediment amount.

Table C A3-16: Totals of discharge and sediment load of the Kikundi River over the six month period of October 1978 up to March 1979.

item	(unit)	amount	%
length of period	(h)	4368	100
period with direct runoff	(h)	273.8	6.3
period with base-flow	(h)	4094.2	93.7
total runoff	($m^3 \times 10^3$)	1705.76	100
direct runoff	($m^3 \times 10^3$)	304.69	18
base-flow	($m^3 \times 10^3$)	1401.07	82
total sediment load	(ton) *	1670	100
sediment load during flood conditions	(ton)	1200	72
sediment load during base-flow conditions	(ton)	470	28
total sediment load	(ton/km^2)	380	100
sediment load during flood conditions	(ton/km^2)	270	72
sediment load during base-flow conditions	(ton/km^2)	110	28

* 1 ton sediment (1000 kg) approximates 0.67 m^3 in a wet state

Rapp et al. (1972) [57] who studied the sediment characteristics of the Morogoro River found an average annual suspended sediment load of 390 ton/km^2 over the 1966 - 1970 year period. When a bed load of 20% is included a value of 470 ton/km^2 is found.
For the Kikundi River, adjacent to the Morogoro River, a much higher annual sediment load may be expected, considering the relatively high six month period value of 380 ton/km^2 and the fact that the usually wet months of April and May are not included in the estimation.
According to the investigations of others (see paragraph 3.4. (chapter 3) on sediment) the higher sediment load of the Kikundi River in comparison with the Morogoro River may be due to:

a. the effect of catchment size, where smaller catchments tend to produce more sediment per km^2 (catchment Kikundi River = 4.4 km^2, catchment Morogoro River = 19.1 km^2);
b. the effect of land use, where less vegetated catchments produce more sediment (catchment Kikundi River: 40% cultivated and 60% grassland, catchment Morogoro River: 40% rainforest, 44% grass and only 10.5% of cultivated area, 5.7% other).

A 3.10. Recommendations

a. Compound crump weirs for continuous flow measurement should not be used in rivers which drain steep and scarcely vegetated catchments in tropical areas because of its high siltation rate.
   A flat-V-type weir provides a more convenient measuring device in this respect.
b. Investigations on the relation between rainfall and direct runoff should be carried out at University level in order to refine and adjust the coefficients of the Curve Number Method for Tanzanian conditions.
   Thereafter a wider application of this method may be recommended.
c. The accuracy of the TRRL East African Flood Model for design peak-flow estimation should be thoroughly tested on a river with reliable continuous flow records and a well-defined annual maximum peak-flow distribution.
d. Detailed studies, lasting at least several years, on small catchments representing typical conditions like that of the Kikundi River and spread over the project area, should be carried out to obtain specific information on basic hydrological aspects like water balance components, flood and low-flow characteristics and sediment load in relation to catchment and precipitation characteristics.
   This knowledge could be used for less gauged or ungauged rivers in order to predict their hydrological characteristics, required to obtain design criteria.
e. To complete and affirm the results of this special study data collection should be continued at least up to the end of October to obtain a complete record of a hydrological year.
   A new V-notch should be installed in July for accurate low-flow measurement during the dry season, or weekly low-flow measurements should be carried out with a current meter.
   A higher flood from a more uniform storm should be selected (if available) to derive a more representative unit hydrograph.
   A rainfall intensity-duration-frequency relationship should be established from the continuous rainfall records of MET Morogoro and Morningside Farm stations to obtain a more representative design storm for flood estimation.
   Sediment sampling of floods in particular with peak-flows above 1 m^3/s should be continued in order to define the extrapolated part of the suspended sediment rating curve.
   The average suspended sediment concentration during base-flow conditions in the dry season should be determined.
   The direct runoff flow duration curve should be updated after one complete record of the hydrological year.

ANNEX CA4

FLOW ANALYSIS OF THE NGERENGERE RIVER

CONTENTS PAGE

CA 4 FLOW ANALYSIS OF THE NGERENGERE RIVER (ABOVE KIHONDA (1HA6))

A 4.1. General

At present the Mindu Dam near Morogoro is under construction. The dam is meant to supplement the existing municipal water supply and to make water available for new industrial development.

The sequential analysis carried out by Sir Alexander Gibbs [71] to derive the required storage volume is based on flow data of the Ngerengere River at Kihonda obtained between 1950 and 1960.

The rural water situation in the Ngerengere valley below the planned dam is rather difficult. The shallow- and deep-wells are often saline, while except for the rivers Morogoro and Mgolole no other perennial rivers enter the valley. Part of the difficulties could be obviated if some Mindu Dam water could be transferred to the valley. The present study will review flow data and extend existing flow series of in-flow into the reservoir up to present. From these extended series it will be judged if water can be spared for rural water supply purposes. Different ways to increase the yield of the reservoir will also be indicated.

A 4.2. Description of the catchment area

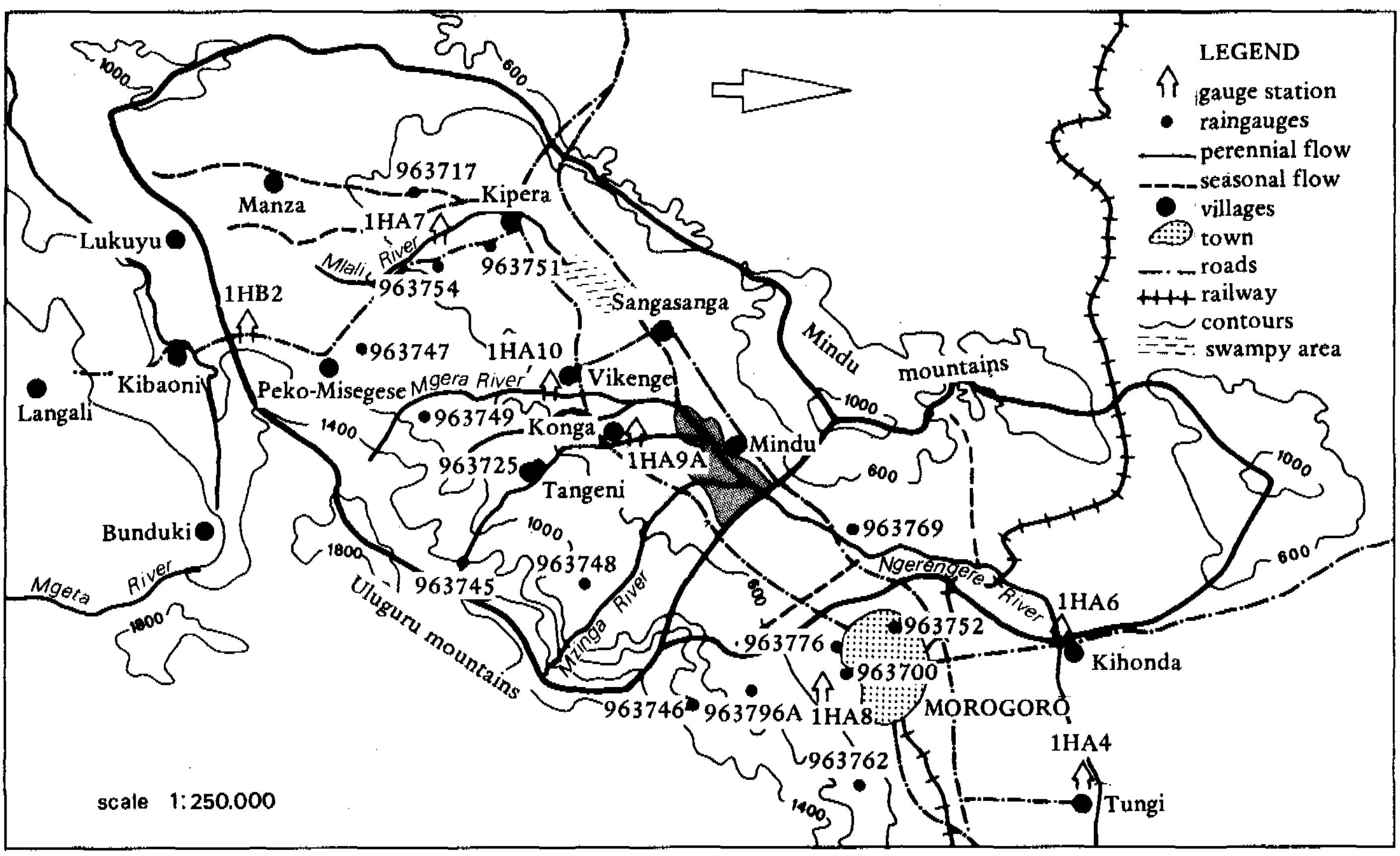


Figure C A4-1 Catchment area of the Ngerengere River above Kihonda gauging site

Figure C A4-1 shows the catchment areas of the Ngerengere River above the Mindu Dam site and the Kihonda gauging station. Their sizes are 291 and 406 km^2 respectively. Hence, the Mindu Dam catchment is only approximately 70% of the catchment above Kihonda. In this latter catchment the 4 main perennial rivers originate on the eastern slopes of the Uluguru Mountains. The Uluguru Mountain slopes and foothills cover 50% of the Mindu Dam site catchment. There are about 12 km^2 of rainforest in this area. The other 50% are slightly hilly or flat, except for a minor part in the north being the slopes of the Mindu Mountains. The hilly and flat parts are heavily cultivated, the main crops being maize and millet; some of the flatter areas are very swampy and some rice is grown there.

The catchment between the Mindu Dam site and Kihonda consists of some foothills of the Mindu Mountains and the Uluguru Mountains, the remaining area being slightly hilly to flat. Most of which is cultivated with sisal.

A 4.3. Available flow- and precipitation-data

Originally 3 hydrometric gauging stations, erected in 1953 and 1954 were located in the different rivers above the Mindu Dam site. They were 1HA7 in the river Mlali, 1HA10 in the river Mgeta and 1HA9 in the river Ngerengere at Konga. 1HA6, started in 1950 and discontinued in 1963 (available processed data only till 1959), was the nearest station downstream from the Mindu Dam site.
Only 1HA9A at Konga, which replaced 1HA9, after it was washed out, is still being observed. All observations of above stations consisted of twice daily gauge readings. Annual discharges at the station sites can be found in Table C A4-1. Monthly flows are given in the data-part of this volume, while daily flow can be found in the yearbooks of the Water Department [40]. Especially the eastern part of the Mindu Dam catchment is richly endowed with precipitation stations (see figure C A4-1). Monthly data can be found in the data-part of this volume. From the present stations, in working order, only Tangeni-mission (nr. 963725) observations started before 1950. Observations of all other stations started after 1954.

A 4.4. Flow analysis

A 4.4.1. General

To obtain a fair impression of the discharge into the Mindu reservoir, it has been decided to extend in the first instance the original Kihonda 1950 - 1959 flow series (station 1HA6) to the present year, using three-monthly values, mainly by simple regression analysis, with no more than two independent variables. This type of analysis can be handled by the HP-67 calculator which was available to the project. The same type of analysis could have been carried out to obtain monthly data, but required many more hand-calculations, and a computer then becomes a necessity.

For the analysis long data series, overlapping the Kihonda series, are required. Some of the precipitation stations and the Ngerengere flow series at Konga were taken into consideration

A preliminary mass-analysis showed some alarming facts, related to the Kihonda flow (see figure C A4-2). Flows are decreasing in relation to precipitation at Tangeni. Tangeni data, when plotted against Morogoro precipitation data, did not show any obvious deviations, hence the Tangeni series is not considered suspect.

Taking this decreasing flow into consideration, and the rather good relation between Kihonda and Konga flows, judged from annual values, the Konga flow data seem the best choice for extending the flow at Kihonda. Figures C A4-3 and C A4-4 show some plots of Kihonda annual flows against Tangeni precipitation and annual Konga flows.

The next stage of the exercise is to fill in missing data of the Konga record.

A 4.4.2. Filling in missing values of the Konga monthly flow series

Table C A4-2 gives an updated and completed version of the monthly discharge volumes at Konga. The original station 1HA9 was washed away in March 1960 and was replaced by station 1HA9A in November 1962. The existing data have been processed by the Water Department up to 1975. However, from the year 1974 onwards up to present, the Consultant has processed data with a rating-curve slightly different from the one used by the Water Department up to 1975. The present rating-curve is given in paragraph 3.3 of this volume. Hence the 1975 data deviate slightly from the originally published data.

The missing months have been estimated by regression analysis with rainfall stations. Three rainfall stations are in or near the catchment above Konga. They are Luhongo (963748), Tangeni mission (963725) and Mondo (963745). The Luhongo data had to be dropped because of inconsistencies in the series. The 1955 - 59 average was 2.7 times the 1960 - 78 average, while for the other rainfall series this was not the case. Based on the Thiessen polygon method a series of weighted average precipitation figures of Mondo and Tangeni has been created and used in the regression analysis. All existing Konga data have been used, although the October - November totals of 1962/63 and 1963/64 surpass the weighted rainfall over the 20.7 km^2 catchment. No obvious errors could be detected in the flow values, while downstream flows also showed rather high values (see Table C A4-1) in the first instance and it was decided to carry out the regression analysis with all available years and repeat the analysis with the two years deleted. The resulting equations were not very much different and the ones calculated from the full records have been used.

Table C A4-1: Annual discharges Ngerengere River and tributaries (x 10^6 m^3)

Year (Nov-Oct)	Mlali IHA 7	Mgera IHA 10	Morogoro IHA 8	Konga IHA 9(A)	Kihonda IHA 6	Kilimanjaro IHA 4	Kingolwira IHA 3	Kiluwa IHA 5	Mgude IHA 15	Utari bridge IHA 1(A)	IHA 14	Precipitation Tangeni	Morogoro
Catch.area (km^2)	10.1	15.5	23.3	20.7	406	-	699	1665	2370	2870	-		
1950 - 51					82.0		119.6			109.1		1085	740
51 - 52					97.2		137.8			138.6		1193	1084
52 - 53					60.7		91.1			132.4		929	586
53 - 54	2.4				51.0	66.8	93.4	114.3		96.5		867	862
54 - 55	12.9	9.1	19.2	24.5	78.7	78.4	108.0	127.6		147.9		1224	757
55 - 56	10.9	4.7	25.9	27.7	86.3	91.2	107.8	149.6		161.3		1228	1004
56 - 57	8.0	11.3	18.0	24.0	63.6	77.0	81.2	115.7		139.9		1179	843
57 - 58	6.5	8.4	11.4	23.3	64.5	69.1	77.9	115.8		100.4		1099	747
58 - 59	4.8	3.4	9.5	12.7	29.3	34.6	37.1	61.9		58.1		1048	727
59 - 60			18.9	(36.5)				119.8		116.1		1346	1072
60 - 61			16.3	(30.5)				80.5		74.4		1260	897
61 - 62			22.6	(49.1)				305.3		372.9		1536	1073
62 - 63	Closed	Closed	14.9	52.0	Closed	Closed	Closed	212.0		150.5		1249	1062
63 - 64			24.7	47.2				174.0		274.1		1404	1176
64 - 65			13.0	29.1				54.4		75.3		1336	800
65 - 66			*	32.5				88.5		149.1		1407	896
66 - 67			*	25.8						208.0		1451	997
67 - 68			30.2	34.9				Closed		345.3		1452	1231
68 - 69				30.3					174.6	133.6		1413	837
69 - 70				20.3					(116.7)			1166	837
70 - 71				17.6					98.6			1605	990
71 - 72				26.8					Closed	Not		1551	1105
72 - 73				34.5						Processed		1633	1273
73 - 74			Not	19.8								1024	996
74 - 75			Processed	17.9								858	739
75 - 76				13.9								851	698
76 - 77				18.2								1217	969
77 - 78				28.8								1120	1009

Figures in brackets = estimated values.

Table C A4-2 Monthly Discharge Volumes ($m^3 \times 10^6$) for the Ngerengere River at Konga (updated and completed) and precipitation data (mm) of weighted average of Tangeni and Mondo precipitation stations*

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.-Dec. Total	Nov.-Oct. Total	Nov.-Oct. Precip.
1954	-	-	-	3.6	5.4	1.5	0.6	-	0.4	0.5	0.7	0.5	-	-	-
1955	0.4	1.0	1.7	6.0	7.8	2.9	1.6	0.9	0.5	1.8	1.1	26.2	24.5	24.5	1825
1956	1.6	1.5	6.2	7.0	4.5	1.7	0.9	0.5	0.5	0.4	0.7	0.6	26.1	27.7	2017
1957	0.8	0.7	1.1	4.0	9.2	1.5	0.8	0.8	2.8	1.0	2.0	1.1	25.8	24.0	2304
1958	0.6	1.0	2.1	8.3	3.8	2.2	0.8	0.6	0.5	0.3	0.3	0.6	21.1	23.3	1904
1959	0.6	0.4	0.7	3.1	2.7	0.7	0.5	1.2	1.0	0.9	0.8	0.7	13.3	12.7	2127
1960	1.2	0.5	3.3	(13.8)	(7.7)	(3.1)	(1.7)	(1.2)	(1.1)	(1.4)	(0.8)	(0.4)	(36.2)	(36.5)	2445
1961	(0.2)	(1.6)	(1.8)	(6.8)	(5.5)	(2.5)	(2.4)	(1.6)	(2.8)	(4.1)	(10.5)	(7.9)	(47.7)	(30.5)	2647
1962	(5.3)	(3.6)	(4.0)	(8.4)	(4.4)	(1.3)	(0.7)	(1.2)	(1.3)	(0.5)	2.2	3.3	(36.2)	(49.1)	2814
1963	4.3	2.8	4.5	12.0	7.1	4.1	3.9	3.3	2.6	1.9	9.3	6.4	62.2	52.0	2197
1964	3.8	2.2	4.0	8.6	4.4	2.8	1.8	1.3	1.1	1.5	0.9	1.2	33.6	47.2	2136
1965	1.1	1.2	1.8	7.9	5.1	3.2	1.7	1.1	1.0	2.9	3.9	2.0	32.9	29.1	1858
1966	1.8	2.7	2.8	7.5	4.8	2.8	1.5	0.9	1.0	0.9	1.0	1.0	28.7	32.7	2320
1967	0.4	0.5	0.4	2.0	5.9	3.6	1.9	2.1	4.9	2.2	3.1	2.0	29.0	25.8	2262
1968	1.0	0.7	3.0	10.2	5.6	5.1	1.8	1.0	0.7	0.7	3.3	3.5	36.6	34.9	2135
1969	0.8	1.0	3.1	7.1	6.2	2.1	0.9	1.0	0.5	0.8	1.9	0.6	26.0	30.3	2048
1970	0.7	2.6	2.9	5.7	2.8	0.7	0.4	0.3	1.3	0.4	0.2	1.1	19.1	20.3	1594
1971	1.2	1.1	0.9	5.6	4.0	1.4	1.1	0.5	0.3	0.2	0.2	0.3	16.8	17.6	1806
1972	0.1	0.2	0.6	5.5	10.3	2.5	1.0	0.7	1.1	2.3	3.9	1.9	30.1	24.8	2267
1973	2.1	1.3	1.5	9.0	7.8	1.7	2.5	0.6	0.4	0.2	0.8	0.6	28.5	32.9	2277
1974	0.5	0.4	0.5	8.2	4.4	1.3	0.9	0.6	0.6	0.1	0.5	0.5	19.4	19.8	1748
1975	0.5	0.5	1.3	5.0	4.9	1.7	0.8	0.6	0.8	0.8	0.5	0.6	18.0	17.9	1629
1976	0.6	0.3	0.9	2.5	3.4	2.1	1.0	0.6	0.7	0.7	0.6	0.4	13.8	13.9	1379
1977	0.8	0.7	1.7	5.3	3.5	1.1	0.7	0.7	1.3	1.5	3.9	3.1	24.2	18.2	1775
1978	2.5	1.0	2.0	8.1	4.1	1.7	0.8	0.7	0.5	0.4	3.9	4.3	30.0	28.8	1862
1979	3.6	3.5	4.3												

( ) = months in brackets estimated by regression anlyses

* = weighted average precipitation = 0,54 × Precipitation of Mondo + 0,46 Precipitation of Tangeni Mission

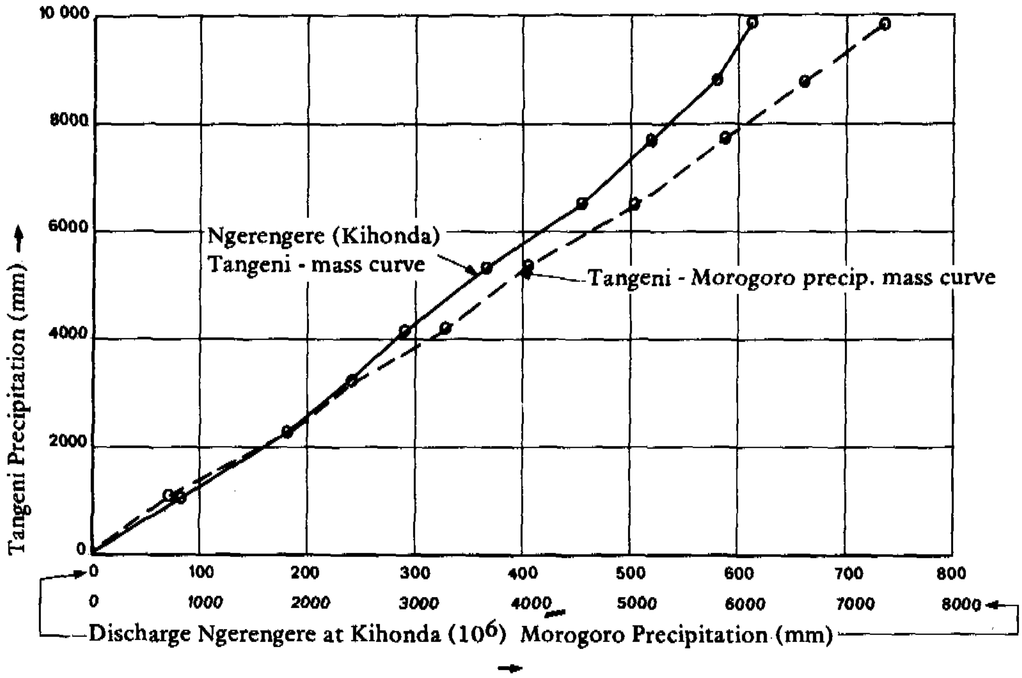


Figure C A4-2 Mass-analysis Ngerengere River at Kihonda

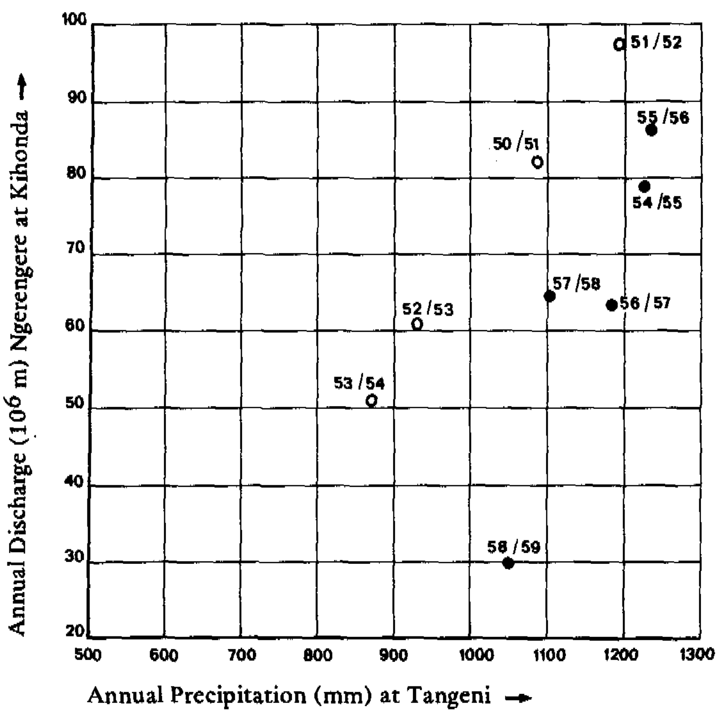


Figure C A4-3 Ngerengere River at Kihonda versus Tangeni precipitation station

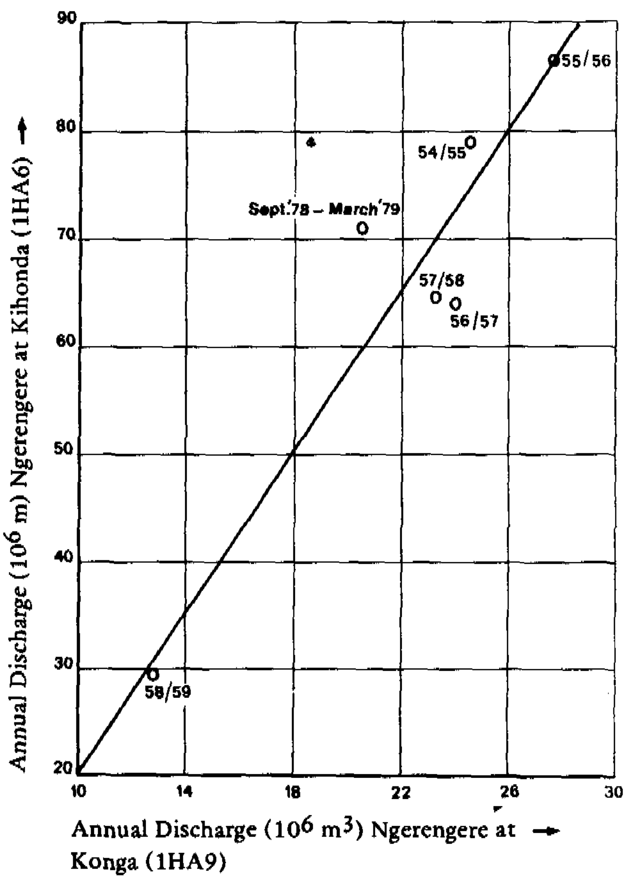


Figure C A4-4 Ngerengere at Konga and Kihonda relation (annual data)

The regression equations obtained have the following form:

$$Q_{(i)} = a + b \cdot Q_{(i-1)} + c \cdot P_{(i)}$$

where:

$Q_{(i)}$ = volume of discharge (x 10^6 m^3) in month (i)

$Q_{(i-1)}$ = volume of discharge (x 10^6 m^3) in month (i-1)

$P_{(i)}$ = weighted Tangeni and Mondo precipitation (mm) in month i.

a, b, c = coefficients determined by regression analysis.

Table C A4-3 gives the calculated coefficients using linear regression, least square techniques, based on 1954 - 78 data. The correlation coefficients, which are also shown in the table are all highly significant. From the average monthly discharge volumes $Q_{(i)}$ and precipitation $P_{(i)}$ given in the table, it can be seen that influence of the discharge of preceeding months is very small in the months with very high rainfall, while the opposite is true for the months with low rainfall.

The finally calculated missing values are given in brackets in Table C A4-2.

Table C A4-3: Coefficients and correlation coefficients of $Q_i = a + b \cdot Q_{i-1} + c \cdot P_i$

Month	n	a	b	c	r	$\bar{Q}$	$\bar{P}$
January	22	- 0.261	0.564	0.004	0.87	1.51	157
February	22	- 0.324	0.557	0.005	0.83	1.24	150
March	22	- 0.559	0.882	0.006	0.76	1.11	280
April	21	- 1.166	0.920	0.012	0.77	2.01	505
May	22	+ 0.268	0.382	0.013	0.78	6.46	245
June	22	+ 0.274	0.213	0.012	0.71	5.35	67
July	22	+ 0.036	0.506	0.004	0.73	2.16	34
August	21	- 0.070	0.647	0.004	0.86	1.30	47
September	21	- 0.366	0.823	0.009	0.92	0.95	82
October	22	+ 0.031	0.285	0.006	0.86	1.11	105
November	22	- 0.757	0.706	0.011	0.96	1.01	186
December	22	- 0.233	0.604	0.004	0.94	1.93	140

n = number of observations
a, b, c = coefficients
r = correlation coefficient
$\bar{Q}$ = mean monthly volume (x 10^6 m^3)
$\bar{P}$ = mean monthly precipitation (mm)

A 4.4.3. Completing the Kihonda three-monthly series

Table C A4-4 shows measured monthly volumes at Kihonda. From this table and Table C A4-2 of monthly Konga volumes, discharge volumes of the two stations have been assembled and listed in Table C A4-5 and plotted in figure C A4-5. As has been explained before, three-monthly values have been chosen rather than monthly values purely in order to decrease the amount of calculation work. Three-monthly values still show the seasonal distribution of in-flow into the reservoir.
The wet season is represented by the April - June volume, while the other three volumes of the year represent the low-flow seasons.

In figure C A4-5 the increasing slope of the curve is striking, because it means that with increasing flows the ratio Kihonda/Konga also increases. This can be explained by the fact that losses between upstream tributaries and the Ngerengere at Kihonda are considerable. The relative influence however decreases with higher flows. The curve has been fitted with a power function for Konga flows below 4.0 x 10^6 m^3 and with a straight line above these values. The functions are shown below:

$$\text{For } Q_{Konga} \leq 4.0 \times 10^6 \text{ m}^3,\ Q_{Kihonda} = 2.10 \times Q_{Konga}^{1.044}$$

$$\text{where } S_e = 1.34 \times 10^6 \text{ m}^3$$

and

$$\text{For } Q_{Konga} > 4.0 \times 10^6 \text{ m}^3,\ Q_{Kihonda} = 7.04 + 3.99\ Q_{Konga}$$

$$\text{where } S_e = 5.77$$

Q's are the discharge volumes in 10^6 m^3, while S_e's are the standard errors (measure for deviation of the fitted curve), also in 10^6 m^3.
It can be seen, that for the lower flows, the flow at the downstream station is only twice the flow at the upstream station Konga, while this figure increases to 3 or 4 for higher volumes. The fit becomes also less pronounced, judging from the S_e's. The 1978 - 1979 measurements carried out by the Consultant are also plotted in figure C A4-5. They do not deviate conspicuously from the 1954 - 59 values, hence it may be assumed that the relation between the two gauging sites has not changed in the course of time.

Table C A4-4 Monthly Discharge Volumes ($m^3 \times 10^6$) for Ngerengere River at Kihonda

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.-Dec. Total	Nov.-Oct. Total	Remarks
1950	-	-	-	-	-	-	-	-	3.9	2.4	0.8	3.5	-	-	
1951	1.6	3.0	2.9	21.4	29.9	8.6	5.2	1.9	0.9	1.9	15.9	15.1	108.3	81.6	
1952	9.7	3.7	3.1	17.5	21.2	4.5	2.3	1.5	1.3	1.4	3.1	9.9	70.2	97.2	
1953	0.6	0.2	0.6	10.6	27.9	5.9	3.2	2.8	2.8	2.1	1.7	1.2	59.6	60.7	
1954	1.7	1.1	3.5	10.1	23.4	3.9	1.6	1.1	0.8	0.9	0.6	0.4	49.1	51.0	Data from
1955	0.2	7.5	1.8	19.2	31.2	9.4	4.0	2.1	1.3	1.1	2.9	2.8	83.5	78.8	year books
1956	5.5	5.6	8.8	31.5	19.4	4.8	2.0	1.3	1.0	0.7	1.1	0.8	82.5	86.3	
1957	1.2	1.7	2.8	14.5	30.0	4.0	2.1	1.7	2.1	1.6	2.5	2.3	66.5	63.6	
1958	0.9	1.3	7.2	22.8	16.6	5.3	2.1	1.7	1.1	0.7	0.8	1.1	61.6	64.5	
1959	1.4	0.9	1.6	7.4	7.1	1.7	1.4	2.6	1.8	1.5	-	-	-	29.3	
		S T A T I O N	C L O S E D												
1978	-	-	-	-	-	-	-	-	0.7	0.4	8.5	16.7	-	-	Measured by
1979	12.8	14.9	17.2												Consultant

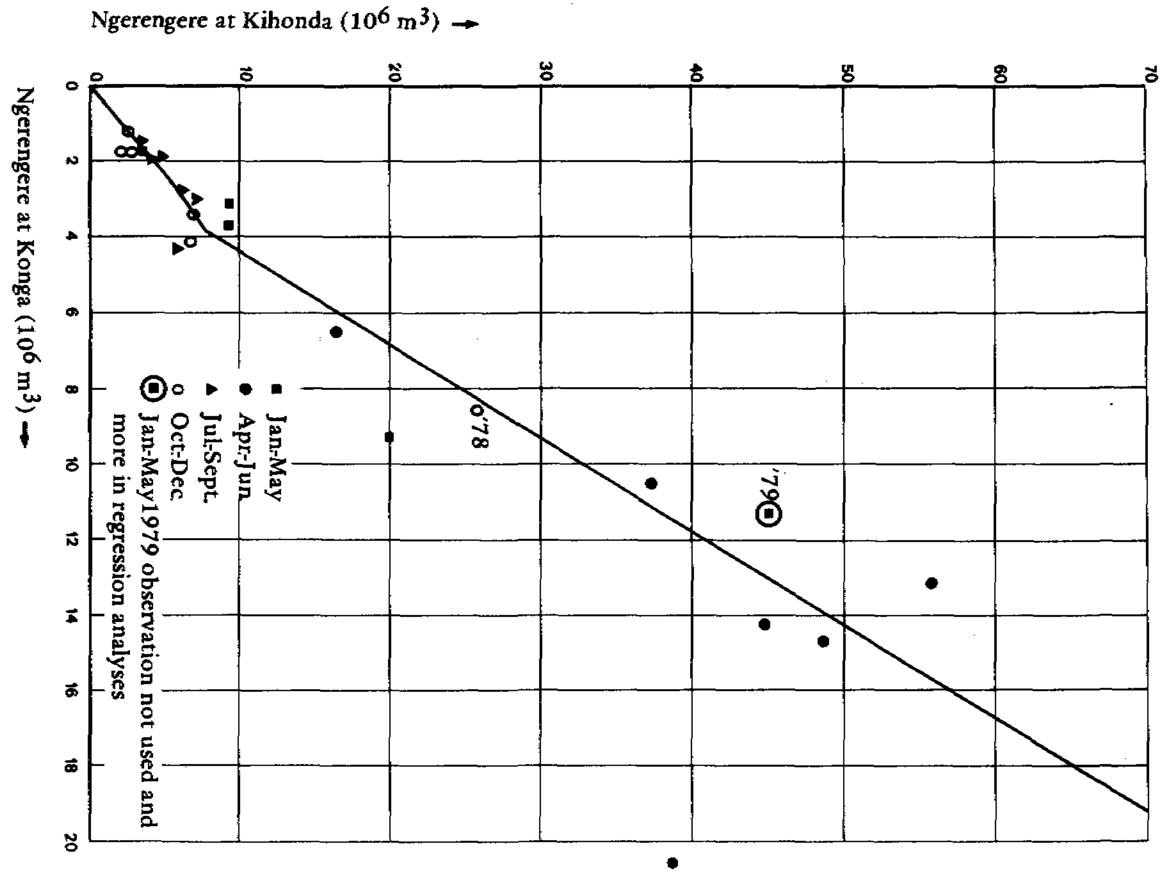


Figure C A4-5 Ngerengere at Konga and Kihonda relation (three monthly data)

Table C A4-5: Three-monthly corresponding river discharge volumes ($x\ 10^6\ m^3$) of the Ngerengere River at Konga and Kihonda

Date	Konga	Kihonda	Date	Konga	Kihonda
Jan-March '54	*	*	Jan-March '58	3.7	9.4
April-June "	10.5	37.4	April-June "	14.3	44.7
July-Sept "	1.5	3.5	July-Sept "	1.9	4.9
Oct-Dec "	1.8	1.9	Oct-Dec "	1.2	2.6
Jan-March '55	3.1	9.5	Jan-March '59	1.7	3.9
April-June "	16.7	59.8	April-June "	6.5	16.2
July-Sept "	3.0	7.4	July-Sept "	2.7	5.8
Oct-Dec "	3.4	6.8	Oct-Dec "	*	*
Jan-March '56	9.3	19.9	Jan-March '78	*	*
April-June "	13.2	55.7	April-June "	*	*
July-Sept "	1.9	4.3	July-Sept "	*	*
Oct-Dec "	1.7	2.6	Oct-Dec "	8.6	25.6
Jan-March '57	2.6	5.7	Jan-March '79	11.4	44.9
April-June "	14.7	48.5	April-June "		
July-Sept "	4.4	5.9	July-Sept "		
Oct-Dec "	4.1	6.4	Oct-Dec "		

* No data available

Based on above relations, Kihonda flows have been extended. They are listed in column 3 of Table C A4-6.
As for the calculated Kihonda volumes, a random adjustment has been added or subtracted (see Annex 2 on hydrological models) to maintain the true variance of the flow volumes. The final, adjusted Kihonda figures are shown in column 6 of the same table.

A 4.4.4. Adjusting Kihonda flow volumes to flow volumes at the Mindu Dam site

Both Gauff [70] and Sir Alexander Gibbs [71] assume that throughout the year the flows passing Mindu Dam site are about 85% of the flows at the downstream Kihonda station. Noting that the catchment area at Kihonda is approximately 30% larger, but that this additional catchment receives less rainfall than the eastern Ulugurus of the catchment above the Mindu Dam site, 85% seems reasonable. However, the question is if this value can be taken throughout the year, because in the dry season, no runoff at all emerges from the additional catchment area. Table C A4-7 lists dry season spot-measurements at Konga, Mindu Dam site and Kihonda. The Mindu Dam site flow is in this period between 8 and 13% larger than the downstream Kihonda site flow. This figure increases at the end of the dry season, hence losses also occur between the Mindu Dam site and Kihonda.

Table C A4-6: Actual and derived Ngerengere River flows (× 10^6 m^3)

Year and season (1)	Ngerengere at Konga (2)	Unadjusted (3)	Ngerengere at Kihonda: Normal random number (4)	Ngerengere at Kihonda: Random adjusted (5)	Adjusted (6)	Ngerengere at Mindu (7)
1950 - 51						
April - June	-	-	-	-	-	-
July - Sept	-	-	-	-	-	-
Oct - Dec	-	-	-	-	6.7	6.7
Jan - March	-	-	-	-	7.5	7.5
TOTALS					-	-
1951 - 52						
April - June	-	-	-	-	59.5	50.6
July - Sept	-	-	-	-	8.0	8.0
Oct - Dec	-	-	-	-	32.9	28.0
Jan - March	-	-	-	-	16.5	14.0
TOTALS					116.6 (57.4)*	100.6 (50.0)*
1952 - 53						
April - June	-	-	-	-	43.2	36.7
July - Sept	-	-	-	-	5.1	5.1
Oct - Dec	-	-	-	-	5.4	5.4
Jan - March	-	-	-	-	1.4	1.5
TOTALS					55.1 (11.9)	48.7 (12.0)
1953 - 54						
April - June	-	-	-	-	44.4	37.7
July - Sept	-	-	-	-	8.8	8.8
Oct - Dec	-	-	-	-	5.0	5.5
Jan - March	-	-	-	-	6.3	6.3
TOTALS					64.5 (20.1)	58.3 (20.6)
1954 - 55						
April - June	10.5	-	-	-	37.4	31.8
July - Sept	1.5	-	-	-	3.5	3.9
Oct - Dec	1.8	-	-	-	1.9	2.1
Jan - March	3.1	-	-	-	9.5	9.5
TOTALS					52.3 (14.9)	47.3 (15.5)
1955 - 56						
April - June	16.7	-	-	-	59.8	50.8
July - Sept	3.0	-	-	-	7.4	7.4
Oct - Dec	3.4	-	-	-	6.8	6.8
Jan - March	9.3	-	-	-	19.9	16.9
TOTALS					93.9 (34.1)	81.9 (31.1)
1956 - 57						
April - June	13.2	-	-	-	55.7	47.4
July - Sept	1.9	-	-	-	4.3	4.7
Oct - Dec	1.7	-	-	-	2.6	2.9
Jan - March	2.6	-	-	-	5.7	5.7
TOTALS					68.3 (12.6)	60.7 (13.3)
1957 - 58						
April - June	14.7	-	-	-	48.5	41.2
July - Sept	4.4	-	-	-	5.9	5.9
Oct - Dec	4.1	-	-	-	6.4	6.4
Jan - March	3.7	-	-	-	9.4	9.4
TOTALS					70.2 (21.3)	62.9 (21.7)

Table C A4-6: Actual and derived Ngerengere River flows (× 10^6 m^3) (continued)

Year and season (1)	Ngerengere at Konga (2)	Ngerengere at Kihonda: Unadjusted (3)	Ngerengere at Kihonda: Normal random number (4)	Ngerengere at Kihonda: Random adjusted (5)	Ngerengere at Kihonda: Adjusted (6)	Ngerengere at Mindu (7)
1958 - 59						
April - June	14.9	-	-	-	44.7	38.0
July - Sept	1.9	-	-	-	4.9	5.4
Oct - Dec	1.2	-	-	-	2.6	2.9
Jan - March	1.7	-	-	-	3.9	4.3
TOTALS					56.1 (11.4)	50.6 (12.6)
1959 - 60						
April - June	6.5	16.2	-	-	16.2	13.8
July - Sept	2.7	5.8	-	-	5.8	5.8
Oct - Dec	2.4	4.9	- 1.43	- 2.2	2.7	3.0
Jan - March	5.0	9.9	+ 0.04	+ 0.1	10.0	10.0
TOTALS		36.8 (20.6)			34.7 (18.5)	32.6 (18.8)
1960 - 61						
April - June	24.6	95.5	+ 2.02	+11.7	107.2	91.1
July - Sept	4.0	7.8	+ 1.48	+ 2.3	10.1	8.6
Oct - Dec	2.6	5.3	- 0.51	- 0.8	4.5	4.9
Jan - March	3.6	7.2	+ 1.01	+ 1.6	8.8	8.8
TOTALS		115.8 (20.3)			126.6 (23.4)	113.4 (22.3)
1961 - 62						
April - June	14.8	51.9	- 0.69	- 4.0	47.9	40.9
July - Sept	6.8	16.4	- 1.10	- 6.4	10.0	10.0
Oct - Dec	29.3	116.4	- 0.73	- 4.2	112.2	95.4
Jan - March	12.9	43.5	- 0.36	- 2.1	41.4	35.2
TOTALS		228.2(176.3)			211.5(163.6)	181.3(140.6)
1962 - 63						
April - June	14.1	48.8	+ 0.51	+ 3.0	51.8	44.0
July - Sept	3.2	6.4	- 0.87	- 1.3	5.8	5.0
Oct - Dec	6.0	11.8	+ 0.76	+ 1.2	13.0	11.1
Jan - March	11.6	37.7	- 0.82	- 4.7	33.0	28.1
TOTALS		104.7 (55.9)			102.9 (51.1)	88.2 (44.2)
1963 - 64						
April - June	23.2	89.3	- 0.95	- 5.5	83.8	71.2
July - Sept	9.8	29.7	+ 1.16	+ 6.7	36.4	30.9
Oct - Dec	17.6	64.4	- 0.18	- 1.0	63.4	53.9
Jan - March	10.0	30.6	- 1.86	-10.6	20.0	17.0
TOTALS		214.0(124.7)			203.6(119.8)	173.0(101.8)
1964 - 65						
April - June	15.8	56.4	- 0.47	- 2.7	53.7	45.7
July - Sept	4.2	8.4	- 0.13	- 0.2	8.2	8.2
Oct - Dec	3.6	7.2	+ 0.14	+ 0.2	7.4	7.4
Jan - March	4.1	8.2	+ 0.68	+ 1.0	9.2	9.2
TOTALS		80.2 (23.8)			78.5 (24.8)	70.5 (24.8)
1965 - 66						
April - June	16.2	58.1	+ 0.46	+ 2.7	60.8	51.7
July - Sept	3.8	7.6	- 1.32	- 2.0	5.6	5.6
Oct - Dec	8.8	25.3	+ 0.84	+ 4.9	30.2	25.7
Jan - March	7.3	18.6	- 0.43	- 2.5	16.1	13.7
TOTALS		109.6 (51.5)			112.7 (51.9)	96.7 (45.0)

Table C A4-6: Actual and derived Ngerengere River flows (× 10^6 m^3) (continued)

Year and season (1)	Ngerengere at Konga (2)	Ngerengere at Kihonda: Unadjusted (3)	Ngerengere at Kihonda: Normal random number (4)	Ngerengere at Kihonda: Random adjusted (5)	Ngerengere at Kihonda: Adjusted (6)	Ngerengere at Mindu (7)
1966 - 67						
April - June	15.1	53.3	+ 1.08	+ 6.2	59.5	50.6
July - Sept	3.4	6.1	+ 1.16	+ 1.8	7.9	7.9
Oct - Dec	2.9	5.9	- 1.86	- 2.9	3.0	3.3
Jan - March	1.3	2.7	- 0.63	- 1.0	1.7	1.9
TOTALS		68.0 (14.7)			72.1 (12.6)	63.7 (13.1)
1967 - 68						
April - June	11.5	37.2	- 0.51	- 3.0	34.2	29.1
July - Sept	8.9	25.7	+ 0.15	+ 0.9	26.6	22.6
Oct - Dec	7.3	18.6	+ 0.36	+ 2.1	20.7	27.6
Jan - March	4.7	9.3	- 1.82	- 2.8	6.5	6.5
TOTALS		90.3 (53.6)			88.0 (53.8)	75.8 (46.7)
1968 - 69						
April - June	20.9	79.0	- 1.10	- 0.6	78.4	66.6
July - Sept	3.5	7.0	- 0.13	- 0.2	6.8	6.8
Oct - Dec	7.5	19.5	- 0.79	- 4.6	14.9	12.7
Jan - March	4.9	9.7	+ 0.49	+ 0.8	10.5	8.9
TOTALS		151.4 (36.2)			110.6 (32.2)	95.0 (28.4)
1969 - 70						
April - June	15.4	54.6	- 0.47	- 2.7	51.9	44.1
July - Sept	2.4	4.9	- 0.08	- 0.1	4.8	5.3
Oct - Dec	3.3	6.6	+ 1.50	+ 2.3	8.9	8.9
Jan - March	6.2	13.7	- 2.08	-12.0	1.7	1.9
TOTALS		79.8 (25.2)			67.3 (15.4)	60.2 (16.1)
1970 - 71						
April - June	9.2	27.0	- 0.45	- 2.6	24.4	20.7
July - Sept	2.0	4.1	+ 1.34	+ 2.1	6.2	6.2
Oct - Dec	1.7	3.5	+ 0.69	+ 1.0	4.5	4.9
Jan - March	3.2	6.4	- 0.90	- 1.4	5.0	5.5
TOTALS		41.0 (14.0)			40.1 (15.7)	37.3 (16.6)
1971 - 72						
April - June	11.0	35.0	- 0.06	- 0.4	34.6	29.4
July - Sept	1.9	3.9	- 0.19	- 0.3	3.6	4.0
Oct - Dec	0.7	1.5	- 0.37	- 0.6	0.9	1.0
Jan - March	0.9	1.9	+ 0.13	+ 0.2	2.1	2.3
TOTALS		42.3 (7.3)			41.2 (6.6)	36.7 (7.3)
1972 - 73						
April - June	18.3	67.5	- 0.39	- 2.3	65.2	55.4
July - Sept	2.8	5.7	+ 0.04	+ 0.1	5.8	5.8
Oct - Dec	8.1	22.1	- 0.40	- 2.3	19.8	16.8
Jan - March	4.9	9.7	- 0.11	- 0.2	9.5	9.5
TOTALS		105.0 (37.5)			100.3 (35.1)	87.5 (32.1)
1973 - 74						
April - June	18.5	68.4	- 0.92	- 1.4	67.0	57.0
July - Sept	3.5	7.0	+ 1.93	+ 3.0	16.0	10.0
Oct - Dec	1.6	3.3	- 1.28	- 2.0	1.3	1.4
Jan - March	1.4	2.9	- 1.24	- 1.9	1.0	1.1
TOTALS		81.6 (13.2)			79.3 (18.3)	69.5 (12.5)

Table C A4-6: Actual and derived Ngerengere River flows (× 10^6 m^3) (concluded)

Year and season (1)	Ngerengere at Konga (2)	Ngerengere at Kihonda: Unadjusted (3)	Ngerengere at Kihonda: Normal random number (4)	Ngerengere at Kihonda: Random adjusted (5)	Ngerengere at Kihonda: Adjusted (6)	Ngerengere at Mindu (7)
1974 - 75						
April - June	13.9	47.9	- 0.75	- 4.3	43.6	37.1
July - Sept	2.1	4.3	- 0.86	- 1.3	3.0	3.3
Oct - Dec	2.0	4.1	- 0.12	- 0.2	3.9	4.3
Jan - March	2.3	4.7	+ 0.40	+ 0.6	5.3	5.3
TOTALS		61.0 (13.1)			55.8 (12.2)	50.0 (12.9)
1975 - 76						
April - June	11.6	37.7	+ 0.83	+ 4.8	42.5	36.1
July - Sept	2.2	4.5	+ 0.14	+ 0.2	4.7	5.2
Oct - Dec	1.9	3.9	+ 0.22	+ 0.3	4.1	4.5
Jan - March	1.8	3.7	- 0.12	- 0.2	3.9	4.3
TOTALS		49.8 (12.1)			55.2 (12.7)	50.1 (14.0)
1976 - 77						
April - June	8.0	21.7	- 0.40	- 2.3	19.4	16.5
July - Sept	2.3	4.7	- 0.54	- 0.8	3.9	4.3
Oct - Dec	1.7	3.5	+ 0.71	+ 1.1	4.6	5.1
Jan - March	3.2	6.4	+ 0.51	+ 0.8	7.2	7.2
TOTALS		36.3 (14.6)			35.1 (15.7)	33.1 (16.6)
1977 - 78						
April - June	9.9	30.1	- 0.21	- 1.2	28.9	24.6
July - Sept	2.6	5.3	+ 1.19	+ 1.8	7.1	7.1
Oct - Dec	8.5	23.9	+ 0.48	+ 2.8	26.7	22.7
Jan - March	5.5	10.8	+ 0.89	+ 1.4	12.2	10.4
TOTALS		70.1 (40.0)			74.8 (45.9)	64.8 (40.2)
1978 - 79						
April - June	13.9	47.9	+ 0.32	+ 1.9	49.8	42.3
July - Sept	2.0	4.1	- 0.02	0	4.1	4.5
Oct - Dec	8.6	25.6	-	-	25.6	21.8
Jan - March	11.4	44.9	-	-	44.9	38.2
TOTALS		122.5 (74.6)			124.4 (74.6)	106.8 (64.5)

* The figures in brackets refer to the July - March totals.

For this reason the approach used for adjusting flows has been slightly different from the one in the reports mentioned before. For the larger flows the same approach has been used, thus 85% of the Kihonda flows has been taken; for the low flows 110% has been taken; while the in-between flows were not adjusted. See also Table C A4-8. Using this approach the mean flow at the Mindu Dam site is 88% of the Kihonda flow. Table C A4-6, column 7, gives the final results, being the three-monthly Mindu Dam site discharge volumes from October 1950 up to March 1979.

Table C A4-7: Corresponding discharges (m^3/s) of the Ngerengere River at Konga, Mindu Dam site and Kihonda.

Data	Konga	Mindu Dam site	Kihonda	ratio	
				Kihonda / Konga	Kihonda / Mindu Dam s.
20/06/78	0.417 *	-	1.657	3.97	-
2/08/78	0.234	-	0.649	2.77	-
28/08/78	0.185 *	0.405	0.371	2.01	0.92
26/09/78	0.143	0.292	0.262	1.83	0.90
23/10/78	0.114	0.172	0.149	1.31	0.87

* All discharges measured by current meter, except the ones indicated by an asterix, where gauge reading has been related to the rating curve.

Table C A4-8: Adjustment factors for the discharge at Kihonda to obtain discharge at Mindu Dam site.

Discharge at Kihonda (x 10^6 m^3/3-month)		Mindu Dam site discharge volume as % of Kihonda discharge volume
$D > 10$	($1.27\ m^3/s$)	85
$5 < D \leq 10$		100
$D \leq 5$	($0.64\ m^3/s$)	110

A 4.5. Reservoir analysis

Table C A4-9 shows the reconstructed flow series at the Mindu Dam site. This series will be regarded as in-flow into the reservoir, although it is a conservative assumption for the low flows. At present there are rather swampy areas above the site, causing losses between the future place of in-flow into the reservoir and the Mindu Dam site.

The average annual in-flow is 74.9 x 10^6 m^3; the life storage of the reservoir at stage I and II is 13% and 24% respectively. This is not particularly large and the reservoir will over-flow almost every year. The most critical flow period of the reconstructed flow series for this particular reservoir will thus be rather short because overyear storage is only occasionally a necessity.

Discharges of three critical periods are analysed, while a critical period is defined as a period with very low flows. The first is the period analysed by Gibbs and partners [71] which is not a natural sequence but a combination of low-flow months. This combination is analysed with the discharges calculated at the Mindu Dam site in this report and not with the discharges mentioned in the report of Gibbs [71]. This flow series is listed in Table C A4-10. The most critical discharges from the reconstructed series are from June 1971 to March 1972 and part of the July 1970 to March 1972 period, called critical period I and listed in Table C A4-10. The discharges over the July 1958 - March 1960 period are also analysed. This is the only time on the record that the reservoir does not over-flow because remaining water from the low-flow period and in-flow in the wet period is less than the requirements in the wet period and the total life storage of the reservoir, which has to be filled up. This is called critical period II.

Table C A4-9: Reconstructed flow series (x 10^6 m^3) for the Ngerengere River at the Mindu Dam site

Year	April-June period	July-March period	Annual Total	Year	April-June period	July-March period	Annual Total
1951/52	50.6	50.0	100.6	1966/67	50.6	13.1	63.7
52/53	36.7	12.0	48.7	67/68	29.1	46.7	75.8
53/54	37.7	20.6	58.3	68/69	66.6	28.4	95.0
54/55	31.8	15.5	47.3	69/70	44.1	16.1	60.2
55/56	50.8	31.1	81.9	70/71	20.7	16.6	37.3
56/57	47.4	13.3	60.7	71/72	29.4	7.3	36.7
57/58	41.2	21.7	62.9	72/73	55.4	32.1	87.5
58/59	38.0	12.6	50.6	73/74	57.0	12.5	69.5
59/60	13.8	18.8	32.6	74/75	37.1	12.9	50.0
60/61	91.1	22.3	113.4	75/76	36.1	14.0	50.1
61/62	40.7	140.6	181.3	76/77	16.5	16.6	33.1
62/63	44.0	44.2	88.2	77/78	24.6	40.2	64.8
63/64	71.2	101.8	173.0	78/79	42.3	64.5	106.8
64/65	45.7	24.8	70.5				
65/66	51.7	45.0	96.7	Mean	42.9 (5.46 m^3/s)	32.0 (1.35 m^3/s)	74.9 (2.38 m^3/s)

Table C A4-10: Flow series used by Gibbs [71] and the most severe, natural series from regression analysis called Critical period I (all values x 10^6 m^3)

	Gibbs and partners		From regression analysis	
Period	Flow at Kihonda	Flow at Mindu Dam site	Period	Flow at Mindu Dam site
Assumption	-	Reservoir full	-	Reservoir full
July-Sept '58	4.9	4.2	July-Sept '70	6.2
Oct-Dec '58	2.6	2.2	Oct-Dec '70	4.9
Jan-March '59	3.9	3.3	Jan-March '71	5.5
April-June '59	16.2	13.8	April-June '71	29.4
July '58 and				
Aug-Sept '52	4.9	4.2	July-Sept '71	4.0
Oct-Dec '52	5.4	4.6	Oct-Dec '71	1.0
Jan-March '53	1.4	1.2	Jan-March '72	2.3

Table C A4-11: Water requirements for 1996 (0.600 m^3/s for treatment, 0.185 m^3/s compensation water) and losses (evaporation minus precipitation)

Period	Requirements (x 10^6 m^3)	Losses (mm)
April-June	6.2	250
July-September	6.3	450
October-December	6.2	350
January-March	6.1	350
Total Year	24.8	1400

To carry out the reservoir analysis, water requirements, losses and reservoir characteristics are needed. The latter ones are given in figure C A4-6. Only the characteristics based on stage II of the Mindu Dam construction' (full supply level 509.5 m a MSL and no siltation) will be analysed. Table C A4-11 lists water requirements and net evaporation. The average water requirements throughout the year 1996 were taken from Gibbs [71]. This particular report did not mention the distribution over the year. It is assumed that the requirements are constant, although they will be different for the wet and dry season, but not to a great extent, because most water is required for industrial purposes. Gibbs [71] takes the losses as 5 mm a day throughout the year, which is mainly evaporated. Part of these losses however are compensated by precipitation falling on the reservoir and the net evaporation is less. A rather conservative year with only 425 mm of rain has been chosen for the loss calculation. Thus losses are (5 mm x 365 - 425 mm = 1400 mm).

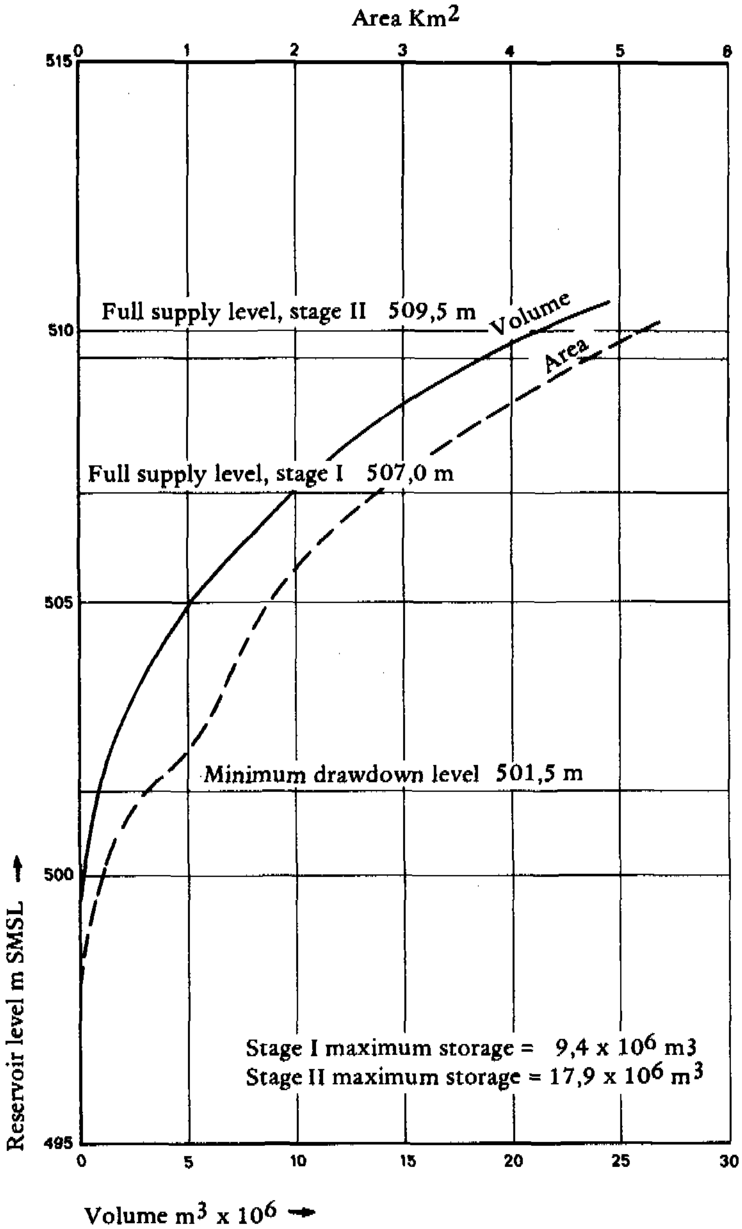


Figure C A4-6 Mindu Reservoirs volume/area characteristics(After Gibbs) [71]

Table C A4-12: Reservoir analysis of stage II of Mindu Dam development for the year 1996, siltation not taken into account. *

Period	In-flow	Requirements	Net-Evaporation	Accumulated Volume	Spill
	Gibbs [71] critical period			17.9 (Reservoir full)	-------
July-Sept '58	4.9	6.3	1.9	14.6	-------
Oct-Dec '58	2.6	6.2	1.1	9.9	-------
Jan-March '59	3.9	6.1	0.8	6.9	-------
April-June '59	16.2	6.2	0.8	16.1	-------
July '58- Aug, Sept'52	4.9	6.3	1.7	13.0	-------
Oct-Dec '52	5.4	6.2	1.2	11.0	-------
Jan-May '53	1.4	6.1	0.7	5.6	-------
	MDWSP critical period I			17.9 (Reservoir full)	-------
July-Sept '70	6.2	6.3	2.0	15.8	-------
Oct-Dec '70	4.9	6.2	1.4	13.1	-------
Jan-May '71	5.5	6.1	1.2	11.3	-------
April-June '71	29.4	6.2	1.0	17.9 Reservoir full	15.6
July-Sept '71	4.0	6.3	1.8	13.8	-------
Oct-Dec '71	1.0	6.2	1.0	7.6	-------
Jan-May '72	2.3	6.1	0.6	3.2	-------
	MDWSP critical period II			17.9 (Reservoir full)	-------
July-Sept '58	5.4	6.3	1.9	15.1	-------
Oct-Dec '58	2.9	6.2	1.2	10.6	-------
Jan-May '59	4.3	6.1	0.9	7.9	-------
April-June '59	13.8	6.2	0.8	14.7	-------
July-Sept '59	5.8	6.3	1.6	12.6	-------
Oct-Dec '59	3.0	6.2	1.0	8.4	-------
Jan-May '60	10.0	6.1	1.0	11.3	-------

* All values x 10^6 m^3
Minimum left over storage experienced in the different critical periods resp. 5.6, 3.2 and 7.9 × 10^6 m^3

Based on above assumptions and the three periods mentioned above, the reservoir-analysis has been carried out in Table C A4-12. It can be seen that critical period I gives a slightly lower minimum storage, like the Gibbs critical period. In both cases the reservoir would not fail. However if the reservoir sedimentation will be taken into account and taken, as Gibbs does, to be 0.5% by volume of the in-flow, then the actual storage should be decreased by 7 x 10^6 m^3 (20 x 0.005 x average annual runoff), and in both the Gibbs critical period and the critical period I the reservoir will fail if these low-flow periods would occur at the end of the 20 year period. A siltation of 0.5% by volume (~ 7 g/l) of silt is considered very high. An average of 1 g/l was found in the detailed study of the Kikundi (Annex 3), while this figure should be lower for the Mindu reservoir, which catchment also has rather flat and swampy areas. This, combined with the fact that the reservoir over-flows almost every wet season, causing a low trap-efficiency, should cause a siltation of only 10% of the Gibbs figure, so 0.7 x 10^6 m^3. In this case no troubles are expected and sufficient (> 50 l/s) flow is available even for other purposes, notably for rural water supply in the Ngerengere Valley below the dam.

The only year in which the reservoir should not have over-flowed is in the April - June 1959 period, as can be seen from the analysis of critical period II also carried out in Table C A4-12. Although the reservoir did not fill up, it did not have any impact on the minimum storage. The minimum storage at the end of the dry period after the April - June 1959 wet period was still higher than the minimum storage before this period.

Hence, it can be stated that with a 97% reliability (27 out of 28 years) failure of the reservoir is only dependent on the July - March in-flow.

Taking this into consideration the minimum reservoir size with an accepted probability of failure can be calculated for the 1966 requirement, as will be done next.

Table C A4-9 lists, besides the annual volumes, also the July-March volumes. They are plotted on log-normal paper in figure C A4-7. The 5% July-March volume is 7.7 x 10^6 m^3. The required yield for the July-March period is 18.6 x 10^6 m^3, while the net losses for the reservoir going from full to empty in this period can be estimated at 4.0 x 10^6 m^3, thus:

Requirements + losses	22.6 x 10^6 m^3
5% low-flow	7.7 x 10^6 m^3
Difference (required from storage)	14.9 x 10^6 m^3

Stage II life storage is calculated as 17.9 x 10^6 m^3, hence 3 x 10^6 m^3 is available for siltation. If a reliability of 99% is required, the needed storage is equal to the stage II life storage and no space is available for siltation.
If accepting a reliability of 95% (failure to fulfill requirements less than 1 year out of 20) and accepting a siltation below 3.0 x 10^6 m^3, some water is available for rural water supply below the dam.

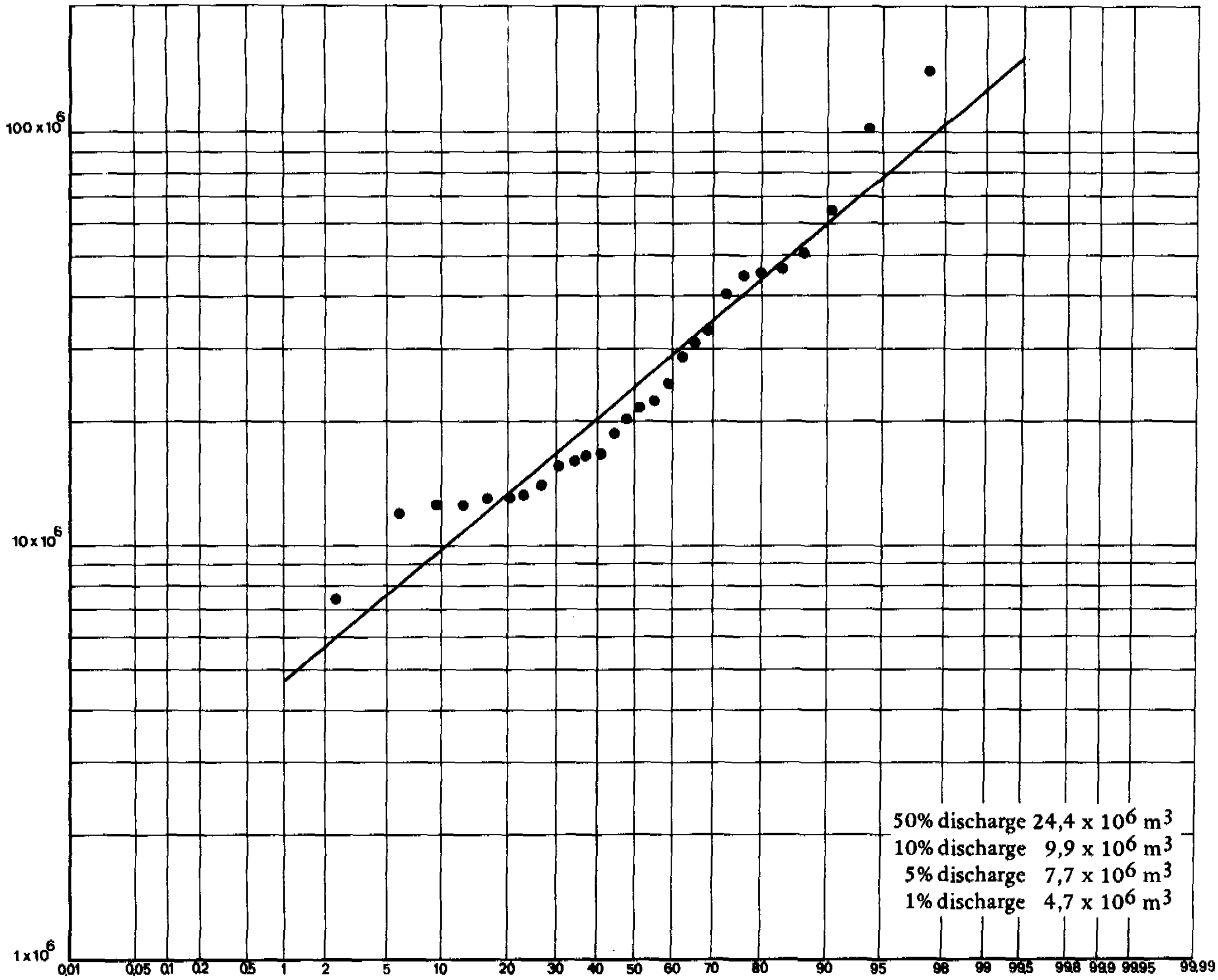


Figure C A4-7 Frequency analysis of July-March discharges at Mindu dam-site (log probability paper)

A 4.6. Suggestions for increasing the yield of the Mindu reservoir

Using the same arguments as in the former paragraph, it can be calculated that failures will only arise if sedimentation is larger than 0.2% by volume of in-flow, as expected by Gibbs [71], but considered high by the present study.

The potential yield of the reservoir could be increased by enlarging the Mindu reservoir above 24% of the mean annual runoff by heightening the dam above the stage II level. However, this is not to be expected, because this requires relocation of the present Dar-es-Salaam - Iringa road and the Zambia oil pipeline. The costs of relocation are considered too high.

Slight increases of low-flows into the reservoir could be created by draining the swampy area south-west of the Sanga Sanga - Mlali road (see figure C A4-1). No flow passed this road during the dry season of 1978 while the Mlali river, which flowed into the swamp, still conveyed some water.
The results of draining seem to be minor and better results can be obtained by abstracting part of the flow of the Mgeta river, which flows east of the Upper Ngerengere river (see figure C A4-1). The low-flows of the river Mgeta at gauging station 1HB2 are 0.5 m^3/s with a probability of non-exceedence of 5% (see paragraph 3.3 chapter 3). Water from the Mgeta river at the site of the gauging station 1HB2 could be pumped over the catchment

boundary into the Mlali catchment from where it can flow to the reservoir. The level of the Mgeta river at 1HB2 is approximately at 940 m (zero of staf gauge), while the lowest point of the catchment boundary is at 1048 m as measured by the Consultant, which is the saddle through which the Mlali - Mgeta road passes. Hence, a lift of 108 m is required over a distance (measured along the road) of 950 m. An alternative solution may be to tap the Mgeta river upstream, perhaps near Bunduki, and to convey the water by gravity along the 1050 contour. According to general field surveys a very long intake-main is required (~ 8 km). No specific intake point can be mentioned, because no contour map exists of the Mgeta catchment, although excellent aerial photographs are available.
The same idea has occurred to the Morogoro-district irrigation section of the Department of Agriculture, although for a different reason. They want to enlarge the low-flows of the Mlali river in order to be able to expand the acreage of the Mlali irrigation scheme near Mlali.

A 4.7. Recommendations

It can be concluded from the three-monthly extended river flow series, that low-flows can be more critical than Gibbs, [71] expected. By using monthly data a new analysis should be carried out along the same lines as in this report, both concerning flows and expected water requirements to obtain a higher reliability of the analysis. Many more calculations have to be performed and the use of a computer becomes attractive.

Relations between Konga (1HA9A) flow and out-flow of the new reservoir should be checked annually to verify the correctness of the above-mentioned analysis.

Every three years the rate of sedimentation of the reservoir should be measured. If the sedimentation is unduly high, other solutions, such as mentioned in the former paragraph, should be considered in order to increase the yield of the reservoir.

D A T A

Data CD 1

Precipitation

CD 1. PRECIPITATION STATIONS

Registered Number	Name of station	Latitude S		Longitude E		Altitude m a MSL
95.3702	Kwekivu School	5	46	37	23	850
95.3704	Kwadundwa	5	40	37	40	850
95.3809	Sakura Estate	5	37	38	53	40
95.3831	Kwamsisi Native Court	5	52	38	37	150
96.3600	Mpwapwa Veterinary Office	6	20	36	30	1130
96.3601	Mpwapwa School	6	21	36	30	1000
96.3606	Mpwapwa Evergreen Forest	6	17	36	33	1780
96.3618	Ukaguru Forest Station	6	20	36	57	1680
96.3621	Chakwale	6	04	36	58	910
96.3623	Tubugwe Farm	6	22	36	38	1020
96.3625	Myombo Sisal Estate	6	55	36	58	200
96.3626	Gairo	6	09	36	54	1790
96.3627	Nongwe	6	28	36	54	1880
96.3628	Mwasa	6	40	36	45	700
96.3629	Kongwa Administration Office	6	12	36	25	1520
96.3630	Sagara	6	16	36	33	1220
96.3631	Mlali	6	18	36	46	1520
96.3632	Mseta Ujamaa village	6	23	36	43	1520
96.3633	Pandambili	6	04	36	44	1220
96.3634	Chamkoro Primary School	6	20	36	40	-
96.3635	Gulwe	6	27	36	25	-
96.3636	Lumuma Primary School	6	50	36	38	-
96.3638	Mtanana Primary School	6	05	36	32	-
96.3642	Pandambili Primary School	6	05	36	42	-
96.3644	Kidete Primary School	6	39	36	41	910
96.3700	Morogoro Agricultural Office	6	51	37	40	580
96.3701	Kilosa Agricultural Office	6	50	37	00	490
96.3702	Tungi Sisal Estate	6	46	37	42	500
96.3703	Berega Mission	6	12	37	10	850
96.3709	Kimamba Railway Station	6	47	37	08	460
96.3710	Muskati Mission	6	05	37	28	1830
96.3711	Kingolwira Prison Farm	6	45	37	48	460
96.3712	Pangawe Sisal Estate	6	47	37	49	460
96.3713	Scutari Sisal Estate	6	47	37	10	460
96.3714	Marios Sisal Estate	6	48	37	12	440
96.3715	Kingolwira Sisal Estate	6	45	37	46	460
96.3716	Kilosa Sisal Estate	6	51	37	00	460
96.3717	Melela	6	58	37	31	580
96.3718	Mhonda Mission	6	08	37	35	490
96.3719	Msowero Ginnery	6	32	37	12	1070
96.3720	Tegetero Mission	6	57	37	43	990
96.3721	Mvomero	6	19	37	26	490
96.3725	Tangeni Mission	6	56	37	36	640
96.3732	Ilonga	6	46	37	02	500
96.3736	Chazi	6	12	37	34	490
96.3738	Kisangata Sisal Estate	6	37	37	10	460

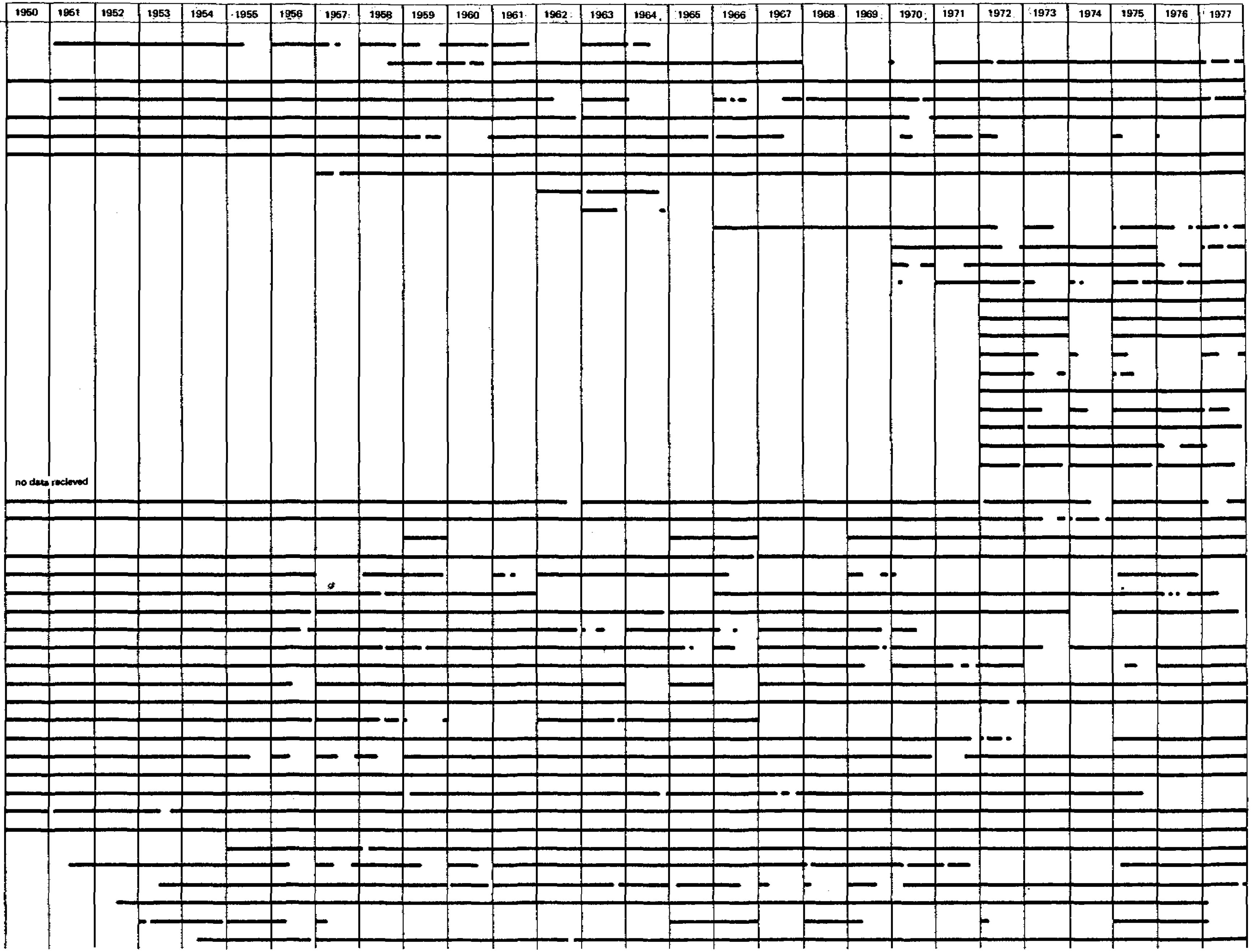
Registered Number	Name of station	Latitude S		Longitude E		Altitude m a MSL
96.3741	Mkuyuni	6	57	37	49	370
96.3742	Mtibwa Estate	6	08	37	39	460
96.3743	Magole	6	24	37	21	460
96.3745	Mondo	6	57	37	38	1120
96.3746	Morningside Farm	6	54	37	40	1450
96.3746A	Morningside Kidunda	6	52	37	40	1000
96.3747	Hobwe	6	59	37	34	740
96.3748	Luhungo	6	55	37	38	880
96.3749	Kwandewa Masa	6	58	37	35	880
96.3751	Mlali	6	58	37	20	590
96.3752	Morogoro Water Department	6	49	37	39	510
96.3753	Mfumbwe	6	54	37	59	520
96.3754	Mlali Irrigation Scheme	6	57	37	33	610
96.3755	Madoto	6	44	37	05	520
96.3756	Wami Prison Farm	6	24	37	26	580
96.3758	Msowero	6	30	37	13	610
96.3760	Kinole Primary School	6	54	37	46	300
96.3761	Mvumi Agricultural Office	6	37	37	10	490
96.3762	Morogoro Teachers Training Centre	6	50	37	42	610
96.3763	Morogoro Agricultural College	6	51	37	40	540
96.3764	Chanjuru Sisal Estate	6	48	37	03	-
96.3765	Ilonga Estate (Msimba Seed Farm)	6	44	37	04	490
96.3766	Kivungu Sisal Estate	6	56	37	02	-
96.3767	Rudewa Sisal Estate	6	42	37	08	440
96.3768	Chazi Rehabilitation Centre	6	10	37	35	370
96.3769	Mafiga Sisal Estate	6	50	37	38	-
96.3770	Kihonda Sisal Estate	6	46	37	39	580
96.3771	Kidete Sisal Estate	6	26	37	15	-
96.3772	Vitonga Sisal Estate	6	54	37	36	550
96.3773	Magubika	6	15	37	15	1310
96.3775	Kilangali	6	57	37	05	460
96.3776	Morogoro Meteorological Station	6	50	37	39	530
96.3778	Mtibwa Sugar Estate (Lukenge)	6	00	37	36	400
96.3779	Kilosa Natural Resources Office	6	46	37	03	670
96.3780	Melela	6	55	37	25	500
96.3781	Mangai	6	55	37	20	480
96.3782	Isanga Sisal Estate	6	55	37	02	-
96.3800	Bagamoyo Agricultural Office	6	25	38	55	10
96.3801	Ngerengere Sisal Estate	6	47	38	07	210
96.3804	Mandera Mission	6	13	38	23	210
96.3805	Lugoba Mission	6	28	38	15	240
96.3808	Athina Sisal Estate	6	47	38	10	210
96.3810	Fatemi Sisal Estate	6	47	38	14	230

Registered Number	Name of station	Latitude S		Longitude E		Altitude m a MSL
96.3812	Kwaruhombo	6	05	38	08	460
96.3813	Mgudeni Sisal Estate	6	47	38	08	210
96.3817	Kiwege Sisal Estate	6	48	38	06	210
96.3819	Kinonko Sisal Estate	6	45	38	01	270
96.3822	Kikondeni Sisal Estate	6	54	38	13	150
96.3828	Ubena Prison Camp	6	37	38	05	300
96.3831	Kate Sisal Estate	6	38	38	09	-
96.3833	Ubena Zomozi	6	37	38	10	-
96.3834	Chalinze Catholic Mission	6	38	38	20	-
96.3604	Sanje Estate	7	49	36	55	370
97.3605	Mazobwe	7	40	36	02	1680
97.3606	Malolo	7	20	36	33	510
97.3607	Ulaya	7	04	36	34	610
97.3608	Kisanga Msolwa	7	18	36	47	820
97.3609	Sonjo	7	44	36	55	-
97.3610	Ichonde	7	41	36	58	-
97.3611	Mikumi	7	24	36	59	790
97.3700	Duthumi Estate	7	23	37	48	90
97.3705	Singiza Mission	7	15	37	43	460
97.3706	Matombo Mission	7	05	37	46	390
97.3708	Kisaki	7	28	37	36	180
97.3709	Tununguo Mission	7	03	37	58	170
97.3711	Kikeo Mission	7	13	37	33	610
97.3713	Kienzema Mission	7	07	37	36	1680
97.3714	Mvuha	7	12	37	51	130
97.3715	Bunduki	7	02	37	37	1280
97.3716	Mizungu Mgeta	7	04	37	35	1100
97.3717	Mtamba	7	04	37	46	320
97.3719	Bwakira Juu	7	16	37	44	340
97.3721	Stieglers Gorge	7	48	37	55	150
97.3724	Kibungo Mission	7	04	37	41	980
97.3725	Kibuko Coffee Plot	7	06	37	33	-
97.3726	Kibungo	7	01	37	48	270
97.3727	Bwakira Estate	7	27	37	45	150
97.3728	Tawa Health Centre	7	02	37	44	460
97.3729	Kilombero Sugar Estate	7	40	37	00	300
97.3730	Kikoboga Mikumi	7	21	37	09	550
97.3731	Mkata Settlement	7	08	37	38	580
97.3732	Tindiga	7	00	37	00	460
97.3808	Kidunda	7	16	38	18	90
97.3809	Ng'hesse (Utari Bridge)	7	01	38	19	90
9 00126 [1])	Lufusi	6	50	36	36	-
9 00127 [1])	Ngalanilo	6	52	36	44	-
9 00128 [1])	Mdukwi Juu	6	54	36	47	-
9 00129 [1])	Kivegeya	6	31	36	49	-
9 00130 [1])	Mdukwi Chini	6	51	36	41	-
1 GDA 17 [1])	Lumuma	6	40	36	41	-

[1]) obtained from Water Department, Ubungo

Precipitation Stations (Data available as from 1950 to 1977)

Registration Number	Station
95.3702	Kwakivu School
95.3704	Kwadundwa
95.3809	Sakura Estate
95.3831	Kwamsisi Natural Court
96.3600	Mpwapwa Vetenary Office
96.3601	Mpwapwa School
96.3606	Mpwapwa Evergreen Forest
96.3618	Ukaguru Forest Station
96.3621	Chakwale
96.3623	Tubugwe Farm
96.3625	Myombo Sisal Estate
96.3626	Gairo
96.3627	Nogwe
96.3628	Mwasa
96.3629	Kongwa Administration Office
96.3630	Sagara
96.3631	Mlali
96.3632	Mseta Ujamaa
96.3633	Pandambili
96.3634	Chamkoro Primary School
96.3635	Gulwe
96.3636	Lumuma Primary School
96.3638	Mtanana Primary School
96.3642	Pandambili Primary School
96.3644	Kidete Primary School
96.3700	Morogoro Agricultural Office
96.3701	Kilosa Agricultural Office
96.3702	Tungi Sisal Estate
96.3703	Berega Mission
96.3709	Kimamba Railway Station
96.3710	Muskati Mission
96.3711	Kingolwira Prison
96.3712	Pangawe Sisal Estate
96.3713	Scutari Sisal Estate
96.3714	Marios Sisal Estate
96.3715	Kingolwira Sisal Estate
96.3716	Kilosa Sisal Estate
96.3717	Melela
96.3718	Mhonda Mission
96.3719	Msowero Ginnery
96.3720	Tegetero Mission
96.3721	Mvomero
96.3725	Tangeni Mission
96.3732	Ilonga
96.3736	Chazi
96.3738	Kisangata Sisal Estate
96.3741	Mkuyuni
96.3742	Mtibwa Sugar Estate
96.3743	Magole
96.3745	Mondo



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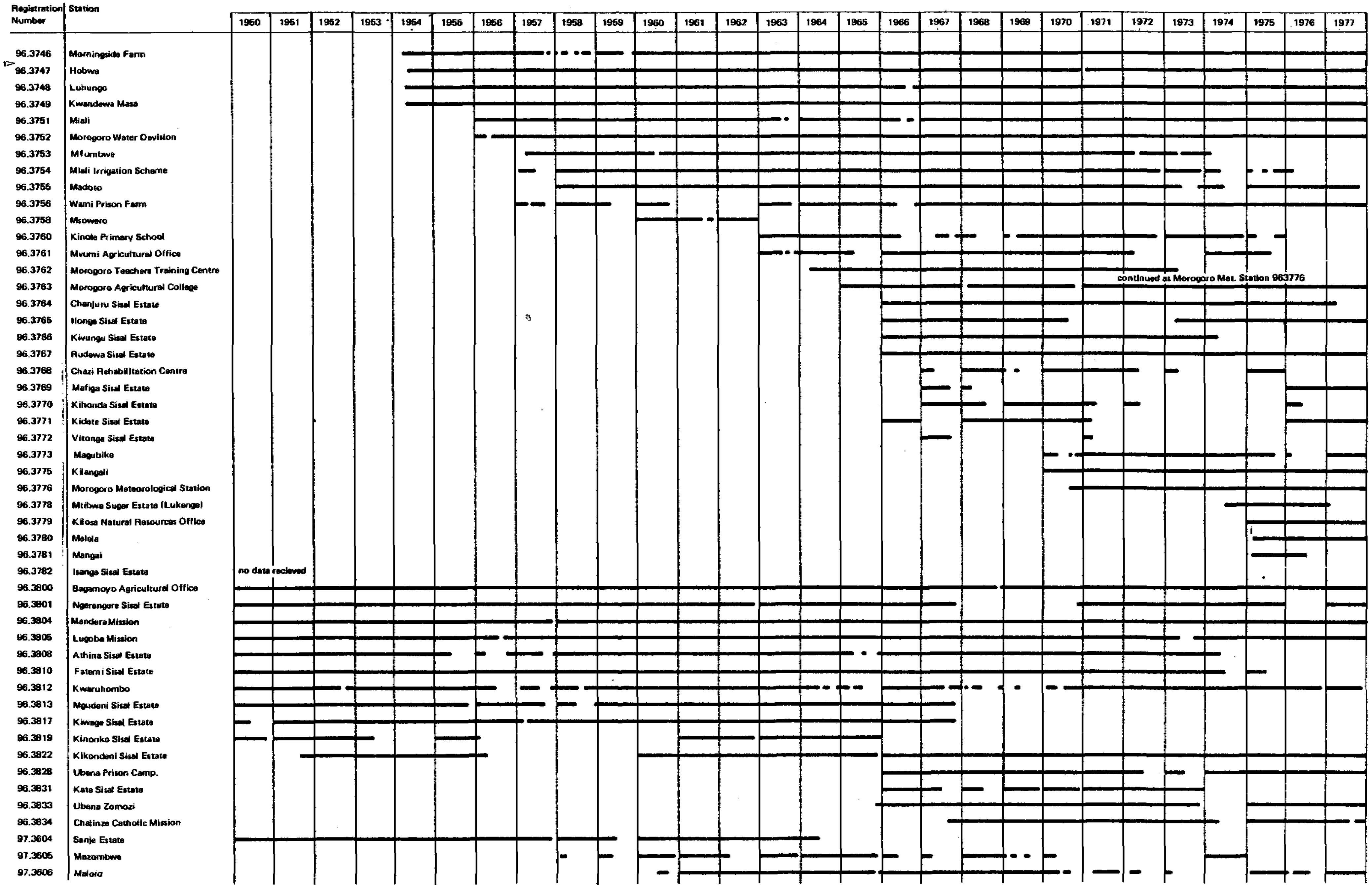
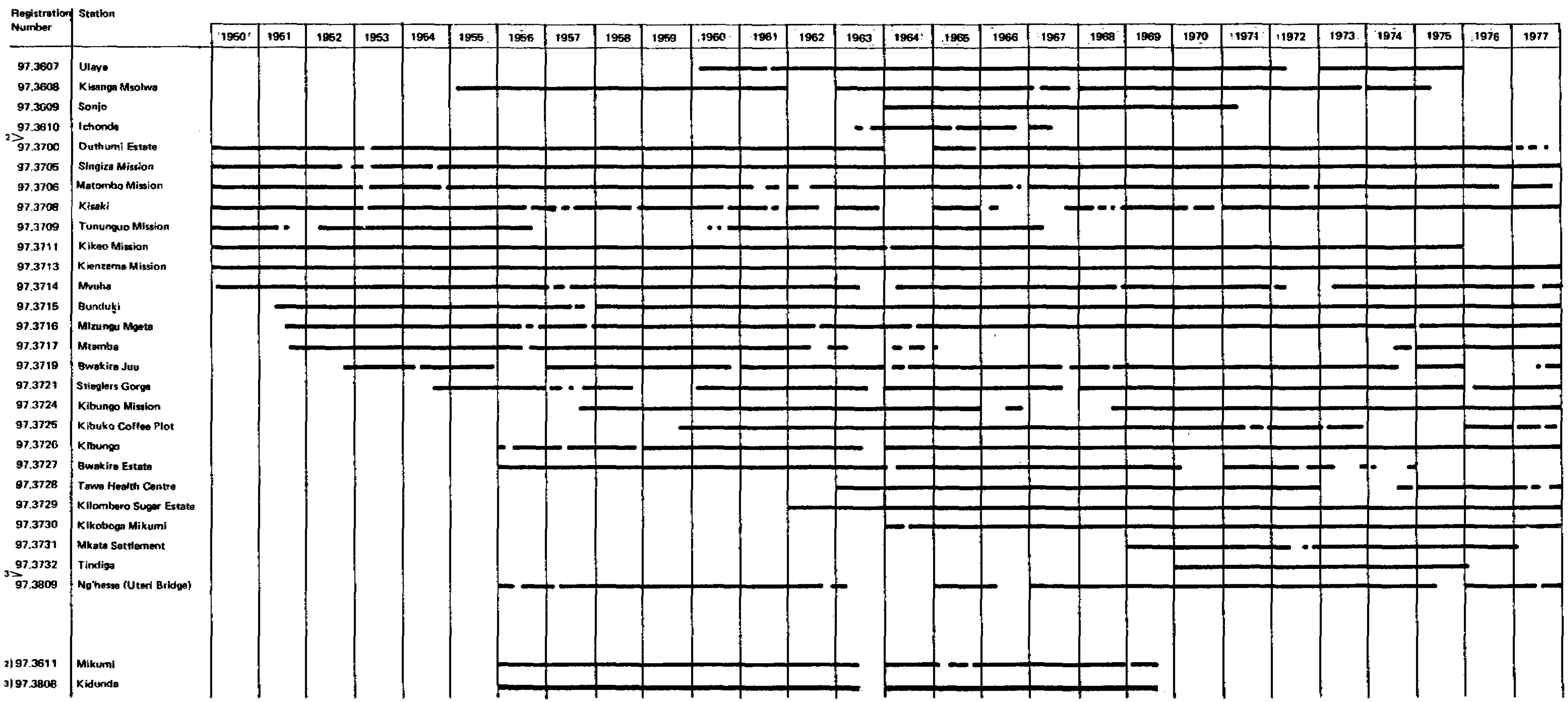


1) 96.3746a Morningside Kidunda

continued



9.0026	Lufusi	not processed
9.0027	Ngalanilo	not processed
9.0028	Mdukwi Juu	not processed
9.0029	Kivegeya	not processed
9.0030	Mdukwi Chini	not processed
1GDA17	Lumuna	

<u>Legend</u> (rainfall tables)

*	= not available because of missing data
( )	= estimated value
n	= number of years involved in determination of m, s and C_v
m	= mean (mm)
s	= standard deviation (mm)
C_v	= coefficient of variation (-)
C_s	= coefficient of skewness (-)

Monthly Rainfall (mm) for Station: KWEKIVU SCHOOL

Registration Number: 95.3702

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1950	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1951	*	121.7	45.7	169.2	61.0	0.0	0.0	0.0	0.0	38.6	64.8	122.9	*	*
1952	118.4	209.8	32.8	163.6	100.8	0.0	0.0	1.8	6.4	6.6	38.6	45.5	724.2	829.9
1953	0.0	0.0	90.2	120.4	79.5	0.0	28.4	13.2	6.9	7.6	10.7	129.0	486.2	430.3
1954	117.1	39.4	50.8	101.1	72.1	2.5	0.0	3.8	0.0	6.4	0.3	16.5	409.7	532.9
1955	87.6	304.8	36.8	62.2	92.2	15.2	7.1	0.0	*	*	*	*	*	*
1956	180.8	78.2	85.3	184.4	32.8	12.2	0.0	0.0	0.0	0.0	15.5	38.6	627.9	*
1957	219.2	40.1	134.4	168.9	*	*	0.0	*	*	*	*	*	*	*
1958	11.4	176.5	247.7	93.0	33.0	31.0	0.0	0.0	0.0	0.0	*	*	*	*
1959	151.1	81.3	198.1	63.5	*	*	*	*	*	*	1.3	43.2	*	*
1960	127.0	19.1	125.7	151.1	50.8	0.0	0.0	0.0	0.0	0.0	*	*	*	*
1961	20.3	151.1	31.8	94.0	69.9	0.0	73.7	0.0	25.4	78.7	*	*	*	*
1962	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1963	46.9	133.4	54.5	91.4	0.0	0.0	0.0	0.0	0.0	0.0	68.5	65.8	460.5	*
1964	201.7	*	100.4	173.9	16.5	0.0	0.0	*	*	*	*	*	*	*
1965														

No data available

Monthly Rainfall (mm) for Station: KWADUNDWA

Registration Number: 95.3704

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1958	*	*	*	*	*	*	*	0.0	7.6	1.3	27.9	144.8	*	*
1959	114.3	94.0	174.0	196.0	153.4	6.4	35.6	106.7	*	109.2	11.4	57.2	*	1162.2
1960	114.0	95.3	148.6	408.9	133.4	*	47.0	8.9	21.6	63.5	*	*	*	1109.8
1961	35.6	177.8	110.5	174.0	68.8	38.6	156.2	17.8	96.5	276.9	287.0	223.5	1663.2	*
1962	352.5	203.2	97.0	125.7	100.1	39.6	24.6	30.7	37.1	7.1	115.1	102.1	1234.8	1528.1
1963	128.2	181.3	185.2	174.4	53.5	33.8	29.3	8.4	13.9	15.2	329.9	82.4	1235.5	1040.4
1964	106.4	94.8	207.9	228.9	37.3	46.9	19.1	10.2	14.0	59.7	13.0	30.5	868.7	1237.5
1965	209.7	76.3	85.5	96.7	148.5	11.4	6.6	8.9	4.3	214.8	64.8	113.8	1041.3	906.2
1966	50.8	53.4	226.6	124.9	103.5	6.2	15.0	13.3	93.1	30.8	105.0	126.6	949.2	896.2
1967	49.0	96.7	63.7	135.7	104.4	8.6	32.1	30.9	147.8	78.4	78.6	204.0	1029.9	978.9
1968	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1969	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1970	42.7	*	*	*	*	*	*	*	*	*	*	*	*	*
1971	430.5	130.6	121.9	62.1	112.4	44.7	36.9	5.6	5.2	0.0	0.0	149.8	1099.7	*
1972	109.3	166.7	106.2	157.8	303.8	0.0	25.1	16.5	111.5	170.1	190.7	75.3	1433.0	1316.8
1973	270.7	155.8	104.5	158.0	171.6	0.0	0.0	32.1	0.0	0.0	70.6	75.1	1038.4	1158.7
1974	48.6	118.4	51.8	245.3	157.8	45.0	63.3	0.0	0.0	6.5	51.3	3.6	821.5	882.3
1975	46.3	33.0	238.0	362.4	143.2	38.0	0.0	24.1	63.6	0.0	28.2	156.1	1132.9	1033.5
1976	70.9	27.3	187.9	106.3	149.9	42.9	21.9	8.2	14.5	80.0	17.4	39.1	766.3	894.1
1977	88.0	80.8	*	180.1	56.6	0.0	18.2	55.1	*	140.5	90.6	153.2	*	*
1978														
n(1961-67, 1971-76)	13	13	13	13	13	13	13	13	13	13	13	13	13	11
m	146.8	116.6	137.4	165.6	127.3	27.4	33.1	15.9	46.3	72.3	104.0	108.6	1101.1	1079.3
s	129.8	58.5	63.2	77.7	67.3	18.8	40.6	10.6	50.4	91.9	103.3	62.0	248.8	209.6
C_v	0.88	0.50	0.46	0.47	0.53	0.69	1.23	0.67	1.09	1.27	0.99	0.57	0.23	0.19

Monthly Rainfall (mm) for Station: SAKURA ESTATE

Registration Number: 95.3809

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1950	0.0	8.1	285.5	263.5	161.5	13.2	73.9	92.5	77.2	98.3	25.4	68.8	1167.6	*
1951	23.1	117.9	43.9	236.0	390.9	60.2	57.4	38.1	50.5	194.3	557.0	144.5	1893.6	1286.3
1952	21.1	5.1	99.1	121.2	57.7	19.6	16.3	40.4	104.4	143.0	181.4	28.2	837.2	1329.1
1953	84.6	0.0	108.2	122.9	280.2	0.0	52.1	145.3	88.9	122.4	159.3	72.4	1236.2	1214.1
1954	24.1	14.2	19.8	170.9	126.0	27.4	56.9	113.3	18.3	99.8	39.6	34.0	744.5	902.6
1955	36.1	55.9	52.1	257.0	321.1	163.3	38.6	0.0	15.7	27.9	71.7	105.9	1145.3	1041.4
1956	70.1	9.1	54.1	210.3	134.6	35.3	4.6	13.2	14.7	17.3	75.9	79.5	718.8	740.9
1957	265.2	100.8	62.7	489.7	265.4	32.8	32.5	21.3	32.3	134.9	397.8	98.8	1934.2	1593.0
1958	5.1	24.6	103.9	153.9	150.6	87.1	21.6	46.5	14.2	16.5	61.2	69.9	755.1	1120.6
1959	58.7	20.8	164.6	434.1	127.3	62.7	65.5	102.6	2.0	142.7	57.7	21.6	1260.3	1312.1
1960	87.6	3.6	161.5	376.9	122.4	39.4	14.2	20.1	14.7	74.7	24.6	11.7	951.5	994.5
1961	23.6	219.7	11.7	201.7	110.2	33.0	136.4	48.3	103.6	463.0	369.8	300.2	2021.3	1387.6
1962	107.4	51.6	100.6	197.1	37.6	17.8	27.4	59.9	37.1	12.2	54.6	108.5	811.8	1318.7
1963	0.0	28.0	160.0	232.8	131.9	98.5	136.2	22.5	24.0	26.5	353.0	79.6	1293.0	1023.5
1964	82.3	42.0	95.0	238.5	136.5	23.0	16.0	51.0	43.5	78.5	40.1	163.3	1009.7	1238.9
1965	43.8	0.0	41.0	217.0	137.0	19.0	40.0	64.7	51.0	60.0	205.5	118.5	997.5	876.9
1966	42.0	17.5	189.8	276.3	288.2	120.3	49.6	32.7	58.5	77.5	17.0	42.0	1206.4	1471.4
1967	3.5	42.0	34.8	339.8	291.5	80.5	133.0	80.0	270.5	242.2	143.5	22.0	683.3	576.8
1968	2.5	21.5	302.4	359.2	225.0	177.0	10.0	33.5	6.0	129.5	216.0	166.0	1646.6	1430.1
1969	34.5	100.0	193.5	235.0	123.5	35.5	23.5	92.5	60.5	48.0	131.0	8.5	1086.0	1328.5
1970	82.0	15.0	102.5	83.5	67.5	3.0	34.5	28.0	88.0	73.5	220.0	82.5	682.0	519.0
1971	34.5	7.0	148.0	54.5	100.0	84.5	55.5	57.5	21.0	32.5	36.5	21.5	653.0	897.5
1972	36.5	48.5	107.5	149.5	412.0	0.0	37.5	43.7	67.0	128.5	117.0	72.5	1220.2	1088.7
1973	29.0	7.5	37.0	273.0	268.0	62.5	9.0	48.0	12.0	13.5	199.0	127.0	1085.5	949.0
1974	29.0	0.0	62.0	120.5	116.2	56.5	105.0	26.0	47.0	8.0	121.5	5.0	696.7	896.2
1975	10.0	0.0	62.0	248.0	126.5	21.5	64.5	19.5	116.5	59.5	38.0	40.0	806.0	854.5
1976	0.0	40.2	44.6	242.2	116.8	121.0	53.8	24.6	46.0	101.8	52.7	22.1	865.8	869.0
1977	70.4	29.0	66.7	89.8	81.7	46.6	30.3	114.7	217.5	149.5	188.0	90.5	1174.7	971.0
n(1950-77)	28	28	28	28	28	28	28	28	28	28	28	28	28	27
m	46.7	36.8	104.1	228.4	175.3	55.0	49.9	52.9	60.8	99.1	148.4	78.8	1092.3	1082.7
s	52.8	47.9	74.0	103.9	100.0	46.8	37.6	35.8	61.3	92.6	135.5	63.8	386.2	271.4
C_v	1.13	1.30	0.71	0.45	0.57	0.85	0.75	0.68	1.01	0.93	0.91	0.81	0.35	0.25

Monthly Rainfall (mm) for Station: KWAMSISI NATIVE COURT

Registration Number: 95.3831

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1951	*	*	54.6	137.2	0.0	19.6	39.4	8.9	25.7	147.8	295.4	163.8	*	*
1952	43.7	54.6	100.6	62.2	29.0	0.0	22.1	29.5	65.3	246.6	61.7	12.7	728.0	1111.8
1953	55.9	1.3	79.2	85.1	168.9	57.2	50.8	85.1	115.6	99.1	77.5	38.1	913.8	872.4
1954	29.2	40.6	25.4	82.6	152.4	168.9	12.4	19.3	115.6	119.6	78.7	0.0	844.7	725.5
1955	37.8	64.5	58.4	149.7	394.2	78.5	86.4	0.0	17.8	32.8	83.8	177.3	1181.2	1098.8
1956	165.1	19.1	77.0	212.6	109.7	22.9	0.0	0.0	0.0	30.0	180.6	50.8	867.8	897.4
1957	212.9	137.2	119.6	324.6	213.6	4.1	36.8	8.4	75.2	95.5	146.3	141.7	1515.9	1459.3
1958	0.0	96.8	297.4	85.3	53.8	31.8	0.0	48.8	20.8	13.0	20.8	17.30	841.5	935.7
1959	65.5	88.1	134.6	228.3	121.9	29.2	44.5	60.7	(0.0)	100.3	53.3	6.4	932.8	1066.9
1960	71.4	53.8	51.8	238.0	85.3	32.0	9.7	2.5	3.8	82.3	52.1	0.0	682.7	690.3
1961	36.3	169.7	55.4	105.4	86.1	16.8	61.2	0.0	77.2	286.3	414.8	262.9	1572.1	946.5
1962	241.3	0.0	39.1	202.7	12.7	*	*	*	*	*	*	*	*	*
1963	23.4	10.7	196.8	167.2	0.0	73.4	45.0	0.0	11.4	25.4	320.2	92.7	966.2	*
1964	55.9	*	*	*	*	*	*	*	*	*	*	*	*	*
1965	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1966	0.0	0.0	0.0	0.0	*	37.2	*	10.5	0.0	*	*	*	*	*
1967	*	*	*	*	*	*	83.9	89.4	298.6	179.3	131.0	17.8	*	*
1968	(40.0)	76.2	165.0	206.1	104.2	47.0	25.4	31.8	0.0	113.0	186.1	146.0	1140.8	957.5
1969	53.6	113.0	196.8	237.5	101.4	30.3	31.7	40.6	29.0	100.3	157.5	0.0	1091.7	1266.3
1970	76.3	47.0	204.4	76.2	87.6	0.0	0.0	0.0	(30.0)	38.1	15.2	280.7	846.5	708.1
1971	62.5	13.4	20.3	165.4	81.0	29.4	22.1	20.9	18.5	48.2	1.5	73.7	556.9	777.6
1972	52.8	55.3	56.2	201.7	197.0	9.6	53.7	52.0	62.3	204.8	162.6	172.9	1280.9	1020.6
1973	69.5	80.5	75.2	169.1	130.0	19.3	8.8	29.4	6.1	0.0	106.8	90.7	785.4	223.4
1974	46.8	0.0	50.0	141.0	139.2	46.7	41.9	2.5	19.0	93.5	72.8	0.0	653.4	877.6
1975	69.2	63.0	127.4	235.1	125.2	50.5	53.6	0.0	72.6	42.6	5.7	46.7	891.6	912.0
1976	15.2	40.1	72.1	240.6	76.3	84.9	53.5	14.9	24.5	75.6	11.6	79.8	789.1	750.1
1977	57.3	97.1	73.9	(150.0)	41.8	1.0	4.5	27.6	146.5	132.1	165.3	132.9	1030.0	823.2
n(1952-61, 1968-77)	20	20	20	20	20	20	20	20	20	20	20	20	20	20
m	62.6	65.6	102.0	169.8	124.9	38.0	31.0	23.7	45.0	97.7	102.7	94.3	957.3	906.1
s	47.7	43.7	69.3	71.9	79.4	39.2	24.4	24.1	43.9	74.8	95.8	87.9	270.8	250.6
C_v	0.76	0.67	0.68	0.42	0.64	1.03	0.79	1.02	0.98	0.77	0.93	0.93	0.28	0.28

Monthly Rainfall (mm) for Station: MPWAPWA VETERINARY OFFICE

Registration Number: 96.3600

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1950	166.6	88.9	78.0	157.0	9.4	0.0	0.0	0.0	0.0	11.7	27.7	57.9	597.2	*
1951	127.0	200.2	79.2	141.7	27.7	0.0	0.0	0.0	0.0	2.8	79.0	111.3	786.9	664.2
1952	124.0	277.4	169.2	74.4	26.7	0.0	0.0	0.0	0.3	1.3	23.1	22.9	719.1	863.6
1953	115.1	38.4	109.2	49.0	49.3	0.0	4.8	0.8	0.0	0.3	2.3	99.1	468.1	412.9
1954	174.5	102.1	82.3	40.9	13.0	0.0	0.0	0.0	0.0	0.0	1.5	44.2	458.5	514.2
1955	67.1	130.6	43.2	34.0	29.0	2.5	1.0	0.0	0.0	0.0	12.4	178.8	498.6	353.1
1956	205.5	220.0	142.5	90.7	2.5	0.0	0.0	0.0	1.8	0.0	24.4	92.5	779.8	854.2
1957	87.4	93.7	161.8	271.0	48.5	0.0	0.0	0.0	1.3	7.9	23.9	180.8	876.3	788.5
1958	85.6	291.3	207.5	42.4	6.6	4.3	0.0	0.0	0.0	0.0	13.5	163.1	814.3	842.4
1959	125.2	158.8	175.8	0.0	9.7	0.0	0.0	0.0	0.0	0.0	11.7	208.0	663.7	646.1
1960	277.6	110.7	134.9	96.3	7.9	0.5	0.8	0.0	0.0	5.6	1.8	65.0	701.0	854.0
1961	36.8	95.5	173.5	78.2	9.1	0.0	15.2	0.0	0.0	63.2	120.7	275.8	868.2	538.3
1962	304.3	178.8	254.0	51.3	7.4	0.0	3.8	1.8	0.0	34.0	38.4	(126.0)	999.8	1231.9
1963	150.5	220.7	280.3	66.2	50.0	13.0	0.0	0.0	0.5	0.8	107.5	120.1	964.6	946.4
1964	234.1	234.1	194.7	58.6	3.9	1.8	0.0	0.3	0.0	1.0	15.7	158.3	794.5	848.1
1965	83.6	127.8	107.4	51.3	8.3	0.0	0.0	0.0	3.6	4.4	36.1	225.8	648.3	560.4
1966	64.2	151.2	164.7	83.1	14.4	2.5	0.5	0.3	0.0	4.7	99.4	139.5	724.5	747.5
1967	76.4	150.4	134.0	217.0	61.0	3.8	12.5	1.5	15.3	13.5	59.0	339.0	1083.4	924.3
1968	206.9	99.1	227.8	316.3	36.3	5.6	0.0	0.0	0.0	16.5	25.4	161.6	1095.5	1306.5
1969	98.6	135.5	117.8	38.4	16.4	3.9	0.0	0.0	0.0	0.0	47.6	114.3	572.5	597.6
1970	255.1	138.2	205.1	21.5	*	*	*	*	*	*	*	177.6	*	*
1971	124.7	200.1	106.0	70.7	11.3	1.5	0.0	0.0	0.0	3.4	32.9	99.8	650.4	*
1972	149.7	134.3	136.9	66.2	60.4	0.0	2.0	0.0	9.0	28.7	55.9	76.0	719.1	719.9
1973	144.0	169.1	34.4	173.7	31.7	0.0	0.0	0.0	0.0	0.0	43.5	104.1	700.5	684.8
1974	74.9	96.1	23.8	192.6	8.5	0.0	1.6	0.0	0.0	1.2	0.0	117.1	545.8	546.3
1975	127.3	96.4	238.8	51.7	17.0	0.0	0.0	0.0	5.3	0.0	52.1	161.5	750.1	653.6
1976	138.3	78.0	57.1	56.8	12.1	11.3	0.0	0.0	0.0	4.9	5.9	56.6	421.0	572.1
1977	178.8	74.3	42.8	42.9	8.9	3.4	0.0	2.6	0.4	1.4	14.1	138.8	588.4	418.0
1978														
n(1950-69, 1971-77)	27	27	27	27	27	27	27	27	27	27	27	27	27	25
m	138.8	142.4	136.2	96.8	21.7	2.0	1.6	0.3	1.4	7.7	36.1	134.7	721.2	723.6
s	64.9	61.5	69.8	77.1	18.0	3.4	3.8	0.7	3.5	14.1	33.1	70.7	180.6	232.2
C_v	0.47	0.43	0.51	0.80	0.83	1.70	2.38	2.33	2.50	1.83	0.92	0.52	0.25	0.32

Monthly Rainfall (mm) for Station: MPWAPWA SCHOOL

Registration Number: 96.3601

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1950	166.1	94.2	85.1	85.6	5.6	0.0	0.0	0.3	0.0	16.8	41.7	55.4	550.7	*
1951	135.4	173.5	89.9	74.2	17.5	0.0	0.0	0.0	0.0	3.0	56.1	107.2	656.8	590.6
1952	79.5	222.0	146.8	34.3	23.9	0.0	0.0	0.0	0.0	3.3	18.5	46.2	574.5	673.1
1953	74.9	38.1	96.3	25.4	38.9	0.0	3.8	0.0	0.0	0.0	0.0	112.0	389.4	342.1
1954	143.0	121.2	54.9	34.5	10.7	0.0	0.0	0.0	0.0	0.0	5.1	46.2	415.5	476.2
1955	30.0	151.1	65.3	26.9	23.6	11.2	0.0	0.0	0.0	0.0	10.2	218.4	562.1	384.8
1956	212.6	142.7	147.3	132.8	2.5	0.0	0.0	0.0	0.3	0.0	10.9	73.7	722.8	866.8
1957	246.9	92.7	144.3	215.1	43.7	0.0	0.0	0.0	0.0	0.0	14.5	149.6	906.8	827.3
1958	127.8	220.7	178.8	29.5	7.9	0.0	0.0	0.0	0.0	0.0	5.8	146.6	717.1	728.8
1959	141.0	162.1	196.3	6.6	0.0	*	0.0	7.1	0.0	0.0	*	*	*	1359.4
1960	*	*	*	*	*	*	*	*	*	*	*	69.3	*	*
1961	36.6	80.0	128.3	129.3	19.6	0.0	8.9	0.0	0.0	61.2	118.9	272.8	855.5	*
1962	270.2	227.1	163.6	35.8	0.0	0.0	1.8	0.3	0.0	7.1	19.6	125.7	851.2	1097.6
1963	152.7	166.4	206.4	53.9	1.5	0.0	0.0	0.0	0.0	0.0	80.6	131.1	792.6	726.2
1964	207.1	154.7	136.6	16.9	18.1	0.0	0.0	0.0	0.0	5.1	2.6	164.4	705.5	750.2
1965	93.8	87.5	124.8	12.2	2.3	0.0	0.0	0.0	5.3	0.0	23.6	*	*	*
1966	*	129.1	214.4	48.7	7.1	4.8	0.0	0.0	0.0	0.0	0.0	137.2	*	*
1967	100.9	183.7	62.5	151.6	38.0	0.0	3.1	*	*	*	*	*	*	*
1968	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1969	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1970	*	*	*	*	0.0	0.0	0.0	*	*	*	*	*	*	*
1971	131.4	60.9	67.4	18.3	4.3	0.5	0.5	0.0	0.0	0.0	*	*	*	*
1972	94.7	140.1	111.0	38.9	29.0	*	*	*	*	*	*	*	*	*
1973	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1974	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1975	166.4	6.1	348.7	*	*	*	*	*	*	*	*	*	*	*
1976	117.0	*	*	*	*	*	*	*	*	*	*	*	*	*
1977	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1978														
n(1950-58, 1961-64)	13	13	13	13	13	13	13	13	13	13	13	13	13	11
m	144.8	145.0	126.4	68.8	16.4	0.9	1.1	0.1	0.0	7.4	58.5	126.9	669.3	678.5
s	76.1	58.7	45.3	58.5	13.8	3.1	2.6	0.1	0.1	16.9	113.5	66.8	164.1	221.7
C_v	0.40	0.36	0.85	0.84	3.44	2.36	1.0	-	2.28	2.28	1.94	0.53	0.25	0.33

Monthly Rainfall (mm) for Station: MPWAPWA EVERGREEN FOREST

Registration Number: 96.3606

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1950	118.1	85.6	87.6	199.4	41.7	0.0	0.0	0.0	0.0	16.8	23.4	100.1	672.6	*
1951	124.2	118.6	154.2	209.6	112.3	0.0	0.0	0.0	0.0	0.0	103.4	136.1	958.3	842.4
1952	183.6	149.6	98.8	135.6	121.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	689.1	928.5
1953	187.7	17.8	54.6	8.6	92.2	0.0	17.8	0.0	0.0	0.3	0.0	73.7	453.9	379.0
1954	146.8	80.0	93.5	169.7	63.0	0.0	0.0	0.0	0.0	14.7	0.0	66.8	634.5	641.4
1955	108.7	174.2	45.0	127.0	136.9	13.5	9.1	0.0	0.0	0.0	14.0	184.7	813.1	681.2
1956	286.8	85.1	111.8	108.2	13.0	0.0	0.0	0.0	0.0	0.0	8.1	97.3	710.2	803.6
1957	203.2	72.4	85.3	241.8	164.8	0.0	0.0	0.0	8.4	14.7	55.4	122.9	969.0	896.0
1958	34.3	251.2	242.1	91.2	45.0	15.7	0.0	0.0	0.0	0.0	1.0	143.0	823.5	857.8
1959	137.4	130.8	176.3	59.4	48.5	0.0	0.0	0.0	0.0	0.0	0.0	121.4	648.5	696.4
1960	156.5	100.6	206.0	298.7	15.2	0.0	0.0	0.0	0.0	26.2	0.0	83.3	889.0	924.6
1961	29.2	147.1	136.4	172.7	29.7	0.0	40.6	0.0	8.6	107.1	125.7	332.7	1127.0	754.7
1962	224.3	153.2	70.4	110.2	30.5	0.0	0.0	0.0	0.0	13.0	22.9	135.6	760.2	1060.0
1963	81.2	184.4	206.6	169.4	0.0	0.0	0.0	0.0	0.0	0.0	170.4	146.4	898.4	800.1
1964	151.1	109.5	216.9	46.2	0.0	0.0	0.0	0.0	0.0	0.0	2.0	85.4	611.1	840.5
1965	106.4	139.8	101.6	89.4	51.7	0.0	0.0	0.0	11.4	9.4	60.5	189.9	760.1	597.1
1966	33.9	132.6	124.8	188.1	37.4	7.2	0.0	0.0	0.0	7.3	37.0	69.8	638.1	781.7
1967	90.2	95.2	89.9	121.5	176.0	27.2	37.7	16.0	20.5	10.1	86.5	303.5	1074.3	791.1
1668	218.3	154.2	275.4	413.7	124.7	0.0	0.0	0.5	0.0	10.8	(25.0)	(161.0)	1383.6	1587.6
1969	90.7	199.6	111.1	37.0	25.7	0.0	0.0	0.0	0.0	15.0	75.8	24.9	579.8	665.1
1970	168.9	183.7	142.8	36.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	36.8	568.9	632.8
1971	149.9	125.9	187.1	166.4	68.2	23.2	12.2	0.0	0.0	19.2	10.3	91.4	853.8	788.9
1972	114.9	155.4	36.2	76.7	135.6	0.0	3.0	0.0	3.8	11.9	22.4	90.0	649.9	639.2
1973	224.7	155.1	67.8	208.2	53.6	0.0	0.0	0.0	0.0	0.0	33.6	99.4	842.4	821.8
1974	48.0	40.4	32.2	220.9	35.3	2.1	11.1	0.0	0.0	1.9	0.9	80.6	473.4	547.8
1975	127.9	131.6	145.1	119.7	91.5	5.1	0.0	0.0	22.9	0.0	39.0	59.9	742.7	725.3
1976	13.9	50.9	47.1	106.3	80.8	36.4	0.0	0.0	0.0	2.9	14.9	40.6	393.8	437.2
1977	284.6	109.3	49.5	109.4	6.5	6.8	0.0	14.7	4.6	15.3	67.8	96.7	765.1	656.2
1978														
n(1950-77)	28	28	28	28	28	28	28	28	28	28	28	28	28	27
m	137.3	126.2	121.3	144.4	64.3	4.9	4.7	1.1	2.9	10.6	35.7	106.6	763.7	770.7
s	72.9	50.9	66.2	86.7	51.5	9.6	10.8	4.0	6.2	20.4	43.5	75.8	213.9	222.4
C_v	0.53	0.40	0.55	0.60	0.80	1.96	2.30	3.64	2.14	1.92	1.22	0.71	0.28	0.29

Monthly Rainfall (mm) for Station: UKAGURU FOREST STATION

Registration Number: 96.3618

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1957	289.3	83.6	231.4	386.6	220.5	*	62.5	30.2	51.8	66.0	181.6	284.0	*	*
1958	25.9	323.6	278.6	261.6	42.7	30.5	1.5	49.3	10.2	14.0	10.9	159.3	1207.8	1503.5
1959	248.9	120.4	154.4	232.7	101.6	10.2	14.7	150.9	36.6	62.5	72.4	246.6	1451.9	1303.1
1960	156.5	72.9	239.5	453.4	81.8	56.4	20.3	5.8	14.0	78.2	4.8	21.6	1205.2	1497.8
1961	32.0	174.2	146.3	324.9	96.3	13.0	99.1	31.8	152.4	320.3	412.5	143.0	1945.6	1416.7
1962	229.4	86.9	183.6	348.2	25.7	1.5	14.2	137.2	67.1	37.6	41.7	290.3	1463.3	1686.9
1963	203.2	151.7	209.1	265.7	43.9	69.4	16.2	16.6	46.7	20.4	416.7	143.7	1603.3	1374.9
1964	228.4	174.9	362.4	269.6	23.5	52.5	25.9	86.6	26.6	69.5	0.0	193.1	1513.0	1880.3
1965	101.1	122.7	139.2	229.5	73.1	0.3	26.0	25.7	73.3	134.7	102.5	367.1	1395.2	1118.7
1966	161.9	211.8	408.3	234.3	136.5	38.4	0.0	17.4	89.7	102.1	87.9	146.7	1635.0	1870.0
1967	37.1	212.4	105.5	410.6	241.7	67.8	71.4	117.9	225.8	114.9	120.0	293.9	2019.0	1839.7
1968	206.1	184.1	251.4	443.3	297.1	114.7	16.8	25.0	16.8	73.3	295.3	214.4	2138.3	2042.5
1969	152.9	153.1	341.9	278.7	99.1	80.8	27.5	82.7	27.9	18.2	78.6	17.8	1356.2	1772.5
1970	117.2	105.4	133.4	115.5	25.2	0.0	6.6	42.9	116.7	39.4	19.1	400.5	1121.9	798.7
1971	109.8	110.0	134.6	277.6	118.8	71.8	70.9	22.2	44.9	45.3	14.8	135.0	1155.7	1425.5
1972	109.8	126.4	208.1	205.4	225.6	5.3	13.0	34.6	72.5	125.3	277.1	500.6	1903.1	1275.8
1973	222.3	81.6	73.9	356.8	104.4	22.3	18.0	43.1	16.5	16.4	113.7	137.7	1206.7	1733.0
1974	64.5	3.4	140.3	276.6	265.0	17.2	37.1	21.3	47.7	78.7	18.5	73.9	1044.2	1203.2
1975	76.2	65.1	248.7	227.6	65.6	6.4	19.4	4.1	90.0	40.2	20.3	198.0	1'61.6	935.7
1976	81.3	189.9	215.6	211.1	144.9	53.0	14.7	20.5	74.2	31.3	50.9	132.5	1189.9	1224.8
1977	247.9	94.3	146.1	218.3	117.2	0.5	26.2	63.2	121.9	72.8	285.1	205.5	1599.0	1291.8
1978	140.5	120.7	192.9	535.9	48.3	36.3	11.2	16.5	7.1	25.4	353.3	312.2	1800.3	1625.4
1979	288.0													
n(1958-77)	20	20	20	20	20	20	20	20	20	20	20	20	20	20
m	140.6	138.2	206.1	282.1	116.5	35.6	27.0	49.9	68.6	74.8	122.1	201.1	1460.8	1459.8
s	75.3	69.3	89.2	85.1	81.5	33.4	25.2	43.3	54.1	68.4	136.4	121.9	337.4	332.6
C_v	0.54	0.50	0.43	0.30	0.70	0.94	0.93	0.87	0.79	0.91	1.12	0.61	0.23	0.23
C_s													0.67	- 0.09

Monthly Rainfall (mm) for Station: CHAKWALE

Registration Number: 96.3621

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1962	506.7	85.6	139.2	51.6	7.6	0.0	9.1	12.2	0.3	1.0	39.6	148.6	1001.5	*
1963	*	132.0	132.0	42.5	9.2	22.4	0.0	0.0	0.0	0.0	67.8	57.8	*	*
1964	68.8	76.4	125.1	37.6	16.2	0.0	0.0	0.0	0.0	*	*	*	*	*
1965														
			(station closed)											

Monthly Rainfall (mm) for Station: TUBUGWE FARM

Registration Number: 96.3623

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1963	145.2	187.6	68.9	173.2	0.0	6.4	0.0	0.0	0.0	0.0	*	*	*	*
1964	*	*	*	*	*	*	*	*	*	*	154.9	*	*	*
1965			(No data available)											

Monthly Rainfall (mm) for Station: MYOMBO SISAL ESTATE

Registration Number: 96.3625

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1966	196.0	197.4	150.1	173.2	58.2	18.3	0.0	3.1	25.7	15.2	76.4	53.6	947.2	*
1967	83.6	241.6	203.6	212.3	102.0	19.1	32.0	8.7	78.5	98.0	352.9	323.8	1756.1	1209.4
1968	216.5	81.6	341.4	364.4	87.5	58.1	0.0	0.0	23.8	34.3	98.5	95.8	1401.9	1884.3
1969	66.1	126.6	110.2	315.0	72.9	0.0	0.0	0.0	0.0	0.0	145.1	34.3	870.2	885.1
1970	261.7	102.9	193.0	100.6	7.4	0.0	0.0	0.0	84.1	34.3	0.0	158.7	942.7	963.4
1971	125.1	161.3	93.7	101.3	54.2	0.0	16.5	15.2	0.0	24.9	18.1	90.5	700.8	750.9
1972	106.2	134.1	102.4	112.2	99.0	*	*	*	*	*	*	*	*	*
1973	266.1	146.4	292.6	290.5	58.2	0.0	0.0	36.3	0.0	*	*	*	*	*
1974	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1975	248.6	*	122.1	143.8	73.6	0.0	0.0	0.0	24.3	2.3	46.2	*	*	*
1976	107.5	83.6	275.4	165.8	49.2	*	*	*	*	6.4	*	79.9	*	*
1977	101.0	25.7	135.6	51.5	28.4	*	0.0	*	*	30.2	63.6	114.5	*	*
1978														

Monthly Rainfall (mm) for Station: GAIRO

Registration Number: 96.3626

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1970	251.2	59.1	98.7	15.4	7.4	0.0	0.0	0.0	0.0	0.0	0.0	102.2	534.0	*
1971	57.3	97.1	50.7	64.9	28.3	15.0	15.3	0.5	3.0	3.3	2.5	30.8	388.9	437.6
1972	77.9	177.4	121.8	39.5	95.9	0.0	0.0	*	*	*	*	118.4	*	*
1973	121.2	184.9	90.0	51.5	53.3	0.7	0.0	0.0	0.0	0.0	0.0	108.8	610.4	*
1974	57.3	15.6	31.1	114.9	45.1	1.0	4.0	1.1	0.7	21.0	28.7	45.7	366.2	430.6
1975	138.0	75.0	103.1	74.4	28.8	0.0	0.0	0.0	13.2	16.9	30.1	143.7	623.2	523.8
1976	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1977	303.0	*	29.1	26.2	11.1	0.0	*	0.0	13.2	13.7	86.3	87.1	*	*
1978														

Monthly Rainfall (mm) for Station: NONGWE

Registration Number: 96.3627

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1970	62.8	164.4	198.9	179.1	89.7	*	*	0.0	32.2	13.9	0.0	0.0	*	*
1971	*	*	*	*	*	*	*	2.0	3.4	6.9	0.0	132.8	*	*
1972	163.0	128.1	170.5	264.1	356.9	5.6	8.9	9.5	55.0	108.2	430.1	232.4	1932.3	1402.6
1973	316.4	84.3	107.1	458.6	99.8	13.5	6.9	13.3	0.1	6.2	74.7	108.3	1289.5	1768.7
1974	101.0	76.7	103.7	417.8	81.0	14.2	14.6	0.7	2.5	30.5	3.2	0.0	845.9	1025.7
1975	131.5	0.0	240.1	185.3	89.0	0.0	0.0	0.0	0.0	0.0	26.7	171.6	844.2	649.1
1976	472.6	11.6	*	*	*	*	1.0	0.0	0.0	*	*	*	*	*
1977			(No data available)											

Monthly Rainfall (mm) for Station: MWASA

Registration Number: 96.3628

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1970	*	*	17.5	*	*	*	*	*	*	*	*	*	*	*
1971	107.7	132.4	32.2	37.2	0.0	0.0	10.2	0.0	0.0	1.1	14.1	92.0	427.0	*
1972	70.2	145.3	118.5	68.6	42.3	0.0	0.0	7.0	7.0	40.0	118.4	*	*	605.0
1973	185.3	73.4	56.1	*	*	*	*	*	*	*	*	*	*	*
1974	97.0	12.0	*	86.4	*	*	*	*	*	*	*	*	*	*
1975	112.8	13.2	44.7	82.3	11.2	0.0	0.0	0.0	*	0.0	0.0	72.3	*	*
1976	31.0	97.3	78.0	81.5	17.0	0.0	0.0	*	0.0	0.0	0.0	279.5	*	*
1977	54.6	50.0	33.0	30.8	9.3	0.0	0.0	76.0	115.0	21.0	112.0	45.1	546.8	669.2
1978														

Monthly Rainfall (mm) for Station: KONGWA ADMINISTRATION OFFICE

Registration Number: 96.3629

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1972	96.2	190.0	117.9	44.5	42.5	0.0	0.0	0.0	0.0	23.2	43.7	45.8	603.8	*
1973	174.6	167.5	44.5	26.0	5.3	0.0	0.0	0.0	0.0	0.0	8.1	84.9	510.9	507.4
1974	17.6	82.9	37.8	112.2	24.0	0.0	0.0	0.0	0.0	0.0	0.0	79.6	354.1	367.5
1975	144.9	28.1	84.1	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	70.2	327.8	337.2
1976	70.4	36.5	53.1	31.9	21.0	0.0	0.0	0.0	0.0	0.0	7.5	78.1	298.7	283.1
1977	205.1	103.2	18.3	72.2	7.0	0.0	0.0	0.0	0.0	0.0	27.3	139.8	572.9	491.4
1978														

Monthly Rainfall (mm) for Station: SAGARA

Registration Number: 96.3630

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1972	95.2	132.5	83.3	34.3	34.0	0.0	0.0	0.0	2.0	58.2	10.5	132.0	582.0	*
1973	140.1	149.5	34.8	37.6	5.1	0.0	0.0	0.0	0.0	0.0	19.0	136.1	522.2	509.6
1974	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1975	68.3	69.5	84.5	63.2	15.7	0.0	0.0	0.0	0 0	0.0	0.0	37.6	338.8	*
1976	161.9	54.3	41.3	105.6	16.5	0.6	0.0	0.0	0.0	0.0	7.3	43.7	431.0	417.8
1977	171.9	91.5	15.5	46.2	27.3	0.0	0.0	0.0	0.0	0.0	0.0	*	*	403.4

Monthly Rainfall (mm) for Station: MLALI

Registration Number: 96.3631

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1972	10.5	137.7	65.9	18.0	5.3	0.0	0.0	0.0	0.0	50.9	20.2	57.8	359.3	*
1973	185.7	148.4	30.2	72.8	11.9	0.0	0.0	0.0	0.0	0.0	12.7	107.2	568.9	527.0
1974	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1975	60.8	37.4	96.7	61.1	32.0	0.0	0.0	0.0	0.0	0.0	0.0	32.0	320.5	*
1976	24.1	117.1	36.1	66.2	8.0	0.0	0.0	0.0	0.0	0.0	0.0	23.0	274.5	283.5
1977	121.6	51.1	0.0	80.1	38.0	0.0	0.0	0.0	0.0	0.0	*	*	*	313.8
1978														

Monthly Rainfall (mm) for Station: MSETA UJAMAA VILLAGE

Registration Number: 96.3632

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1972	87.3	252.6	250.8	197.4	48.4	0.0	0.1	0.0	10.0	48.6	141.5	53.4	1090.1	*
1973	163.2	176.5	57.4	89.7	*	*	*	*	*	*	*	*	*	*
1974	92.4	78.0	26.0	150.8	*	*	*	*	*	*	*	*	*	*
1975	137.3	70.0	123.7	43.6	*	*	*	*	*	*	*	*	*	*
1976	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1977	152.5	149.5	65.5	18.5	1.6	*	*	*	*	*	16.1	162.8	*	*
1978														

Monthly Rainfall (mm) for Station: PANDAMBILI

Registration Number: 96.3633

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1972	63.1	165.8	175.6	116.0	0.0	0.0	0.0	0.0	0.0	44.3	77.0	78.5	670.3	*
1973	145.5	107.9	26.8	*	*	*	*	*	*	*	*	92.5	*	*
1974	35.3	*	*	*	*	*	*	*	*	*	*	*	*	*
1975	195.6	*	118.1	13.1	9.0	0.0	*	*	*	*	*	*	*	*
1976			(No data available)											

Monthly Rainfall (mm) for Station: CHAMKORO PRIMARY SCHOOL

Registration Number: 96.3634

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1972	92.2	98.1	101.6	40.3	55.5	0.0	1.2	0.0	3.3	59.4	35.0	70.1	558.2	*
1973	326.7	107.5	43.5	22.2	38.0	0.0	0.0	0.0	0.0	0.0	17.9	150.9	706.7	643.0
1974	59.0	45.6	8.4	460.8	72.3	2.3	0.0	0.0	0.0	0.0	0.0	54.8	703.2	817.2
1975	106.7	72.0	140.1	115.1	0.0	0.0	0.0	0.0	0.0	0.0	2.5	88.1	524.8	489.0
1976	64.4	94.1	43.1	123.6	16.1	9.0	0.0	0.0	0.0	0.0	13.3	31.3	394.9	440.9
1977	109.0	108.8	147.7	94.7	25.5	0.0	0.0	0.0	0.0	0.0	29.4	66.8	581.9	530.3
1978														

Monthly Rainfall (mm) for Station: GULWE

Registration Number: 96.3635

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1972	131.0	98.2	38.9	5.3	12.6	0.0	0.0	0.0	0.0	9.5	22.5	131.6	449.6	*
1973	184.2	78.7	48.4	50.1	10.0	*	*	*	*	*	*	*	*	*
1974	47.1	28.4	3.9	62.6	60.9	*	*	*	*	*	*	*	*	*
1975	137.9	21.1	141.0	9.4	28.6	0.0	0.0	0.0	0.0	0.0	0.0	140.1	478.1	*
1976	86.1	36.3	105.7	9.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	40.2	227.6	377.5
1977	186.5	*	0.0	31.1	13.2	0.0	0.0	0.0	*	*	*	*	*	*
1978														

Monthly Rainfall (mm) for Station: LUMUMA PRIMARY SCHOOL

Registration Number: 96.3636

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1972	175.4	189.5	86.1	63.0	19.0	0.0	9.6	0.0	11.5	50.7	14.5	386.2	1005.2	*
1973	*	121.5	0.0	36.3	0.0	0.0	0.0	17.7	0.0	0.0	22.1	208.4	*	*
1974	81.1	79.6	53.0	555.1	16.7	0.0	5.3	0.0	0.0	0.0	0.0	44.0	334.8	*
1975	162.4	87.5	125.7	111.5	11.9	0.0	0.0	0.0	0.0	0.0	0.0	157.8	656.8	443.0
1976	42.2	124.1	144.1	63.5	32.2	0.0	0.0	5.2	0.0	0.0	0.0	96.4	507.7	569.1
1977	145.8	67.0	57.6	32.8	6.8	0.0	0.0	0.0	0.0	12.6	53.8	*	*	419.0
1978														

Monthly Rainfall (mm) for Station: MTANANA PRIMARY SCHOOL

Registration Number: 96.3638

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1972	39.0	203.3	168.6	67.8	44.2	0.0	0.0	0.0	0.0	0.0	18.5	103.7	645.1	*
1973	179.4	92.2	78.3	65.3	5.0	0.0	0.0	0.0	0.0	6.0	58.7	119.0	603.9	548.4
1974	56.2	66.7	17.3	129.4	4.0	0.0	0.0	0.0	0.0	0.0	0.0	32.6	329.2	451.3
1975	81.5	99.6	172.7	45.6	11.6	3.6	0.0	0.0	0.0	0.0	11.6	51.6	477.8	447.2
1976	33.7	59.5	*	*	*	*	0.0	0.0	0.0	0.0	0.0	44.2	*	*
1977	84.8		(No data available)											

Monthly Rainfall (mm) for Station: PANDAMBILI PRIMARY SCHOOL

Registration Number: 96.3642

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1972	42.7	140.7	93.8	81.4	26.9	0.0	1.9	0.0	0.0	44.9	22.2	*	*	*
1973	116.5	116.5	26.8	23.0	3.0	0.0	0.0	0.0	*	*	*	*	*	*
1974	25.5	73.3	6.2	93.8	3.0	0.0	0.0	0.0	0.0	0.0	0.0	10.0	211.8	*
1975	123.0	84.8	107.0	35.0	0.0	0.0	0.0	0.0	0.0	*	*	*	*	*
1976	39.8	72.0	68.1	10.3	23.0	0.0	0.0	0.0	0.0	0.0	0.0	19.2	232.4	*
1977	107.2	23.0	41.0	50.1	19.0	0.0	0.0	2.5	0.0	*	*	*	*	*
1978														

Monthly Rainfall (mm) for Station: MOROGORORO AGRICULTURAL OFFICE

Registration Number: 96.3700

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1950	86.4	99.8	220.5	218.7	97.8	8.9	8.6	6.1	23.6	37.1	31.2	31.0	896.7	*
1951	79.2	178.8	97.8	154.4	94.2	23.1	17.0	5.3	0.3	27.7	143.8	236.5	1058.2	740.0
1952	63.2	192.0	70.4	177.0	98.0	17.3	8.9	0.2	30.5	46.5	25.9	7.4	748.5	1084.3
1953	41.7	3.3	82.3	210.1	132.8	2.5	20.1	0.4	11.9	28.2	10.4	74.4	637.5	586.0
1954	170.9	11.3	80.8	177.8	161.0	2.0	15.7	0.1	3.6	54.1	7.4	68.3	854.7	862.1
1955	9.1	213.4	60.2	173.2	152.4	33.8	14.2	0.0	21.3	3.3	73.9	90.7	845.8	756.6
1956	119.9	207.0	83.6	319.3	79.5	15.2	0.3	0.3	8.6	5.3	37.3	40.4	916.7	1003.6
1957	101.9	98.0	151.6	188.0	120.4	1.3	9.9	4.8	65.0	24.1	64.0	51.3	880.4	842.7
1958	21.3	112.3	229.1	171.2	29.2	42.4	0.0	16.5	8.9	0.8	34.8	97.5	764.0	747.0
1959	87.9	79.2	105.4	124.2	51.6	15.0	10.7	66.3	17.5	36.8	24.1	88.4	707.1	727.4
1960	154.9	57.2	239.8	385.8	36.1	38.6	2.3	3.6	3.6	37.8	0.3	4.8	964.9	1072.2
1961	22.1	233.4	51.1	163.6	60.7	48.5	118.9	2.5	22.4	168.4	214.6	218.2	1324.4	896.7
1962	159.5	24.6	112.3	161.5	109.2	1.3	11.4	17.3	(15)	(28)	(62)	(78)	(780.1)	(1072.9)
1963	142.4	113.1	179.6	360.0	47.9	54.0	12.1	1.5	0.0	12.7	330.3	36.3	1288.9	(1062.3)
1964	85.5	91.9	284.0	240.7	33.3	5.0	3.8	5.1	1.3	58.7	7.1	58.3	874.7	1175.9
1965	101.6	77.0	111.1	242.8	74.7	0.0	0.3	0.3	36.9	90.1	72.7	175.4	982.9	800.2
1966	97.5	119.3	135.5	139.0	62.7	43.5	0.0	9.1	7.1	34.3	81.6	47.6	777.3	896.2
1967	1.3	47.6	37.2	318.6	170.3	10.2	63.4	79.1	110.0	30.5	142.3	258.6	1269.1	997.4
1968	65.8	52.3	282.6	330.0	56.4	43.3	0.0	0.0	0.0	0.0	78.0	68.5	976.9	1231.3
1969	65.6	88.4	171.9	211.8	44.7	0.0	25.4	28.0	2.5	51.8	80.5	0.0	770.6	836.6
1970	222.0	105.3	163.3	159.3	35.3	4.5	3.2	6.1	31.1	26.1	6.1	164.6	926.9	836.7
1971	119.9	46.0	177.3	342.4	78.1	45.4	8.3	0.0	2.2	0.0	0.0	18.9	838.5	990.3
1972	(117.2)	110.9	187.6	230.0	221.8	0.0	26.9	21.6	34.8	135.8	129.9	139.8	(1356.5)	(1105.5)
1973	252.0	91.5	36.2	478.1	72.5	24.3	7.6	12.3	21.5	7.8	93.5	178.2	1275.5	1273.5
1974	35.8	30.5	91.0	348.1	143.6	24.1	(12.0)	(3.8)	(5.6)	(29.3)	(1.8)	(12.8)	(738.4)	(995.5)
1975	86.1	56.2	163.2	218.4	122.4	27.1	4.0	0.0	13.7	33.8	31.2	70.4	826.5	(739.5)
1976	88.8	34.3	132.3	175.9	51.4	58.6	8.8	7.0	36.0	3.5	7.2	66.7	670.5	698.2
1977	152.0	187.9	(169.6)	(159.1)	(110.9)	(3.0)	(19.9)	7.7	21.3	63.3	32.0	259.0	(1185.7)	(698.6)
1978	183.5	69.2	182.0	224.0	39.4	10.4	0.0	6.0	0.0	3.5	230.4	370.2	1255.6	1009.0
n(1953-77)	25	25	25	25	25	25	25	25	25	25	25	25	25	25
m	100.9	95.7	140.7	241.2	90.4	21.7	16.0	11.7	20.1	38.6	64.9	94.7	937.4	927.0
s	62.3	60.4	70.2	92.6	51.4	20.1	25.2	19.9	24.2	41.2	76.1	74.8	218.6	175.5
C_v	0.63	0.63	0.50	0.38	0.57	0.92	1.58	1.69	1.21	1.07	1.17	0.79	0.23	0.19

Monthly Rainfall (mm) for Station: KILOSA AGRICULTURAL OFFICE

Registration Number: 96.3701

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1950	154	47	244	259	49	10	5	19	6	2	19	70	882	*
1951	115	164	147	146	85	13	3	4	0	73	341	159	1249	838
1962	42	179	197	159	129	0	0	35	29	37	118	62	987	1307
1953	96	52	118	356	187	0	0	14	13	31	67	266	1200	1047
1954	88	157	126	163	55	0	0	7	2	41	53	51	743	972
1955	37	156	94	193	119	14	4	1	3	24	57	63	764	748
1956	96	37	185	311	67	11	0	0	1	3	10	141	861	830
1957	84	80	139	253	212	9	4	6	8	34	20	270	1117	978
1958	18	150	253	137	48	14	2	29	4	2	0	156	812	946
1959	195	149	194	150	42	1	4	12	1	11	94	16	868	914
1960	91	90	364	311	11	21	2	0	14	23	0	13	944	1041
1961	43	168	90	291	37	14	65	22	32	190	310	165	1422	960
1962	144	87	94	244	25	0	23	60	25	16	10	94	774	1145
1963	130	235	200	215	5	33	3	7	0	0	285	120	1233	932
1964	196	236	235	138	28	2	8	15	0	66	0	50	975	1330
1965	82	155	171	155	39	13	1	2	35	16	90	421	1182	721
1966	106	141	286	304	47	41	8	2	0	95	88	145	1266	1544
1967	61	221	85	356	87	12	45	25	64	42	166	328	1491	1230
1968	191	83	304	291	51	39	0	23	7	9	50	138	1186	1522
1969	91.7	119.7	163.9	241.0	28.2	8.4	0.0	8.1	12.8	79.4	289.1	62.2	1104.5	941.2
1970	208.3	99.1	277.9	89.6	8.4	0.0	0.0	23.5	30.4	20.5	35.0	119.4	912.1	1109.0
1971	122.6	115.3	141.3	243.9	33.9	20.2	11.6	0.5	11.1	7.7	54.4	64.1	826.6	862.5
1972	185.6	122.9	253.8	142.5	121.7	0.0	0.0	32.8	77.5	100.3	228.3	136.7	1402.1	1155.6
1973	162.1	144.3	190.8	173.4	84.9	(0.0)	(5.0)	(40.0)	(0.0)	(0.0)	36.9	71.8	(909.2)	(1165.5)
1974	137.9	(100.0)	126.2	236.9	200.2	36.5	9.7	52.7	29.6	(40.0)	(30.0)	14.8	(1014.5)	(1078.4)
1975	143.0	79.2	146.5	206.2	153.4	0.3	0.0	0.0	32.6	16.9	30.1	195.0	1003.2	(822.9)
1976	239.8	117.2	257.6	246.1	71.1	7.6	10.8	4.0	0.0	0.0	16.0	37.7	1007.9	1179.3
1977	227.3	107.9	198.5	210.6	91.0	0.0	0.0	30.1	105.0	22.9	149.3	274.5	1417.1	1047.0
1978	149.8	29.6	136.5	204.1	27.1	12.6	1.5	5.7	0.0	0.0	129.6	146.5	843.0	990.7
n(1953-77)	25	25	25	25	25	25	25	25	25	25	25	25	25	25
m	127.1	128.1	187.8	226.3	74.1	11.9	8.2	16.7	20.3	35.6	86.8	136.5	1057.4	1048.9
s	61.2	51.4	75.2	72.3	59.9	13.2	15.3	16.9	26.9	43.0	95.9	105.6	225.8	208.2
C_v	0.48	0.40	0.40	0.32	0.81	1.11	1.87	1.01	1.33	1.21	1.10	0.77	0.21	0.20

Monthly Rainfall (mm) for Station: TUNGI SISAL ESTATE

Registration Number: 96.3702

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1959	149.1	161.3	69.3	66.0	47.0	2.0	11.2	20.1	21.8	16.0	7.1	68.8	639.8	*
1960	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1961	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1962	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1963	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1964	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1965	144.0	112.0	103.0	128.0	30.0	0.0	1.0	1.0	15.0	28.0	40.0	133.0	735.0	*
1966	37.0	144.0	146.0	79.0	34.0	40.0	0.0	2.0	0.0	16.0	35.0	23.0	556.0	671.0
1967	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1968	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1969	29.1	120.7	85.2	100.3	33.2	20.2	20.0	14.8	2.0	23.5	64.8	21.4	535.2	*
1970	229.2	172.1	132.7	110.5	27.2	4.5	0.0	2.0	48.8	15.2	3.5	111.8	857.5	828.4
1971	143.3	41.4	59.7	105.3	64.7	14.2	11.5	0.0	7.2	32.5	7.5	125.5	612.8	595.1
1972	92.8	62.4	105.4	126.3	81.8	0.0	20.9	8.6	10.2	68.6	19.7	93.4	690.1	710.0
1973	227.7	107.1	22.1	130.7	41.5	19.8	4.5	32.9	8.5	1.1	12.1	111.2	719.2	709.0
1974	53.9	13.7	66.4	201.4	62.9	5.5	16.4	5.3	15.2	53.9	0.0	11.8	506.4	617.9
1975	86.0	51.1	111.1	133.7	67.3	23.4	0.0	4.8	8.4	34.5	8.5	123.9	652.7	532.1
1976	284.7	40.6	106.5	94.3	21.4	32.7	7.2	0.0	8.6	33.2	12.8	69.6	711.6	761.6
1977	275.6	109.0	68.7	90.3	38.2	0.0	8.4	8.6	26.0	48.2	47.3	152.8	873.1	755.4
1978														
n(1959,65, 1966, 1969-77)	12	12	12	12	12	12	12	12	12	12	12	12	12	9
m	146.0	94.6	89.7	113.8	45.8	13.5	8.4	8.3	14.3	30.9	21.5	87.2	674.1	686.7
s	90.5	51.8	34.5	34.9	19.0	13.7	7.7	9.9	13.2	18.9	20.4	47.9	115.8	87.4
C_v	0.62	0.55	0.38	0.26	0.41	1.01	0.92	1.19	0.92	0.61	0.95	0.55	0.17	0.13

Monthly Rainfall (mm) for Station: BEREGA MISSION

Registration Number: 96.3703

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1950	103.1	150.1	143.5	159.0	59.7	4.3	8.4	0.0	0.0	18.0	16.8	99.1	762.0	*
1951	51.8	198.4	68.8	55.4	70.1	4.8	8.6	0.0	0.0	29.2	49.8	125.5	662.2	603.1
1952	227.1	128.3	100.1	135.4	82.6	2.8	0.0	0.0	30.0	0.0	54.9	25.4	786.4	881.1
1953	144.8	12.4	136.7	101.3	92.5	12.4	14.7	12.2	0.0	0.0	2.5	104.1	633.7	607.4
1954	158.2	191.8	39.9	95.5	53.1	1.0	0.0	0.0	0.0	21.3	5.1	77.7	643.6	667.4
1955	56.1	219.5	24.9	108.7	111.3	40.4	5.1	0.0	0.0	0.0	24.6	166.1	756.7	648.8
1956	215.9	124.5	83.3	175.0	44.2	17.3	0.0	0.0	5.1	0.0	54.6	100.6	820.4	855.9
1957	178.1	45.7	141.0	264.9	154.4	11.7	0.0	0.0	3.0	25.4	27.4	245.6	1097.3	979.5
1958	58.2	174.8	189.7	116.1	52.3	35.3	0.0	0.0	0.0	0.0	14.2	99.3	739.9	899.4
1959	133.1	218.9	191.0	94.2	32.8	0.0	0.0	30.5	0.0	0.0	0.0	77.0	777.5	814.0
1960	149.6	62.7	99.8	139.2	38.4	25.9	25.7	0.0	1.3	1.5	0.0	0.0	544.1	621.1
1961	15.2	200.7	52.1	147.3	59.7	0.0	77.5	0.0	0.0	104.1	150.4	184.4	991.4	656.6
1962	315.0	97.0	83.3	81.3	30.5	0.0	25.4	0.0	0.0	0.0	3.0	148.6	784.9	968.1
1963	100.5	136.6	99.6	71.8	15.1	12.7	0.0	0.0	0.0	0.0	231.2	88.1	755.6	587.9
1964	198.6	172.7	206.3	85.8	55.8	55.7	28.0	0.0	0.0	20.3	0.0	218.7	1041.9	1142.5
1965	238.8	194.5	78.7	35.6	35.6	0.0	0.0	0.0	0.0	20.4	63.4	104.1	771.2	822.4
1966	25.5	27.9	111.8	139.7	73.6	53.3	40.6	0.0	0.0	0.0	38.1	(50.0)	(560.5)	639.9
1967	27.9	94.3	30.5	250.7	207.1	2.3	33.0	12.7	10.2	0.0	43.1	230.3	942.1	(756.8)
1968	150.7	139.5	286.0	135.1	51.6	25.4	0.0	0.0	0.0	0.0	58.4	20.3	967.0	1161.7
1969	57.9	186.0	128.2	69.0	33.5	10.5	2.8	6.8	8.9	9.4	36.8	41.7	591.5	591.7
1970	284.5	179.8	121.1	53.6	62.3	0.8	0.0	0.0	0.0	2.8	7.4	84.2	796.5	783.4
1971	129.5	111.3	60.6	157.0	57.4	19.3	0.0	0.0	0.0	12.9	1.4	61.2	611.8	640.8
1972	63.0	162.8	197.2	92.5	127.6	2.1	24.7	0.0	45.1	40.3	29.5	137.7	922.5	817.9
1973	267.6	218.7	30.3	217.0	24.4	12.8	0.0	5.1	0.0	1.6	18.5	115.9	911.9	944.7
1974	64.8	55.2	28.7	278.7	75.7	3.1	14.0	0.0	0.0	17.1	10.0	53.9	501.2	571.7
1975	160.4	38.9	177.6	160.2	62.6	9.9	2.9	1.6	9.9	1.0	1.3	88.5	714.8	688.9
1976	66.9	164.6	86.3	107.3	71.7	18.9	15.4	0.2	0.5	0.0	2.5	54.5	588.8	621.6
1977	195.6	188.8	96.1	105.6	123.1	1.1	21.1	14.9	19.4	11.0	81.3	127.0	985.0	833.7
1978	114.0	112.2	216.9	136.0	67.1	15.6	3.4	1.0	0.0	0.0	111.6	309.1	1086.9	874.5
n(1953-77)	25	25	25	25	25	25	25	25	25	25	25	25	25	25
m	138.3	136.8	111.2	131.3	69.9	14.9	13.2	3.4	4.1	11.1	36.2	107.2	778.1	773.0
s	84.8	65.6	67.1	64.3	44.8	16.4	18.5	7.2	9.8	22.2	53.2	63.5	168.9	170.0
C_v	0.61	0.48	0.60	0.49	0.64	1.10	1.40	2.10	2.39	2.00	1.47	0.59	0.22	0.22

Monthly Rainfall (mm) for Station: KIMAMBA RAILWAY STATION

Registration Number: 96.3709

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1950	63.6	94.0	168.9	234.7	19.8	0.0	0.0	0.0	0.0	0.0	40.1	158.2	779.3	*
1951	72.1	148.1	88.9	135.9	50.0	5.1	0.0	0.0	0.0	60.2	163.8	82.8	807.0	758.6
1952	23.9	258.1	0.0	212.9	253.0	17.8	0.0	0.0	0.0	0.0	26.9	0.0	792.6	1012.3
1953	18.0	21.1	119.1	167.9	28.2	0.0	0.0	0.0	0.0	0.0	6.4	13.7	374.4	381.2
1954	10.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.9	31.0
1955	87.6	20.8	23.9	20.1	13.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	165.9	165.9
1956	326.1	177.3	49.5	182.9	1.0	0.0	0.0	0.0	0.0	0.0	0.0	45.2	782.1	736.8
1957	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1958	0.0	57.4	409.7	144.5	21.6	32.3	5.6	0.0	11.4	0.0	0.0	338.8	1022.1	*
1959	310.1	358.9	198.6	318.5	133.1	0.0	0.0	6.4	0.0	0.8	130.3	*	*	*
1960	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1961	28.7	120.4	79.5	*	32.3	*	*	*	*	*	*	*	*	*
1962	140.5	167.6	144.3	159.8	0.0	0.0	0.0	25.9	9.7	14.0	29.5	67.1	758.2	*
1963	190.9	139.9	383.6	194.6	0.0	0.0	0.0	0.0	0.0	0.0	213.1	85.6	1207.1	1005.0
1964	149.5	144.8	292.9	131.9	20.3	1.5	0.0	7.9	0.0	72.4	0.0	31.0	852.2	1119.9
1965	103.7	178.5	205.7	71.7	32.5	0.0	0.0	0.0	0.0	25.2	37.4	268.4	923.1	648.3
1966	59.2	89.5	138.5	132.4	*	*	*	*	*	*	*	*	*	*
1967	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1968	*	*	*	*	*	*	*	*	*	60.9	57.1	*	*	*
1969	96.5	27.9	153.2	287.0	*	*	*	*	*	*	*	*	*	*
1970	299.9	*	*	*	*	*	*	*	*	*	*	*	*	*
1971	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1972	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1973	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1974	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1975	*	25.7	183.7	163.0	92.7	40.2	0.0	0.0	23.6	0.0	0.0	77.0	*	*
1976	59.5	46.0	32.0	44.0	18.0	0.0	0.0	0.0	0.0	0.0	3.9	*	*	276.5
1977														
1978			(No data available)											
n(1950-56, 1961-65)	11	11	11	11	11	11	11	1	11	11	11	11	11	9
m	107.9	122.7	134.3	137.5	38.0	2.2	0.0	3.1	0.9	15.6	47.0	68.4	677.5	651.0
s	92.5	80.3	123.1	76.8	73.1	5.4	0.0	7.9	2.9	26.5	72.5	82.2	350.3	385.2
C_v	0.86	0.65	0.92	0.56	1.92	2.45	0.00	2.55	3.22	1.70	1.54	1.20	0.52	0.59

Monthly Rainfall (mm) for Station: MUSKATI MISSION

Registration Number: 96.3710

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1950	161.3	153.7	227.8	248.2	127.5	15.8	20.3	19.1	102.9	40.4	68.1	156.0	1341.0	*
1951	106.2	140.5	101.3	275.3	141.0	18.8	21.8	74.9	0.0	97.5	171.7	305.3	1454.3	1201.4
1952	86.9	58.9	66.5	361.2	128.0	51.6	1.0	1.8	51.3	35.3	129.0	143.8	1115.3	1319.5
1953	73.7	13.2	118.1	151.9	171.2	4.6	62.7	31.2	10.9	44.7	109.0	100.3	891.5	954.4
1954	213.9	107.7	96.0	164.9	97.3	2.5	21.3	18.8	48.3	47.0	8.1	31.0	856.7	1026.9
1955	74.9	365.0	83.8	226.8	123.2	44.5	4.8	0.0	33.8	10.4	87.9	121.7	1176.8	1006.3
1956	232.2	77.0	229.4	278.9	59.2	12.7	0.0	13.2	16.0	22.1	24.9	67.1	1032.7	1150.3
1957	166.1	79.2	135.4	290.6	137.4	0.0	7.4	28.2	23.4	47.0	76.7	127.0	1118.4	1006.7
1958	17.8	157.7	232.9	226.8	81.3	39.6	(3.0)	24.9	8.6	17.3	0.5	53.8	(864.2)	(1013.6)
1959	136.9	72.6	136.7	141.0	79.0	1.3	34.3	0.0	0.0	38.6	65.5	86.1	792.0	694.7
1960	70.6	6.4	177.8	134.4	35.1	7.9	7.9	0.0	2.5	14.0	0.0	5.8	462.4	608.2
1961	5.8	30.5	37.1	79.8	42.4	6.9	6.9	0.8	0.0	118.1	64.8	107.4	500.5	334.1
1962	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1963	9.9	10.1	70.6	331.5	76.1	163.6	158.6	4.1	4.1	0.0	157.6	54.6	1040.8	*
1964	35.6	143.3	273.4	329.9	64.5	22.6	3.8	32.3	4.1	57.2	5.9	176.1	1148.7	1178.9
1965	151.3	99.9	107.4	198.6	166.1	0.0	13.3	20.6	71.7	123.6	238.4	275.3	1466.2	1134.5
1966	146.2	122.8	317.6	236.2	121.5	47.2	1.8	16.8	26.0	130.7	54.4	82.4	1303.6	1680.5
1967	68.9	95.5	113.4	305.9	300.9	23.6	71.0	123.9	156.3	102.2	217.3	165.7	1744.6	1498.4
1968	241.6	142.6	370.1	408.0	170.7	57.7	4.0	6.2	13.2	64.9	232.4	98.3	1809.7	1862.0
1969	80.9	191.3	263.5	221.0	99.7	28.0	15.5	54.3	18.1	80.2	306.9	35.1	1394.5	1383.2
1970	218.5	178.5	195.0	214.6	59.2	1.5	11.1	5.6	29.2	58.6	0.1	236.3	1208.2	1313.8
1971	131.2	142.2	166.6	239.4	98.8	57.3	58.5	0.5	25.2	31.7	51.8	298.1	1301.3	1187.8
1972	47.0	124.7	173.2	246.4	218.1	0.2	32.7	11.0	78.2	87.5	166.5	64.9	1250.4	1368.9
1973	144.1	123.4	70.4	451.0	182.4	17.0	22.7	37.5	28.7	9.9	97.7	146.2	1331.0	1318.5
1974	61.7	35.8	196.3	521.7	121.1	17.0	35.8	0.0	0.0	0.0	0.0	47.1	1036.5	1233.3
1975	61.7	77.0	203.2	239.5	162.8	20.3	12.5	9.0	37.1	22.5	12.0	122.0	978.9	892.0
1976	73.5	0.0	*	182.8	*	69.9	*	*	13.1	0.0	80.8	121.9	*	*
1977	152.8	146.8	147.4	207.1		(No data available)								
1978														
n(1950-75)	25	25	25	25	25	25	25	25	25	25	25	25	25	23
m	109.8	100.0	166.5	260.9	122.6	26.5	25.3	21.4	31.6	52.1	93.9	124.3	1144.8	1146.4
s	69.8	74.9	84.7	101.1	60.0	34.2	34.1	28.3	37.3	39.3	87.9	82.3	322.6	334.0
C_v	0.64	0.75	0.51	0.39	0.49	1.29	1.35	1.32	1.18	0.75	0.94	0.66	0.28	0.29

Monthly Rainfall (mm) for Station: KINGOLWIRA PRISON FARM

Registration Number: 96.3711

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1950	142.2	83.6	178.8	187.7	30.5	5.6	55.6	7.1	26.4	22.4	42.4	49.8	644.4	*
1951	94.7	134.1	161.3	198.9	76.5	13.0	6.4	11.9	0.8	57.2	147.6	170.2	1072.6	847.0
1952	100.8	129.3	129.3	58.9	39.6	9.4	8.1	17.5	34.8	119.4	72.9	7.6	727.6	1811.9
1953	43.9	13.0	110.0	135.4	86.6	6.6	8.1	25.7	16.8	35.8	26.4	25.1	533.4	562.4
1954	209.6	182.1	39.6	61.7	106.4	10.2	17.8	9.1	2.5	149.6	14.2	25.9	828.7	840.1
1955	23.4	186.2	11.9	138.7	192.0	19.8	25.4	4.3	3.0	0.0	108.7	118.4	831.8	644.8
1956	174.5	82.8	45.0	154.2	37.3	21.8	0.8	5.6	3.3	5.6	93.5	(80.0)	(704.4)	758.0
1957	216.7	23.4	118.6	110.7	50.3	9.9	13.2	0.0	51.1	30.0	109.2	109.7	842.8	807.4
1958	0.0	209.0	260.1	130.6	39.1	24.1	8.9	16.0	5.6	0.0	45.5	118.6	857.5	912.3
1959	146.8	123.7	118.4	60.2	44.2	1.0	7.6	14.2	19.6	18.8	11.2	103.9	669.6	718.6
1960	142.2	41.7	148.1	186.9	40.9	10.4	6.1	0.0	4.6	44.7	7.6	5.6	638.8	740.7
1961	8.4	142.7	320.5	109.7	32.5	43.4	63.0	17.8	40.6	253.7	437.6	169.4	1639.3	1045.5
1962	67.6	56.1	94.5	148.1	32.5	5.3	14.7	78.5	16.8	29.7	53.1	130.3	727.2	1150.8
1963	178.8	103.4	102.9	190.8	18.3	15.6	9.2	4.1	5.6	27.4	272.7	83.6	1012.4	839.5
1964	113.6	138.8	109.2	116.4	15.0	1.9	16.0	7.5	0.0	52.9	(5.0)	(140.0)	(716.3)	927.6
1965	164.4	98.5	123.5	110.6	58.0	0.0	1.8	6.3	4.8	51.4	52.1	288.1	959.5	764.3
1966	29.7	277.7	229.2	114.2	48.2	20.3	6.6	4.3	10.5	23.1	26.4	258.5	1048.7	1104.0
1967	5.1	101.9	34.3	414.5	90.0	19.6	55.4	39.3	90.2	93.0	148.7	33.8	1125.8	1228.2
1968	93.8	98 1	176.9	174.0	45.4	35.0	5.3	0.0	8.1	23.8	95.0	30.7	786.1	842.9
1969	64.0	152.0	138.0	100.4	30.6	5.4	43.0	6.4	10.7	16.6	36.2	116.4	719.7	692.8
1970	206.7	174.3	101.0	66.0	29.3	16.3	0.0	7.1	118.3	10.0	7.3	0.0	736.3	881.6
1971	116.2	89.1	59.8	86.2	9.6	8.1	37.1	0.1	2.6	37.7	0.0	112.3	558.8	453.8
1972	182.2	129.8	159.6	224.6	110.8	2.5	29.3	3.3	35.2	89.1	64.4	119.9	1150.7	1078.7
1973	146.5	53.2	51.9	231.6	61.4	8.5	0.0	0.0	0.0	0.0	72.8	110.9	736.8	737.4
1974	*	*	*	*	*	*	*	*	*	*	(7)	(27)	*	*
1975	86.9	86.3	117.0	100.6	60.0	10.6	0.0	0.0	20.3	0.0	10.6	148.1	640.4	(515.7)
1976	303.5	212.0	233.5	683.4	108.0	60.0	100.0	14.2	19.0	6.5	13.0	211.0	1964.1	1750.7
1977	345.0	137.0	105.0	73.0	57.5	20.0	15.0	23.0	76.0	88.3	*	*	*	1163.8
1978														
n(1950-73, 1975-76)	26	26	26	26	26	26	26	26	26	26	26	26	26	25
m	117.8	120.1	129.7	165.7	57.4	14.8	20.8	11.6	21.2	46.1	74.9	106.5	879.8	932.2
s	76.2	62.1	73.3	129.0	39.6	13.8	24.6	16.4	28.3	56.8	96.5	74.6	316.3	311.9
C_v	0.65	0.52	0.57	0.78	0.69	0.93	1.18	1.41	1.33	1.23	1.29	0.70	0.36	0.33

Monthly Rainfall (mm) for Station: PANGAWE SISAL ESTATE

Registration Number: 96.3712

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1950	175.0	80.3	172.7	198.9	12.7	5.6	61.7	42.7	26.7	16.0	21.1	98.6	912.0	*
1951	123.7	156.5	135.6	256.0	81.0	5.8	12.7	24.1	0.0	39.6	125.7	149.4	1110.1	954.7
1952	167.4	116.3	112.8	167.1	49.3	101.1	13.5	74.7	39.4	135.9	67.3	20.6	1065.4	1252.6
1953	110.7	33.3	124.2	76.5	164.1	5.1	3.8	50.8	55.4	57.7	37.3	108.7	827.6	769.5
1954	234.7	113.8	144.8	121.7	125.7	11.7	10.7	19.6	2.5	116.8	24.9	54.1	981.0	1048.0
1955	2.8	210.6	24.9	167.6	179.3	24.6	27.4	8.1	5.6	12.4	128.5	109.7	901.5	742.3
1956	179.9	132.3	68.1	197.9	80.3	50.8	8.4	9.4	(10.0)	(15.0)	115.8	97.3	956.2	981.3
1957	235.0	102.6	100.3	137.2	53.1	18.3	26.2	17.3	17.3	74.4	54.9	131.3	1116.2	1032.4
1958	16.8	156.7	282.2	126.2	72.6	40.1	9.7	19.1	4.8	2.0	27.9	184.7	942.8	1027.1
1959	111.3	157.0	102.1	122.9	60.2	3.0	18.0	31.2	75.2	34.0	24.6	74.4	813.9	927.5
1960	150.1	33.5	201.4	200.9	46.7	20.6	22.1	9.1	9.4	82.6	44.5	0.3	821.2	875.4
1961	37.1	223.5	109.0	127.0	46.7	59.2	117.9	32.3	63.5	219.7	297.7	225.3	1558.9	1080.7
1962	114.0	110.2	111.5	97.8	36.1	10.7	26.2	123.4	14.0	25.9	58.4	(120.0)	848.2	1192.8
1963	166.8	*	*	*	*	39.4	*	*	*	*	*	*	*	*
1964	72.6	119.6	106.3	205.6	18.1	5.9	7.6	17.8	6.6	64.6	0.0	149.7	774.4	*
1965	68.4	83.0	135.9	144.7	112.5	0.5	10.6	3.6	7.1	63.0	111.3	245.6	986.2	779.0
1966	1.5	150.0	*	*	*	20.1	*	*	*	*	*	*	*	*
1967	2.0	168.0	23.9	287.0	103.6	20.9	72.0	50.6	100.2	95.8	187.6	274.9	1386.5	*
1968	79.3	90.0	222.5	254.3	67.9	33.4	0.0	0.0	8.9	23.6	130.1	75.7	985.7	1242.4
1969	20.9	84.2	215.5	131.6	31.2	3.3	43.3	17.0	14.3	*	*	*	*	*
1970	213.0	219.0	137.2	111.8	38.1	30.4	0.0	15.2	*	*	*	*	*	*
1971			(Station closed)											
n(1950-62, 1964,65, 1967,68)	17	17	17	17	17	17	17	17	17	17	17	17	17	14
m	110.1	122.8	128.1	170.0	77.1	24.6	26.4	31.4	29.6	62.3	90.2	126.7	999.3	993.3
s	73.1	52.8	65.4	59.2	46.9	26.2	30.4	30.9	31.9	55.6	75.6	75.8	207.0	166.7
C_v	0.66	0.43	0.51	0.35	0.61	1.07	1.15	0.98	1.08	0.89	0.84	0.60	0.21	0.17

Monthly Rainfall (mm) for Station: SCUTARI SISAL ESTATE

Registration Number: 96.3713

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1950	69.3	106.4	169.9	223.3	48.0	0.0	0.0	0.5	29.5	0.0	5.3	157.5	809.7	*
1951	79.0	164.1	87.1	170.2	58.2	5.8	0.0	0.0	1.8	44.2	196.9	58.7	866.0	773.2
1952	50.3	239.8	264.9	206.5	84.8	4.8	0.0	5.6	5.8	19.3	37.1	13.2	932.1	1137.4
1953	74.2	32.0	126.7	171.2	106.9	0.0	0.0	8.1	4.8	8.6	29.0	150.4	711.9	582.8
1954	98.0	138.7	50.8	183.4	66.0	0.0	3.0	6.1	0.0	48.3	8.6	66.5	669.4	773.7
1955	99.8	118.6	159.8	285.5	122.2	4.8	17.0	1.3	0.0	3.6	25.1	129.5	967.2	887.7
1956	146.1	154.9	95.0	195.3	35.8	0.0	0.0	0.0	0.0	0.0	15.2	39.9	682.2	781.7
1957	198.9	144.8	112.0	283.2	97.8	1.8	0.0	1.0	2.5	12.4	86.1	183.4	1123.9	909.5
1958	10.7	274.1	217.7	72.6	7.1	10.4	(2.0)	4.3	6.9	0.0	0.0	180.3	786.1	968.9
1959	140.5	278.6	102.1	156.7	72.9	(1.0)	4.3	8.4	0.0	25.7	72.4	48.0	910.6	970.5
1960	163.3	63.2	399.8	165.1	2.5	10.2	2.5	0.0	0.0	0.0	0.0	0.0	806.6	927.0
1961	41.1	140.7	66.5	179.6	43.7	26.3	7.6	7.6	21.1	112.3	180.3	384.3	1211.0	646.4
1962	292.9	172.2	128.0	116.6	16.5	3.8	7.9	38.4	17.8	0.0	24.6	58.9	877.6	1358.7
1963	188.7	209.3	349.3	234.6	0.0	8.1	0.0	2.5	0.0	0.0	203.6	112.9	1309.0	1076.0
1964	191.0	165.9	297.5	138.1	22.1	0.0	0.0	3.8	0.0	72.1	0.0	52.4	942.9	1207.0
1965	103.1	236.6	289.6	64.9	24.2	0.0	(0.0)	2.5	(0.0)	(30.0)	*	*	*	*
1966	58.7	119.9	161.8	161.9	51.5	3.6	*	*	*	*	*	*	*	*
1967	29.7	120.1	114.0	412.2	75.7	10.4	53.4	27.2	60.4	29.0	163.5	366.7	1462.3	*
1968	189.2	53.9	281.6	292.1	147.3	53.0	0.0	17.0	0.0	86.9	104.0	181.6	1406.6	1651.2
1969	27.9	53.4	134.9	188.0	64.7	0.0	0.0	15.2	0.0	(10.0)	58.9	(40.0)	593.0	779.7
1970	218.3	229.1	192.2	35.8	0.0	0.0	0.0	0.0	46.5	0.0	0.0	100.8	822.7	817.8
1971	144.1	80.6	39.5	148.9	0.0	0.0	0.0	0.0	0.0	23.0	25.5	52.5	514.1	536.9
1972	108.6	83.8	235.0	154.3	63.5	0.0	0.0	0.0	86.0	74.4	83.3	277.7	1166.6	883.6
1973	277.7	151.2	32.4	181.6	42.4	(2.0)	(1.0)	(0.0)	(0.0)	(5.0)	(50.0)	(100.0)	843.3	1054.3
1974	148.5	23.7	125.9	308.7	86.4	11.5	5.3	0.0	3.8	12.4	0.0	17.4	743.6	876.2
1975	214.1	27.6	292.2	228.4	74.4	20.0	0.0	0.0	23.5	0.0	0.0	195.0	1075.2	897.6
1976	105.5	112.8	123.7	97.4	43.5	0.0	0.0	0.0	0.0	0.0	0.0	47.9	530.8	677.9
1977	235.8	50.1	126.5	225.1	28.4	0.0	0.0	9.7	82.0	0.0	118.4	199.5	1075.5	805.5
1978														
n(1950-64, 1967-77)	26	26	26	26	26	26	26	26	26	26	26	26	26	25
m	136.3	130.4	166.4	194.4	54.3	6.7	4.0	6.0	15.1	22.6	57.2	123.7	916.9	812.5
s	78.0	73.8	97.9	79.3	39.5	11.6	10.8	9.4	25.6	31.5	66.1	102.2	253.0	371.0
C_v	0.57	0.57	0.59	0.41	0.73	1.73	2.70	1.57	1.70	1.39	1.16	0.83	0.28	0.46

Monthly Rainfall (mm) for Station: MARIOS SISAL ESTATE

Registration Number: 96.3714

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1950	54.1	108.7	168.1	210.5	22.6	0.0	3.3	3.0	45.2	5.6	44.7	170.7	837.7	*
1951	68.8	216.4	83.8	144.0	47.5	9.7	0.0	24.1	0.0	51.5	30.5	116.8	792.7	860.8
1952	77.7	216.2	253.5	188.7	73.9	0.0	0.0	0.0	0.0	4.8	29.0	6.9	850.6	962.1
1953	52.3	30.5	107.4	179.3	112.3	0.0	0.0	4.3	12.7	12.7	34.3	102.1	548.0	547.4
1954	95.3	115.3	20.8	168.4	34.0	0.0	14.0	3.0	0.0	0.0	0.0	69.3	520.2	587.2
1955	77.5	129.5	129.5	216.9	109.5	0.0	14.7	0.0	0.0	0.0	27.9	63.2	814.3	746.9
1956	122.7	144.8	67.3	210.8	37.1	0.0	0.0	0.0	0.0	0.0	15.0	36.1	634.5	673.8
1957	171.2	113.3	134.4	282.7	63.5	0.0	0.0	0.0	0.0	36.5	81.5	160.3	1043.7	852.7
1958	20.3	209.8	142.2	52.6	17.0	6.6	2.5	3.0	3.0	2.0	0.0	176.3	619.8	700.8
1959	103.1	235.0	82.3	88.1	51.6	1.8	1.0	3.8	2.3	5.3	45.5	52.8	672.6	750.6
1960	121.7	36.6	262.9	124.7	0.0	6.9	14.0	1.3	0.0	5.8	0.0	0.0	573.8	672.2
1961	31.2	117.3	81.3	161.3	41.1	2.0	7.4	0.0	24.1	98.0	181.4	328.7	1089.2	563.7
1962	155.7	145.5	146.8	79.0	43.7	0.0	11.4	22.9	8.1	17.5	9.7	62.7	703.1	1140.7
1963	137.6	151.8	341.7	191.7	5.8	6.6	0.0	0.0	2.5	0.0	172.2	113.8	1123.6	910.0
1964	188.0	181.7	220.7	124.8	30.0	12.4	1.3	6.1	0.0	50.8	5.6	36.8	858.2	1101.8
1965	102.4	173.1	187.4	80.5	19.7	0.0	0.0	2.0	0.0	26.2	63.4	257.4	912.1	633.7
1966	40.7	117.7	212.8	156.6	41.6	0.0	0.0	2.0	3.8	35.5	148.1	73.2	832.0	931.5
1967	8.4	86.1	93.7	372.8	54.0	5.1	60.5	12.6	53.4	31.8	111.7	276.2	1166.3	1019.7
1968	134.3	52.1	287.3	251.4	94.7	25.4	0.0	4.6	13.9	78.7	123.3	185.4	1251.1	1330.3
1969	49.0	47.0	99.8	222.9	57.3	(0.0)	(0.0)	(0.0)	(0.0)	(15.0)	(50.0)	(60.0)	601.0	799.7
1970	165.0	159.2	201.7	51.0	27.9	2.5	0.0	0.0	26.7	16.3	0.0	142.1	792.4	760.3
1971	149.3	78.2	48.5	157.3	0.0	(0.0)	(0.0)	0.0	0.0	(20.0)	25.4	91.4	570.1	595.4
1972	98.0	102.3	210.3	176.1	60.4	0.0	0.0	0.0	54.5	73.4	66.4	69.2	910.6	891.8
1973	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1974	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1975	*	*	*	143.8	97.2	6.7	*	*	*	*	*	*	*	*
1976	147.6	66.9	89.9	92.1	69.7	10.8	5.0	0.0	0.0	0.0	7.4	41.9	531.3	*
1977	230.4	89.7	126.3	185.9	38.4	0.0	1.4	0.0	80.4	88.3	94.4	261.8	1197.4	890.1
1978														
n(1950-72, 1976,77)	25	25	25	25	25	25	25	25	25	25	25	25	25	23
m	104.1	125.0	152.0	166.8	46.1	3.6	5.5	3.7	13.2	27.0	54.7	118.2	817.9	822.8
s	56.6	58.4	80.6	74.1	30.1	6.0	12.5	6.6	22.1	30.1	55.0	88.8	224.7	200.8
C_v	0.54	0.47	0.53	0.44	0.65	1.67	2.27	1.78	1.67	1.11	1.01	0.75	0.27	0.24

Monthly Rainfall (mm) for Station: KINGOLWIRA SISAL ESTATE

Registration Number: 96.3715

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1950	108.5	123.4	192.5	193.8	11.2	4.6	87.1	37.3	26.7	20.3	34.3	68.8	908.5	*
1951	94.7	156.2	173.0	213.9	200.4	6.4	11.2	22.1	0.0	32.3	114.6	334.3	1359.1	1013.3
1952	133.6	119.1	141.0	145.8	39.6	30.0	22.4	29.7	38.9	103.6	55.1	20.1	878.9	1252.6
1953	80.5	11.2	100.1	122.7	135.9	7.6	7.9	52.8	25.9	39.6	26.4	84.6	695.2	659.4
1954	208.8	142.0	35.3	123.2	98.6	5.8	12.2	17.8	7.1	110.2	26.7	17.0	804.7	872.0
1955	11.9	260.6	78.0	140.7	152.9	19.8	21.8	0.3	21.6	1.5	67.6	109.2	885.9	752.8
1956	207.5	127.5	59.2	190.0	53.8	48.8	(1.0)	(5.0)	(3.0)	(6.0)	(90.0)	(80.0)	871.8	878.6
1957	201.2	108.2	74.2	90.4	51.3	9.7	19.6	25.9	56.9	29.7	112.0	103.1	882.2	837.1
1958	29.7	140.7	260.1	145.8	76.7	52.1	4.3	12.2	1.0	0.0	13.7	134.6	870.9	937.7
1959	138.9	120.4	133.1	78.7	81.3	4.8	11.7	32.3	44.5	17.3	9.9	14.5	687.4	811.3
1960	157.2	7.1	140.2	132.6	21.1	10.7	10.9	0.0	0.0	67.1	5.1	13.2	565.2	571.3
1961	14.7	144.0	62.7	100.1	33.8	90.7	75.4	11.2	47.0	194.3	170.2	126.5	1070.6	792.2
1962	93.7	15.2	134.4	87.6	45.5	2.5	16.3	110.5	8.9	10.2	39.4	101.6	665.8	821.5
1963	146.0	66.3	157.5	157.3	9.3	24.5	14.5	2.3	7.9	7.9	285.9	147.9	1027.3	734.7
1964	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1965	58.2	101.1	146.9	138.1	44.1	0.0	0.0	7.4	1.8	17.8	65.0	242.1	822.5	*
1966	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1967	4.3	74.6	38.4	297.5	85.9	17.2	56.7	40.2	119.7	74.7	201.7	283.8	1294.7	*
1968	76.2	64.6	243.6	210.0	74.3	45.4	0.0	0.0	0.0	12.4	92.7	49.4	868.6	1212.0
1969	30.5	128.3	181.8	135.5	40.6	2.0	31.2	20.3	7.3	60.7	118.1	13.0	769.3	782.3
1970	210.2	219.0	137.2	111.8	38.1	30.4	0.0	15.2	81.3	12.7	10.4	89.0	955.3	987.0
1971	207.0	90.4	57.1	118.0	27.8	8.9	24.1	3.8	2.6	27.4	3.8	94.5	665.4	666.5
1972	88.8	50.3	180.4	169.5	63.2	0.0	8.9	2.5	26.6	85.2	33.8	129.0	838.2	773.7
1973	138.3	88.2	73.6	152.9	61.2	5.1	0.1	15.4	8.4	7.9	58.4	86.1	695.6	713.9
1974	37.5	2.1	54.1	181.8	69.1	3.1	12.1	15.4	15.8	64.8	7.1	27.0	489.9	600.3
1975	123.9	63.9	120.5	115.3	66.0	28.9	17.7	0.0	12.7	8.9	6.8	178.1	742.7	591.9
1976	217.7	86.8	93.2	72.0	25.6	20.1	9.2	0.0	7.9	72.1	5.3	48.0	657.9	789.5
1977	213.9	87.5	93.6	55.2	33.0	0.0	19.3	0.0	33.0	47.0	80.0	181.1	843.6	653.8
1978														
n(1950-63, 1967-77)	26	26	26	26	26	26	26	26	26	26	26	26	26	23
m	116.7	100.0	121.6	141.6	63.1	18.4	19.1	18.5	23.3	43.5	66.7	106.8	839.1	813.3
s	71.5	60.7	60.3	52.4	44.3	21.4	21.9	23.7	28.4	44.7	69.2	83.4	196.4	177.5
C_v	0.61	0.61	0.50	0.37	0.70	1.16	1.15	1.28	1.22	1.03	1.04	0.78	0.23	0.22

Monthly Rainfall (mm) for Station: KILOSA SISAL ESTATE

Registration Number: 96.3716

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1950	205.2	33.5	265.4	222.3	51.3	6.6	4.1	19.6	17.0	2.5	5.6	74.7	907.8	*
1951	158.5	209.8	93.7	179.6	78.5	18.5	3.6	4.1	2.5	84.6	335.8	143.5	1312.7	913.7
1952	27.2	206.5	211.6	164.6	123.7	2.3	0.0	16.3	28.7	34.0	29.5	18.0	862.3	1494.2
1953	142.0	58.9	129.8	118.9	109.2	0.0	0.8	21.8	37.3	37.3	43.4	237.5	935.2	703.5
1954	168.7	186.4	115.1	108.2	60.2	2.0	7.1	4.8	8.9	35.3	60.2	64.5	821.4	977.6
1955	55.4	176.5	99.1	252.0	157.2	14.0	9.9	0.0	26.9	88.9	96.5	65.3	1041.7	1004.6
1956	142.0	62.5	153.2	288.3	37.6	18.0	0.0	0.0	9.1	19.3	1.3	177.5	908.8	891.8
1957	130.6	69.3	118.4	237.7	166.6	7.6	7.9	6.1	8.4	20.6	25.1	268.7	1067.2	954.9
1958	34.0	118.4	220.7	109.7	79.2	19.1	0.3	12.2	4.1	5.1	1.0	155.4	759.2	896.6
1959	226.7	129.0	257.0	142.5	35.8	0.0	4.1	10.9	1.5	5.1	71.6	20.8	905.0	1009.0
1960	131.6	106.7	272.8	305.8	17.5	16.3	0.3	0.0	8.9	14.0	0.8	9.9	884.6	966.3
1961	21.3	146.6	140.0	233.4	27.2	4.3	22.9	14.0	38.4	189.5	375.7	186.2	1399.5	848.3
1962	159.5	150.9	136.1	148.6	12.2	2.5	13.7	77.5	22.1	7.1	2.3	82.3	814.8	1292.1
1963	146.6	175.5	275.5	181.9	10.5	25.2	5.9	2.5	8.1	4.1	437.9	179.7	1453.4	920.4
1964	222.3	232.2	221.5	172.4	26.2	5.4	6.1	20.8	0.0	136.3	0.0	84.5	1127.7	1660.8
1965	72.7	201.5	226.2	160.0	51.3	0.0	4.1	9.2	31.2	22.9	88.2	303.7	1171.0	863.6
1966	101.8	133.2	191.0	155.0	49.0	10.0	0.0	2.8	11.7	65.9	82.8	92.9	896.1	1109.3
1967	22.6	177.9	43.2	230.8	74.1	8.4	37.9	11.1	59.2	26.0	168.5	243.7	1103.4	866.9
1968	141.6	56.8	222.2	278.9	32.3	25.9	0.0	17.3	3.5	11.6	29.5	129.1	948.7	1202.3
1969	85.1	117.3	71.4	149.1	59.9	5.8	0.0	4.3	5.3	65.3	154.4	8.9	726.8	722.1
1970	152.2	87.9	105.7	34.0	46.8	0.0	2.5	7.9	33.8	3.6	0.0	121.8	596.2	590.9
1971	122.5	82.5	132.5	158.1	26.7	5.1	16.1	6.6	11.1	6.0	9.0	77.1	653.3	689.0
1972	188.0	176.7	164.4	106.7	98.1	0.0	6.7	11.4	(70.0)	(100.0)	157.7	327.2	1406.9	1008.1
1973	211.0	87.0	85.0	228.0	68.0	0.0	9.6	27.0	0.0	0.0	1000.0	100.0	915.6	1200.5
1974	250.0	110.0	200.0	400.0	76.2	80.0	80.0	10.0	180.0	40.0	8.5	128.9	1563.6	1626.2
1975	280.1	133.0	(180.0)	88.5	41.0	11.4	0.0	1.1	35.9	13.5	24.1	136.5	945.1	921.9
1976	108.1	107.9	289.6	199.4	56.4	9.3	11.1	0.8	1.0	12.2	22.9	14.2	832.9	969.9
1977	151.7	79.9	168.9	168.1	70.0	0.0	0.0	19.1	78.1	43.1	142.1	294.5	1215.5	816.0
1978														
n(1950-77)	28	28	28	28	28	28	28	28	28	28	28	28	28	27
m	137.8	129.1	171.1	186.5	62.2	10.6	9.1	12.1	26.5	39.1	88.4	133.8	1006.3	1004.5
s	69.1	53.9	68.3	76.3	39.7	15.7	16.2	14.9	36.8	45.3	117.5	93.5	247.2	264.6
C_v	0.50	0.42	0.40	0.41	0.64	1.45	1.78	1.23	1.39	1.16	1.33	0.70	0.25	0.26

Monthly Rainfall (mm) for Station: ***MELELA***

Registration Number: 96.3717

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1950	54.4	121.2	218.7	234.2	32.8	4.1	2.0	3.0	18.0	4.3	20.8	13.2	726.7	*
1951	90.4	157.5	154.9	242.3	80.5	2.5	0.0	0.0	0.0	93.2	141.7	145.3	1108.3	855.3
1952	4.1	102.6	107.4	212.3	58.4	0.0	0.0	0.0	19.1	8.9	24.6	0.0	537.5	799.8
1953	27.4	21.6	132.8	141.7	84.6	0.0	0.0	8.1	9.1	12.2	34.0	72.9	544.6	462.1
1954	85.6	37.3	66.0	122.2	100.1	0.0	0.0	10.2	0.0	58.7	9.7	0.0	489.7	587.0
1955	73.2	365.8	85.9	181.1	103.6	4.3	0.0	0.0	0.0	2.0	10.4	65.8	892.0	825.6
1956	149.4	118.1	107.7	325.4	1.3	0.0	0.0	0.0	0.0	6.9	2.8	(5.0)	716.1	785.0
1957	98.0	69.1	88.9	179.6	118.6	0.0	2.5	2.5	81.8	13.5	56.4	64.0	775.0	662.3
1958	26.7	149.4	278.6	138.9	100.3	3.6	(0.0)	11.4	0.0	10.2	0.0	(100.0)	819.1	839.5
1959	*	*	*	*	*	*	*	*	*	*	*	115.1	*	*
1960	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1961	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1962	275.8	49.5	90.4	148.8	42.2	0.0	2.8	3.8	3.3	4.1	19.8	47.0	688.7	*
1963	102.2	113.8	124.5	236.9	12.9	5.6	0.0	0.0	0.0	0.0	(50.0)	20.9	666.8	682.7
1964	53.4	46.9	270.6	193.5	12.7	20.6	0.0	0.0	0.0	50.8	0.0	22.8	671.3	662.6
1965	117.1	224.9	143.0	7.6	0.0	0.0	0.0	0.0	0.0	17.8	25.4	90.3	626.1	533.2
1966	16.0	98.6	159.1	221.5	35.7	0.0	0.0	0.0	0.0	6.3	51.6	6.1	594.9	652.9
1967			(Station closed)											
n(1950-58, 1962-66)	14	14	14	14	14	14	14	14	14	14	14	14	14	12
m	83.8	119.7	144.9	184.7	56.0	2.9	0.5	2.8	9.4	20.6	31.9	46.7	704.0	695.7
s	69.2	89.4	67.1	73.9	41.6	5.5	1.1	4.1	21.9	27.3	36.8	44.7	161.1	127.5
C_v	0.83	0.75	0.46	0.40	0.74	1.90	2.20	1.46	2.33	1.33	1.15	0.96	0.23	0.18

Monthly Rainfall (mm) for Station: MHONDA MISSION

Registration Number: 96.3718

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1950	187.7	185.9	317.5	316.5	213.9	77.5	74.9	59.4	134.9	28.4	6.1	151.1	1753.8	*
1951	147.6	130.3	107.4	558.8	228.1	91.9	30.0	5.6	3.3	101.1	235.0	310.9	1950.0	1561.3
1952	184.9	277.9	154.2	343.2	174.8	4.8	2.8	38.6	74.9	69.3	174.0	66.3	1565.7	1871.3
1953	117.3	50.3	165.6	239.8	251.7	34.8	49.5	86.9	57.4	55.6	135.1	379.0	1623.0	1349.2
1954	147.6	199.6	144.0	269.5	144.0	17.3	20.8	70.4	4.1	120.7	61.2	100.3	1299.5	1652.1
1955	163.1	292.9	232.4	363.0	341.6	96.8	78.0	11.4	13.0	35.8	131.1	240.5	1999.6	1789.5
1956	381.0	183.9	333.0	349.3	181.4	70.6	37.3	68.6	45.7	26.9	85.9	217.7	1981.3	2049.3
1957	302.8	72.1	202.2	601.7	244.3	57.7	46.0	4.3	72.1	108.0	94.0	527.6	2332.8	2014.8
1958	25.1	111.8	475.5	205.2	52.1	81.8	6.1	20.6	24.1	39.4	25.9	138.2	1205.7	1663.3
1959	199.4	147.6	217.4	226.9	209.8	28.7	86.4	139.4	4.6	94.0	39.4	118.1	1511.6	1518.3
1960	205.7	120.7	419.9	370.6	104.6	73.2	55.6	12.2	9.1	93.7	3.0	8.4	1476.8	1622.8
1961	70.1	211.3	292.4	305.8	89.4	37.3	176.8	36.1	136.4	398.5	425.2	401.6	2580.9	1765.5
1962	234.4	111.5	273.6	373.1	91.4	32.8	115.6	91.7	55.9	56.4	55.6	247.7	1739.6	2263.2
1963	149.6	139.2	422.0	239.7	119.5	51.5	71.7	35.8	11.1	37.0	455.7	122.2	1855.0	1580.4
1964	469.3	95.9	391.5	302.0	74.7	23.0	18.5	31.9	8.8	85.8	26.3	247.0	1774.7	2079.3
1965	199.6	138.0	141.0	434.1	294.2	0.0	113.0	46.0	99.9	97.5	237.7	516.1	2317.1	1836.6
1966	68.1	143.0	389.2	271.5	172.0	40.0	91.0	46.0	28.0	81.5	46.0	120.5	1496.8	2084.1
1967	101.0	57.1	194.0	475.0	420.0	71.0	121.5	119.5	140.7	145.0	282.0	646.0	2772.8	2011.3
1968	227.5	163.5	346.0	824.5	265.0	125.0	31.5	15.2	31.3	124.2	369.8	185.1	2708.6	3081.7
1969	131.0	294.8	211.2	270.2	156.6	100.6	51.0	87.9	51.3	71.3	89.5	187.8	1703.7	1980.8
1970	370.1	226.0	600.0	185.9	65.3	9.4	26.0	40.1	155.5	39.6	0.0	273.9	1992.4	1879.3
1971	222.1	93.6	219.7	308.8	102.1	76.1	50.7	18.2	27.0	40.0	(20.0)	(180.0)	1358.3	1432.2
1972	228.2	*	49.0	243.3	216.4	20.1	*	3.0	*	*	*	*	*	*
1973	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1974	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1975	181.9	59.1	299.1	337.8	129.8	62.7	15.3	16.7	117.3	16.1	7.8	172.3	1415.9	*
1976	157.7	183.0	322.1	195.7	160.0	46.4	33.4	0.0	70.1	52.7	21.6	37.7	1280.4	1401.2
1977	214.0	166.6	178.7	236.8	0.0	12.5	10.2	10.2	184.7	24.5	218.0	(250.0)	1506.2	1097.5
1978														
n(1950-71, 1975-77)	25	25	25	25	25	25	25	25	25	25	25	25	25	23
m	194.3	149.3	282.0	344.2	171.5	52.9	56.5	44.5	62.5	81.7	129.8	233.8	1808.1	1808.0
s	101.0	75.3	120.8	145.1	96.9	33.3	42.8	37.5	54.6	74.9	136.2	157.4	444.9	396.7
C_v	0.52	0.50	0.43	0.42	0.57	0.63	0.76	0.84	0.87	0.92	1.05	0.67	0.25	0.22

Monthly Rainfall (mm) for Station: MSOWERO GINNERY

Registration Number: 96.3719

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1950	57.9	83.3	208.3	480.1	196.6	0.0	0.0	1.3	0.0	0.0	0.0	150.6	1178.1	*
1951	262.9	290.1	107.2	288.3	78.2	7.1	0.0	0.0	0.0	7.1	128.0	85.1	1254.0	1191.5
1952	85.9	144.0	145.0	389.1	89.7	0.0	0.0	0.0	24.9	0.0	47.8	0.0	926.3	1091.7
1953	97.0	0.0	97.3	268.0	142.2	0.0	6.1	9.1	5.1	0.0	6.1	72.9	703.8	672.6
1954	157.0	138.2	85.3	167.4	86.6	11.9	0.0	0.0	0.0	7.1	11.9	17.0	682.5	732.5
1955	20.3	253.0	63.5	133.6	214.1	25.4	*	*	*	*	*	*	*	*
1956	26.7	80.8	55.4	264.4	66.5	*	*	*	*	*	*	*	*	*
1957	253.7	136.9	115.1	398.0	104.0	2.0	91.4	*	*	*	*	61.2	*	*
1958	0.0	132.8	388.6	239.3	21.1	*	*	*	*	*	*	*	*	*
1959	183.6	161.0	145.0	147.8	26.4	10.9	0.0	6.4	0.0	0.0	2.3	40.6	724.0	*
1960	145.0	39.6	206.0	312.9	10.7	12.4	0.0	3.3	0.0	41.4	0.0	5.1	776.5	814.2
1961	21.3	120.4	110.7	297.2	90.9	3.3	12.4	0.0	0.0	117.9	201.7	307.6	1276.6	779.2
1962	223.5	68.8	192.5	242.8	90.9	6.9	20.6	19.1	2.8	10.2	51.3	131.8	1061.2	1387.4
1963	114.4	132.1	176.0	199.4	33.0	0.0	21.1	0.0	0.0	0.0	225.4	93.5	994.9	859.1
1964	66.8	102.5	283.8	285.3	14.0	6.4	7.6	0.0	0.0	0.0	0.0	74.9	841.3	1085.3
1965	133.4	122.1	72.9	169.3	55.8	0.0	0.0	7.6	0.0	81.8	60.9	253.9	1057.7	817.8
1966	43.4	83.3	187.0	117.1	76.2	19.5	8.1	3.1	26.7	34.1	86.1	135.3	819.9	913.3
1967	15.5	106.7	139.7	336.9	340.6	23.2	53.8	4.6	66.4	26.8	59.4	401.4	1575.0	1335.6
1968	85.1	77.6	286.0	461.5	81.2	83.0	0.0	0.0	0.0	0.0	56.0	261.4	1391.8	1536.2
1969	55.4	48.8	117.9	262.1	131.9	33.2	2.6	0.0	7.6	13.0	19.6	158.7	855.8	989.9
1970	306.4	144.7	308.6	101.1	2.1	0.0	0.0	0.0	7.6	0.0	0.0	(300.0)	1170.5	1048.8
1971	*	*	*	*	*	*	*	*	0.0	0.0	20.1	85.6	*	*
1972	143.0	89.5	286.8	125.9	158.8	2.2	0.0	0.0	32.0	73.5	48.5	135.5	1095.7	1017.2
1973	294.3	71.8	0.0	189.4	70.3	0.0	0.0	7.8	0.0	0.0	41.0	4.5	679.1	817.6
1974	95.6	15.2	84.5	268.9	102.2	17.1	10.9	0.0	0.0	0.0	0.0	0.0	594.4	639.9
1975	33.0	34.0	89.0	76.8	73.0	24.1	0.0	0.0	0.0	0.0	12.0	74.2	416.1	329.9
1976	45.8	56.7	111.7	79.0	39.0	21.6	13.2	0.0	0.0	0.0	20.0	58.7	445.7	453.2
1977	187.6	93.3	140.7	164.6	135.2	0.0	0.0	0.0	0.0	100.4	74.9	175.9	1071.9	900.5
1978														
n(1950-54, 1959-70, 1972-77)	23	23	23	23	23	23	23	23	23	23	23	23	23	21
m	124.1	96.7	155.7	236.1	92.4	12.3	6.8	2.7	7.5	22.3	50.1	131.0	938.8	924.5
s	85.6	60.2	79.6	113.2	73.1	18.3	12.3	4.7	16.0	36.1	61.6	111.3	296.6	294.0
C_v	0.69	0.62	0.51	0.48	0.79	1.48	1.81	1.74	2.13	1.62	1.23	0.85	0.32	0.32

Monthly Rainfall (mm) for Station: TEGETERO MISSION

Registration Number: 96.3720

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1950	190.8	218.4	638.4	689.4	447.3	147.8	228.9	283.0	207.5	82.3	129.0	168.4	3431.0	*
1951	152.7	304.0	198.0	500.9	407.7	241.6	85.6	0.0	0.0	0.0	506.2	417.1	2814.1	2187.3
1952	108.0	269.2	462.3	351.5	245.1	131.1	82.3	142.2	132.1	368.6	189.7	79.8	2561.8	3215.7
1953	148.1	29.7	311.2	561.3	611.9	67.6	54.1	211.8	155.2	185.4	193.5	331.2	2861.1	2605.8
1954	352.0	211.1	249.2	538.0	401.8	14.7	71.6	71.9	71.1	71.1	244.3	160.0	2631.7	2750.4
1955	234.3	273.3	172.2	698.2	571.5	188.0	187.5	32.5	78.7	129.3	153.2	354.1	3173.0	3071.3
1956	340.9	199.6	353.3	530.9	351.0	166.1	26.2	43.9	82.3	109.2	192.3	255.0	2650.7	2710.7
1957	283.5	79.5	365.3	717.3	422.1	33.0	166.4	101.9	248.4	173.3	162.3	175.0	2928.4	3038.4
1958	15.5	150.1	858.0	478.5	192.5	156.5	28.7	116.8	87.6	55.6	147.1	155.7	2442.7	2477.1
1959	277.9	91.9	240.0	396.5	222.5	45.0	57.2	175.8	75.2	201.2	130.3	203.5	2116.8	2085.8
1960	212.3	176.0	591.3	712.5	88.6	176.0	42.4	22.1	37.8	164.1	79.0	34.8	2337.1	2556.9
1961	69.1	344.4	251.5	464.3	198.4	169.9	299.2	64.0	250.2	378.2	729.0	354.8	3573.0	2603.0
1962	264.4	104.9	439.4	705.1	212.6	18.3	82.3	396.2	123.7	114.0	135.9	239.3	2818.1	3526.7
1963	332.8	220.7	528.9	492.2	77.9	126.8	99.4	38.3	41.7	31.5	785.7	199.4	2975.3	2365.4
1964	223.5	99.6	92.7	415.0	260.5	56.0	50.5	80.5	31.1	337.1	26.4	333.0	2005.9	2631.6
1965	198.5	240.2	353.9	759.1	439.7	9.6	50.3	44.8	55.4	404.3	518.7	470.2	3544.7	2915.2
1966	297.7	252.1	413.5	508.5	173.7	203.6	24.1	110.0	95.2	28.4	346.6	71.6	2625.0	3195.7
1967	16.3	449.1	287.6	729.5	475.4	131.0	321.5	151.1	316.3	164.4	586.6	616.4	4145.2	3360.4
1968	122.4	168.7	404.0	914.3	340.0	343.0	68.4	85.9	41.1	97.0	415.8	275.1	3275.7	3787.8
1969	104.0	101.7	573.0	666.9	175.6	156.6	126.6	194.6	97.0	181.3	259.1	26.7	2663.1	3068.2
1970	306.9	391.9	499.0	680.7	133.4	100.6	16.8	58.2	238.1	82.5	33.0	639.3	3186.4	2793.9
1971	213.8	189.4	322.1	915.6	243.4	131.3	81.4	0.0	43.7	74.3	49.5	198.1	2462.6	2887.3
1972	359.9	231.6	417.0	383.1	262.4	8.9	22.6	8.4	368.9	621.5	192.0	309.1	3185.4	2931.9
1973	316.8	360.5	385.8	741.6	103.7	11.9	72.1	78.5	16.2	6.1	58.4	149.9	2301.5	2594.3
1974	197.4	14.0	8.6	472.5	448.9	184.9	104.1	15.7	139.5	14.3	0.0	23.3	1623.2	1808.2
1975	324.7	56.4	234.2	257.4	478.7	135.0	194.0	63.0	289.6	0.9	2.2	35.7	2071.8	2057.2
1976	18.0	74.5	187.5	144.1	81.4	63.3	22.6	7.5	29.2	67.5	24.9	45.6	766.1	733.5
1977	160.5	64.2	116.8	120.2	104.2	7.5	46.2	40.4	66.0	51.8	122.6	210.3	1110.7	848.3
1978	97.9	52.1	121.5	133.5	96.3									
n(1953-77)	25	25	25	25	25	25	25	25	25	25	25	25	25	25
m	214.9	183.0	346.2	560.1	282.9	108.2	92.6	88.6	123.2	156.7	220.2	238.1	2619.0	2616.2
s	109.1	116.7	181.2	207.8	160.4	83.4	82.3	86.4	101.4	147.2	222.1	167.2	754.6	707.3
C_v	0.51	0.64	0.52	0.37	0.57	0.77	0.89	0.98	0.82	0.94	1.01	0.70	0.29	0.27
C_s													- 0.55	- 1.25

Monthly Rainfall (mm) for Station: MVOMERO

Registration Number: 96.3721

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1950	126.0	196.9	204.5	212.6	74.9	11.4	28.7	0.0	38.4	10.2	8.1	30.2	941.9	*
1951	168.7	82.6	84.6	286.0	88.1	9.1	7.1	3.6	0.8	32.5	84.6	161.3	1009.0	801.4
1952	98.0	112.5	167.1	221.7	63.5	13.0	0.0	0.0	54.6	23.4	78.2	24.1	856.1	999.7
1953	89.2	63.8	59.9	304.3	243.3	0.3	15.0	22.9	35.3	50.0	26.4	94.7	1005.1	986.3
1954	164.1	59.9	85.3	219.2	65.8	1.3	3.8	10.4	0.0	44.5	22.9	46.5	723.7	775.4
1955	119.4	209.6	119.9	250.4	110.2	31.0	1.8	0.0	0.0	15.7	34.5	93.0	985.5	927.4
1956	156.7	92.2	86.4	210.8	123.4	5.3	18.5	0.0	3.8	0.0	19.1	62.7	778.9	824.6
1957	203.2	20.8	73.2	357.4	142.0	0.0	0.0	2.0	3.6	5.3	72.9	86.9	967.3	889.3
1958	2.0	108.7	222.5	154.4	28.2	94.0	0.0	0.0	0.0	2.5	15.2	76.5	704.0	772.1
1959	(120.0)	(260.0)	113.8	116.8	45.5	5.8	3.8	34.0	0.0	21.6	4.1	86.4	811.8	813.0
1960	109.2	16.3	144.3	244.6	64.0	57.0	2.0	0.0	6.1	27.7	0.0	1.0	672.2	762.1
1961	83.1	189.2	82.0	168.7	16.8	33.3	93.5	0.0	47.0	191.0	262.1	172.7	1339.4	905.6
1962	101.9	116.3	174.8	274.6	69.1	22.4	6.9	25.9	22.9	0.0	74.2	77.7	966.7	1249.6
1963	40.4	143.3	347.3	206.5	25.7	12.9	13.2	0.0	0.0	7.6	344.9	103.9	1246.7	948.8
1964	175.6	74.6	192.8	(250.0)	87.1	3.3	18.3	12.2	0.0	(30.0)	(10.0)	70.4	924.2	1292.7
1965	80.5	35.8	169.2	177.3	39.9	0.0	0.0	12.2	11.4	76.7	65.6	139.8	808.4	683.4
1966	19.3	96.5	279.0	186.7	119.0	33.0	0.0	4.8	7.1	7.9	35.8	65.9	855.0	958.7
1967	23.8	27.7	144.9	405.0	296.6	(20.0)	(50.0)	66.2	144.8	(150.0)	100.5	281.7	1711.3	1430.8
1968	198.0	48.0	113.5	413.8	77.0	42.8	0.0	0.0	0.0	20.4	121.5	67.6	1102.6	1295.7
1969	50.3	56.6	108.2	243.0	80.1	10.7	13.7	3.1	13.7	14.2	70.5	18.6	682.7	782.7
1970	202.3	47.7	180.4	148.7	29.7	0.0	0.0	9.7	29.6	7.6	0.0	341.8	997.5	744.8
1971	92.2	81.5	27.9	158.3	60.4	13.0	3.9	0.7	0.0	1.6	0.0	8.5	448.0	781.3
1972	17.4	28.7	94.8	62.8	55.8	0.5	7.9	2.9	31.9	32.7	11.6	22.5	369.5	343.9
1973	32.2	19.5	12.4	54.7	97.5	1.8	2.8	30.0	0.0	5.6	80.4	70.6	407.5	290.6
1974	65.4	3.9	131.2	253.8	97.9	19.7	76.8	0.0	5.2	3.4	0.0	53.8	711.1	808.3
1975	98.4	25.0	273.9	255.9	243.8	16.3	0.0	0.0	*	*	*	*	*	*
1976														
1977			(No data obtained)											
1978														
n(1950-74)	25	25	25	25	25	25	25	25	25	25	25	25	25	24
m	101.6	87.7	136.8	223.3	88.1	17.7	14.7	9.6	18.3	31.3	61.7	90.4	881.0	877.8
s	61.7	67.3	75.6	89.1	63.8	21.9	24.2	15.7	31.3	46.1	82.1	79.9	290.2	262.8
C_v	0.61	0.77	0.55	0.40	0.72	1.24	1.65	1.64	1.71	1.47	1.33	0.88	0.33	0.30

Monthly Rainfall (mm) for Station: TANGENI MISSION

Registration Number: 96.3725

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1950	108.0	96.3	281.7	538.0	195.1	0.0	37.3	5.3	49.8	18.3	79.8	58.2	1467.8	*
1951	(98.0)	139.7	130.6	237.0	212.3	10.9	12.4	0.0	0.0	106.4	300.5	189.2	(1437.0)	(1085.3)
1952	58.4	146.3	133.4	252.0	132.1	11.9	0.0	1.0	22.9	29.2	70.4	5.8	863.4	1193.1
1953	36.3	1.0	114.6	262.1	367.5	0.0	(1.0)	(5.0)	(20.0)	45.5	45.5	58.9	(957.4)	(929.2)
1954	128.0	96.0	84.6	210.3	201.7	0.0	0.0	16.3	1.8	23.6	53.8	7.6	823.7	866.7
1955	81.0	276.4	124.5	366.3	245.6	30.2	16.0	0.0	7.9	14.7	95.0	109.7	1367.3	1224.0
1956	199.6	173.7	131.6	443.5	59.9	3.0	0.0	0.0	1.0	10.9	18.3	70.1	1111.8	1227.9
1957	88.6	79.8	190.8	258.6	292.1	0.0	4.6	10.7	148.3	16.8	127.3	79.5	1296.9	1178.7
1958	21.8	89.7	285.8	366.0	63.0	32.0	0.0	21.6	10.9	1.0	34.0	94.0	1019.8	1098.6
1959	137.9	32.5	150.6	316.2	90.7	8.9	0.0	137.9	28.2	17.0	37.3	14.0	971.3	1047.9
1960	168.4	48.0	321.6	535.4	100.6	26.9	5.1	2.0	1.3	85.6	0.0	0.0	1294.9	1346.2
1961	47.2	245.6	75.2	347.5	86.9	20.3	144.0	0.0	54.4	338.6	412.8	304.0	2076.5	1359.7
1962	260.9	68.6	78.2	319.3	40.9	0.0	0.0	33.3	5.8	12.4	18.3	158.2	995.9	1536.2
1963	163.9	81.5	246.3	455.8	44.0	62.4	6.1	0.0	12.5	0.0	501.8	53.6	1627.9	1249.0
1964	67.3	80.0	265.0	253.8	63.8	29.5	0.0	0.0	5.1	84.2	8.4	39.8	896.9	1404.1
1965	80.7	99.1	209.3	370.4	159.8	0.0	0.0	35.6	196.6	136.8	223.8	94.5	1606.6	1336.1
1966	91.2	111.1	214.1	304.2	254.4	28.2	4.8	0.0	0.0	80.6	81.8	64.5	1234.9	1406.9
1967	20.6	79.3	55.1	402.4	240.0	35.0	86.1	130.1	223.8	32.1	141.7	194.5	1640.7	1450.8
1968	137.4	45.0	278.5	377.3	201.4	66.3	0.0	0.5	0.0	9.1	181.8	148.1	1445.4	1451.7
1969	112.3	201.1	212.1	421.1	4.8	36.6	12.9	27.8	0.0	54.9	113.6	4.3	1201.5	1413.5
1970	179.6	289.1	238.5	228.3	60.4	0.0	0.0	0.0	38.6	13.5	0.0	100.0	1148.0	1165.9
1971	476.0	294.1	84.4	389.0	127.5	47.1	21.3	0.0	4.1	61.0	5.2	76.4	1586.1	1604.5
1972	111.8	175.5	133.1	374.9	425.9	0.0	17.2	1.8	36.8	192.3	134.9	144.2	1748.4	1550.9
1973	255.4	175.3	85.8	668.4	104.3	19.5	24.8	5.0	1.5	14.1	70.0	76.3	1500.4	1633.2
1974	52.3	20.7	100.3	497.5	116.6	25.1	30.1	0.0	2.5	33.0	0.8	4.5	883.4	1024.4
1975	37.1	43.6	169.7	408.9	116.6	13.7	0.4	2.1	20.6	39.9	11.6	88.2	952.4	857.9
1976	76.4	31.0	184.9	211.0	112.7	87.7	16.2	2.2	19.7	9.8	52.2	27.4	831.4	851.4
1977	124.3	196.8	157.1	270.6	135.0	9.8	18.2	9.6	54.3	161.7	110.4	210.8	1458.3	1216.7
1978	124.4	29.0	238.9	282.3	82.2	12.0	4.7	3.3	7.3	14.8	316.2	177.8	1292.9	1120.1
n(1950-77)	28	28	28	28	28	28	28	28	28	28	28	28	28	27
m	120.9	122.0	169.2	360.2	152.0	21.6	12.8	16.0	34.6	58.7	104.7	88.4	1262.4	1244.8
s	95.2	83.8	75.7	111.7	100.9	22.8	19.0	34.9	58.2	74.1	123.5	73.6	317.4	226.9
C_v	0.79	0.50	0.45	0.31	0.66	1.06	1.48	2.18	1.68	1.26	1.18	0.83	0.25	0.18

Monthly Rainfall (mm) for Station: ILONGA

Registration Number: 96.3732

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1950	243.3	103.9	274.1	265.2	34.3	0.0	4.8	7.1	22.1	0.0	47.2	69.3	1071.3	*
1951	101.4	181.4	178.1	180.6	65.8	9.4	8.4	4.3	3.3	42.2	343.9	105.9	1224.7	891.3
1952	52.1	248.2	196.6	153.9	52.1	21.8	10.4	11.9	12.2	63.2	47.8	12.4	882.6	1272.2
1953	65.5	53.6	118.9	227.3	209.6	0.5	3.0	22.4	9.9	26.4	28.7	126.2	892.0	797.3
1954	207.3	230.1	139.2	110.5	85.6	0.3	0.5	1.3	5.8	31.2	8.1	168.7	988.6	966.7
1955	114.3	169.7	138.4	401.6	146.3	13.7	22.4	0.0	0.8	4.3	27.2	172.7	1211.3	1188.3
1956	159.0	143.5	243.1	366.0	22.6	25.7	0.0	0.0	22.1	0.0	19.8	287.8	1289.6	1181.9
1957	128.8	183.4	147.6	339.1	219.2	2.8	8.9	4.3	4.1	17.5	68.1	188.5	1312.3	1363.3
1958	26.2	140.2	287.0	192.5	64.3	3.6	0.8	0.8	2.5	0.0	0.0	121.2	839.0	974.5
1959	200.2	192.3	273.8	99.1	75.4	0.0	0.5	5.8	0.0	55.4	44.7	30.7	977.9	1023.7
1960	126.7	39.6	278.4	236.2	7.4	20.3	6.1	0.0	2.3	13.2	0.0	3.8	734.1	805.6
1961	36.3	188.2	211.8	350.8	28.4	31.8	16.3	27.4	33.3	160.0	253.5	254.0	1591.1	1087.4
1962	218.2	83.3	192.3	167.4	7.4	1.3	6.9	74.9	22.9	28.2	32.8	118.4	953.8	1310.3
1963	118.6	259.2	486.3	181.8	2.1	24.7	7.6	10.2	0.8	0.3	239.7	119.6	1450.9	1242.8
1964	116.8	155.0	297.1	154.3	24.9	3.8	3.8	19.3	0.8	48.6	0.5	56.4	881.3	1183.7
1965	132.6	88.2	218.7	140.3	42.6	0.0	7.9	7.5	28.9	13.3	130.1	203.0	1013.1	736.9
1966	96.6	145.9	301.9	176.1	73.9	7.7	0.0	16.5	12.4	61.3	109.2	96.8	1098.9	1225.4
1967	68.1	171.7	178.3	391.5	65.1	12.6	40.6	11.0	67.9	24.0	212.1	378.7	1621.6	1236.8
1968	193.3	67.0	191.2	257.1	64.0	34.7	3.8	20.4	19.4	34.1	72.7	177.3	1135.0	1475.8
1969	55.4	106.6	213.0	178.3	58.6	10.8	1.3	40.8	10.9	26.0	96.7	16.1	814.5	951.7
1970	251.0	120.0	273.0	49.0	7.0	9.2	3.0	10.0	54.0	18.0	6.0	199.0	999.2	907.0
1971	102.0	114.0	154.0	228.0	27.0	17.0	10.0	3.0	10.0	23.0	27.0	55.0	770.0	893.0
1972	147.0	101.0	302.7	137.8	126.8	0.0	1.5	0.6	57.3	80.0	130.4	113.3	1198.4	1036.7
1973	251.8	132.7	105.0	223.6	44.3	0.9	3.4	1.7	2.0	2.7	57.3	157.2	980.6	1011.8
1974	113.5	30.5	230.5	302.6	150.7	11.0	22.3	22.4	9.6	18.1	2.1	71.5	984.9	1125.8
1975	84.2	46.6	245.9	297.7	91.6	6.0	1.2	1.8	19.2	8.4	10.2	182.1	994.9	876.2
1976	89.5	156.4	148.6	220.5	59.2	39.4	5.8	23.6	0.0	12.3	3.0	10.3	798.6	947.6
1977	306.2	130.8	72.4	154.1	32.8	1.6	2.6	17.2	103.8	23.0	153.8	346.4	1344.7	857.8
1978														
n(1950-77)	28	28	28	28	28	28	28	28	28	28	28	28	28	27
m	135.9	135.1	217.8	220.8	67.5	11.1	7.3	13.1	19.2	29.8	77.6	137.3	1073.4	1058.2
s	72.7	60.6	83.2	91.1	56.7	11.7	8.9	15.9	24.5	33.1	90.1	97.6	233.4	191.5
C_v	0.53	0.45	0.38	0.41	0.84	1.05	1.22	1.21	1.28	1.11	1.16	0.71	0.22	0.18

Monthly Rainfall (mm) for Station: CHAZI

Registration Number: 96.3736

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1956	168.7	139.2	156.5	237.7	97.8	20.6	9.1	6.9	16.5	4.1	57.4	70.9	985.4	*
1957	192.3	135.9	107.7	578.9	164.3	0.0	14.7	0.0	28.7	83.1	37.3	389.1	1732.7	1434.6
1958	17.3	98.0	350.3	226.8	46.7	0.0	0.0	16.3	6.1	0.0	31.2	180.3	973.0	1187.9
1959	276.6	(110.0)	183.1	211.6	146.3	0.0	10.4	45.5	4.1	59.4	28.4	98.3	(1173.7)	(1258.5)
1960	227.8	71.1	333.5	293.6	45.5	34.0	0.8	0.0	0.0	27.9	0.0	58.9	1093.2	1160.9
1961	52.3	270.8	48.0	342.6	68.1	11.7	73.2	1.3	88.6	295.4	334.5	262.1	1848.6	1310.9
1962	229.4	177.3	274.1	195.6	39.9	5.1	54.6	40.1	30.0	34.3	34.0	161.8	1276.2	1677.0
1963	203.7	74.0	276.7	211.9	71.5	16.1	16.5	0.0	9.7	17.0	325.2	88.6	1310.9	1092.9
1964	270.7	43.8	221.1	178.2	17.2	5.1	7.9	1.1	0.0	76.4	0.0	185.7	1007.2	1235.3
1965	115.5	137.3	179.2	200.1	107.9	0.0	0.8	11.4	20.7	43.5	135.7	321.8	1273.9	1002.1
1966	60.7	98.0	398.3	129.4	122.1	9.2	0.0	12.8	9.2	16.8	101.9	58.6	1017.0	1314.0
1967	33.3	80.8	29.9	487.4	213.0	30.2	75.5	59.2	82.1	146.5	164.3	418.1	1820.3	1398.4
1968	134.2	45.7	362.9	466.7	107.2	84.9	0.0	31.7	1.5	54.4	190.6	152.2	1632.0	1871.6
1969	209.2	161.6	111.4	145.8	122.7	33.9	2.3	23.9	37.3	29.7	70.3	78.5	976.6	1220.6
1970	259.5	229.0	339.6	110.5	44.9	0.0	28.2	3.1	45.9	10.7	0.0	154.2	1225.6	1220.2
1971	195.6	138.9	295.6	168.9	77.7	20.1	17.5	0.0	5.5	0.0	37.8	115.2	1072.8	1074.0
1972	118.2	68.6	176.6	174.1	180.1	2.6	9.6	5.0	31.6	113.0	138.4	112.4	1130.2	1032.4
1973	269.9	125.8	69.2	361.8	93.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	947.6	1198.4
1974	73.0	0.0	53.3	47.5	124.3	2.6	4.6	5.0	31.6	101.3	37.0	162.7	642.9	443.2
1975	84.2	50.5	147.7	191.0	65.6	36.0	0.0	0.0	0.0	7.0	0.0	31.3	613.3	781.7
1976	102.2	188.1	147.6	73.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	18.0	529.4	542.7
1977		(No data obtained)												
n(1956-76)	21	21	21	21	21	21	21	21	21	21	21	21	21	20
m	158.2	116.4	203.0	239.7	93.2	14.9	15.5	12.5	21.4	53.4	82.1	148.5	1156.3	1172.9
s	86.5	65.4	114.5	137.7	54.3	20.6	23.4	17.5	25.7	69.5	100.7	115.0	366.0	329.7
C_v	0.55	0.56	0.56	1.74	0.58	1.38	1.51	1.40	1.20	1.30	1.23	0.77	0.32	0.28

Monthly Rainfall (mm) for Station: KISANGATA SISAL ESTATE

Registration Number: 96.3738

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1951	*	*	*	*	*	20.1	5.1	0.0	0.0	3.8	125.7	95.0	*	*
1952	43.2	256.5	142.2	209.6	76.2	0.0	0.0	0.0	22.9	12.7	74.9	0.0	838.2	984.0
1953	118.1	14.0	69.9	141.0	81.3	0.0	0.0	22.9	0.0	1.3	0.0	81.3	529.8	523.4
1954	111.8	80.0	134.6	218.4	63.5	0.0	0.0	0.0	0.0	30.5	5.1	26.7	670.6	720.1
1955	59.7	162.6	106.7	132.1	233.7	7.6	0.0	99.1	0.0	0.0	11.4	18.5	831.4	833.3
1956	171.5	113.0	188.0	119.9	34.3	*	*	*	*	*	*	*	*	*
1957	228.6	172.7	144.8	449.1	92.7	(0.0)	(0.0)	(0.0)	(0.0)	11.4	81.3	149.9	*	*
1958	30.5	86.4	277.9	106.2	75.4	0.0	0.0	0.0	0.0	0.0	15.2	22.9	614.4	807.6
1959	104.1	184.2	174.0	138.4	52.1	*	*	*	*	*	*	*	*	*
1960	88.4	55.9	181.6	325.1	6.4	0.0	0.0	0.0	*	*	*	*	*	*
1961	11.4	119.4	149.9	165.4	36.8	10.2	3.8	0.0	36.8	152.4	203.2	188.0	1077.3	*
1962	240.0	138.4	228.6	165.4	47.0	0.0	30.5	12.7	0.0	6.4	43.2	54.6	966.8	1260.2
1963	89.0	69.8	328.9	255.2	0.0	12.7	0.0	0.0	0.0	0.0	234.2	155.0	1144.8	866.2
1964	72.3	124.4	141.0	149.4	0.0	0.0	0.0	29.2	0.0	22.9	0.0	72.5	611.7	918.6
1965	128.2	58.5	125.7	196.8	62.2	0.0	0.0	0.0	24.1	48.3	52.9	134.6	831.3	660.9
1966	43.2	133.4	289.7	182.9	63.6	0.0	0.0	0.0	24.1	26.7	73.6	116.8	954.0	951.1
1967	19.0	153.7	45.6	370.9	179.0	28.0	19.1	3.8	53.3	15.2	94.0	284.6	1266.2	1078.0
1968	125.7	(40.0)	210.9	357.0	156.0	55.9	12.7	0.0	2.5	0.0	124.4	169.0	1254.1	1339.3
1969	50.8	66.0	141.0	211.0	72.4	8.8	1.3	1.3	0.0	8.9	33.0	22.9	617.4	854.9
1970	192.0	78.6	175.2	(200.0)	102.0	0.0	0.0	40.0	44.0	0.0	0.0	268.0	1099.8	887.7
1971	57.1	72.4	(50.0)	191.7	59.7	10.1	46.9	0.0	(0.0)	(0.0)	(10.0)	(70.0)	567.9	755.9
1972	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1973	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1974	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1975	*	*	62.4	172.1	42.5	10.5	0.0	0.0	20.5	0.0	4.0	0.0	*	*
1976	91.4	128.8	223.0	141.7	55.6	23.0	4.0	0.0	0.0	0.0	0.0	0.0	667.5	671.5
1977	62.3	148.5	44.0	133.0	162.0	0.0	0.0	0.0	9.0	9.0	0.0	0.0	565.8	567.8
1978														
n(1952-55, 1957,58, 1961-71, 1976,77)	17	17	17	17	17	17	17	17	17	17	17	17	17	16
m	89.1	108.5	153.4	201.3	85.4	9.2	7.0	12.3	12.8	19.7	56.5	97.8	852.6	867.0
s	59.7	57.7	82.4	70.2	63.1	14.8	13.4	25.5	17.9	36.9	72.2	90.6	250.2	219.3
C_v	0.67	0.53	0.54	0.05	0.74	1.61	1.91	2.07	1.40	1.87	1.28	0.93	0.29	0.25

Monthly Rainfall (mm) for Station: *MKUYUNI*

Registration Number: 96.3741

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1952	*	*	*	*	*	37.3	13.2	78.8	50.0	181.1	62.0	91.1	*	*
1953	129.0	31.2	366.8	538.7	588.8	14.5	8.4	63.5	35.3	83.1	56.4	239.8	2155.4	2012.3
1954	155.4	152.7	467.1	179.3	267.0	47.2	0.0	74.7	0.0	115.6	55.1	143.0	1657.1	1755.2
1955	89.2	203.4	60.7	277.9	266.7	48.8	64.8	5.3	0.0	0.0	112.3	142.5	1331.5	1274.9
1956	260.4	267.0	215.1	391.9	105.7	69.1	22.6	27.2	26.2	31.8	106.2	79.2	1602.2	1671.6
1957	272.3	145.8	221.7	705.1	139.7	20.8	31.0	7.9	114.0	127.8	141.2	142.0	2069.3	1971.5
1958	9.1	169.9	332.5	239.8	192.3	106.7	13.0	32.8	15.5	34.3	40.1	228.6	1414.5	1429.1
1959	181.6	189.0	142.0	207.8	70.4	16.8	17.8	77.7	12.7	86.4	43.7	200.4	1246.1	1270.9
1960	(400.0)	150.4	679.5	625.9	40.9	69.6	35.3	13.0	20.3	88.1	35.6	(20.0)	2178.6	2367.1
1961	76.7	195.3	162.3	334.0	137.2	70.9	173.0	29.2	193.0	287.8	542.3	528.1	2729.7	1714.9
1962	416.1	227.1	514.6	345.4	194.3	15.2	23.4	152.7	69.3	49.8	28.7	170.2	2219.5	3078.3
1963	686.6	195.6	353.0	350.6	67.3	55.5	38.0	3.3	10.1	(25.0)	730.8	117.2	2633.0	1983.9
1964	136.6	112.2	222.2	215.0	89.3	11.3	53.9	57.0	5.3	79.7	0.0	19.8	1084.3	1830.5
1965	*	*	*	357.1	182.9	0.0	52.6	12.2	75.7	96.5	203.0	377.1	*	*
1966	107.2	115.7	241.4	208.3	87.2	80.5	3.8	*	*	*	*	*	*	*
1967	9.7	471.8	37.4	*	*	*	*	*	*	*	*	*	*	*
1968	99.4	75.3	*	*	*	*	*	*	*	*	*	*	*	*
1969	102.1	142.0	142.6	380.1	103.5	26.6	63.0	31.8	*	*	*	*	*	*
1970	*	*	*	187.1	49.7	23.8	24.8	26.1	129.2	56.0	19.4	299.7	*	*
1971	135.7	118.4	195.4	296.1	159.4	58.2	57.2	4.8	17.8	76.2	15.4	87.5	1222.1	1438.3
1972	165.5	65.3	289.5	305.2	230.5	7.6	35.0	20.8	79.0	118.9	134.1	22.1	1673.5	1420.2
1973	446.8	229.9	206.3	464.3	110.4	42.9	21.6	50.5	75.7	9.3	67.8	113.3	1838.8	2013.9
1974	230.1	85.7	191.3	468.3	152.2	79.7	62.8	14.2	59.7	65.0	63.2	58.6	1530.8	1590.1
1975	77.8	23.8	283.0	326.7	165.9	57.6	112.8	56.0	46.5	79.8	115.5	198.9	1544.3	1351.7
1976	85.5	83.7	341.0	206.8	83.5	90.0	34.4	4.1	26.2	72.9	21.6	124.8	1174.5	1342.5
1977	200.6	136.7	159.2	193.1	111.3	4.0	55.3	59.4	120.3	101.7	(250.0)	487.1	1878.7	1288.0
1978														
n(1953-64, 1971-75)	19	19	19	19	19	19	19	19	19	19	19	19	19	19
m	218.7	154.9	284.4	351.2	167.0	45.7	45.3	39.7	48.8	80.7	134.7	164.4	1746.5	1728.1
s	166.0	83.5	148.3	149.5	121.0	29.1	40.3	37.4	50.5	61.9	188.9	138.0	480.5	447.4
C_v	0.76	0.54	0.52	0.43	0.72	0.64	0.89	0.94	1.03	0.77	1.40	0.84	0.28	0.26

Monthly Rainfall (mm) for Station: MTIBWA ESTATE

Registration Number: 96.3742

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1952	*	*	*	*	*	8.9	0.0	20.8	41.9	46.7	147.6	26.7	*	*
1953	133.6	0.5	171.5	146.1	207.5	3.8	34.3	51.3	46.7	50.0	114.3	130.0	1089.6	1019.6
1954	68.3	94.0	67.1	201.2	101.9	11.9	2.0	31.2	5.1	144.5	51.1	53.3	831.6	971.5
1956	47.0	334.5	116.3	357.6	297.2	33.8	41.7	4.6	4.8	6.9	64.8	140.0	1448.3	1348.8
1956	201.9	69.1	108.0	304.3	99.3	21.3	5.6	12.4	9.1	0.5	47.0	95.5	974.1	1036.3
1957	194.8	109.7	150.4	564.9	169.2	9.1	9.7	0.0	20.1	64.8	39.4	101.1	1433.1	1435.2
1958	11.4	133.6	232.4	122.4	91.4	43.9	5.8	22.9	12.4	2.5	7.4	122.7	835.4	819.2
1959	157.0	143.3	170.2	273.1	90.9	4.6	23.6	51.1	3.3	63.2	5.6	101.9	1087.6	1110.4
1960	133.6	48.8	352.8	220.7	80.3	37.8	3.3	3.0	2.3	92.5	0.0	17.8	992.4	1082.6
1961	49.8	169.4	127.5	172.5	103.4	24.1	67.1	16.0	61.2	329.9	383.8	240.8	1745.5	1138.7
1962	166.9	64.5	161.3	239.3	41.2	3.6	49.3	46.5	39.1	30.0	37.1	73.7	952.5	1466.3
1963	168.1	97.2	349.8	242.5	74.0	36.1	14.0	12.7	12.4	14.0	403.5	143.5	1567.8	1131.6
1964	185.3	57.2	296.5	181.9	54.0	11.2	11.4	4.3	1.8	59.9	0.0	202.8	1066.3	1410.5
1965	90.3	142.9	111.0	148.4	160.4	0.0	5.3	30.0	46.3	153.6	202.7	275.0	1365.9	1091.0
1966	53.2	114.9	229.5	228.6	99.0	12.7	0.0	8.4	36.3	23.4	35.9	58.6	900.5	1283.7
1967	4.6	72.4	78.7	297.7	320.9	44.9	64.1	72.9	114.4	128.4	225.9	368.7	1799.6	1293.5
1968	174.2	99.1	295.9	404.2	117.0	66.1	7.4	0.0	11.0	74.9	189.4	64.3	1503.5	1844.4
1969	139.0	155.2	160.7	165.8	113.1	14.7	9.7	25.4	25.5	33.2	81.5	32.8	956.6	1096.0
1970	187.5	254.6	345.8	112.2	38.5	0.8	9.4	4.7	93.4	15.3	0.1	75.6	1137.9	1176.5
1971	201.0	150.5	230.2	196.3	77.9	30.2	24.5	3.8	14.8	14.7	5.0	110.4	1059.3	1019.6
1972	96.7	58.8	261.2	248.3	238.4	0.8	18.1	1.0	129.4	172.4	90.0	193.5	1488.6	1340.5
1973	263.2	181.6	48.0	336.9	107.2	4.9	4.1	22.9	16.5	9.7	89.4	75.2	1159.6	1278.5
1974	94.5	14.4	138.5	338.9	156.9	16.6	56.6	4.4	16.2	65.0	25.9	24.7	952.6	1066.6
1975	42.9	38.6	141.0	237.7	68.4	61.9	2.8	77.2	43.0	1.7	1.0	170.7	886.9	765.8
1976	80.2	229.0	211.2	137.6	109.6	42.5	23.8	1.2	35.0	18.8	29.1	20.6	938.6	1060.5
1977	111	168	143	230	64	7	34	29	86	156	180	185	1393	1077.7
1978	87.7	48.3	367.5	198.1	84.6	31.2					10.2			
n(1953-77)	25	25	25	25	25	25	25	25	25	25	25	25	25	25
m	122.2	120.1	187.9	238.4	123.3	21.8	21.1	21.5	35.6	68.6	92.4	123.1	1182.7	1174.6
s	67.6	77.1	89.1	111.5	73.7	19.4	20.4	22.6	35.8	77.0	113.2	85.7	289.2	225.0
C_v	0.55	0.64	0.47	0.47	0.60	0.89	0.97	1.05	1.01	1.12	1.23	0.70	0.24	0.19

Monthly Rainfall (mm) for Station: MAGOLE

Registration Number: 96.3743

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1953	87.1	17.5	*	200.7	96.8	24.6	0.0	12.2	6.6	0.0	0.0	29.7	*	*
1954	177.0	37.6	36.8	132.1	118.6	0.0	0.0	0.0	0.0	58.9	0.0	*	*	*
1955	44.5	222.8	30.7	169.9	122.4	56.4	3.0	0.0	0.0	0.0	24.9	72.9	776.0	*
1956	142.7	105.9	30.7	233.3	*	*	*	*	*	*	*	*	*	*
1957	144.3	47.2	105.4	*	*	*	*	*	*	*	*	*	*	*
			(no data available)											
1965	88.1	121.9	261.9	142.7	63.3	43.3	0.0	0.0	0.0	9.9	51.8	39.9	822.7	*
1966	56.9	68.0	59.0	370.2	461.2	28.9	40.7	30.0	93.3	22.1	51.1	229.0	1505.4	1322.0
1967	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1968	199.0	83.7	317.7	272.7	88.6	34.7	0.0	0.0	0.0	8.1	84.6	119.5	1228.6	*
1969	30.9	75.0	104.9	177.6	*	*	*	*	*	*	*	*	*	*
			(no data available)											
1975	25.4	68.6	192.4	102.3	5.8	8.4	33.8	0.0	0.0	0.0	0.0	30.9	467.6	*
1976	69.4	104.6	87.7	138.0	57.2	16.0	25.6	0.0	20.3	0.0	4.8	91.0	614.6	549.7
1977	118.5													
1978			(no data available)											

Monthly Rainfall (mm) for Station: MONDO

Registration Number: 96.3745

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1954	*	*	*	*	433.8	2.3	20.1	54.9	59.2	181.6	169.9	62.5	*	*
1955	34.8	300.5	148.6	733.0	475.2	175.3	68.8	9.4	58.7	100.8	248.7	158.8	2512.6	2337.5
1956	398.0	197.6	586.5	623.6	259.1	105.2	8.4	0.0	37.3	66.5	154.2	(250.0)	(2686.4)	2689.7
1957	360.7	197.6	651.0	579.1	672.8	13.5	93.0	65.5	114.6	111.3	298.2	323.9	3481.2	(3263.2)
1958	8.9	130.6	513.1	700.8	193.8	150.9	9.4	93.7	109.7	56.4	174.8	126.5	2268.6	2589.4
1959	306.1	343.2	357.9	685.0	476.3	3.0	79.0	232.9	49.5	211.8	194.6	135.4	3074.7	3046.0
1960	254.0	191.0	397.0	1380.0	227.3	157.2	37.6	61.7	107.2	238.5	89.9	85.1	3226.5	3381.5
1961	85.1	462.3	370.1	677.9	295.9	146.6	397.8	71.4	330.5	730.0	1059.9	582.2	5182.7	3742.6
1962	294.6	293.4	371.6	631.7	100.6	8.9	77.7	330.2	127.3	(25.0)	136.9	440.7	(2838.6)	(3903.1)
1963	277.1	162.6	687.3	794.6	125.8	215.1	62.6	29.2	68.8	3.6	743.9	189.1	3359.7	3004.3
1964	249.6	79.2	413.0	526.5	131.3	148.1	18.3	56.2	0.0	205.1	0.0	257.0	2084.3	2760.3
1965	87.7	168.5	207.0	639.0	342.7	2.5	26.7	56.7	123.5	390.8	422.6	221.7	2689.5	2302.2
1966	209.0	262.6	452.4	686.8	378.2	119.4	11.1	50.3	96.5	184.9	197.1	145.9	2794.2	3095.5
1967	10.7	163.8	92.3	433.0	501.2	94.0	148.6	356.6	487.3	321.1	281.4	111.9	3001.9	2951.6
1968	124.8	104.5	453.0	751.4	396.4	294.0	25.1	40.8	69.5	64.5	414.1	135.0	2873.1	2717.3
1969	83.1	171.9	431.2	637.9	176.5	105.0	99.5	105.6	52.3	131.4	186.8	24.1	2250.3	2588.5
1970	197.4	334.0	321.2	368.2	138.5	5.0	4.0	29.0	258.1	92.3	15.2	319.0	2081.9	1958.6
1971	157.0	90.0	239.5	526.7	227.0	160.2	107.0	0.0	69.7	87.2	78.0	197.0	1939.3	1978.5
1972	183.1	189.0	204.5	611.8	753.5	0.0	84.2	33.0	157.5	384.1	453.1	223.0	3276.9	2875.7
1973	326.0	285.9	153.5	691.5	260.8	105.4	68.5	106.5	65.8	83.0	350.0	195.2	2694.1	2825.0
1974	64.0	27.0	234.0	918.9	252.3	41.5	57.0	12.3	66.9	146.0	17.0	26.7	1863.6	2365.1
1975	115.7	119.5	422.4	799.4	376.4	140.6	23.4	24.0	115.0	105.8	19.0	156.9	2418.1	2285.9
1976	84.0	45.4	267.8	431.5	249.5	281.0	65.0	23.0	169.3	90.0	96.0	87.0	1889.6	1882.5
1977	219.0	171.0	340.5	387.7	182.5	180.0	57.0	93.0	294.0	304.0	473.7	328.3	2868.7	2249.7
1978	271.0	99.0	377.8	592.5	263.0	89.4	20.0	33.0	49.1	84.0	595.8			2680.2
n(1955-77)	23	23	23	23	23	23	23	23	23	23	23	23	23	23
m	179.6	195.3	361.5	661.6	312.8	108.3	70.9	83.7	131.7	179.7	265.4	205.2	2754.6	2730.2
s	114.7	105.2	157.3	208.0	171.9	87.3	80.4	97.4	112.5	162.3	252.0	129.9	715.7	535.9
C_V	0.64	0.54	0.44	0.31	0.55	0.81	1.12	1.16	0.85	0.90	0.95	0.63	0.26	0.20

Monthly Rainfall (mm) for Station: MORNINGSIDE FARM

Registration Number: 96.3746

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1954	*	*	*	463.8	385.1	2.5	59.4	32.0	42.7	117.1	51.6	0.0	*	*
1955	48.3	199.6	127.8	528.1	416.8	152.9	99.3	10.7	119.1	65.5	199.9	268.5	2236.5	1819.7
1956	208.8	178.8	266.2	600.7	271.5	80.5	7.6	2.5	58.7	54.1	79.5	180.8	1989.8	2197.8
1957	169.2	109.2	233.7	375.7	455.2	17.3	78.5	69.3	97.5	*	183.9	*	*	*
1958	131.6	*	259.8	472.4	155.7	128.8	11.9	80.5	*	29.5	*	*	*	*
1959	146.6	*	90.4	338.8	*	*	23.6	*	50.0	116.8	96.0	*	*	*
1960	155.7	52.8	313.9	649.2	136.1	98.3	22.9	38.4	*	*	6.9	5.1	*	*
1961	47.5	392.7	127.8	388.9	182.9	131.3	358.1	30.0	185.7	285.5	444.0	259.8	2834.1	2142.4
1962	193.0	109.0	92.7	357.4	72.1	3.3	65.0	117.9	39.6	63.8	42.2	137.7	1293.6	1817.6
1963	207.3	103.6	325.3	458.2	129.6	216.2	100.0	56.2	33.4	82.8	627.6	186.9	2527.1	1892.5
1964	102.3	137.3	465.8	494.1	179.9	62.8	32.8	63.7	36.0	174.6	0.0	153.4	1902.7	2563.8
1965	118.2	124.1	170.6	657.0	354.6	9.7	20.3	32.0	66.7	368.6	299.6	192.5	2413.9	2075.2
1966	168.1	239.8	272.6	495.3	264.2	171.5	9.0	56.7	91.1	242.2	127.3	63.9	2201.7	2502.6
1967	14.4	134.0	128.0	539.4	591.1	136.9	241.5	276.3	512.2	109.0	386.6	189.7	3259.1	2874.0
1968	118.3	77.1	532.0	708.8	302.6	219.2	53.3	41.6	45.6	49.5	322.7	178.8	2649.5	2724.3
1969	67.9	228.0	394.9	678.1	200.6	164.8	138.4	225.5	61.9	217.1	238.3	69.6	2685.1	2878.7
1970	286.7	208.2	275.5	472.0	169.8	31.5	26.5	60.9	162.7	84.8	12.5	384.6	2175.7	2086.5
1971	165.8	80.4	257.1	384.5	280.4	285.6	85.5	7.4	64.5	63.9	10.2	128.2	1813.5	2072.2
1972	122.8	209.8	250.5	465.8	665.7	1.1	132.6	29.0	132.6	324.2	304.9	229.0	2867.6	2474.1
1973	244.2	182.0	221.7	979.6	154.7	121.7	60.9	120.5	40.9	39.0	190.0	155.7	2510.9	2699.1
1974	58.2	8.4	116.6	630.2	338.1	53.1	94.3	35.6	55.6	87.0	40.3	21.4	1538.8	1822.8
1975	87.7	95.6	291.3	555.7	429.6	129.7	32.9	33.9	96.0	79.0	53.7	190.8	2075.9	1893.1
1976	82.9	43.7	300.2	434.5	227.7	173.0	77.7	27.5	102.9	72.3	68.6	128.2	1739.2	1786.9
1977	237.2	206.2	253.7	353.7	225.3	19.0	124.5	115.5	224.9	171.4	223.7	447.3	2602.4	2127.8
1978	263	102	262	544	236	74	17	35	(31.7)	31.7	664.9	430.2		(2267.4)
n(1961-77)	17	17	17	17	17	17	17	17	17	17	17	17	17	17
m	136.6	151.8	263.3	532.5	280.5	113.6	97.2	78.3	114.8	147.9	199.5	183.4	2299.5	2260.8
s	77.2	91.4	121.1	159.9	158.7	86.4	88.2	73.6	116.9	104.1	180.4	106.5	522.9	385.4
C_v	0.57	0.60	0.46	0.30	0.57	0.76	0.91	0.94	1.02	0.70	0.90	0.58	0.23	0.17

Monthly Rainfall (mm) for Station: MORNINGSIDE KIDUNDA

Registration Number: 96.3746A

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1978											414.5	229.0		

Monthly Rainfall (mm) for Station: HOBWE

Registration Number: 96.3747

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1954	*	*	*	*	*	6.4	0.0	0.5	13.7	78.0	30.2	26.7	*	*
1955	68.3	327.2	129.5	147.6	133.6	14.7	3.8	0.0	0.0	8.0	60.2	59.7	952.8	889.7
1956	203.5	85.1	118.4	260.9	26.9	1.3	0.0	0.0	0.8	10.2	23.6	45.2	775.7	827.0
1957	145.4	70.6	124.5	269.2	131.1	0.0	7.4	3.3	116.1	18.0	70.4	52.8	1008.9	954.5
1958	13.2	199.6	246.9	213.9	49.0	10.4	0.0	7.4	2.8	2.8	9.7	150.4	906.0	869.2
1959	77.5	79.8	126.0	192.5	48.0	2.0	0.0	47.5	0.0	15.5	11.7	138.4	738.9	737.5
1960	195.3	73.4	242.6	287.0	33.0	22.9	3.8	1.3	0.8	29.7	0.0	2.3	892.0	1039.9
1961	49.5	207.8	95.3	267.0	57.2	6.6	36.8	0.0	25.9	192.5	271.3	307.8	1517.7	940.9
1962	165.4	45.7	131.8	214.9	34.5	1.0	5.1	28.5	4.6	16.3	37.3	84.6	769.1	1226.9
1963	106.1	128.4	204.4	315.5	41.0	18.7	4.8	0.5	1.0	0.8	272.4	68.7	1162.3	943.1
1964	104.1	67.8	902.4	138.1	20.6	15.6	0.0	5.4	7.1	31.0	0.0	44.9	1337.0	1633.2
1965	(96.5)	168.9	132.6	322.3	40.9	0.0	0.0	11.0	39.2	59.2	148.4	111.5	(1130.5)	(915.5)
1966	92.1	167.5	182.6	319.9	90.7	26.2	2.5	5.1	0.0	23.4	66.6	58.0	1034.6	1169.9
1967	11.5	139.2	33.2	317.3	144.6	12.7	69.6	38.9	88.9	65.9	184.0	110.3	1216.1	1046.4
1968	143.7	39.9	282.8	374.4	110.4	69.0	2.5	0.0	1.3	8.1	168.0	143.2	1343.3	1326.4
1969	131.8	120.6	106.1	254.7	77.7	6.6	0.0	8.9	0.0	3.7	94.7	53.6	858.4	1021.4
1970	(217.9)	651.2	309.2	146.9	29.4	0.0	0.0	0.0	118.5	50.1	1.3	149.4	1673.9	1671.5
1971	(181.3)	85.5	70.3	179.0	48.8	16.6	21.5	0.0	5.4	18.4	20.5	63.9	(711.2)	(777.5)
1972	145.5	98.7	134.8	221.7	158.1	0.0	5.4	11.9	71.7	140.5	102.3	84.3	1174.9	1072.7
1973	252.8	117.1	72.8	197.7	83.1	21.1	7.6	0.0	0.0	31.0	79.0	110.7	972.9	969.8
1974	39.2	16.5	115.9	471.1	155.3	57.9	10.7	0.0	10.0	42.5	0.0	5.3	924.4	1108.8
1975	72.4	78.4	268.4	262.1	282.1	31.3	0.0	0.0	17.1	16.0	19.0	89.5	1136.3	1033.1
1976	81.8	67.4	212.5	218.9	45.9	25.9	12.0	0.0	31.6	32.7	21.0	65.5	815.2	837.2
1977	234.9	167.0	215.3	180.3	321.2	3.2	9.7	9.7	44.5	161.4	148.2	258.4	1753.8	1433.7
1978	94.8	32.8	213.3	299.0	87.8	14.0	5.4	0.0	0.0	8.5	218.6	216.9	1191.1	1162.2
n(1955-78)	24	24	24	24	24	24	24	24	24	24	24	24	24	24
m	121.9	134.8	194.7	253.0	93.8	15.7	8.7	7.5	24.5	40.7	84.5	103.1	1083.1	1067.0
s	67.9	129.8	167.5	78.5	77.4	17.6	15.4	12.9	37.6	51.7	86.6	74.2	285.1	245.7
C_v	0.56	0.96	0.86	0.31	0.83	1.12	1.77	1.72	1.60	1.27	1.02	0.72	0.26	0.23

Monthly Rainfall (mm) for Station: LUHUNGO [1)]

Registration Number: 96.3748

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1954	*	*	*	*	312.7	0.0	30.0	35.1	32.3	135.6	64.0	57.7	*	*
1955	59.7	313.2	95.3	430.3	357.1	85.9	27.7	2.3	29.7	106.9	155.7	200.9	1864.6	1629.8
1956	268.0	227.6	362.7	442.7	181.1	84.8	0.0	0.0	26.9	6.9	104.6	194.3	1899.7	1957.3
1957	285.8	138.1	224.0	797.1	747.8	0.0	31.2	59.2	139.4	198.4	332.2	317.8	3271.5	2919.9
1958	46.2	247.7	559.8	436.6	150.9	126.2	0.0	173.5	21.6	6.9	124.7	158.0	2052.1	2419.4
1959	137.2	67.3	127.3	250.2	22.6	19.1	17.8	172.2	38.1	70.9	103.1	250.2	1275.8	1205.4
1960	208.8	48.3	195.1	208.3	27.2	0.0	0.0	0.0	0.0	64.5	0.0	0.0	752.1	1105.5
1961	0.0	213.6	54.4	208.8	78.7	61.0	95.3	0.0	41.7	211.6	233.2	108.5	1306.6	964.9
1962	127.0	14.2	48.0	175.5	11.9	0.0	0.0	34.5	2.5	12.7	3.8	90.2	520.5	768.0
1963	74.9	16.4	147.9	204.9	1.3	30.4	1.3	0.0	0.0	6.3	187.2	18.1	688.7	577.4
1964	6.6	20.1	150.3	156.2	7.6	0.0	0.0	3.1	0.0	15.3	0.0	50.7	409.9	564.5
1965	74.5	30.5	53.6	224.6	39.5	0.0	0.0	0.0	14.0	77.9	165.2	60.1	739.8	565.3
1966	19.3	65.0	57.7	141.5	130.2	1.0	0.0	1.3	(0.0)	(50.0)	24.8	50.1	540.9	691.2
1967	31.8	28.5	103.0	158.3	182.5	47.0	73.2	31.3	116.6	28.5	93.8	149.5	1044.0	875.6
1968	94.4	24.9	142.8	130.1	65.2	64.3	0.0	0.0	8.9	2.5	68.7	41.1	642.9	776.4
1969	46.7	49.1	156.8	262.0	50.0	34.2	23.1	22.2	15.3	21.8	102.0	3.3	786.5	791.0
1970	92.1	110.0	114.5	164.8	9.2	0.0	0.0	0.0	42.5	16.0	0.0	137.0	686.1	654.4
1971	127.0	52.0	53.0	261.0	76.0	59.0	24.0	0.0	10.0	20.0	16.0	81.0	779.0	819.0
1972	100.0	123.8	186.0	253.0	301.0	0.0	29.0	0.0	43.0	110.0	178.0	133.0	1456.8	1242.8
1973	183.0	118.0	84.0	392.0	42.0	15.0	0.0	0.0	0.0	30.0	59.0	145.2	1078.2	1185.0
1974	23.0	12.0	140.0	283.0	179.0	18.0	21.0	0.0	11.0	20.0	0.0	0.0	707.0	911.2
1975	60.0	44.0	159.0	287.0	87.0	20.0	0.0	0.0	10.0	8.0	10.0	115.0	800.0	585.0
1976	47.0	29.0	276.0	231.0	98.0	73.0	18.0	0.0	18.0	9.0	12.0	76.0	887.0	924.0
1977	117.0	109.0	149.0	176.0	99.0	7.0	17.0	32.0	60.0	97.0	188.0	124.0	1175.0	951.0
1978	91.0	84.0	154.0	227.0	95.0	11.0	0.0	0.0	6.0	0.0	115.0	174.0	957.0	980.0
n(1960-79)	19	19	19	19	19	19	19	19	19	19	19	19	19	19
m	80.2	62.8	127.6	218.2	83.2	23.2	15.9	6.6	21.0	42.2	76.7	81.9	839.9	838.5
s	56.6	52.1	59.9	63.4	74.7	25.7	26.5	12.7	29.2	52.2	79.5	54.9	271.9	206.4
C_v	0.71	0.83	0.47	0.29	0.90	1.11	1.67	1.92	1.39	1.24	1.04	0.67	0.32	0.25

1) 1954-1959 data seem unreliable

Monthly Rainfall (mm) for Station: KWANDEWA MASA

Registration Number: 96.3749

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1954	*	*	*	*	154.2	0.8	0.0	21.1	1.8	106.4	48.8	14.0	*	*
1955	115.1	438.2	158.2	203.7	164.3	36.3	15.7	0.0	0.8	14.0	89.7	112.0	1248.0	1209.1
1956	246.6	123.2	144.8	306.8	34.8	3.0	0.0	0.0	5.6	20.1	29.7	99.3	1014.0	1086.6
1957	142.2	93.2	162.1	300.2	201.4	3.0	19.3	4.1	122.2	123.4	111.1	98.8	1381.3	1300.1
1958	2.3	199.9	353.1	199.4	83.1	15.5	0.0	14.2	12.7	1.0	33.5	133.9	1048.5	1091.3
1959	117.1	144.5	195.6	337.6	62.0	0.5	1.0	75.2	1.5	17.0	58.7	65.8	1076.5	1119.4
1960	263.9	84.3	300.0	336.0	35.6	32.8	0.0	2.5	1.3	78.0	0.5	15.0	1149.9	1258.9
1961	44.7	208.0	76.7	274.3	88.9	6.9	78.0	2.0	50.0	299.0	416.3	344.4	1889.3	1144.0
1962	242.1	86.6	175.5	214.1	31.2	0.3	8.9	35.1	13.2	26.7	50.3	156.7	1040.6	1594.4
1963	189.4	132.4	231.3	295.5	31.8	39.3	8.7	0.8	7.1	1.8	295.5	94.4	1328.0	1145.1
1964	100.0	53.2	348.3	302.1	52.7	29.3	2.1	4.8	0.0	50.4	0.0	64.3	1007.2	1332.8
1965	112.1	136.9	136.5	384.3	78.2	0.0	0.8	12.7	41.7	68.8	153.3	147.3	1272.7	1036.3
1966	82.9	171.9	235.9	210.6	94.0	33.8	2.5	7.7	5.6	34.4	73.9	68.1	1221.3	1179.9
1967	13.3	157.3	71.8	355.2	174.6	23.9	63.3	77.5	168.9	74.2	189.6	122.0	1491.6	1322.0
1968	135.0	56.7	283.0	420.9	129.7	70.8	0.0	3.3	5.4	8.4	213.1	159.7	1486.0	1424.8
1969	129.5	179.8	151.8	314.9	100.1	21.8	2.3	26.2	3.9	40.9	160.0	27.9	1159.1	1344.0
1970	273.2	361.3	214.5	220.4	39.4	0.0	0.0	0.5	124.7	24.3	8.8	96.2	1263.3	1446.2
1971	163.8	97.3	102.5	279.0	61.4	32.5	36.5	0.0	11.5	17.2	49.0	93.2	943.9	906.7
1972	143.3	152.4	125.3	264.7	220.7	0.0	18.0	8.0	84.7	139.8	149.2	103.1	1409.2	1299.1
1973	246.0	145.7	67.0	437.7	86.7	14.7	21.2	3.0	2.0	21.0	93.3	98.1	1236.4	1297.3
1974	46.9	20.0	120.2	433.0	117.5	58.0	22.8	0.0	15.0	39.0	10.0	15.0	897.4	1063.8
1975	66.2	74.0	189.2	254.0	127.0	20.0	1.0	4.0	22.0	23.0	22.0	97.0	899.4	805.4
1976	93.5	43.0	196.4	217.0	71.0	61.0	10.0	0.0	37.0	33.0	21.0	33.0	815.9	880.9
1977	244.5	196.0	148.5	173.0	115.0	5.0	11.0	16.5	73.0	135.1	174.0	203.5	1495.1	1171.6
1978	135.0	60.0	203.5	207.0	73.0	15.0	7.0	5.0	4.0	15.0	230.0	254.0	1208.5	1102.0
n(1955-78)	24	24	24	24	24	24	24	24	24	24	24	24	24	24
m	139.5	142.3	183.0	289.2	94.8	21.8	13.7	12.6	33.9	54.4	109.7	112.6	1211.8	1190.1
s	80.1	95.5	79.3	77.7	53.3	20.7	20.1	21.5	47.0	65.8	105.1	74.9	245.5	185.0
C_v	0.57	0.67	0.43	0.27	0.56	0.95	1.47	1.71	1.39	1.21	1.00	0.67	0.20	0.16

Monthly Rainfall (mm) for Station: MLALI

Registration Number: 96.3751

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1956	143.3	126.2	136.7	289.9	2.8	0.0	0.0	0.0	0.0	6.9	4.3	18.3	728.3	*
1957	99.8	73.4	95.5	183.9	122.4	0.0	1.8	0.0	82.6	14.0	57.7	64.8	795.9	696.0
1958	29.2	147.3	262.4	161.3	106.4	3.3	0.0	12.7	0.0	0.0	11.9	98.3	831.3	845.1
1959	88.4	95.5	97.3	151.1	43.9	0.0	0.0	21.8	0.0	5.6	18.5	96.6	591.8	613.8
1960	163.3	68.1	231.1	178.6	3.8	7.4	0.0	0.0	0.0	16.3	0.0	0.0	668.5	756.7
1961	66.0	238.8	61.5	176.5	34.0	7.6	29.0	0.0	14.7	154.4	215.9	274.6	1273.0	782.5
1962	214.9	49.3	89.4	188.0	23.4	0.0	2.5	5.1	2.5	10.4	19.6	58.9	664.0	1076.0
1963	105.6	124.5	127.6	232.5	11.7	5.6	0.0	(0.0)	0.0	(0.0)	(46.3)	(43.0)	(696.8)	(686.0)
1964	55.4	49.1	253.7	196.9	30.4	5.8	0.0	0.0	5.1	85.1	0.0	21.8	703.3	(770.8)
1965	87.3	219.7	48.5	329.4	29.5	0.0	0.0	0.0	0.0	20.3	141.0	88.0	963.7	756.5
1966	46.4	262.6	429.7	153.4	285.2	119.4	(0.0)	(0.0)	96.5	185.0	(43.0)	(28.0)	(1649.2)	(1807.2)
1967	32.5	74.5	77.0	284.0	84.0	7.1	30.6	15.3	78.2	35.1	112.1	152.8	983.2	(789.3)
1968	157.7	30.7	195.6	242.1	36.8	128.2	0.0	0.0	3.3	22.8	133.6	67.2	1016.0	1082.1
1969	58.2	149.0	111.6	222.6	45.8	12.1	0.0	0.0	0.0	21.6	53.6	15.2	689.7	821.7
1970	276.2	382.6	82.3	143.3	3.8	0.0	0.0	0.0	56.3	21.6	0.0	96.1	1066.2	1034.9
1971	202.3	126.2	65.4	263.5	34.3	12.3	25.5	0.0	8.0	2.5	12.2	120.5	872.7	836.1
1972	72.5	75.0	148.0	280.6	102.7	0.0	0.0	3.0	60.8	102.0	117.5	138.5	110.6	977.3
1973	245.5	120.0	33.5	238.5	47.5	8.5	2.5	5.5	0.0	16.5	59.5	62.5	840.0	974.0
1974	27.5	56.0	76.5	235.5	84.0	34.0	4.5	0.0	0.0	25.5	7.5	2.0	553.0	665.5
1975	79.0	55.0	128.9	214.0	102.5	23.5	0.0	0.0	11.5	9.0	3.0	95.0	719.4	632.9
1976	68.0	151.0	241.0	221.5	36.5	21.0	2.5	0.0	12.5	5.5	30.0	59.0	848.5	857.5
1977	265.0	130.0	180.0	141.0	69.5	0.0	0.0	3.0	17.5	69.0	94.5	158.0	1127.5	964.0
1978	86.0	20.0	201.5	255.0	28.5	3.0	2.0	2.5	0.0	3.0	210.5	182.5	994.5	854.0
n(1956-78)	23	23	23	23	23	23	23	23	23	23	23	23	23	22
m	116.1	122.8	146.7	216.7	59.5	17.3	4.4	3.0	19.5	36.2	60.5	87.3	886.0	876.4
s	77.4	85.8	92.5	52.2	60.6	34.7	9.6	5.8	31.1	50.1	65.9	64.0	250.7	249.3
C_v	0.67	0.70	0.63	0.24	1.02	2.01	2.18	1.93	1.59	1.38	1.09	0.73	0.28	0.28

Monthly Rainfall (mm) for Station: MOROGORO WATER DEPARTMENT (Maji)

Registration Number: 96.3752

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1956	183.6	208.8	57.7	301.5	(70.0)	10.7	0.0	0.0	2.5	3.8	35.1	25.9	(899.6)	*
1957	132.1	61.2	123.7	216.7	72.1	1.3	4.3	3.6	28.4	19.3	59.9	25.1	747.8	723.7
1958	19.5	67.1	236.2	189.7	16.8	31.2	0.0	4.3	0.0	0.0	16.3	111.8	692.9	649.8
1959	84.3	103.9	55.4	103.4	53.1	0.0	0.0	25.4	0.0	13.7	13.2	66.5	518.9	567.3
1960	107.2	25.4	159.0	279.9	18.5	17.5	0.0	0.0	0.0	21.3	0.0	6.6	635.5	708.5
1961	0.0	155.2	48.5	87.4	42.2	36.6	81.5	0.0	18.5	128.3	166.1	130.3	894.6	604.8
1962	170.7	26.4	80.5	88.1	30.1	0.0	12.2	11.7	0.0	0.0	17.3	29.0	465.8	716.1
1963	145.2	101.4	61.2	165.6	16.0	20.3	7.0	0.5	0.0	0.3	199.7	63.7	780.9	563.8
1964	36.2	38.9	128.4	168.2	27.1	0.3	1.1	1.6	0.0	70.9	0.0	35.6	508.3	736.1
1965	110.8	68.1	56.9	179.7	47.3	0.0	0.0	0.0	5.8	102.5	71.4	161.3	804.8	607.7
1966	82.9	172.4	142.5	92.0	62.3	40.8	1.5	7.0	4.8	21.9	76.4	30.7	735.2	860.8
1967	15.3	52.9	65.6	316.6	143.3	9.6	65.0	33.0	74.7	29.0	179.0	207.4	1192.3	913.0
1968	121.6	97.3	238.4	293.2	49.8	51.4	2.3	0.0	0.8	5.1	48.4	88.7	997.0	1246.3
1969	30.0	154.8	130.5	164.5	53.1	18.2	16.5	15.3	0.0	14.0	40.6	25.4	663.2	734.0
1970	206.3	143.1	156.2	167.7	42.0	3.5	2.7	2.2	61.2	11.3	5.8	160.4	962.4	862.2
1971	138.4	56.5	50.4	160.6	44.3	20.9	5.6	0.0	0.3	65.4	3.4	70.3	616.1	708.6
1972	96.1	141.9	171.7	149.1	151.1	0.0	20.7	20.9	16.4	62.3	47.8	51.7	929.7	903.9
1973	218.6	56.8	23.5	248.7	68.3	12.0	4.3	5.2	1.2	19.4	31.2	154.2	843.4	757.5
1974	23.1	24.3	54.2	226.9	41.7	11.6	15.4	7.9	4.5	5.4	2.3	15.7	433.0	600.4
1975	67.5	31.5	157.2	192.8	76.8	18.3	0.8	0.0	9.9	11.2	10.5	104.9	681.4	584.0
1976	54.5	39.1	128.4	141.5	46.5	37.4	0.0	0.0	16.7	3.4	11.2	104.6	583.3	582.9
1977	168.9	156.0	134.6	135.9	73.2	4.3	13.9	3.6	29.4	47.6	57.9	122.2	947.5	883.2
1978														
n(1956-77)	22	22	22	22	22	22	22	22	22	22	22	22	22	21
m	100.6	90.1	111.9	185.0	56.6	15.7	11.6	6.5	12.5	29.8	49.7	81.5	751.5	738.8
s	65.3	56.1	60.8	69.1	34.5	15.3	21.2	9.3	20.3	35.3	58.8	57.0	194.8	164.3
C_v	0.65	0.62	0.54	0.37	0.61	0.7	1.83	1.43	1.62	1.18	1.18	0.70	0.26	0.22

Monthly Rainfall (mm) for Station: MFUMBWE

Registration Number: 96.3753

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1957	*	*	*	209.3	192.5	18.5	16.8	8.4	101.1	89.4	127.8	104.1	*	*
1958	5.6	178.6	381.0	245.1	261.9	85.6	18.0	36.3	16.8	0.3	69.1	189.7	1488.0	1461.1
1959	220.2	306.1	164.3	231.6	91.9	22.9	25.9	60.8	57.8	90.4	123.4	119.1	1478.5	1530.7
1960	244.1	144.5	378.0	328.9	53.1	36.1	(15.0)	7.9	37.6	59.2	6.9	1.5	1297.8	1531.9
1961	46.2	293.9	109.5	140.2	131.3	102.1	140.7	36.1	120.7	291.6	287.3	492.3	2191.8	1420.7
1962	360.0	112.3	214.4	220.2	78.2	12.5	47.5	164.1	25.4	51.3	33.3	154.9	1430.0	2065.5
1963	259.4	102.0	306.2	249.3	60.8	55.0	40.9	5.9	8.1	25.0	515.2	186.8	1814.8	1301.0
1964	122.3	131.7	245.9	268.7	29.2	14.0	35.4	44.6	15.8	168.5	0.0	152.2	1228.3	1778.1
1965	188.0	102.5	287.3	289.4	192.3	0.0	31.6	12.7	81.8	64.2	169.6	315.2	1734.6	1402.0
1966	43.6	105.5	307.1	323.3	90.0	62.1	17.8	3.9	133.6	39.1	112.1	49.9	1288.0	1610.8
1967	14.2	134.4	79.5	334.2	215.3	38.3	187.4	93.2	160.2	118.3	316.5	904.4	2595.9	1537.0
1968	215.5	190.6	372.8	505.2	151.4	90.7	8.7	11.4	9.9	34.8	216.8	131.7	1939.5	2811.9
1969	47.3	133.4	293.7	274.1	86.1	19.1	95.4	27.9	25.4	123.7	240.1	23.2	1389.4	1474.6
1970	244.7	422.1	220.3	174.3	60.9	45.2	7.9	10.1	144.0	64.0	10.1	218.3	1621.9	1656.8
1971	160.1	194.2	130.9	573.5	162.3	83.8	159.4	0.9	26.6	40.5	16.0	161.4	1709.6	1760.6
1972	106.7	133.2	276.8	126.8	(300.0)	0.8	32.2	65.4	24.6	343.0	644.3	428.0	2481.8	1586.9
1973	363.8	229.7	227.7	679.3	(200.0)	131.1	274.8	198.7	274.2	166.8	266.7	273.9	3286.7	3818.4
1974	220.5	28.0	*	*	*	*	*	*	*	*	*	*	*	*
1975			(no data available)											
n(1958-73)	16	16	16	16	16	16	16	16	16	16	16	16	16	16
m	165.1	182.2	249.7	310.3	135.3	50.0	71.2	48.7	72.7	105.0	189.2	237.7	1811.0	1796.8
s	115.8	90.3	93.8	153.1	80.3	39.3	78.7	58.3	75.0	96.3	187.8	222.2	569.9	645.9
C_v	0.70	0.50	0.38	0.49	0.55	0.79	1.11	1.20	1.03	0.92	0.99	0.93	0.31	0.36

Monthly Rainfall (mm) for Station: MLALI IRRIGATION SCHEME

Registration Number: 96.3754

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1957	(125.1)	38.1	105.7	171.7	138.9	(0.0)	(0.0)	(0.0)	(0.0)	(0.9)	66.3	(55.0)	(709.7)	*
1958	27.7	103.4	316.7	161.3	77.7	3.8	0.0	0.8	2.5	0.0	0.0	73.4	767.3	(815.2)
1959	73.4	78.2	120.4	167.9	33.8	0.0	0.0	18.8	1.3	0.6	2.8	68.8	571.5	567.8
1960	150.1	35.3	274.8	231.6	14.0	20.3	0.0	0.0	0.0	31.2	0.0	0.0	757.4	828.9
1961	58.2	240.3	25.4	148.6	39.1	5.6	28.2	0.0	20.3	180.1	210.3	279.1	1108.2	745.8
1962	289.3	32.5	123.7	195.6	37.6	0.0	4.3	11.4	4.3	5.3	15.2	42.7	762.0	1193.4
1963	120.9	84.2	148.8	256.5	17.7	5.6	5.9	0.0	0.0	0.0	357.2	36.4	1033.2	697.5
1964	61.2	35.6	172.3	182.7	20.8	4.1	0.0	0.0	0.0	61.5	0.0	23.0	561.2	931.8
1965	98.5	164.9	61.9	402.2	20.5	0.0	0.0	0.0	0.0	26.2	139.7	113.0	1027.2	797.2
1966	79.8	142.7	69.4	121.9	31.4	12.0	0.0	0.0	1.3	30.0	33.5	23.7	545.6	741.2
1967	90.2	62.8	33.3	236.6	137.5	8.4	39.9	11.7	69.1	35.1	97.7	113.8	936.1	781.8
1968	101.1	17.8	196.3	253.0	31.5	20.3	0.0	0.0	3.5	4.9	96.3	33.2	757.9	938.9
1969	4.3	148.3	70.4	218.7	39.7	3.8	0.0	4.3	0.0	23.4	66.2	24.7	603.8	642.4
1970	255.3	278.0	78.6	140.8	2.5	0.0	0.0	0.0	28.4	11.4	0.0	98.7	893.7	885.9
1971	206.4	88.7	411.2	680.5	141.5	19.2	73.0	0.0	0.8	0.0	0.0	26.5	1647.8	1720.0
1972	24.1	24.3	88.1	115.6	43.0	0.0	1.0	0.0	32.0	44.5	38.5	(116.0)	(527.1)	399.1
1973	110.8	4.0	13.5	108.0	46.4	0.2	3.0	0.0	0.0	0.0	3.0	(52.0)	(374.4)	(473.9)
1974	2.2	7.4	48.3	84.3	32.8	*	*	*	*	*	*	*	*	*
1975	47.9	50.8	*	*	*	0.0	*	*	0.0	0.0	14.0	44.5	*	*
1976	29.3	21.1	(no data available)											
n(1957-73)	17	17	17	17	17	17	17	17	17	17	17	17	17	16
m	110.4	94.7	135.9	223.1	51.4	6.1	9.1	2.8	9.6	27.3	62.4	69.4	799.1	816.4
s	78.3	77.1	109.5	137.6	45.0	7.5	19.9	5.6	18.5	43.4	97.2	64.9	298.9	304.1
C_v	0.71	0.81	0.81	0.62	0.88	1.23	2.19	2.00	1.93	1.59	1.56	0.94	0.37	0.37

Monthly Rainfall (mm) for Station: MADOTO

Registration Number: 96.3755

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1958	4.8	211.1	215.4	89.9	5.1	15.2	0.0	0.0	10.2	4.6	6.4	158.2	720.9	*
1959	148.3	206.8	131.1	118.4	37.6	0.0	2.5	12.2	0.0	4.3	33.8	36.9	731.8	825.8
1960	173.5	70.4	376.4	189.2	0.0	3.8	0.0	0.0	0.0	0.0	0.0	0.0	813.3	884.0
1961	25.4	209.6	101.6	215.6	54.1	16.5	3.0	19.1	47.2	115.6	152.9	242.6	1203.2	807.7
1962	202.2	99.1	129.8	99.1	78.7	2.5	12.7	24.6	17.8	21.6	15.2	37.6	740.9	1083.6
1963	155.0	164.1	294.0	189.1	0.0	7.6	0.0	0.0	0.0	0.0	194.1	80.2	1084.1	862.6
1964	147.7	145.8	263.4	168.3	47.3	3.6	2.8	36.3	0.3	11.4	10.2	89.4	926.5	1101.2
1965	134.6	149.2	272.3	85.2	47.4	0.0	0.0	3.0	27.0	15.2	56.6	256.4	1046.9	833.7
1966	41.0	117.2	205.5	167.9	45.8	5.1	0.0	2.5	5.4	86.1	64.3	70.6	811.4	989.5
1967	23.6	102.1	207.8	302.6	49.0	6.4	29.6	7.7	46.1	14.6	126.5	312.5	1228.5	924.4
1968	87.5	40.5	288.3	169.8	92.3	21.3	0.0	30.5	12.7	44.2	111.0	193.6	1091.7	1226.1
1969	38.7	73.8	156.1	163.4	51.8	0.0	0.0	8.0	0.0	18.0	56.3	38.1	604.2	814.4
1970	184.1	186.3	211.0	64.3	8.5	8.0	0.0	17.0	27.0	2.5	4.0	114.5	827.2	803.1
1971	144.5	75.0	64.5	254.5	35.5	18.5	4.0	0.0	5.0	0.0	0.0	107.0	708.5	720.0
1972	127.0	112.0	253.0	147.0	88.5	0.0	0.0	6.0	60.0	65.0	55.0	125.0	1038.5	900.5
1973	310.0	129.7	59.3	172.3	20.0	*	*	*	*	*	32.9	222.2	*	*
1974	92.1	85.3	90.1	280.2	98.0	5.5	*	*	*	*	*	*	*	*
1975	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1976	107.3	89.0	120.4	141.9	65.0	18.0	0.0	15.6	0.9	0.0	5.4	16.5	580.0	*
1977	209.8	116.5	131.9	191.7	24.0	0.0	11.8	0.0	58.6	15.9	*	*	*	782.1
n(1958-72)	15	15	15	15	15	15	15	15	15	15	15	15	15	14
m	109.2	130.9	211.4	161.6	42.8	7.2	3.6	11.1	17.3	26.9	59.1	124.2	905.2	912.6
s	66.0	55.9	83.7	65.2	29.8	7.3	7.9	11.9	20.0	35.4	61.0	91.5	196.8	140.4
C_v	0.60	0.43	0.40	0.40	0.70	1.01	2.19	1.07	1.16	1.32	1.03	0.74	0.22	0.15

Monthly Rainfall (mm) for Station: WAMI PRISON FARM

Registration Number: 96.3756

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1957	149.9	66.5	149.9	444.0	*	2.8	5.8	0.0	47.5	27.9	*	*	*	*
1958	6.9	81.0	246.9	106.9	36.6	53.6	0.0	13.7	0.8	0.0	19.8	61.7	627.9	*
1959	114.0	253.0	128.3	120.1	34.3	*	*	*	*	*	*	*	*	*
1960	82.8	73.4	250.7	193.0	284.0	61.2	1.3	0.0	9.9	15.0	*	*	*	*
1961	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1962	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1963	77.5	76.9	158.0	102.8	64.8	12.0	3.8	0.0	1.8	0.0	*	*	*	*
1964	114.3	10.9	97.3	178.7	29.3	7.6	0.0	2.6	0.0	14.7	1.5	40.1	497.0	*
1965	112.8	216.7	138.8	133.3	30.5	0.0	0.8	3.3	0.0	34.8	64.5	128.3	863.8	712.6
1966	94.8	104.1	348.7	185.9	83.2	(20.0)	(0.0)	(5.0)	(5.0)	(10.0)	35.6	87.8	980.1	1049.5
1967	13.0	34.0	50.0	367.0	323.9	10.7	38.4	29.3	94.5	103.0	121.2	289.9	1465.9	1187.2
1968	181.5	41.2	250.0	257.5	79.2	71.1	3.1	0.0	0.0	27.0	110.1	71.9	1092.6	1312.7
1969	32.4	192.0	80.6	211.6	144.1	11.0	3.1	14.0	14.7	30.2	133.1	0.8	867.6	742.9
1970	228.0	169.8	236.7	162.7	29.6	1.1	6.9	0.0	58.7	11.1	0.4	269.2	1174.2	1038.5
1971	173.5	79.3	114.2	246.1	83.9	29.0	12.2	0.0	3.5	34.3	3.3	81.3	860.6	1045.6
1972	75.8	33.2	145.3	174.4	151.3	0.0	9.7	0.3	0.0	135.4	67.6	93.4	886.4	810.0
1973	241.3	203.8	19.6	356.0	115.2	3.6	1.7	11.5	0.0	1.3	57.3	31.0	1042.3	1115.0
1974	151.2	48.0	56.5	256.5	91.5	34.5	50.5	2.5	5.5	44.0	1.5	166.5	908.7	829.0
1975	124.0	39.9	465.0	231.5	64.5	19.0	2.0	0.0	6.0	14.0	0.0	69.5	1035.4	1133.9
1976	68.5	84.0	161.5	195.0	87.5	26.5	23.5	0.5	14.5	23.0	16.5	57.5	758.5	754.0
1977	117.5	252.0	66.5	203.5	117.5	0.0	12.5	12.5	82.0	65.0	104.5	82.3	1115.8	993.5
1978														
n(1964-77)	14	14	14	14	14	14	14	14	14	14	14	14	14	13
m	123.5	107.7	159.3	225.7	102.2	16.7	11.7	5.8	20.3	39.1	51.2	104.3	967.8	978.8
s	67.0	81.9	126.1	67.9	74.6	19.5	15.5	8.4	32.6	38.1	49.8	82.7	223.0	191.1
C_v	0.54	0.76	0.79	0.30	0.73	1.17	1.32	1.45	1.61	0.97	0.97	0.79	0.23	0.20

Monthly Rainfall (mm) for Station: MSOWERO

Registration Number: 96.3758

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1960	249.9	64.0	278.6	364.5	35.3	8.4	2.3	0.0	1.0	31.8	0.0	0.0	1035.8	*
1961	12.4	72.4	114.0	186.7	87.6	4.1	19.8	0.0	*	40.6	284.5	*	*	*
1962	386.8	17.3	287.0	308.6	91.2	2.0	30.7	0.0	27.4	0.0	43.2	55.9	1250.2	*
1963			(Station closed)											

Monthly Rainfall (mm) for Station: KINOLE PRIMARY SCHOOL

Registration Number: 96.3760

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1963	405.7	204.4	391.5	320.3	92.5	102.6	45.2	36.2	23.5	14.2	771.4	195.2	2602.7	*
1964	358.8	107.7	392.5	282.4	66.0	27.4	44.5	144.9	22.1	54.2	2.0	198.0	1700.5	2467.1
1965	203.1	136.7	190.4	611.0	242.5	0.0	38.5	13.0	49.4	98.0	317.9	501.0	2381.5	1782.6
1966	75.0	211.6	471.8	330.2	101.9	56.7	*	*	*	*	*	*	*	*
1967	*	*	*	*	98.5	158.1	164.8	127.4	*	*	386.2	795.5	*	*
1968	123.8	145.3	236.4	402.7	*	*	*	*	*	*	*	*	*	*
1969	311.6	323.4	*	*	178.2	81.8	51.5	63.2	39.3	179.0	91.9	8.0	*	*
1970	174.5	311.1	344.7	362.0	96.7	54.0	9.3	45.2	185.7	74.0	22.3	506.0	2185.5	1757.1
1971	164.8	172.2	320.1	568.2	152.6	92.5	125.2	15.9	67.0	71.7	68.7	68.2	1887.1	2278.5
1972	241.5	63.9	447.4	289.5	142.6	11.2	53.5	57.5	72.8	*	*	*	*	*
1973	265.7	51.6	259.2	629.2	125.1	65.2	40.5	62.2	23.5	0.0	132.0	19.0	1673.2	*
1974	77.0	11.0	270.0	539.6	114.0	101.5	175.0	67.8	74.9	51.6	64.2	*	*	1633.4
1976			(No data available)											

Monthly Rainfall (mm) for Station: MVUMI AGRICULTURAL OFFICE

Registration Number: 96.3761

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1963	165.1	153.8	328.8	251.4	10.2	7.6	0.0	*	1.3	*	298.8	109.2	*	*
1964	85.0	127.0	222.9	355.5	58.5	7.1	17.8	11.4	21.6	31.8	0.0	47.1	985.7	1346.6
1965	47.1	72.9	139.4	233.5	*	*	*	*	*	*	*	*	*	*
1966	43.2	146.1	161.0	274.1	79.8	20.9	0.0	0.0	25.4	12.2	0.0	119.3	882.0	*
1967	19.0	75.9	101.1	491.3	334.3	48.3	106.7	26.7	55.9	48.4	73.6	357.0	1738.2	1426.9
1968	206.3	43.2	259.0	548.2	175.3	144.8	0.0	0.0	0.0	0.0	108.8	164.0	1649.6	1807.4
1969	0.0	2.4	119.0	295.0	115.0	0.0	0.0	0.0	0.0	6.1	40.0	95.0	672.6	810.3
1970	309.0	192.0	238.0	226.0	50.0	0.0	0.0	15.0	0.0	0.0	0.0	312.0	1342.0	1165.0
1971	456.0	84.2	32.0	241.1	95.0	15.0	16.0	0.0	0.0	0.0	12.0	55.5	1006.8	1251.3
1972	242.5	259.9	640.0	*	*	*	*	*	*	*	*	*	*	*
1973	*	*	*	*	*	*	*	8.5	*	*	*	*	*	*
1974	20.2	38.5	110.9	216.3	71.1	0.0	0.0	0.0	0.0	9.6	0.0	0.0	466.6	*
1975	60.7	10.5	55.2	44.0	1.1	0.0	0.0	0.0	*	*	*	*	*	*
1976			(Station closed)											

Monthly Rainfall (mm) for Station: MOROGORO TEACHERS TRAINING CENTRE

Registration Number: 96.3762

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1964	*	*	*	249.1	55.4	8.7	18.5	24.7	5.8	114.5	10.7	105.1	*	*
1965	85.8	73.0	163.2	300.0	159.5	0.0	1.1	1.8	50.8	81.4	160.3	201.0	1277.9	1032.4
1966	95.8	130.6	120.3	130.3	95.6	61.9	3.8	13.5	31.5	44.1	73.7	31.1	831.7	1088.2
1967	2.9	109.8	107.6	399.4	198.4	22.1	120.7	65.0	118.5	44.4	272.5	256.3	1717.6	1293.6
1968	53.1	43.4	365.1	258.4	76.9	77.8	29.0	0.0	4.8	8.9	91.1	89.1	1097.6	1446.2
1969	27.8	111.8	236.2	225.7	65.8	21.0	53.4	37.0	5.0	63.1	117.8	65.8	1030.4	1027.0
1970	200.3	170.7	35.1	164.1	61.5	9.3	2.1	15.5	73.9	20.8	4.9	261.2	1019.4	936.9
1971	74.2	57.5	91.0	165.0	141.6	35.6	69.3	0.0	5.0	8.2	15.5	72.8	735.7	913.5
1972	123.6	220.5	165.3	(250.0)	213.0	0.0	32.6	32.1	112.4	34.7	101.1	109.2	1394.5	1272.5
1973	166.4	111.8	*	328.4	*	*	*	*	*	*	*	*	*	*
1974			(No data available)											
n(1965-72)	8	8	8	8	8	8	8	8	8	8	8	8	8	8
m	82.9	114.7	160.5	236.6	126.5	28.5	39.0	20.6	50.2	38.2	104.6	135.8	1138.1	1126.3
s	61.0	59.4	101.8	87.0	60.1	28.5	41.4	22.8	47.2	25.7	84.9	90.4	317.2	190.1
C_v	0.74	0.52	0.63	0.37	0.48	1.00	1.06	1.11	0.94	0.67	0.81	0.67	0.28	0.17

Monthly Rainfall (mm) for Station: MOROGORO AGRICULTURAL COLLEGE

Registration Number: 96.3763

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1965	81.7	75.7	100.5	272.9	73.1	0.0	1.6	0.0	7.5	107.7	58.2	154.7	933.6	*
1966	74.8	134.7	126.0	141.8	65.0	45.1	0.0	12.7	8.2	42.4	91.6	40.0	782.3	863.6
1967	1.2	53.1	46.9	288.1	168.4	13.0	68.3	81.1	106.7	20.7	146.9	246.0	1240.4	979.1
1968	(63.3)	(47.8)	85.4	134.4	41.8	40.7	7.1	0.0	1.8	0.0	67.1	65.4	(554.8)	815.2
1969	51.9	98.7	100.7	162.2	24.7	32.0	22.3	40.5	3.3	40.9	57.1	0.0	639.3	714.7
1970	141.8	85.7	122.0	164.7	41.2	0.6	0.0	3.5	35.8	12.1	(4.8)	(121.9)	(734.1)	664.5

Continued as MOROGORO METEOROLOGICAL STATION Reg. no. 96.3776

Monthly Rainfall (mm) for Station: CHANJURU SISAL ESTATE

Registration Number: 96.3764

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1966	76.2	120.9	245.2	276.2	75.2	13.0	0.0	6.6	5.6	83.6	122.6	95.0	1120.1	*
1967	72.2	203.1	113.8	331.7	57.6	12.2	52.9	21.3	51.1	18.1	198.2	383.2	1515.4	1151.6
1968	127.3	46.6	222.4	249.1	77.0	21.8	6.3	37.9	11.9	27.4	56.7	196.9	1081.3	1409.1
1969	54.2	82.3	146.0	213.1	61.2	13.2	0.0	21.8	8.4	27.7	113.5	22.7	764.1	881.5
1970	262.7	155.6	242.0	24.6	3.0	0.0	0.3	6.9	58.0	12.1	0.0	159.2	924.4	901.4
1971	81.3	95.1	152.8	238.4	24.9	12.4	0.5	1.9	6.6	14.0	30.1	62.4	720.4	787.1
1972	117.8	76.0	291.1	112.3	105.2	0.0	0.0	0.0	56.8	58.6	147.7	103.3	1068.8	910.3
1973	156.1	149.0	87.0	186.9	36.9	2.9	0.8	1.8	0.0	0.0	13.2	49.3	683.9	872.4
1974	122.1	8.8	152.5	223.1	182.9	0.3	15.0	13.7	11.0	13.0	0.0	24.8	767.2	804.9
1975	39.4	35.9	136.4	242.3	43.9	0.0	0.0	0.0	30.8	0.0	0.0	70.6	559.3	553.5
1976	81.0	150.2	105.3	92.1	81.9	10.7	0.0	10.4	0.0	10.0	0.0	10.3	551.9	612.4
1977	319.5	131.2	30.3											
1978			(No data available)											
n(1966-76)	11	11	11	11	11	11	11	11	11	11	11	11	11	10
m	108.2	102.1	172.2	199.1	68.2	7.9	6.9	11.1	21.8	24.1	62.0	107.1	887.0	888.4
s	61.8	59.4	66.9	89.3	47.6	7.5	15.9	11.8	23.1	25.5	71.4	108.2	290.0	246.5
C_v	0.57	0.58	0.39	0.45	0.70	0.95	2.30	1.06	1.06	1.06	1.15	1.01	0.33	0.28

Monthly Rainfall (mm) for Station: ILONGA ESTATE (MSIMBA SEED FARM)

Registration Number: 96.3765

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1966	138.3	109.1	339.8	245.2	73.7	13.5	0.0	8.4	6.4	85.5	64.3	43.6	1127.8	*
1967	68.1	95.0	132.9	397.6	63.2	17.3	38.0	33.5	53.3	18.3	179.7	356.0	1452.9	1025.1
1968	181.2	67.4	265.7	288.8	74.2	41.4	1.0	19.1	16.2	27.4	196.1	339.4	1517.9	1518.1
1969	108.7	122.8	254.0	285.8	79.9	10.1	0.0	10.2	0.0	50.0	0.0	82.0	1003.5	1457.0
1970	182.4	154.1	266.5	23.2	5.1	0.0	0.0	0.0	*	*	*	*	*	*
1971	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1972	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1973	*	*	*	72.7	50.4	2.3	0.0	1.3	0.0	12.7	48.1	221.5	*	*
1974	125.6	51.0	87.1	235.5	214.2	5.1	59.1	0.0	3.1	0.0	13.2	18.8	812.7	1050.3
1975	83.4	63.3	187.8	208.1	80.4	6.4	0.0	1.0	15.8	9.2	0.0	197.5	852.9	687.4
1976	118.1	122.0	101.0	208.7	51.3	26.9	0.0	0.0	0.0	6.1	0.0	75.9	710.0	831.6
1977	339.4	135.2	133.9	191.4	38.5	0.0	11.7	11.7	77.0	38.3	214.7	248.5	1440.3	1053.0
1978														

Monthly Rainfall (mm) for Station: KIVUNGU SISAL ESTATE

Registration Number: 96.3766

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1966	91.6	261.7	195.5	142.9	40.0	18.5	0.0	5.1	8.4	10.2	76.0	40.4	890.3	*
1967	9.9	164.7	90.7	152.0	65.5	14.7	41.9	8.8	40.9	31.3	361.4	304.7	1286.3	736.6
1968	141.4	46.0	255.5	246.8	22.1	45.5	0.0	15.5	6.1	29.9	59.4	120.9	989.1	1474.9
1969	29.2	65.5	85.1	157.7	49.5	4.8	0.0	16.0	17.0	0.0	62.1	0.0	486.9	605.1
1970	115.2	96.9	220.3	100.7	5.3	0.0	0.0	0.0	62.9	20.1	0.0	163.0	784.4	683.5
1971	156.5	96.7	132.4	84.6	31.6	0.0	21.6	5.5	10.3	9.3	6.5	55.0	610.0	711.5
1972	210.4	128.0	180.7	90.7	72.7	0.0	0.0	9.8	63.1	84.5	268.5	55.1	1163.5	901.4
1973	112.6	128.5	66.2	145.3	51.0	0.0	7.5	13.5	8.5	0.0	8.0	75.5	616.6	856.7
1974	145.2	69.0	94.2	91.5	*	*	*	*	*	*	*	*	*	*
1975	64.7	92.0	116.0	*	48.9	4.6	0.0	0.0	*	24.0	0.0	171.8	637.5	*
1976	154.7													
			(No data available)											

Monthly Rainfall (mm) for Station: RUDEWA SISAL ESTATE

Registration Number: 96.3767

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1966	58.4	121.4	189.9	177.4	34.7	3.5	2.5	2.6	4.4	24.0	86.9	38.3	744.0	*
1967	30.4	150.0	177.6	355.5	46.4	14.5	20.9	8.8	72.3	16.4	92.8	327.3	1312.9	1018.0
1968	92.4	61.0	273.8	280.7	93.1	55.1	0.0	5.6	8.1	3.8	148.1	170.8	1192.5	1293.7
1969	65.7	76.4	164.9	224.2	73.3	3.5	1.3	6.3	3.1	9.6	75.5	22.9	726.7	947.2
1970	161.9	121.0	173.7	57.1	2.8	7.6	2.5	3.1	16.	0.0	31.5	126.2	711.8	644.5
1971	114.6	84.4	159.1	233.1	16.0	16.6	6.9	1.8	12.0	3.0	16.0	126.0	790.1	805.2
1972	118.6	135.5	194.1	197.9	75.8	0.0	4.5	16.6	50.5	78.3	47.0	111.5	1030.3	1014.4
1973	369.6	117.9	114.4	247.6	83.6	2.5	1.0	0.1	0.0	4.8	39.3	112.3	1093.1	1100.0
1974	49.5	39.0	50.1	87.4	72.7	25.6	11.0	13.0	10.0	28.3	5.0	34.1	425.7	538.2
1975	72.9	27.6	103.6	166.6	29.6	5.3	0.3	0.0	25.6	10.8	6.5	139.5	588.3	481.4
1976	63.8	151.4	138.8	135.8	78.3	35.2	0.0	0.0	0.0	9.3	0.0	41.5	654.1	619.1
1977	214.8	117.3	100.7	143.4	39.0	0.0	0.0	20.6	19.9	21.0	70.0	214.5	961.2	718.2
1978														
n(1966-77)	12	12	12	12	12	12	12	12	12	12	12	12	12	11
m	117.7	100.2	153.4	192.2	53.8	14.1	4.2	6.5	18.5	17.4	51.6	122.1	852.6	834.5
s	94.8	41.8	57.5	83.1	29.4	16.9	6.2	6.9	22.0	21.1	44.6	87.7	264.8	258.7
C_v	0.81	0.42	0.37	0.43	0.55	1.2	1.48	1.06	1.19	1.21	0.86	0.72	0.31	0.31

Monthly Rainfall (mm) for Station: CHAZI REHABILITATION CENTRE

Registration Number: 96.3768

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1967	45.2	79.6	42.5	504.8	*	*	*	*	*	*	*	*	*	*
1968	134.2	43.7	363.0	467.2	107.2	84.9	0.0	31.8	1.5	54.4	193.1	*	*	*
1969	209.2	*	*	*	24.0	*	*	*	*	*	*	*	*	*
1970	259.5	229.0	339.4	110.5	44.9	0.0	0.0	0.0	57.1	27.0	0.0	225.1	1292.5	*
1971	199.3	155.3	133.2	166.8	90.0	14.0	27.2	0.0	9.0	0.0	24.0	107.1	925.9	1019.9
1972	173.7	78.1	176.6	174.1	203.7	*	*	*	*	*	*	*	*	*
1973	314.0	137.5	73.7	370.1	*	*	*	*	*	*	*	*	*	*
1974	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1975	84.2	50.5	14.7	421.6	65.6	36.0	0.0	0.0	0.0	7.0	0.0	31.3	843.9	*
1976			(No data available)											

Monthly Rainfall (mm) for Station: MAFIGA SISAL ESTATE

Registration Number: 96.3769

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1967	4.8	89.3	48.8	351.9	180.7	11.9	61.6	37.1	58.2	*	*	*	*	*
1968	126.0	59.0	51.0	*	*	*	*	*	*	*	*	*	*	*
			(no data available)											
1976	119.8	12.0	106.6	127.0	34.4	37.2	45.0	0.0	12.7	7.8	10.0	30.5	543.0	*
1977	143.4	119.4	108.8	79.2	80.9	0.0	21.0	0.0	25.5	34.1	28.7	142.5	783.5	652.8
1978														

Monthly Rainfall (mm) for Station: KIHONDA SISAL ESTATE

Registration Number: 96.3770

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1967	19.0	66.0	83.8	97.2	97.7	11.9	47.5	31.7	63.5	24.1	129.5	256.8	923.6	*
1968	81.8	71.9	204.2	284.5	20.8	39.4	16.5	*	*	*	*	*	*	*
1969	70.8	103.2	88.9	136.4	77.0	0.0	0.0	26.7	0.0	22.9	36.8	10.9	573.6	*
1970	271.9	158.4	146.5	70.8	30.5	0.0	0.0	0.0	41.2	0.0	0.0	104.2	823.5	767.0
1971	142.0	65.5	94.6	124.6	*	*	*	*	*	*	*	*	*	*
1973	78.3	74.8	96.5	97.5	138.4	*	*	*	*	*	*	*	*	*
			(No data available)											
1976	199.0	50.0	123.0	142.0	18.0	*	*	*	*	*	*	*	*	*
1977														
			(No data available)											

Monthly Rainfall (mm) for Station: KIDETE SISAL ESTATE

Registration Number: 96.3771

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1966	62.0	97.0	233.4	104.1	63.0	11.4	2.5	0.0	3.6	0.0	44.5	51.3	672.8	*
1967	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1968	181.9	61.4	325.6	315.8	126.9	71.7	0.0	0.0	1.3	12.0	78.0	169.4	1344.0	*
1969	38.8	53.6	227.7	227.0	105.8	9.4	7.0	4.6	11.2	19.1	81.7	35.6	822.1	951.6
1970	100.7	188.4	300.5	101.2	55.0	0.0	0.0	0.0	29.9	0.0	0.0	116.1	991.8	993.0
1971	126.0	59.0	51.0	*	*	*	*	*	*	*	*	*	*	*
			(No data available)											
1976	119.8	12.0	106.0	127.0	34.4	37.2	45.0	0.0	12.7	7.8	10.0	30.5	543.0	*
1977	143.4	119.4	108.8	79.2	80.9	0.0	21.0	0.0	25.5	34.1	28.7	142.5	783.5	652.8

Monthly Rainfall (mm) for Station: VITONGA SISAL ESTATE

Registration Number: 96.3772

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1967	40.1	41.7	62.8	302.5	196.1	6.4	14.0	8.9	*	*	*	*	*	*
			(No data available)											
1971	132.6	103.5	93.5	*	*	*	*	*	*	*	*	*	*	*
1972	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1973			(Station closed)											

Monthly Rainfall (mm) for Station: **MAGUBIKA**

Registration Number: 96.3773

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1970	276.4	214.3	207.0	88.6	72.4	*	*	*	9.7	*	1.4	60.4	*	*
1971	162.7	106.3	46.7	237.7	55.2	91.0	14.6	0.0	0.0	0.0	0.0	83.7	797.9	776.0
1972	79.0	98.9	109.1	127.9	188.1	5.6	16.7	6.2	45.2	96.9	12.3	95.8	881.7	857.3
1973	239.1	140.1	15.0	150.8	56.8	18.4	0.0	0.0	0.0	0.0	4.2	134.7	759.1	728.3
1974	16.8	53.8	28.1	157.6	76.6	12.3	17.9	0.0	0.0	8.5	6.5	32.4	410.5	510.5
1975	89.5	50.3	196.2	97.4	102.5	22.9	10.5	0.0	19.0	*	*	*	*	*
1976	8.3	170.3	*	*	*	*	*	*	*	*	*	*	*	*
1977	99.2	76.4	32.6	13.2	0.0	0.0	0.0	19.6	0.0	0.0	60.9	31.4	333.3	*
1978														
n(1971-75)	5	5	5	5	5	5	5	5	5	5	5	5	5	4
m	119.4	95.1	46.3	137.4	75.3	25.5	9.8	5.2	9.0	21.1	16.8	75.6	636.5	718.0
s	84.8	32.5	36.9	80.9	69.2	37.3	9.1	8.5	20.2	42.5	22.4	44.1	247.1	148.3
C_V	0.71	0.32	0.80	0.59	0.92	1.46	0.93	1.6	2.24	1.00	1.33	0.58	0.39	0.21

Monthly Rainfall (mm) for Station: KILANGALI

Registration Number: 96.3775

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1970	136.9	52.8	106.3	86.8	9.4	0.0	0.0	4.6	41.1	0.0	0.0	185.3	623.2	*
1971	134.2	103.6	119.6	101.0	28.4	7.3	27.2	0.5	10.6	13.9	28.3	123.4	698.0	731.6
1972	205.6	148.1	242.2	89.2	119.7	0.0	6.4	0.0	55.8	87.0	170.1	59.3	1183.4	1105.7
1973	129.9	138.8	85.6	111.0	58.3	0.0	0.0	7.4	4.4	4.5	41.1	75.1	656.4	769.3
1974	139.4	108.0	74.5	270.0	94.8	7.1	3.0	0.0	2.0	13.7	0.0	14.9	828.2	829.8
1975	56.0	12.0	189.0	137.4	69.6	3.0	0.0	0.0	29.0	22.8	21.0	118.7	658.5	533.7
1976	161.3	104.5	143.3	372.8	68.3	0.0	0.0	0.0	4.0	11.8	8.0	47.7	921.7	1005.7
1977	144.2	76.3	148.7	96.8	57.8	0.0	0.0	5.1	6.4	34.2	65.1	185.3	819.9	625.2
1978														

Monthly Rainfall (mm) for Station: MOROGORO METEOROLOGICAL STATION

Registration Number: 96.3776

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1970	*	*	*	*	*	*	*	*	52.5	7.8	5.4	143.9	*	*
1971	124.6	37.6	63.9	226.7	55.4	36.5	7.4	0.0	3.9	6.0	3.7	34.5	600.2	711.3
1972	109.3	116.4	177.0	165.9	152.8	0.0	26.1	14.2	22.8	83.0	71.3	107.2	1046.0	905.7
1973	248.7	85.7	41.7	291.0	61.3	14.7	9.6	8.9	3.5	18.1	48.3	125.5	956.5	961.7
1974	26.6	12.3	86.5	278.8	102.4	22.5	14.3	3.6	4.4	25.0	1.4	9.5	587.3	750.2
1975	104.1	38.0	163.3	197.7	102.7	25.3	2.3	0.4	11.3	21.7	29.7	78.3	774.7	677.7
1976	106.4	22.3	118.3	156.7	41.5	54.0	7.5	3.9	28.9	7.5	9.4	61.6	618.0	655.0
1977	136.6	166.4	128.5	123.3	84.0	2.9	23.7	9.4	22.9	50.3	45.0	152.2	945.2	819.0
1978	202.1	62.0	204.8	191.4	37.6	11.5	15.0	3.3	3.1	5.0	173.6	255.7	1166.0	933.9
n(1971-78)	8	8	8	8	8	8	8	8	8	8	8	8	8	8
m	132.3	67.6	123.0	203.9	79.7	21.0	13.2	5.5	12.6	27.1	47.8	103.1	836.8	801.8
s	67.3	52.6	57.0	58.7	38.9	17.9	8.3	4.9	10.7	27.0	56.4	77.5	223.0	120.7
C_v	0.51	0.78	0.46	0.29	0.49	0.85	0.63	0.89	0.85	1.00	1.18	0.75	0.27	0.15

Monthly Rainfall (mm) for Station: MTIBWA SUGAR ESTATE (LUKENGE). [1)]

Registration Number: 96.3778

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1974	*	*	*	*	*	*	70.1	3.6	10.0	47.5	32.6	18.9	*	*
1975	93.6	61.2	156.8	206.2	93.4	54.3	0.9	12.9	33.5	11.0	6.0	160.1	889.9	775.3
1976	44.9	179.6	130.0	140.0	106.8	29.9	13.4	64.8	35.8	20.5	14.2	32.4	812.3	931.8
1977	63.6	*	*	*	*	*	*	*	*	*	*	*	*	*
1978														

1) For a better record of MTIBWA ESTATE, see Registration Number 963742

Monthly Rainfall (mm) for Station: KILOSA NATURAL RESOURCES OFFICE

Registration Number: 96.3779

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1975	120.3	67.7	163.5	174.3	60.6	5.2	2.3	2.5	29.9	28.3	4.1	190.1	848.8	*
1976	113.0	130.4	260.6	237.6	93.7	12.2	11.9	1.1	1.1	20.0	6.8	40.3	928.7	1075.8
1977	188.7	99.1	159.0	271.6	49.3	(0.0)	1.5	23.7	125.7	27.3	125.3	359.4	1430.6	993.0
1978	154.8	31.9	197.0	173.7	27.8	18.1	3.9	4.4	2.9	4.5	231.7	175.7	1026.4	1104.0

Monthly Rainfall (mm) for Station: MELELA

Registration Number: 96.3780

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1975	*	18.1	132.9	177.1	40.3	5.4	0.0	0.0	8.9	1.5	11.0	76.8	*	*
1976	50.8	91.6	112.4	138.5	62.0	7.3	1.3	0.0	0.0	3.4	4.3	44.4	516.0	555.1
1977	205.1	98.1	83.3	99.1	*	*	0.0	0.5	13.4	*	*	45.8	*	*
1978	120.5	72.2	172.2	215.7	14.6	8.2	0.0	0.0	0.0	3.0	141.8			

Monthly Rainfall (mm) for Station: MANGAI

Registration Number: 96.3781

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1975	*	36.3	130.1	204.2	70.7	2.1	0.0	0.0	16.5	4.8	17.9	81.3	*	*
1976	30.5	37.1	197.4	120.6	67.3	8.0								
1977														
1978			No data available											

Monthly Rainfall (mm) for Station: ISANGA SISAL ESTATE

Registration Number: 96.3782

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
			No data received											

Monthly Rainfall (mm) for Station: BAGAMOYO AGRICULTURAL OFFICE

Registration Number: 96.3800

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1931	43	183	191	240	294	24	38	22	14	37	14	88	1187	
1932	117	140	39	198	500	73	9	0	23	7	0	79	1185	
1933	94	11	15	87	38	9	62	34	0	3	134	32	519	
1934	39	39	57	287	306	123	35	30	30	17	56	95	1114	
1935	17	111	117	213	362	54	4	57	42	34	31	42	1084	
1936	54	223	106	335	217	96	8	35	18	4	6	167	1269	
1937	52	1	151	244	192	33	5	20	0	158	89	91	1036	
1938	4	75	208	238	149	15	51	13	13	119	98	50	1032	
1939	23	18	220	113	322	43	60	20	17	0	54	122	1013	
1940	166	70	151	549	194	11	22	25	30	32	102	60	1413	
1941	47	0	116	204	92	49	2	18	67	53	106	249	1002	
1942	87	64	294	463	356	36	11	24	2	22	47	58	1463	
1943	122	114	90	182	115	45	37	34	12	1	24	7	783	
1944	137	97	106	349	168	78	47	35	40	71	203	61	1392	
1945	97	54	52	199	209	6	22	29	37	36	101	51	892	
1946	6	20	36	256	283	22	3	4	56	82	61	172	1001	
1947	68	75	92	375	176	58	6	25	76	4	103	100	1157	
1948	74	19	231	310	274	33	30	18	6	80	80	202	1356	
1949	29	30	8	212	152	37	86	66	17	5	8	226	876	
1950	156.0	216.9	184.4	372.4	98.0	46.7	44.7	74.2	48.8	33.8	77.5	84.3	1437.6	-
1951	27.4	18.3	40.9	162.1	264.9	49.5	22.1	45.7	15.2	185.4	208.0	261.1	1300.7	993.3
1952	77.7	44.5	19.3	78.0	144.5	39.1	0.0	110.7	43.4	0.0	130.0	78.7	766.1	1026.3
1953	55.1	47.2	37.6	154.4	324.6	0.0	39.6	80.0	27.2	88.9	146.3	87.1	1088.1	1063.3
1954	95.0	23.6	43.9	175.5	264.2	19.6	3.8	53.1	26.9	171.2	26.7	44.5	947.9	1110.2
1955	20.6	65.5	3.8	241.8	361.4	49.8	42.7	0.0	0.0	15.2	120.1	88.4	1009.4	856.0
1956	163.1	35.1	74.9	299.2	129.0	47.8	4.3	22.1	0.0	20.6	45.5	47.5	889.0	1004.6
1957	145.3	115.8	86.1	181.1	230.4	36.1	26.4	35.6	23.4	67.3	139.4	19.1	1105.9	1040.5
1958	0.0	261.4	97.0	79.2	64.3	27.2	27.4	69.9	7.9	13.5	19.1	125.2	792.0	806.3
1959	65.5	49.0	91.7	243.1	109.7	0.0	34.5	62.0	0.0	11.9	41.9	74.9	784.4	811.7
1960	182.6	16.8	125.5	203.2	44.5	43.9	9.9	7.4	2.5	46.2	10.7	16.5	709.7	799.3
1961	9.7	224.3	30.5	161.0	225.6	91.2	119.6	26.4	23.9	296.7	335.5	427.7	1974.1	1270.6
1962	71.4	71.4	10.9	365.5	34.3	6.6	22.6	72.6	18.8	20.8	41.9	128.8	865.6	1458.1
1963	43.5	49.3	176.8	387.1	37.6	97.1	34.9	5.0	10.7	8.7	173.0	98.5	1122.2	1021.4
1964	98.2	126.0	277.2	124.8	48.8	34.8	21.4	7.1	21.3	59.7	0.0	147.2	966.5	1090.8
1965	110.3	31.5	9.4	234.9	53.7	0.0	13.4	20.1	20.9	60.1	29.3	155.2	738.8	701.5
1966	83.1	100.8	97.6	347.7	359.0	238.3	11.5	39.3	32.3	58.3	0.0	144.2	1482.3	1552.4
1967	1.3	32.5	50.8	389.1	372.7	137.1	102.9	30.0	126.0	117.6	82.4	94.0	1536.4	1474.2
1968	0.0	101.6	374.4	205.0	165.1	53.3	0.0	0.0	38.1	68.8	(40.0)	132.8	(1179.1)	1182.7
1969	94.2	127.0	271.7	218.4	139.7	50.8	15.0	5.5	55.9	8.9	118.4	38.3	1143.8	1159.9
1970	96.3	228.5	43.2	193.5	74.1	6.2	11.7	3.5	77.2	20.0	0.0	148.0	902.2	910.9
1971	79.6	10.6	69.5	194.8	159.7	36.5	18.3	3.6	4.5	11.0	2.6	136.0	726.7	736.1
1972	139.5	1.6	148.1	279.2	433.9	0.0	44.4	24.1	45.3	63.4	81.1	62.8	1323.4	1318.1
1973	133.3	85.5	131.0	168.2	102.6	34.9	18.0	15.1	7.0	1.9	29.0	154.9	881.4	841.4

Monthly Rainfall (mm) for Station: BAGAMOYO AGRICULTURAL OFFICE

Registration Number: 96.3800 (continued)

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1974	11.2	14.6	100.8	214.0	183.7	13.8	109.6	9.0	4.1	30.1	17.8	23.2	831.9	974.8
1975	23.9	9.7	168.9	318.1	30.4	46.7	77.0	0.0	59.1	3.3	10.3	112.3	859.7	778.1
1976	66.5	53.9	77.8	160.6	121.6	89.5	30.9	0.0	27.0	37.9	5.7	87.9	759.3	788.3
1977	16.2	2.2	78.3	207.9	104.9	0.0	51.0	42.6	115.4	71.9	121.9	115.8	928.1	784.0
1978	75.7	39.1	233.3	*	95.9	42.9	9.7	11.2	*	88.3	145.3	231.5	*	*
n(1953-77)	25	25	25	25	25	25	25	25	25	25	25	25	25	25
m	76.2	75.4	107.1	229.9	165.8	46.5	35.6	25.4	31.0	55.0	65.5	108.4	1021.9	1021.4
s	53.1	72.4	90.2	81.8	124.0	53.3	33.1	25.3	33.6	64.3	77.2	80.1	298.0	246.1
C_v	0.70	0.96	0.84	0.36	0.75	1.15	0.93	1.00	1.08	1.17	1.18	0.74	0.29	0.24
C_s													1.68	0.72

Monthly Rainfall (mm) for Station: NGERENGERE SISAL ESTATE

Registration Number: 96.3801

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1950	174.8	134.9	264.9	366.0	87.1	0.0	20.1	71.9	32.5	10.9	23.6	52.8	1239.5	*
1951	109.7	190.5	183.1	206.2	113.8	15.2	18.5	0.0	0.0	47.2	194.3	129.0	1207.8	960.9
1952	0.0	41.9	145.0	204.7	96.5	0.0	0.0	5.1	53.3	55.9	90.2	24.1	716.8	925.8
1953	72.1	5.8	191.3	121.4	168.9	19.8	2.5	19.6	15.8	46.0	26.7	69.9	759.7	777.4
1954	49.5	126.2	38.9	144.8	137.2	17.8	2.5	11.2	0.0	222.3	41.9	0.0	792.3	847.0
1955	41.9	265.4	25.4	125.7	171.2	23.6	20.3	0.0	0.0	0.0	49.0	59.9	782.4	715.4
1956	127.5	64.8	46.7	138.7	13.5	0.0	5.1	0.0	2.5	3.8	44.2	16.0	462.8	511.5
1957	111.8	53.3	94.5	194.8	86.1	1.5	43.7	0.0	8.9	31.0	155.7	43.9	825.3	685.8
1958	5.1	164.1	266.7	53.1	26.2	23.6	0.0	6.4	26.4	3.8	22.6	114.3	712.2	775.0
1959	116.8	209.3	111.3	119.4	65.0	7.6	9.9	39.1	0.0	54.6	21.6	34.5	789.1	869.9
1960	115.1	11.4	141.2	151.9	59.4	37.6	0.5	0.0	11.4	37.9	0.0	1.3	567.7	622.4
1961	43.9	244.9	21.1	141.0	70.6	29.0	41.9	1.8	65.3	181.4	190.8	236.5	1268.0	842.2
1962	147.1	82.6	82.8	78.0	2.3	0.0	7.6	56.1	43.4	20.3	60.5	(180.0)	760.7	947.5
1963	62.7	53.0	125.0	267.0	10.7	20.4	12.4	1.0	19.2	5.6	310.7	208.9	1096.6	817.5
1964	82.8	109.9	241.5	238.4	16.9	0.0	13.7	20.6	4.3	81.5	17.3	53.3	880.2	1392.2
1965	120.4	65.4	93.0	197.4	95.3	0.0	4.6	51.6	72.6	112.2	117.4	153.9	1083.8	883.1
1966	28.3	63.7	216.0	174.2	102.1	24.9	0.0	0.0	48.2	88.4	63.5	110.4	919.7	1017.1
1967	0.0	67.4	74.1	293.3	190.1	41.2	35.6	33.2	120.7	40.6	*	*	*	1070.1
1968	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1969	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1970	*	*	*	*	*	*	*	*	*	*	38.5	157.0	*	*
1971	144.0	81.0	109.0	163.0	73.0	0.0	6.1	0.0	10.2	24.2	6.0	45.9	662.4	806.0
1972	67.5	86.5	182.6	163.1	205.3	0.0	6.0	2.0	51.3	110.2	89.2	188.0	1151.7	926.4
1973	202.7	108.0	92.3	244.6	129.3	6.0	0.0	15.0	0.0	8.0	99.7	70.5	976.1	1083.1
1974	98.8	60.0	99.9	221.7	53.3	3.0	12.0	15.0	0.0	60.5	0.0	22.0	646.2	794.4
1975	66.2	0.0	185.0	235.3	111.7	10.8	0.0	5.0	18.1	5.0	30.7	176.2	844.0	659.1
1976	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1977	30.0	8.8	194.0	100.0	32.0	0.0	15.0	14.5	92.5	106.0	126.0	121.0	839.8	*
1978														
n(1950-66, 1971-77)	23	23	23	23	23	23	23	23	23	23	23	23	23	22
m	87.8	97.0	137.0	176.1	83.8	10.5	10.5	14.6	25.0	57.3	77.5	91.8	868.9	860.5
s	52.9	74.9	73.4	69.0	55.0	11.8	12.2	20.6	27.3	58.4	76.9	70.8	218.0	185.4
C_v	0.60	0.77	0.54	0.39	0.66	1.12	1.16	1.41	1.09	1.02	0.99	0.77	0.25	0.22

Monthly Rainfall (mm) for Station: **MANDERA MISSION**

Registration Number: 96.3804

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1950	57.9	152.7	180.3	377.7	126.5	36.3	18.0	75.4	69.3	61.2	15.2	77.2	1247.9	*
1951	86.6	103.4	79.0	145.5	218.2	55.4	39.9	2.5	12.4	116.6	208.8	95.3	1163.6	951.9
1952	71.6	28.7	165.6	76.5	53.1	20.6	0.0	14.0	28.4	29.5	152.2	21.1	651.3	792.1
1953	65.0	32.5	108.5	112.5	294.9	0.5	16.0	49.5	48.0	112.3	87.9	55.6	983.2	1003.2
1954	45.0	158.8	43.2	168.1	136.1	1.8	10.9	49.0	6.1	128.0	50.8	30.5	828.3	890.5
1955	69.1	206.0	36.1	142.0	154.4	28.2	35.6	1.0	0.0	19.1	91.7	124.7	907.8	772.8
1956	184.7	39.4	84.3	230.6	91.7	18.0	4.1	9.4	2.5	0.0	69.6	58.9	793.2	881.1
1957	330.7	102.6	111.8	217.4	260.9	5.1	8.6	6.4	55.9	143.0	295.9	(70.0)	(1608.3)	1371.2
1958	2.0	77.2	269.7	87.6	71.6	27.2	0.0	28.4	5.6	0.0	39.1	35.1	643.6	(935.3)
1959	11.9	167.1	192.0	337.3	169.4	0.0	94.0	81.8	0.0	55.4	15.7	63.2	1188.0	1183.1
1960	379.7	72.6	192.3	234.7	94.2	89.4	8.1	17.0	0.0	37.8	70.1	6.6	1202.7	1204.7
1961	13.2	227.1	57.2	167.4	173.2	26.7	104.9	8.1	80.0	453.1	566.4	222.0	2099.3	1387.6
1962	270.5	282.7	66.0	372.4	36.2	0.0	23.1	91.2	34.5	45.2	80.8	125.5	1428.0	2010.1
1963	46.3	74.9	291.1	351.1	27.7	30.0	14.4	0.0	0.0	91.4	310.7	179.0	1416.6	1133.2
1964	80.6	317.1	338.6	351.9	50.8	10.2	5.3	0.0	8.7	118.4	9.3	175.7	1466.6	1771.3
1965	77.5	72.7	150.8	370.6	114.8	3.2	17.0	18.6	30.6	89.5	113.6	173.0	1231.9	1130.3
1966	62.4	109.8	154.0	191.5	157.7	72.7	39.0	11.0	20.5	99.5	50.8	69.0	1037.9	1204.7
1967	7.5	39.0	80.9	258.8	231.2	71.6	77.5	60.1	236.3	195.9	118.3	78.6	1455.7	1378.6
1968	19.5	37.8	198.0	173.3	157.6	83.4	10.3	3.4	23.5	33.8	253.7	149.2	1143.7	1167.9
1969	36.9	186.8	116.0	181.3	122.0	26.0	10.1	20.9	13.1	23.9	66.4	0.0	803.4	1139.9
1970	170.4	59.4	91.3	100.2	45.9	0.0	6.4	17.7	113.2	23.3	18.0	144.8	790.6	694.2
1971	50.5	37.7	71.4	247.1	88.2	50.5	4.3	23.7	5.8	26.7	24.7	155.0	775.6	768.7
1972	45.4	73.8	211.8	109.0	343.2	0.0	54.0	6.8	44.4	178.0	105.0	133.4	1284.8	1236.1
1973	78.5	70.5	50.5	247.0	78.1	13.6	7.4	12.6	26.2	17.0	76.0	78.3	755.6	819.7
1974	94.8	12.7	121.8	263.8	78.4	55.6	43.6	2.8	2.0	31.5	103.0	1.3	811.3	861.3
1975	159.6	44.0	98.9	276.1	114.4	32.5	5.7	3.7	57.7	21.9	24.3	35.6	874.4	918.8
1976	59.2	101.5	154.5	195.6	60.6	36.4	22.0	9.5	51.6	37.6	15.8	13.1	757.7	788.4
1977	96.2	74.5	88.9	205.2	124.2	7.6	36.2	61.6	120.6	74.5	247.6	121.4	1258.5	918.4
1978	47.7	26.2	258.6	170.2	98.5	8.9	9.8	12.3	22.7	36.7	186.7	228.1	1106.4	1023.9
n(1953-77)	25	25	25	25	25	25	25	25	25	25	25	25	25	25
m	98.3	107.1	135.2	223.7	131.1	27.6	26.3	23.8	39.5	82.3	115.8	91.2	1101.7	1102.8
s	99.6	81.4	80.2	85.4	80.8	28.0	28.8	26.3	53.3	94.5	128.3	63.4	348.1	314.5
C_v	1.01	0.76	0.59	0.38	0.62	1.02	1.09	1.10	1.35	1.15	1.11	0.70	0.32	0.29

Monthly Rainfall (mm) for Station: LUGOBA MISSION

Registration Number: 96.3805

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1950	35.8	159.0	325.1	276.4	186.4	17.4	52.6	45.5	93.0	38.6	28.2	64.0	1326.9	*
1951	166.6	98.8	82.8	195.8	203.5	24.4	20.3	22.9	14.5	74.7	337.6	195.8	1437.7	996.5
1952	11.4	85.6	208.0	139.2	52.8	7.6	0.0	3.6	49.0	12.2	147.8	30.5	747.8	1102.8
1953	162.8	4.8	86.4	238.5	357.9	10.2	32.8	25.4	22.1	133.4	151.6	184.4	1410.2	1252.6
1954	136.7	194.8	85.9	157.5	193.0	0.0	4.3	39.6	26.7	274.1	59.2	61.7	1233.4	1448.6
1955	45.7	189.0	98.6	157.5	300.5	35.8	25.4	14.5	19.1	33.0	148.6	136.9	1204.5	1040.0
1956	97.5	83.6	87.4	293.9	70.6	15.7	2.5	(10.0)	12.2	2.0	91.2	115.1	(881.7)	(960.9)
1957	216.2	74.9	111.8	432.3	225.3	0.0	15.7	5.6	7.6	124.0	260.4	71.1	1544.8	1419.7
1958	0.0	92.7	362.0	122.7	19.1	44.5	0.0	20.3	12.7	0.0	54.6	162.6	891.0	1005.5
1959	113.5	194.8	48.3	109.3	160.0	0.0	0.0	24.1	3.8	45.0	22.4	59.4	931.4	1016.0
1960	165.4	29.7	174.8	175.8	45.7	37.1	21.3	0.0	8.9	77.5	7.4	0.0	743.5	818.0
1961	30.7	207.3	18.8	116.8	87.4	6.1	80.0	14.7	93.2	337.1	274.6	165.4	1431.0	998.5
1962	236.5	67.6	172.0	105.2	7.9	0.0	5.8	82.0	20.6	13.7	83.8	88.7	883.7	1151.3
1963	118.2	60.0	142.2	240.0	46.0	15.2	17.2	0.0	6.3	14.3	274.8	132.7	1066.4	831.9
1964	85.6	67.9	126.1	103.3	16.8	45.6	5.8	0.0	11.9	109.5	1.0	87.4	660.9	980.0
1965	153.7	71.1	33.5	229.0	73.2	1.5	7.9	46.8	50.0	111.2	112.8	177.2	1067.9	866.3
1966	43.7	166.5	161.2	290.3	114.3	14.7	8.6	16.0	13.5	81.8	66.6	0.0	977.2	1200.6
1967	5.1	26.8	27.9	298.4	122.4	59.5	43.0	22.1	167.1	109.3	135.1	78.0	1094.7	948.2
1968	9.6	52.0	462.7	247.9	96.2	132.0	12.7	0.0	83.6	6.4	294.9	118.0	1516.0	1316.2
1969	42.2	180.7	132.2	128.4	45.6	15.8	11.4	34.3	10.9	10.3	102.7	1.8	716.3	1024.7
1970	145.0	110.0	160.1	77.5	16.5	0.0	0.2	4.5	78.1	25.0	5.0	88.5	710.6	721.4
1971	116.5	61.7	84.0	157.7	57.8	10.8	10.8	3.7	52.7	14.2	11.0	100.5	681.4	663.4
1972	47.0	2.2	115.5	216.8	186.6	0.0	17.9	3.1	38.4	162.2	134.6	140.7	1065.0	901.2
1973	74.4	28.5	70.5	192.5	62.0	(20.0)	(5.0)	(14.0)	(0.0)	28.0	57.1	141.5	693.7	(770.2)
1974	67.7	55.9	49.6	255.4	88.9	31.2	36.5	0.0	6.9	47.0	17.7	20.9	677.7	837.7
1975	124.3	21.0	111.2	249.2	108.5	28.4	10.0	0.0	57.4	22.0	9.0	83.3	824.3	770.6
1976	33.7	96.3	96.4	223.8	74.5	19.6	0.0	19.0	40.0	25.8	6.8	61.9	697.8	721.4
1977	137.3	162.7	151.1	87.0	80.5	2.9	11.7	20.1	105.2	90.8	124.5	179.5	1152.7	918.0
1978														
n(1950-77)	28	28	28	28	28	28	28	28	28	28	28	28	28	27
m	93.7	94.5	135.2	197.0	110.7	21.3	16.4	17.6	39.5	72.3	107.9	98.1	1009.7	995.6
s	65.3	62.9	101.1	81.9	86.9	27.0	18.4	18.8	39.9	80.5	99.5	58.3	287.3	200.6
C_v	0.70	0.67	0.75	0.42	0.79	1.27	1.12	1.07	1.01	1.11	0.92	0.59	0.28	0.20

Monthly Rainfall (mm) for Station: ATHINA SISAL ESTATE

Registration Number: 96.3808

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1950	69.6	111.0	213.9	384.3	43.9	0.0	23.4	42.9	78.7	3.0	39.4	109.7	1119.8	*
1951	89.4	103.1	195.3	237.5	130.0	3.0	17.9	17.9	0.0	25.6	206.5	70.1	1096.3	968.8
1952	21.1	31.0	57.4	145.8	69.1	9.4	0.0	0.0	31.0	36.1	100.3	46.2	547.4	677.5
1953	117.6	10.2	146.1	162.6	143.5	15.2	0.0	156.2	30.0	51.8	27.2	52.3	912.6	979.7
1954	154.9	82.3	9.1	128.5	12.4	0.0	5.1	5.8	17.8	223.5	45.7	0.0	685.3	718.9
1955	86.4	228.6	63.5	142.2	218.4	*	*	*	*	*	*	*	*	*
1956	35.6	81.3	73.7	*	*	*	*	*	*	11.4	51.3	36.3	*	*
1957	151.1	17.8	66.3	165.1	118.6	43.2	14.2	1.8	*	*	*	155.2	*	*
1958	8.1	158.8	237.2	68.3	21.6	18.0	0.0	13.2	12.4	11.9	20.3	214.1	784.1	*
1959	113.0	114.6	151.9	164.1	96.3	11.4	7.9	53.3	3.0	64.5	44.5	42.9	867.4	1014.4
1960	199.1	29.2	151.9	194.3	64.0	51.1	0.8	0.0	17.5	39.4	0.0	2.3	749.6	834.7
1961	31.0	192.8	30.5	93.5	109.0	23.9	46.0	0.0	37.3	206.8	221.2	252.7	1244.6	773.1
1962	155.2	94.5	162.8	163.8	5.1	0.0	7.9	73.2	56.6	34.0	16.3	158.2	927.6	1227.0
1963	74.3	52.2	115.8	283.1	7.4	19.8	17.5	2.0	9.9	13.3	352.6	193.9	1141.8	769.8
1964	54.4	147.3	149.3	240.1	25.7	4.7	14.7	5.8	4.5	57.3	13.5	62.7	780.2	1197.2
1965	50.2	98.5	85.5	188.9	*	*	*	0.0	*	*	102.0	161.5	*	*
1966	13.3	60.6	182.0	134.5	113.0	34.0	0.0	0.0	31.2	77.5	108.5	123.0	777.6	909.6
1967	1.0	68.0	134.5	332.5	192.5	37.5	37.0	38.0	105.0	56.0	138.0	73.5	1213.5	1233.5
1968	37.0	39.5	385.0	333.0	68.5	51.5	0.0	4.0	15.0	9.0	214.5	51.0	1208.0	1154.0
1969	42.0	140.0	142.5	156.0	78.0	35.5	1.5	37.5	16.0	36.0	128.5	19.0	832.5	950.5
1970	151.0	113.5	174.5	69.5	29.0	1.0	0.0	2.0	106.5	6.5	66.0	108.0	827.5	801.0
1971	246.5	136.5	108.5	159.0	56.5	24.0	7.0	1.5	25.0	31.5	28.5	51.0	876.0	970.0
1972	109.0	48.0	179.0	226.5	149.0	0.0	10.0	0.0	78.5	117.0	75.5	138.5	1131.0	996.5
1973	226.5	31.0	86.5	225.8	66.6	1.0	3.5	18.0	0.0	16.0	126.0	80.0	880.9	888.9
1974	103.5	43.5	89.3	325.5	80.0	*	*	*	*	*	*	*	*	*
1975			(no data available)											
n(1950-54, 1958-73)	20	20	20	20	20	20	20	20	20	20	20	20	20	18
m	95.7	88.2	150.7	195.1	74.1	17.1	10.0	23.6	33.8	55.8	98.7	92.5	930.2	948.1
s	74.0	50.9	80.0	87.6	52.5	17.2	13.0	37.8	33.5	61.1	91.4	69.7	197.5	171.5
C_v	0.77	0.58	0.53	0.45	0.71	1.01	1.30	1.60	0.99	1.09	0.93	0.75	0.21	0.18

Monthly Rainfall (mm) for Station: FATEMI SISAL ESTATE

Registration Number: 96.3810

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1950	27.9	106.9	174.0	327.9	65.5	0.0	59.9	41.9	69.6	17.5	51.3	126.7	1069.6	-
1951	112.5	97.5	164.6	253.0	128.0	24.1	86.9	62.7	0.0	1.8	161.0	96.5	1188.7	1109.7
1952	0.0	43.2	91.2	221.2	107.2	10.9	0.0	22.1	50.3	61.0	110.0	38.1	755.1	864.5
1953	86.1	0.0	140.0	227.8	211.8	18.3	93.0	165.4	52.3	46.2	32.0	35.8	1108.7	1189.0
1954	101.4	92.5	51.1	209.6	132.8	0.0	0.0	30.7	22.9	248.7	41.2	0.0	930.7	957.3
1955	98.0	294.9	54.1	110.7	207.0	53.3	20.1	0.0	0.0	4.1	42.9	91.4	976.6	883.5
1956	266.9	69.6	74.4	245.9	23.1	2.5	5.1	0.0	5.3	0.0	69.6	53.6	815.9	827.0
1957	137.2	134.4	87.1	206.0	122.4	2.0	7.6	2.0	14.7	91.2	222.5	63.7	1090.9	927.9
1958	10.7	150.1	151.9	83.8	21.6	17.3	0.0	7.4	12.7	21.1	34.3	154.4	665.2	762.8
1959	85.6	82.0	212.1	186.2	96.8	6.4	12.5	56.1	7.1	57.2	41.7	45.5	889.0	990.5
1960	229.4	22.4	180.3	174.8	77.0	40.1	3.6	0.0	18.8	26.7	1.5	13.8	788.4	860.3
1961	39.1	197.6	34.8	93.7	106.9	19.6	49.8	0.0	51.8	220.7	216.4	214.4	1244.9	829.4
1962	162.6	122.4	161.5	153.9	6.1	0.0	5.3	71.6	69.3	54.6	22.1	160.8	990.4	1238.3
1963	82.1	49.3	164.2	238.9	8.0	12.0	10.7	0.0	12.3	2.8	377.5	147.8	1105.6	763.2
1964	54.0	142.6	167.9	273.4	24.2	1.5	13.6	6.8	3.8	56.1	19.7	48.5	812.1	1269.2
1965	37.6	97.7	69.1	191.2	112.4	0.0	0.0	70.0	64.5	79.5	100.8	186.5	1009.3	790.2
1966	17.5	57.0	224.0	125.5	91.9	44.0	0.0	0.0	26.0	76.5	120.5	98.5	881.4	949.7
1967	0.0	60.0	98.0	283.5	198.0	46.4	36.0	24.0	115.5	49.0	141.5	67.0	1118.9	1129.4
1968	69.0	13.0	335.5	287.5	94.0	49.5	0.0	3.0	19.0	10.0	184.0	49.5	1114.0	1089.0
1969	42.5	132.5	113.5	173.0	91.5	40.5	0.0	41.5	14.0	39.5	131.0	7.0	826.5	922.0
1970	128.0	123.0	116.5	75.0	22.5	1.5	0.0	2.0	100.5	3.5	67.0	113.0	752.5	710.5
1971	228.0	84.5	72.0	155.0	54.0	21.0	0.0	0.0	19.5	48.0	20.0	24.5	726.5	862.0
1972	90.5	34.5	190.0	265.5	189.5	0.0	9.5	0.0	61.5	118.0	55.0	125.0	1139.0	1003.5
1973	297.5	36.0	109.5	235.0	73.5	1.0	3.5	16.0	0.0	17.0	112.0	54.5	955.5	969.0
1974	90.0	44.0	126.5	332.9	78.0	*	*	*	*	*	*	*	*	*
1975	88.5	0.0	225.5	221.5	46.0	14.5	0.0	0.0	*	*	*	*	*	*
1976			(no data available)											
n(1950-73)	24	24	24	24	24	24	24	24	24	24	24	24	24	23
m	100.2	93.5	134.9	199.9	94.4	17.2	17.4	26.0	33.8	56.3	99.0	84.0	957.7	956.4
s	83.7	64.9	68.2	69.0	63.3	18.6	27.5	38.5	32.7	63.4	86.9	58.8	168.6	154.7
C_v	0.84	0.69	0.51	0.34	0.66	1.08	1.58	1.48	0.97	1.13	0.88	0.70	0.18	0.16

Monthly Rainfall (mm) for Station: **KWARUHOMBO**

Registration Number: 96.3812

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1950	85.3	153.4	244.1	272.3	117.9	9.4	45.7	31.2	79.0	33.3	25.9	31.2	1128.8	*
1951	0.0	48.3	72.1	105.7	185.7	21.1	32.0	3.0	2.3	83.8	239.3	112.8	906.0	611.1
1952	48.8	102.9	41.7	111.0	74.7	9.1	0.0	(0.0)	52.8	36.6	108.5	8.1	594.2	829.7
1953	79.0	22.9	71.1	98.3	191.8	3.8	22.1	24.6	32.3	39.4	61.7	0.0	646.9	701.9
1954	85.1	31.8	22.1	139.2	78.5	4.8	5.8	23.6	9.1	180.1	52.8	19.1	652.0	641.8
1955	25.9	67.1	52.1	87.6	114.3	21.6	8.9	4.1	8.9	8.9	13.2	30.7	443.2	471.3
1956	64.8	54.6	66.0	92.7	0.0	29.2	*	*	*	*	*	*	*	*
1957	*	104.9	91.4	202.7	168.4	4.6	*	*	*	140.0	135.4	122.9	*	*
1958	0.0	117.9	256.8	66.8	14.0	40.4	6.9	(0.0)	0.0	0.0	31.5	79.8	614.1	761.1
1959	6.6	114.3	259.8	207.0	134.4	3.6	0.0	57.2	2.5	4.6	27.2	97.8	914.9	901.3
1960	111.0	80.5	222.0	132.6	45.7	39.4	7.6	0.0	5.1	48.3	29.2	0.0	734.1	817.2
1961	15.7	152.4	118.1	113.3	102.6	22.4	72.9	7.6	56.6	314.2	466.1	169.7	1611.6	1005.0
1962	255.8	76.7	98.8	216.7	0.0	0.0	0.0	73.9	3.8	32.3	7.4	71.4	836.8	1393.8
1963	34.0	1.3	279.6	468.6	7.6	26.9	0.0	17.8	0.0	3.6	311.6	43.7	1194.7	918.2
1964	25.6	44.1	226.0	121.2	33.0	4.9	(0.0)	0.0	0.0	69.9	(5.0)	152.3	682.0	880.0
1965	67.5	25.5	5.6	*	73.9	0.0	0.5	0.0	*	*	*	*	*	*
1966	88.7	112.1	258.9	77.7	81.7	17.0	12.7	0.0	12.7	32.5	5.6	5.3	704.9	*
1967	10.2	55.9	120.7	148.5	145.5	27.7	74.2	(10.0)	141.2	171.9	219.4	127.5	1252.7	916.7
1968	*	56.3	*	287.6	282.8	*	*	*	*	*	*	332.7	*	*
1969	*	*	*	*	207.0	*	*	*	*	*	*	*	*	*
1970	(145.0)	5.0	68.6	89.2	(16.0)	(0.0)	5.3	26.5	172.9	0.0	4.0	130.2	662.7	*
1971	116.6	27.0	100.3	124.8	110.5	21.0	0.0	0.0	10.0	15.0	0.0	128.3	653.5	659.4
1972	76.4	84.9	124.2	178.4	231.6	0.0	22.4	4.3	44.3	208.6	186.1	143.0	1304.2	1103.4
1973	256.3	67.0	34.5	313.0	230.5	0.0	15.5	11.5	3.0	0.0	87.8	63.1	1082.2	1260.4
1974	82.5	21.0	51.8	358.6	142.1	120.2	52.5	5.5	3.0	61.0	5.5	0.0	903.7	1049.1
1975	97.8	76.0	187.0	279.4	450.6	23.1	35.5	0.0	66.1	7.7	18.4	53.2	1294.8	1228.7
1976	0.0	37.6	196.7	397.4	0.0	10.8	36.0	27.4	21.1	30.6	9.9	(60.0)	827.5	829.2
1977	219.6	123.3	171.7	209.3	44.0	0.0	20.6	92.2	100.2	119.4	224.1	(180.0)	1504.4	1170.2
1978														
n(1950-55, 1958-64, 1966, 67, 1970-78)	23	23	23	23	23	23	23	23	23	23	23	23	23	20
m	81.1	70.6	142.6	187.7	111.0	18.6	21.2	18.3	36.0	65.3	93.1	74.2	919.6	907.5
s	77.2	44.4	85.8	111.4	102.5	25.4	23.5	25.1	48.0	81.4	123.5	58.9	318.2	240.2
C_v	0.95	0.63	0.60	0.59	0.92	1.37	1.11	1.37	1.33	1.25	1.33	0.79	0.35	0.26

Monthly Rainfall (mm) for Station: MGUDENI SISAL ESTATE

Registration Number: 96.3813

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1950	149.9	149.9	406.4	273.1	33.0	0.0	11.2	55.9	53.3	4.3	29.7	56.6	1223.3	-
1951	109.0	195.8	218.4	219.7	104.6	0.0	0.0	6.4	0.0	34.3	168.9	69.9	1127.0	974.5
1952	0.0	49.5	83.8	168.9	78.2	0.0	0.0	2.5	47.8	20.3	83.8	30.5	565.3	689.8
1953	130.8	6.9	166.4	146.1	192.0	8.9	0.0	35.6	20.3	40.6	36.6	75.7	859.9	861.9
1954	58.4	144.8	25.1	189.0	130.3	19.6	1.3	15.5	4.1	231.6	45.5	4.6	869.8	932.0
1955	35.3	287.3	75.9	171.5	244.9	46.5	18.0	1.3	0.0	0.0	*	*	*	930.8
1956	149.1	54.6	99.1	218.9	19.6	0.0	0.8	0.0	2.8	17.0	40.6	22.9	625.4	*
1957	133.9	54.6	113.3	160.0	128.0	0.0	9.1	0.0	5.1	*	*	*	*	*
1958	0.0	190.5	188.5	53.1	26.2	23.6	*	*	*	*	*	128.0	*	*
1959	101.6	155.2	180.3	133.4	117.6	5.3	6.4	41.4	3.0	67.1	17.8	20.8	849.9	*
1960	127.3	23.6	156.7	182.4	47.0	27.2	13.5	0.0	16.0	32.3	0.0	22.9	648.9	664.6
1961	23.6	248.4	39.1	154.7	102.1	25.9	49.8	0.0	56.6	209.0	200.7	177.0	1286.9	932.1
1962	153.2	130.3	216.7	116.6	2.8	0.0	7.6	39.4	41.4	27.4	28.5	166.9	930.7	1113.1
1963	127.0	79.0	149.2	268.1	10.4	20.3	5.6	0.0	15.8	6.6	273.9	209.4	1165.3	877.4
1964	49.0	98.9	182.9	223.7	23.8	0.0	8.4	11.9	2.5	66.0	7.6	53.1	727.8	1150.4
1965	93.5	55.7	78.7	126.9	79.2	0.0	0.0	48.7	58.7	90.7	100.8	139.7	872.6	692.8
1966	10.2	68.6	211.7	113.0	102.3	26.2	0.0	0.0	35.0	61.2	46.7	106.7	781.6	868.7
1967	0.0	57.0	87.1	239.2	169.4	30.8	0.0	31.2	89.0	60.9	*	*	*	918.0
			(no data available)											
n(1950-54, 1959-66)	13	13	13	13	13	13	13	13	13	13	13	13	13	11
m	87.2	108.2	162.7	178.1	78.7	10.3	8.0	19.8	27.3	68.6	79.3	87.2	916.1	887.0
s	53.2	70.3	98.4	54.3	54.3	11.7	13.4	21.2	22.4	72.0	84.2	66.8	223.3	161.0
C_v	0.60	0.65	0.60	0.30	0.69	1.14	1.68	1.07	0.82	1.05	1.06	0.77	0.24	0.18

Monthly Rainfall (mm) for Station: KIWEGE SISAL ESTATE

Registration Number: 96.3817

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1950	147.3	110.5	270.3	330.7	102.1	*	*	*	*	*	*	*	*	*
1951	90.2	154.2	197.6	155.7	123.2	10.2	9.1	7.9	0.0	47.0	172.0	126.5	1093.5	*
1952	7.9	38.9	139.7	134.9	37.1	0.0	0.0	0.0	50.3	37.1	73.2	35.8	552.5	744.4
1953	89.9	14.5	282.2	194.6	163.3	0.0	17.5	41.4	30.0	78.0	37.1	58.2	1006.6	1020.4
1954	88.9	117.1	81.3	200.9	91.7	22.1	5.1	9.1	0.0	223.8	57.2	2.0	899.2	935.3
1955	55.9	301.0	36.1	199.4	189.5	22.1	30.0	0.0	0.0	2.0	51.6	78.7	966.2	895.2
1956	179.1	97.8	95.3	170.2	12.7	20.3	1.3	1.3	6.4	3.8	41.9	20.3	650.2	718.5
1957	165.1	85.1	(150.0)	208.0	137.9	1.5	22.6	5.6	16.3	85.6	165.1	49.3	1092.1	939.9
1958	0.0	158.0	163.6	99.3	16.0	56.1	0.0	11.4	34.3	15.2	52.8	140.2	747.0	768.3
1959	90.2	141.2	81.3	223.0	101.1	2.5	29.2	76.2	0.0	66.0	30.7	97.5	939.0	1003.7
1960	164.8	37.6	215.9	257.8	82.6	59.4	0.0	0.0	11.2	65.5	0.0	0.0	894.8	1023.0
1961	47.8	189.0	25.4	156.7	51.8	58.4	56.9	2.3	52.3	225.8	198.9	368.3	1433.6	866.4
1962	196.1	96.0	176.5	191.3	21.8	0.0	1.3	71.4	64.8	36.8	60.2	164.1	1080.3	1423.2
1963	72.4	39.4	161.4	212.1	17.8	22.7	0.0	0.0	0.0	3.8	338.3	148.5	1016.4	753.9
1964	104.1	66.0	160.2	213.1	26.7	3.8	15.2	30.5	15.2	67.8	15.2	27.9	745.7	1189.4
1965	167.7	66.2	73.7	195.3	90.2	0.0	17.8	29.6	72.3	85.7	98.1	223.0	1119.6	841.6
1966	29.9	72.4	203.1	186.0	106.6	32.3	0.0	0.0	33.0	62.9	96.4	99.6	922.2	1049.3
1967	0.0	25.7	77.6	278.1	187.1	35.0	0.0	25.7	97.9	48.3	*	*	*	971.4
			(no data available)											
n(1950-66)	16	16	16	16	16	16	16	16	16	16	16	16	16	15
m	96.9	104.7	140.2	187.4	79.4	19.5	12.9	17.9	24.1	69.2	93.0	102.5	947.4	944.8
s	62.0	72.2	69.9	37.5	55.9	21.8	16.0	25.3	24.8	67.2	86.9	95.2	210.6	187.7
C_v	0.64	0.69	0.50	0.20	0.70	1.12	1.24	1.41	1.03	0.97	0.93	0.93	0.22	0.20

Monthly Rainfall (mm) for Station: KINONKO SISAL ESTATE

Registration Number: 96.3819

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1950	188.7	84.3	162.8	234.2	67.9	5.1	1.8	3.3	4.8	39.4	*	82.8	*	*
1951	82.0	105.2	81.5	102.1	90.7	20.3	0.0	0.0	0.0	48.3	140.2	250.2	902.2	*
1952	22.1	66.8	144.0	153.2	34.8	5.1	0.0	2.3	72.9	39.9	47.2	8.1	596.4	931.5
1953	112.0	0.0	202.4	151.6	179.3	*	*	*	*	*	*	*	*	*
1954	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1955	54.4	233.7	58.2	144.8	283.0	29.0	0.0	0.0	0.3	0.0	40.4	46.0	889.5	*
1956	197.1	*	*	*	*	*	*	*	*	*	*	*	*	*
			(no data available)											
1961	0.0	332.7	25.9	243.1	61.7	42.7	57.2	42.7	27.9	226.1	274.3	320.3	1654.6	*
1962	311.4	41.9	131.8	0.0	0.0	0.0	6.6	59.2	0.0	0.0	73.7	*	*	1145.5
1963	27.8	77.5	236.6	244.5	6.9	0.0	0.0	0.0	3.3	273.6	179.7	234.0	1283.7	*
1964	24.9	122.4	139.8	253.7	36.9	16.9	5.1	0.0	15.8	139.1	6.6	131.6	992.8	1268.3
1965	41.9	64.8	5.6	152.4	93.2	0.0	0.0	0.0	0.0	132.6	80.7	146.8	718.0	628.7

Monthly Rainfall (mm) for Station: KIKONDENI SISAL ESTATE

Registration Number: 96.3822

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1951	*	*	*	*	*	*	*	*	0.0	61.0	144.8	128.3	*	*
1952	27.9	38.1	88.9	179.1	29.2	0.0	0.0	3.8	33.0	43.2	68.6	35.6	547.4	716.3
1953	72.4	0.0	132.1	111.8	169.9	0.0	0.0	0.0	48.3	40.6	0.0	142.2	716.3	678.3
1954	83.8	142.2	12.7	201.9	125.7	0.0	0.0	5.1	0.0	149.9	0.0	15.2	736.6	863.5
1955	63.4	290.8	95.3	184.2	299.7	72.6	0.0	11.4	0.0	2.8	34.3	50.8	1105.4	1035.5
1956	191.8	170.2	134.6	195.6	*	*	*	*	*	*	*	*	*	*
			(no data available)											
1960	186.2	88.4	196.1	406.4	45.7	35.6	0.0	0.0	8.9	34.3	0.0	48.3	1049.8	*
1961	30.5	174.5	40.6	129.5	106.7	19.1	69.9	8.9	113.0	176.5	270.5	199.4	1339.1	958.1
1962	176.5	78.7	102.9	156.2	19.1	24.1	33.0	78.7	67.3	35.6	78.7	156.2	1007.1	1242.0
1963	105.4	88.9	227.0	350.4	14.0	26.7	19.1	10.1	16.5	26.7	373.3	237.6	1495.7	1119.7
1964	114.3	130.7	287.3	232.4	57.2	36.7	29.3	40.6	27.9	83.8	28.0	69.9	1138.1	1651.1
1965	87.7	39.2	81.4	275.6	64.9	21.6	28.0	35.7	23.0	161.3	132.4	(180.0)	1130.8	916.3
1966	124.7	125.6	174.1	207.1	138.6	38.1	0.0	10.2	45.9	48.2	64.8	99.1	1076.4	1224.9
1967	0.0	83.8	16.5	276.4	208.6	37.3	57.2	38.3	128.9	64.7	112.2	157.7	1181.6	1075.6
1968	48.8	15.5	328.2	315.2	99.0	33.5	0.0	0.0	0.0	17.0	301.1	63.9	1222.2	1127.1
1969	58.3	69.9	279.6	157.7	135.6	29.2	3.6	16.4	19.9	23.4	175.1	14.7	982.5	1157.7
1970	190.2	135.4	212.7	136.9	41.3	1.8	1.3	1.3	103.9	15.2	10.8	142.0	992.8	1029.8
1971	224.7	97.0	209.7	244.1	48.0	19.8	15.6	2.0	14.8	51.1	3.4	95.8	1026.0	1085.6
1972	122.4	50.9	216.8	218.3	290.3	0.0	10.6	12.9	28.3	189.2	90.8	125.0	1355.5	1238.9
1973	235.7	114.7	70.0	298.3	91.4	0.0	1.7	20.2	3.1	11.6	89.9	82.1	1018.7	1062.5
1974	116.1	25.0	198.9	335.5	28.5	26.5	34.6	5.9	0.0	58.4	0.1	21.4	850.9	991.4
1975	150.0	0.0	176.7	288.2	96.8	17.0	9.3	0.0	62.2	13.4	12.9	136.3	962.8	836.0
1976	51.1	63.1	128.9	152.2	51.1	49.8	14.5	0.0	26.7	4.1	31.4	26.0	598.9	690.7
1977	106.6	105.7	136.7	104.8	19.3	0.0	3.7	4.7	92.9	96.5	145.7	104.7	921.3	728.3
1978														
n(1952-55, 1960-77)	22	22	22	22	22	22	22	22	22	22	22	22	22	22
m	108.0	89.0	155.1	225.6	99.1	22.3	15.1	13.9	39.3	61.3	92.0	100.2	1020.7	1020.4
s	64.5	65.5	87.3	83.8	82.1	19.3	19.7	19.1	39.4	57.7	105.4	63.7	235.3	230.6
C_v	0.60	0.74	0.56	0.37	0.83	0.87	1.30	1.37	1.00	0.94	1.15	0.64	0.23	0.23

Monthly Rainfall (mm) for Station: UBENA PRISON CAMP

Registration Number: 96.3828

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1966	56.8	323.6	419.2	152.5	133.1	22.2	5.6	9.6	6.9	39.8	25.7	45.4	1240.4	*
1967	0.0	37.4	47.5	310.9	141.6	41.7	49.6	46.5	97.0	43.3	124.1	74.8	1014.4	886.6
1968	33.7	26.0	271.7	271.3	66.9	49.5	0.0	1.0	13.4	43.7	184.0	73.4	1034.6	976.1
1969	38.2	88.4	117.9	98.9	101.2	13.6	0.0	1.3	20.8	10.2	92.4	2.5	585.4	674.9
1970	76.4	116.2	83.5	84.0	25.1	7.1	0.0	3.7	135.5	10.1	1.4	129.4	672.4	636.5
1971	313.8	77.3	94.7	179.7	51.3	14.3	8.2	1.1	9.7	51.0	10.0	166.0	977.1	931.9
1972	200.0	34.5	33.2	195.8	261.2	6.2	15.0	0.0	*	*	*	*	*	*
1973	121.2	70.7	80.3	269.2	160.2	0.0	0.0	*	*	*	*	*	*	*
1974	9.8	98.5	278.0	412.5	106.2	1.4	47.0	64.0	0.0	0.0	6.8	4.4	1028.6	*
1975	76.3	122.2	190.5	285.4	91.3	14.9	23.0	1.8	105.5	80.4	17.9	156.1	1165.3	1002.5
1976	32.9	112.9	104.3	126.2	18.7	36.8	11.3	0.0	8.1	17.4	39.3	60.8	568.7	642.6
1977	191.0	145.6	191.7	92.6	62.6	4.0	25.2	22.7	95.3	234.7	132.9	132.4	1330.7	1165.5
1978	142.2	26.4	183.9	222.6	95.6	39.5	5.9	2.7	4.4	17.7	167.0	192.0	1099.9	1006.2
n(1966-71, 1974-77)	10	10	10	10	10	10	10	10	10	10	10	10	10	9
m	83.2	114.8	179.9	201.4	79.8	20.6	17.0	15.2	49.2	53.1	63.5	84.5	961.8	880.3
s	97.1	82.2	115.1	112.1	42.1	16.6	18.8	22.6	52.3	68.2	64.9	59.2	268.3	187.8
C_v	1.17	0.72	0.64	0.56	0.53	0.81	1.11	1.49	1.06	0.28	1.02	0.70	0.28	0.21

Monthly Rainfall (mm) for Station: KATE SISAL ESTATE

Registration Number: 96.3831

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1966	30.2	44.5	114.3	178.3	15.2	3.8	19.6	19.3	63.3	80.8	86.3	73.5	729.1	796.8
1967	1.8	54.8	36.9	206.2	47.0	52.3	52.0	*	*	*	*	*	*	*
1968	23.9	85.1	276.4	97.9	69.6	5.3	*	*	*	*	*	*	*	*
1969	151.2	108.2	113.7	61.7	59.2	10.2	14.2	22.1	40.9	163.9	44.1	*	*	*
1970	130.5	112.0	154.7	30.6	0.0	5.1	0.0	113.3	0.0	20.8	222.1	*	*	*
1971	211.0	37.8	92.2	168.7	68.1	15.2	0.0	0.0	45.5	25.2	20.6	150.4	834.7	*
1972	166.6	127.5	245.5	241.6	249.9	0.0	12.2	6.1	45.5	77.0	149.0	106.4	1421.3	1342.9
1973	155.7	62.0	2.9	238.1	53.4	4.8	12.2	11.4	0.0	0.0	123.4	62.9	726.8	795.9
1974			(no data available)											

Monthly Rainfall (mm) for Station: UBENA ZOMOZI

Registration Number: 96.3833

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1966	21.3	69.3	166.4	103.9	110.2	13.2	0.0	16.0	32.3	52.3	95.8	90.4	771.1	*
1967	0.0	33.8	28.3	157.3	166.5	39.7	44.2	41.9	131.6	92.5	109.8	54.1	899.7	922.0
1968	34.3	47.5	314.5	189.3	93.5	48.1	3.6	1.5	34.5	41.4	222.3	81.0	1111.3	971.9
1969	97.1	118.3	80.7	154.9	87.9	27.2	0.0	0.0	15.2	20.3	153.3	0.0	754.9	904.9
1970	150.8	120.1	139.9	62.8	31.5	0.0	0.0	5.2	98.9	0.0	0.0	140.6	749.8	762.5
1971	185.8	17.5	108.5	131.1	48.2	21.8	17.1	3.1	19.6	20.5	24.9	170.6	768.7	713.8
1972	92.9	81.2	183.5	256.7	240.3	0.0	0.0	12.3	22.0	156.7	190.0	180.2	1415.8	1241.1
1973	77.0	50.8	48.9	196.8	93.3	20.4	5.0	13.8	0.0	0.0	133.3	60.0	699.3	876.2
1974	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1975	170.3	12.0	181.0	254.7	75.9	0.0	0.0	0.0	58.5	0.0	34.0	88.0	874.8	*
1976	34.0	42.2	103.0	99.0	74.5	65.0	3.5	8.5	10.8	30.0	42.2	22.1	534.8	592.5
1977	141.0	115.0	130.2	120.5	69.5	0.0	16.1	14.4	115.0	16.3	209.9	173.0	1121.4	802.3
1978														
n(1966-73, 1975-78)	11	11	11	11	11	11	11	11	11	11	11	11	11	9
m	91.3	64.3	135.0	157.0	99.2	21.4	8.1	10.6	49.0	39.1	110.5	96.4	882.0	865.2
s	64.2	39.7	78.2	62.6	58.3	22.1	13.5	12.0	45.7	47.7	78.3	62.2	246.6	183.5
C_v	0.70	0.62	0.58	0.40	0.59	1.03	1.67	1.13	0.93	1.22	0.71	0.65	0.28	0.21

Monthly Rainfall (mm) for Station: CHALINZE CATHOLIC MISSION

Registration Number: 96.3834

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1967	*	*	*	*	*	*	*	*	52.3	76.0	204.5	26.3	*	*
1968	17.8	62.1	464.6	228.4	55.4	58.2	0.0	0.0	83.6	31.5	343.0	84.0	1428.6	1232.4
1969	144.0	136.7	180.8	159.7	65.1	17.6	15.0	29.4	12.5	87.0	82.9	19.0	949.7	1293.6
1970	242.3	149.0	178.5	74.8	27.2	0.0	0.0	0.0	131.0	16.7	6.2	107.7	933.5	919.4
1971	166.8	54.0	151.4	218.9	70.7	30.6	5.8	2.2	45.9	64.5	6.2	101.8	918.8	924.7
1972	96.5	51.9	179.0	236.1	236.8	0.0	22.0	5.0	37.7	150.5	125.1	157.7	1298.3	1123.5
1973	86.3	38.8	98.5	210.0	79.2	1.0	0.0	20.3	40.0	18.0	64.0	117.9	774.0	874.9
1974	91.1	3.0	79.6	134.5	*	*	*	*	*	*	*	*	*	*
1975	60.7	17.8	124.3	294.4	143.2	39.9	4.9	1.0	30.4	8.4	14.0	150.3	889.3	*
1976	14.4	100.0	63.8	130.1	67.0	16.5	7.4	9.7	19.1	19.8	18.8	30.9	497.5	612.1
1977	106.3	44.8	56.5	49.4	61.3	3.7	8.0	16.0	(100.0)	55.8	146.9	106.5	755.2	521.5
1978														
n(1966-77)	9	9	9	9	9	9	9	9	9	9	9	9	9	8
m	103.9	72.8	166.4	178.0	89.5	18.6	7.0	9.3	55.6	50.2	89.7	97.3	938.3	937.8
s	72.8	41.4	121.8	80.6	63.2	20.6	7.4	10.5	40.2	45.9	108.5	47.2	280.1	275.6
C_v	0.70	0.57	0.73	0.45	0.71	1.11	1.06	1.13	0.72	0.91	1.21	0.49	0.30	0.29

Monthly Rainfall (mm) for Station: SANJE ESTATE

Registration Number: 97.3604

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1950	291.3	173.0	522.0	446.0	223.0	3.6	38.1	66.0	67.6	35.6	98.6	91.7	2056.5	*
1951	80.0	317.0	149.9	436.1	252.5	24.9	71.6	28.7	1.5	61.5	290.3	159.8	1873.8	1614.0
1952	49.0	288.0	408.2	508.5	175.8	45.2	25.2	73.4	80.5	25.9	154.4	31.2	1866.4	2129.8
1953	235.7	77.7	259.6	327.7	162.8	3.3	2.8	17.8	42.2	0.0	10.0	269.5	1410.0	1315.2
1954	253.5	281.2	355.3	288.6	147.6	0.0	0.0	3.0	11.4	39.4	8.6	10.4	1339.1	1599.5
1955	198.6	271.3	228.1	457.5	331.7	118.6	43.9	0.0	1.8	34.0	115.8	87.6	1889.0	1704.5
1956	434.8	434.1	553.2	504.7	269.0	53.3	0.0	24.1	26.4	6.6	26.4	334.0	2666.7	2509.6
1957	188.2	112.0	359.7	617.2	246.6	22.1	34.5	27.7	117.6	107.7	90.9	(150.0)	2074.2	2193.7
1958	50.3	181.9	669.5	324.9	53.1	22.9	1.8	10.9	3.3	0.0	32.3	169.7	1520.4	1386.6
1959	320.8	248.4	510.5	264.2	50.5	7.1	*	*	*	*	*	*	*	*
1960	133.6	166.9	495.0	426.2	47.8	45.7	10.2	0.0	14.7	39.1	0.0	37.8	1417.1	*
1961	249.2	205.7	142.5	470.4	119.1	64.8	118.1	10.7	33.3	236.5	287.3	284.7	2222.3	4606.3
1962	124.7	292.4	289.1	423.9	47.0	0.0	89.9	0.0	4.6	28.2	10.9	192.5	1503.2	1871.8
1963	230.8	384.7	574.1	451.0	110.3	111.9	12.5	4.3	3.8	24.4	542.9	217.8	2668.5	2111.2
1964	244.1	207.1	492.9	587.4	51.9	9.9	*	*	*	*	*	*	*	*
1965			(no data available)											
n(1950-58, 1960-63)	13	13	13	13	13	13	13	13	13	13	13	13	13	11
m	197.3	245.1	385.1	432.5	168.2	39.7	34.5	20.5	31.4	49.2	128.3	156.7	1885.2	2094.8
s	110.7	103.7	168.7	96.6	92.1	39.7	37.8	24.2	36.5	62.9	159.4	102.5	449.6	909.9
C_v	0.56	0.42	0.44	0.22	0.55	1.00	1.10	1.18	1.16	1.28	1.24	0.65	0.24	0.43

Monthly Rainfall (mm) for Station: **MAZOBWE (IRINGA DISTRICT)**

Registration Number: 97.3605

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1958	*	59.7	140.7	40.9	*	*	*	*	*	*	*	*	*	*
1959	46.7	95.3	147.6	17.3	*	*	*	*	*	*	*	*	*	*
1960	140.7	93.5	133.9	135.1	3.8	0.0	2.3	0.0	0.0	0.0	0.0	*	*	*
1961	69.6	182.6	54.1	33.5	18.8	0.0	0.0	0.0	0.0	7.4	74.2	408.4	848.6	*
1962	280.9	119.9	382.8	41.4	35.6	*	*	*	*	*	*	*	*	*
1963	376.1	110.9	185.4	55.9	0.0	0.0	0.0	0.0	0.0	40.9	87.5	*	*	*
1964	186.2	312.3	212.5	34.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	67.6	813.1	*
1965	111.5	195.1	93.0	63.6	8.9	0.0	0.0	0.0	0.0	0.0	*	122.8	*	472.1
1966	73.9	58.1	119.2	62.0	5.1	*	*	*	*	*	*	*	*	*
1967	5.3	55.7	11.4	*	*	*	*	*	*	*	*	*	*	*
1968	25.2	15.4	28.0	25.8	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	*	*
1969	28.4	*	29.8	1.6	*	*	18.0	*	*	*	*	*	*	*
1970	81.4	21.0	46.0	77.3	*	*	*	*	*	*	*	*	*	*
			(no data available)											
1974	*	17.1	20.9	32.1	0.1	0.0	0.0	0.0	0.7	29,0	10.0	109.7	*	*

Monthly Rainfall (mm) for Station: MALOLO (MOROGORO DISTRICT)

Registration Number: 97.3606

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1960	*	*	*	*	*	*	0.0	0.0	0.0	*	*	0.0	*	*
1961	29.7	118.9	10.2	71.6	11.7	5.6	0.0	0.0	0.0	36.3	31.2	220.5	535.7	*
1962	137.9	74.4	50.8	58.7	8.4	0.0	0.0	16.0	0.0	0.0	37.6	113.5	471.9	597.9
1963	85.2	129.6	107.7	30.3	2.3	0.0	2.5	0.0	0.0	7.6	73.7	51.4	490.3	516.3
1964	70.4	95.7	124.0	102.3	2.3	0.3	0.0	0.0	0.0	2.0	0.0	41.4	438.4	522.1
1965	81.1	67.9	94.7	130.2	24.2	0.0	0.0	0.0	0.0	0.0	(50.0)	111.6	559.7	439.5
1966	29.4	27.4	55.1	58.4	12.0	0.0	0.0	0.0	0.0	4.6	2.8	52.3	242.0	348.5
1967	44.5	77.8	47.4	85.1	71.0	2.3	2.8	0.0	19.1	2.5	40.5	216.1	609.1	407.6
1968	205.2	52.8	128.0	250.3	5.4	12.7	0.0	0.0	0.0	0.0	37.1	0.0	689.5	909.0
1969	222.3	95.5	99.7	44.9	14.5	0.0	0.0	0.0	0.0	0.0	39.7	0.0	516.6	514.0
1970	302.6	67.3	73.8	28.6	45.9	0.0	*	0.0	0.0	*	*	*	*	*
1971	*	*	27.6	48.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	*	*	*
1972	*	*	73.2	104.1	14.6	*	*	*	*	*	*	*	*	*
1973	56.0	295.0	*	*	*	*	*	*	*	*	*	*	*	*
1974	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1975	*	1.5	57.0	67.0	21.0	6.0	0.0	0.0	0.0	0.0	1.0	36.0	*	*
1976	0.0	*	10.0	94.0	10.0	9.0	0.0	*	*	*	*	*	*	*
1977	47.9	96.6	17.9	57.2	8.5	0.0	7.2	0.0	0.0	0.0	120.0	68.6	423.9	*
1978														
n(1961-69)	9	9	9	9	9	9	9	9	9	9	9	9	9	8
m	100.6	82.2	79.5	92.4	16.9	2.3	0.6	1.8	2.1	5.9	34.7	89.6	505.9	531.9
s	72.4	31.8	40.0	66.5	21.4	4.3	1.2	5.3	6.4	11.7	22.5	83.2	124.4	171.1
C_v	0.72	0.39	0.50	0.72	1.27	1.87	2.00	2.9	3.05	1.98	0.65	0.93	0.25	0.32

Monthly Rainfall (mm) for Station: ULAYA

Registration Number: 97.3607

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1960	*	*	277.1	110.7	17.8	0.0	0.8	0.0	0.8	33.8	0.8	1.8	*	*
1961	42.4	261.4	56.4	173.2	46.5	8.1	31.5	(10.0)	2.5	255.0	(100.0)	285.8	1272.8	889.6
1962	133.3	67.3	116.6	130.1	17.0	0.0	28.9	216.7	0.0	38.6	37.3	230.6	1016.4	1134.3
1963	253.2	181.0	351.7	212.3	36.1	13.5	1.0	5.6	4.6	9.9	261.5	96.8	1427.2	1336.8
1964	155.3	160.3	266.1	102.9	48.4	4.8	3.8	22.6	4.6	51.4	3.0	48.3	871.5	1178.5
1965	169.6	57.4	332.8	147.0	21.8	0.0	4.1	1.3	21.2	10.2	164.6	248.4	1178.4	816.7
1966	181.0	87.7	188.1	130.9	33.8	19.5	0.0	0.0	0.0	50.5	196.9	77.2	965.6	1104.5
1967	63.7	135.9	275.1	380.0	49.2	32.8	28.1	9.7	50.8	49.8	344.8	325.6	1745.5	1299.4
1968	98.0	61.0	234.2	270.0	174.6	44.2	3.8	0.0	0.0	9.1	93.1	106.6	1094.6	1565.3
1969	125.0	17.7	121.3	186.3	0.0	15.5	0.0	7.9	0.0	8.9	74.7	40.7	598.0	682.3
1970	116.1	132.4	184.3	89.5	10.2	0.0	1.5	2.5	59.0	9.7	0.0	266.3	871.5	720.6
1971	74.4	150.1	76.2	194.3	95.0	12.7	12.7	20.8	24.7	44.9	67.8	332.6	1106.2	972.1
1972	10.7	15.3	56.7	145.1	*	*	*	*	*	*	*	*	*	*
1973	240.0	117.0	162.0	115.0	50.0	6.0	0.3	24.0	4.6	2.7	75.0	111.0	907.6	*
1974	233.0	58.0	213.0	415.1	55.0	20.0	24.3	101.0	12.0	21.0	0.0	24.5	1176.9	1338.4
1975	84.5	90.2	240.7	140.7	145.1	8.8	0.0	0.0	0.9	0.0	0.0	150.0	860.9	635.4
1976			(no data available)											
n(1961-75)	14	14	14	14	14	14	14	14	14	14	14	14	14	13
m	140.7	112.7	201.3	192.0	55.9	13.3	10.0	30.2	13.2	40.1	101.3	167.5	1078.1	1051.8
s	67.7	63.4	89.7	99.5	50.1	12.8	12.5	59.7	19.4	64.8	105.7	110.1	282.1	291.8
C_v	0.48	0.56	0.45	0.52	0.90	0.96	1.25	1.98	1.47	1.62	1.04	0.66	0.26	0.28

Monthly Rainfall (mm) for Station: KISANGA MSOLWA

Registration Number: 97.3608

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1955	*	*	176.8	260.6	203.2	36.3	29.2	8.9	12.7	10.2	88.9	134.4	*	*
1956	453.4	285.0	144.8	315.0	87.6	40.6	0.0	5.1	0.0	0.0	66.0	25.4	1422.9	1554.8
1957	246.1	90.2	96.0	146.1	88.9	0.0	6.4	0.0	29.2	24.1	47.0	123.2	897.1	818.4
1958	22.9	252.7	408.9	248.9	87.6	14.0	0.0	0.0	0.0	0.0	55.9	74.9	1165.9	1205.2
1959	68.6	127.0	196.9	31.8	25.4	0.0	0.0	0.0	12.7	0.0	25.4	330.2	817.9	593.2
1960	269.2	61.0	198.1	242.6	20.3	119.4	0.0	0.0	0.0	33.0	0.0	12.7	956.3	1299.2
1961	205.7	213.4	221.0	377.2	82.6	29.2	90.2	0.0	8.9	214.6	195.6	288.3	1926.7	1455.5
1962	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1963	186.4	154.8	283.2	137.2	17.8	0.0	0.0	0.0	0.0	22.9	449.6	274.3	1526.2	*
1964	205.8	238.5	282.0	207.1	24.1	15.2	0.0	12.8	0.0	20.3	0.0	63.6	1069.4	1729.7
1965	45.7	172.7	250.1	326.4	33.0	0.0	0.0	12.7	0.0	35.5	71.0	220.9	1168.0	939.7
1966	121.9	124.5	209.9	213.6	84.0	16.5	5.1	0.0	6.4	35.6	95.2	69.9	982.6	1109.4
1967	29.2	*	*	137.1	152.4	33.1	40.6	6.4	64.9	119.4	231.2	*	*	*
1968	152.5	114.4	249.0	430.6	187.9	47.0	12.7	0.0	0.0	5.1	226.0	99.1	1524.3	*
1969	10.2	134.5	188.1	204.6	101.5	13.9	2.5	7.5	7.6	5.1	34.3	36.7	746.5	1000.6
1970	333.8	141.0	153.7	91.4	48.3	6.3	10.1	0.0	25.4	0.0	16.5	167.7	994.2	881.0
1971	83.8	125.8	147.3	186.4	59.8	5.1	19.0	0.0	1.3	8.9	45.8	242.6	925.8	821.6
1972	215.8	242.5	289.4	189.0	111.6	0.0	16.5	0.0	74.9	35.6	135.9	72.4	1383.6	1463.7
1973	318.9	71.1	73.6	314.9	10.2	50.8	0.0	0.0	0.0	0.0	12.7	(50.0)	902.2	1047.8
1974	86.4	64.9	73.6	336.6	91.3	17.8	20.2	0.0	0.0	46.9	0.0	25.4	763.1	800.4
1975	98.2	97.6	337.7	206.6	*	*	*	*	*	*	*	*	*	*
1976			(no data available)											
n(1956-61, 1963-66, 1968-74)	17	17	17	17	17	17	17	17	17	17	17	17	17	15
m	178.1	153.8	203.8	235.3	68.3	22.1	10.8	2.2	9.8	28.7	86.9	128.1	1127.8	1114.7
s	122.2	69.7	87.1	104.9	45.5	30.1	21.7	4.5	19.1	50.5	114.4	104.4	326.0	327.3
C_v	0.69	0.46	0.43	0.45	0.67	1.36	2.01	2.05	1.95	1.76	1.32	0.81	0.29	0.29

Monthly Rainfall (mm) for Station: SONJO (ULANGA DISTRICT)

Registration Number: 97.3609

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1964	272.9	222.0	467.7	342.2	57.8	8.9	9.4	28.2	1.3	14.1	12.7	129.1	1566.3	*
1965	89.7	241.5	459.8	565.3	82.7	0.0	0.0	5.3	67.3	48.6	86.9	198.2	1845.3	1702.0
1966	131.4	124.7	101.6	*	55.9	10.2	0.0	0.0	12.2	94.0	106.9	115.5	*	*
1967	119.1	214.9	309.1	562.4	435.6	182.1	60.2	36.8	118.9	34.5	540.6	574.2	3188.4	2296.0
1968	92.3	333.1	462.5	968.4	275.3	70.1	4.6	35.5	0.0	0.0	324.2	191.3	2757.3	3356.6
1969	92.3	189.2	593.1	614.9	141.4	61.0	31.8	22.2	0.0	0.0	227.4	70.1	2043.4	2261.4
1970	608.0	357.2	484.9	330.3	9.7	0.0	9.0	0.0	0.0	0.0	0.0	194.3	1993.4	2096.6
1971	153.6	103.5	376.1	555.3										
			(no data available)											

Monthly Rainfall (mm) for Station: ICHONDE (ULANGA DISTRICT)

Registration Number: 97.3610

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1963	*	*	*	*	*	40.4	21.5	*	*	39.4	369.2	123.2	*	*
1964	195.6	172.3	508.4	395.2	63.5	0.0	0.5	25.9	0.0	20.3	2.3	137.9	1520.9	*
1965	112.9	253.4	445.3	454.9	124.2	*	0.0	36.1	45.8	229.8	88.4	230.4	*	*
1966	202.2	57.6	317.5	357.6	88.1	7.3	3.8	0.0	7.1	*	*	*	*	*
1967	119.1	214.8	309.1	550.5	336.1	107.1	*	*	*	*	*	*	*	*

(station closed 20/8/1970)

Monthly Rainfall (mm) for Station: MIKUMI

Registration Number: 97.3611

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1971	88.6	71.5	87.2	59.6	4.0	9.0	10.2	0.0	2.0	5.6	25.6	104.0	467.3	*
1972	149.2	183.3	195.0	175.2	111.3	1.5	7.0	1.5	59.7	16.0	35.0	57.0	991.7	1029.3
1973	304.0	116.0	40.6	206.6	45.2	22.3	0.0	21.5	0.0	3.0	25.0	47.0	831.2	851.2
1974	200.0	67.0	44.5	352.0	101.0	*	36.5	0.0	0.0	*	38.0	71.0	*	*
1975			(no data available)											

Monthly Rainfall (mm) for Station: DUTHUMI ESTATE (MOROGORO DISTRICT)

Registration Number: 97.3700

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1950	71.9	135.1	264.4	304.3	119.6	0.8	2.0	11.2	46.0	13.5	32.0	26.7	1027.4	*
1951	141.5	199.4	136.1	329.7	128.8	16.0	11.9	0.0	3.8	69.9	160.8	83.3	1281.2	1095.8
1952	7.6	206.2	249.9	199.4	125.2	8.4	0.0	0.0	42.2	16.8	104.1	0.0	959.9	1099.8
1953	0.0	0.0	144.3	124.2	166.1	0.0	3.3	9.4	16.3	38.4	11.9	90.7	604.3	606.1
1954	21.8	86.6	164.6	135.6	216.4	0.0	0.0	0.0	0.0	11.4	0.0	24.1	660.7	739.0
1955	17.0	242.8	30.7	299.2	231.4	53.1	9.9	0.0	0.0	0.0	70.6	136.9	1191.6	908.2
1956	142.2	107.4	122.9	321.6	33.3	43.9	0.0	0.0	0.0	18.5	0.0	46.2	836.2	997.3
1957	297.2	30.2	106.2	355.9	176.5	11.2	15.2	12.2	56.1	82.3	111.8	52.8	1307.6	1189.2
1958	0.0	144.3	506.5	212.3	32.0	116.1	0.0	0.0	19.1	0.0	21.6	134.9	1186.7	1194.9
1959	185.7	130.6	90.9	136.9	60.5	6.6	6.9	25.4	5.1	36.8	12.7	10.2	708.2	841.9
1960	165.9	45.2	188.5	256.8	37.1	68.1	0.0	5.3	0.0	30.0	0.0	0.0	796.9	819.8
1961	22.9	290.3	133.1	251.7	93.2	36.1	62.0	7.4	73.7	172.0	190.0	187.7	1520.1	1142.4
1962	182.4	162.3	285.2	291.6	51.1	0.0	20.8	84.8	13.5	45.5	150.4	73.7	1361.3	1514.9
1963	304.3	137.1	407.2	229.2	6.8	35.0	0.0	0.0	0.0	56.7	487.8	158.1	1822.2	1400.4
1964	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1965	133.2	51.1	124.0	402.2	100.6	0.0	4.6	38.4	7.4	26.6	111.5	(150.0)	1149.6	*
1966	241.2	115.7	241.4	208.3	87.2	80.5	3.8	3.8	0.0	10.1	64.3	24.0	1080.3	1253.5
1967	18.3	81.4	78.3	192.7	361.2	46.3	67.6	42.5	63.4	53.9	187.5	329.5	1522.6	1093.9
1968	158.9	75.5	294.3	350.4	93.2	78.0	0.0	6.1	4.6	17.8	138.6	162.1	1379.5	1595.8
1969	104.7	121.9	254.8	367.8	75.9	28.3	6.3	7.4	3.3	9.9	42.4	3.1	1025.5	1281.0
1970	264.9	111.0	232.4	102.8	12.8	0.0	0.0	1.8	120.4	9.4	0.0	177.2	1033.2	901.0
1971	142.2	85.5	143.6	275.7	48.8	49.7	18.2	0.0	4.4	23.6	12.9	102.8	907.4	968.9
1972	116.4	172.0	239.9	319.2	219.2	0.0	28.3	11.8	58.9	86.9	179.6	70.9	1503.1	1368.3
1973	170.7	105.1	104.8	332.6	48.8	2.8	2.3	11.7	12.8	19.5	176.6	61.0	1048.8	1061.6
1974	179.6	52.5	70.4	357.5	123.8	47.5	61.3	1.7	8.8	65.1	26.8	28.4	1023.4	1205.8
1975	215.8	5.2	260.5	270.5	137.2	88.9	7.4	2.3	30.3	5.2	17.3	150.2	1190.8	1078.5
1976	93.4	133.1	156.3	196.2	111.4	29.4	5.6	0.0	2.5	0.0	11.7	131.4	871.0	895.4
1977	*	142.9	162.8	*	63.2	7.6	*	10.1	*	*	*	*	*	*
1978														
n(1950-63, 1965-76)	26	26	26	26	26	26	26	26	26	26	26	26	26	24
m	130.8	116.4	193.5	262.5	111.5	32.6	13.0	10.9	22.8	35.4	89.3	92.9	1115.4	1093.9
s	92.0	69.3	107.6	83.2	80.8	33.1	20.1	18.8	30.4	37.8	106.3	77.2	294.6	240.7
C_v	0.70	0.60	0.56	0.32	0.72	1.02	1.55	1.72	1.33	1.07	1.19	0.83	0.26	0.22

Monthly Rainfall (mm) for Station: SINGIZA MISSION (MOROGORO DISTRICT)

Registration Number: 97.3705

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1950	145.3	159.3	589.3	504.7	167.4	3.6	32.5	3.3	14.5	22.4	207.8	52.8	1743.6	*
1951	517.1	744.2	368.3	970.3	480.1	71.1	0.0	0.0	0.0	10.9	462.0	109.2	3733.3	3422.6
1952	0.0	357.1	145.8	786.6	146.3	0.0	0.0	0.0	43.9	(45.0)	(25.0)	90.2	(1639.9)	(2095.9)
1953	51.6	0.0	323.9	922.8	162.6	0.0	0.0	22.9	5.6	59.4	16.8	113.0	1678.6	(1664.0)
1954	130.6	126.2	268.7	308.9	170.4	0.5	0.0	0.0	(0.0)	0.0	224.0	122.9	(1352.2)	(1135.1)
1955	331.0	257.6	160.3	345.9	468.6	84.6	22.4	0.0	0.0	21.1	71.4	98.6	1861.5	2038.4
1956	290.1	161.8	564.6	362.2	52.3	52.3	3.3	0.0	7.6	21.1	45.0	96.5	1656.8	1685.3
1957	146.3	69.6	212.6	678.7	338.1	4.8	0.0	0.0	100.6	34.3	97.0	150.6	1832.6	1726.5
1958	7.6	180.8	404.1	476.3	83.8	78.5	0.0	0.0	7.1	12.7	22.1	158.8	1431.8	1495.5
1959	47.0	90.2	502.7	225.3	68.8	33.0	11.2	79.0	0.0	30.5	270.8	18.3	1376.8	1268.6
1960	275.6	121.4	275.8	500.4	65.5	104.4	0.0	8.4	7.6	11.4	0.0	0.0	1370.5	1659.6
1961	106.9	351.5	105.7	400.1	105.4	51.3	91.2	11.2	40.1	235.0	270.8	275.6	2044.8	1498.4
1962	204.2	179.1	224.0	471.9	63.5	0.0	0.0	73.2	4.3	24.1	99.8	133.6	1477.8	1790.7
1963	172.2	136.5	378.2	343.4	61.6	61.9	0.0	0.0	0.0	38.6	417.0	84.9	1694.3	1425.8
1964	115.0	0.0	362.5	236.0	43.2	0.0	0.0	0.0	0.0	29.2	0.0	64.5	850.4	1287.8
1965	88.7	82.2	141.4	317.7	152.0	0.0	0.0	0.0	35.4	36.8	167.0	160.0	1181.2	918.7
1966	35.1	71.7	176.3	371.0	96.1	45.0	31.2	13.5	0.0	21.6	28.0	12.5	902.0	1188.5
1967	53.3	66.8	195.2	290.9	366.8	33.8	80.2	74.5	60.9	0.0	153.5	260.5	1636.4	1262.9
1968	123.6	104.6	350.8	396.4	123.5	48.3	0.0	2.0	4.3	8.3	142.7	243.0	1547.4	1575.7
1969	62.7	117.1	300.5	432.5	92.6	22.9	3.1	10.9	15.0	17.6	55.4	10.4	1140.7	1460.6
1970	251.8	275.9	307.8	185.2	33.6	0.0	8.4	6.3	64.0	6.9	19.1	158.3	1317.3	1207.7
1971	129.5	95.8	191.1	440.7	106.6	89.4	28.6	0.7	4.9	32.1	19.8	130.3	1269.5	1296.8
1972	122.6	119.1	170.3	466.9	400.1	0.0	0.0	38.0	47.0	123.7	186.0	160.6	1834.3	1637.8
1973	172.0	151.8	161.1	582.9	77.2	9.4	45.0	10.4	9.9	8.0	82.4	33.6	1343.7	1574.3
1974	128,6	65.2	91.5	485.9	251.3	79.6	46.4	0.0	88.0	19.2	3.8	33.2	1292.7	1371.7
1975	98.1	14.7	321.8	482.7	208.8	107.5	9.7	0.0	36.6	8.3	37.9	103.0	1429.1	1325.2
1976	199.6	131.1	356.0	297.4	134.5	36.2	37.5	4.0	106.0	0.0	15.2	29.0	1346.5	1443.2
1977	170.7	104.0	137.1	257.6	153.3	4.7	26.3	37.0	148.1	51.6	266.7	126.2	1483.3	1134.6
1978	222.2	70.5	227.8	*	82.6	*	4.2	15.0	50.0	*	397.1	344.1		
n(1953-77)	25	25	25	25	25	25	25	25	25	25	25	25	25	25
m	140.6	123.0	267.4	411.2	155.2	37.9	17.8	15.7	31.7	34.1	108.5	111.1	1454.1	1442.9
s	83.2	81.9	121.4	157.3	119.8	36.5	25.6	25.0	41.2	49.0	110.8	76.9	285.9	250.0
C_v	0.59	0.67	0.45	0.38	0.77	0.96	1.44	1.59	1.30	1.44	1.02	0.69	0.20	0.17
C_s													- 0.07	0.21

Monthly Rainfall (mm) for Station: MATOMBO MISSION (MOROGORO DISTRICT)

Registration Number: 97.3706

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1950	276.6	117.6	499.6	317.8	37.6	41.9	219.2	108.2	190.2	89.9	53.8	181.1	2133.6	*
1951	81.3	114.3	184.9	579.9	228.3	53.3	25.4	33.3	6.9	119.9	275.3	240.8	1943.6	1662.4
1952	91.7	362.5	216.4	231.9	75.9	64.3	8.1	41.7	32.0	151.1	90.7	31.0	1397.3	1791.7
1953	51.3	44.5	278.6	224.3	336.0	16.8	19.1	129.5	73.9	90.2	99.3	395.7	1759.2	1385.9
1954	108.2	153.2	212.1	281.9	229.1	11.9	0.0	38.4	44.2	36.1	(18.0)	10.4	(1133.1)	1610.1
1955	137.7	512.6	83.6	330.7	273.6	58.2	173.7	15.2	14.7	23.6	126.2	201.3	1951.0	(1628.4)
1956	342.6	193.0	239.8	371.3	183.1	98.0	22.4	16.8	16.8	47.2	55.6	118.1	1704.8	1858.5
1957	167.9	143.5	224.8	309.6	94.2	41.7	79.2	59.4	18.8	15.0	37.3	263.9	1455.4	1327.8
1958	21.1	484.6	455.9	375.2	124.0	108.7	14.2	181.4	30.5	28.7	207.8	295.1	2327.1	2125.5
1959	289.1	223.8	468.9	19.1	121.2	48.3	19.1	58.9	0.0	101.6	88.9	20.6	1459.2	1852.9
1960	236.5	137.2	612.9	445.3	80.8	103.6	71.1	83.3	93.7	221.5	60.7	26.4	2173.0	2195.4
1961	94.0	268.5	178.8	340.1	(129.0)	(81.0)	(193.0)	111.8	260.4	253.5	(276.0)	(300.0)	(2486.1)	(1997.2)
1962	235.7	363.5	272.0	(404.0)	(54.0)	(34.0)	144.8	356.1	24.1	139.4	57.2	235.0	(2319.8)	(2603.6)
1963	557.5	748.7	295.0	350.3	72.4	101.7	87.8	16.9	26.7	34.8	1068.7	403.1	3763.6	2584.0
1964	433.6	111.0	766.0	342.3	126.5	51.6	36.7	131.0	44.2	343.0	175.0	349.5	2910.4	3857.7
1965	502.5	425.2	410.7	463.4	261.1	0.0	210.2	3.3	178.6	218.4	628.2	743.8	4045.4	3197.9
1966	164.0	214.0	381.3	441.8	127.3	39.4	10.7	14.9	(77.0)	148.9	(171.0)	(141.0)	(1901.3)	(2961.3)
1967	53.1	246.9	119.5	414.8	297.8	61.7	87.2	96.8	164.3	68.9	403.9	607.4	2622.3	(1923.0)
1968	221.0	139.8	394.5	586.0	167.4	72.6	26.0	55.3	13.8	48.5	309.2	134.0	2168.1	2736.2
1969	64.4	87.4	265.8	322.2	55.8	56.4	24.3	54.9	35.1	162.3	235.4	76.9	1440.9	1571.8
1970	310.4	285.5	247.6	153.7	73.0	65.3	51.9	76.1	202.5	5.3	24.2	323.9	1819.4	1783.6
1971	161.4	64.3	184.7	283.1	130.8	68.5	148.7	7.6	19.6	28.2	40.2	201.7	1338.8	1445.0
1972	220.9	90.5	360.2	269.9	192.7	9.6	31.3	32.8	58.2	123.0	(18.0)	124.1	(1531.2)	1631.0
1973	561.0	251.1	170.8	391.7	195.6	54.9	99.0	87.6	29.9	29.9	151.8	184.2	2207.1	(2013.6)
1974	116.8	72.4	526.5	254.5	138.5	125.8	28.2	23.1	139.7	130.7	37.2	185.0	1778.4	1892.2
1975	253.6	43.0	185.1	544.5	244.5	76.4	57.6	32.8	93.3	65.4	35.0	94.4	1725.6	1818.4
1976	88.0	139.2	357.9	161.9	133.0	70.3	81.1	15.7	36.0	*	*	*	*	*
1977	238.0	176.0	225.4	179.0	130.0	32.8	36.7	87.4	157.5	209.4	*	*	*	*
1978														
n(1950-75)	26	26	26	26	26	26	26	26	26	26	26	26	26	25
m	221.3	226.9	316.8	348.1	155.8	59.5	72.7	71.8	72.7	104.8	182.5	226.5	2057.4	2058.2
s	154.8	170.4	162.8	125.4	82.3	31.7	67.7	73.4	71.9	84.0	230.2	174.5	692.2	614.8
C_v	0.70	0.75	0.50	0.36	0.53	0.53	0.93	1.02	0.99	0.80	1.26	0.77	0.34	0.30

Monthly Rainfall (mm) for Station: KISAKI (MOROGORO DISTRICT)

Registration Number: 97.3708

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1950	94.0	106.4	219.2	297.9	137.9	0.8	0.0	11.9	16.8	4.1	33.0	7.4	929.4	*
1951	81.0	138.7	170.9	281.4	156.5	14.0	0.0	0.0	2.5	34.5	114.6	107.2	1101.3	919.9
1952	3.3	122.9	188.2	261.6	141.0	11.9	0.0	0.0	7.6	17.8	60.5	2.5	817.4	976.1
1953	100.1	0.0	69.1	164.8	147.6	0.0	0.0	2.5	15.0	19.8	0.0	167.1	686.1	581.9
1954	103.1	67.6	51.1	182.1	178.1	3.0	0.0	7.1	0.0	17.8	0.0	0.0	609.9	609.9
1955	52.8	149.6	150.1	356.1	317.8	53.6	0.0	0.0	0.0	0.0	43.2	82.6	1205.7	1205.8
1956	0.0	50.8	20.3	322.8	53.3	14.2	0.0	5.0	0.0	0.0	0.0	70.9	*	*
1957	160.3	32.0	88.4	*	191.3	0.0	*	0.0	43.2	66.0	61.0	39.9	*	*
1958	0.0	179.3	355.3	367.5	53.8	31.8	0.0	0.0	0.0	*	*	124.5	*	*
1959	73.7	63.5	142.2	253.7	22.6	35.6	10.2	17.8	0.0	35.1	14.0	8.9	677.2	*
1960	190.2	36.6	292.4	233.7	92.2	98.6	5.1	0.0	*	5.3	0.0	0.0	*	*
1961	40.6	151.1	86.4	202.4	54.8	39.4	51.0	*	53.3	168.9	*	*	*	*
1962	159.5	24.6	112.3	186.4	109.7	1.3	11.4	*	*	*	*	*	*	*
1963	144.9	35.6	402.7	262.4	21.0	32.2	0.0	0.0	0.0	24.1	181.2	*	*	*
1964	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1965	83.8	59.6	133.3	275.7	114.2	0.0	0.0	6.3	16.6	39.4	102.9	167.2	999.0	*
1966	*	*	232.4	194.9	*	*	*	*	*	*	*	*	*	*
1967	*	*	*	*	*	*	*	*	*	51.9	66.6	95.0	*	*
1968	225.2	59.6	290.4	330.5	*	60.2	0.0	*	*	9.8	*	43.4	*	*
1969	47.0	103.9	139.1	350.3	130.0	21.6	0.0	25.0	9.5	27.5	24.8	16.2	894.9	*
1970	261.7	162.0	214.6	119.6	*	3.6	2.4	0.0	63.5	0.5	*	*	*	*
1971	110.8	46.4	227.0	312.4	42.8	24.3	14.0	0.0	5.2	12.8	3.4	69.8	868.9	*
1972	39.6	112.3	269.9	446.2	385.0	0.0	6.0	5.4	33.2	97.3	155.2	74.3	1624.4	1468.1
1973	229.7	33.5	102.4	314.0	194.5	0.0	10.1	0.0	0.0	0.0	52.5	30.9	967.6	1113.7
1974	204.0	0.0	95.6	491.7	520.5	14.2	45.9	0.0	0.0	112.1	0.0	0.0	1484.0	1567.4
1975	20.3	0.0	23.1	89.1	137.2	25.5	6.0	0.0	16.2	0.0	0.0	83.4	400.8	317.4
1976	74.2	113.4	185.5	103.3	102.0	33.5	19.2	0.0	0.0	0.0	0.0	0.0	631.1	714.5

(no data available)

Monthly Rainfall (mm) for Station: TUNUNGUO MISSION

Registration Number: 97.3709

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1950	23.6	43.2	483.1	573.3	124.0	7.1	84.8	87.1	72.9	8.4	19.1	238.8	1765.3	*
1951	153.2	254.8	212.9	599.4	228.3	*	0.0	*	*	*	*	*	*	*
1952	*	*	517.9	445.0	192.5	109.7	0.0	0.0	79.2	100.3	247.1	0.0	*	*
1953	132.1	14.7	343.4	404.6	424.4	9.9	0.0	124.5	83.8	1735.3	144.8	151.6	2009.1	1959.8
1954	335.5	230.1	160.3	497.3	392.9	31.0	0.0	23.9	0.0	192.5	49.0	245.9	2158.5	2159.9
1955	246.4	104.6	328.4	603.8	633.2	77.2	46.2	0.0	6.9	0.0	156.7	295.9	2931.2	2341.6
1956	648.0	330.5	420.4	1052.1	108.7	0.0	18.5	0.0	*	*	*	*	*	*
			(no data available)											
1960	*	*	*	*	36.6	9.4	*	*	11.2	57.7	15.2	0.5	*	*
1961	32.8	227.8	47.0	154.4	60.5	50.0	66.0	4.8	58.4	306.6	175.3	556.3	1739.9	1024.0
1962	220.0	106.7	120.7	137.4	16.8	5.8	17.5	98.3	25.9	16.0	37.3	137.2	939.5	1496.1
1963	240.5	78.7	206.3	240.5	28.8	28.8	17.4	7.7	3.4	37.8	394.6	270.6	1554.9	1064.4
1964	114.3	63.3	406.3	172.4	33.3	0.0	0.0	21.9	0.0	118.2	2.5	79.3	1011.5	1594.9
1965	118.6	63.2	125.2	220.2	159.2	0.0	10.1	6.4	100.4	21.6	179.4	283.4	1287.7	906.7
1966	49.5	90.2	351.5	182.7	142.2	40.6	0.0	27.9	0.0	28.0	134.6	71.1	1118.3	1375.4
1967	15.2	203.2	99.1	*	*	*	*	*	*	*	*	*	*	*
			(station closed 14/1/1970)											

Monthly Rainfall (mm) for Station: KIKEO MISSION

Registration Number: 97.3711

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1950	87.9	166.9	494.5	274.6	111.8	3.0	1.5	2.5	6.9	63.5	93.5	134.4	1434.6	*
1951	229.6	195.6	149.9	179.6	169.7	24.6	4.3	0.0	0.0	41.9	202.4	241.3	1438.9	1223.1
1952	110.7	197.9	124.0	342.1	122.2	1.5	0.0	0.0	11.4	49.3	50.3	43.7	1053.1	1402.8
1953	121.9	30.7	199.4	411.7	169.7	3.6	6.6	20.3	5.1	33.5	19.3	103.9	1125.7	1096.5
1954	162.8	156.5	125.5	212.9	170.2	1.0	7.9	0.5	0.0	21.1	21.6	93.0	972.8	981.6
1955	43.9	326.4	233.2	327.2	317.2	97.8	2.3	1.3	0.0	2.3	66.0	144.0	1561.6	1466.2
1956	385.1	166.6	287.8	460.5	18.0	11.9	2.0	0.0	2.5	12.4	34.5	140.2	1521.7	1556.8
1957	191.8	36.1	116.1	338.3	249.7	0.0	0.0	0.0	137.2	59.7	69.9	177.0	1357.7	1303.6
1958	27.2	144.3	388.6	278.1	34.3	23.6	0.0	0.0	0.0	0.0	15.2	147.8	1059.2	1143.0
1959	105.4	215.9	185.9	145.0	28.4	19.1	6.6	116.1	0.0	5.6	24.4	33.0	885.4	991.0
1960	104.4	169.4	287.0	310.9	63.5	64.0	0.0	3.6	2.5	0.0	0.0	13.7	1019.3	1063.0
1961	70.1	216.2	197.6	509.8	89.7	43.4	63.2	3.8	6.6	161.0	278.6	300.0	1940.1	1375.1
1962	198.4	208.8	222.8	356.6	63.0	0.0	30.2	39.9	0.0	25.7	51.1	132.3	1328.7	1724.0
1963	236.6	167.7	347.9	543.1	50.1	113.6	3.3	0.0	0.0	39.9	436.0	157.8	2096.0	1685.6
1964	145.1	130.9	320.9	185.0	20.2	0.0	2.8	3.3	0.0	26.7	26.1	162.8	1023.8	1428.7
1965	85.7	(125.0)	219.8	284.6	83.4	0.0	0.0	0.0	31.3	23.2	119.6	176.3	1148.9	1041.9
1966	61.7	74.2	328.4	234.8	108.2	52.8	0.0	4.2	1.4	11.4	89.9	71.8	1479.6	1173.0
1967	100.9	98.2	155.6	281.6	263.1	23.2	82.7	64.4	61.9	41.6	70.4	236.0	1444.1	1334.9
1968	205.4	150.5	422.5	395.9	51.9	58.8	24.5	0.0	0.0	0.0	75.8	58.8	1493.0	1615.9
1969	74.2	138.2	433.0	593.9	72.4	8.6	0.0	4.9	1.7	6.2	83.3	66.6	1133.7	1477.7
1970	174.7	366.7	225.3	117.2	44.1	0.0	0.0	0.0	29.0	0.0	16.2	161.5	1134.7	1106.9
1971	144.9	146.6	191.2	315.6	82.1	77.3	2.0	0.0	0.0	5.8	24.3	144.1	1149.9	1143.2
1972	96.1	71.7	254.2	343.7	227.0	3.7	2.4	1.8	6.0	129.5	147.9	234.7	1518.7	1304.5
1973	178.6	317.4	193.1	470.1	50.0	2.8	0.0	0.0	0.0	0.0	63.6	148.5	1424.1	1594.6
1974	205.4	49.6	81.8	603.0	210.0	44.9	30.5	0.0	0.0	0.0	85.5	68.2	1378.9	1437.3
1975	188.1	97.2	209.7	259.5	247.0	76.5	0.0	0.0	18.6	0.0	87.1	83.4	1267.1	1250.3
1976			(no data available)											
n(1950-75)	27	27	27	27	27	27	27	27	27	27	27	27	27	26
m	144.9	167.9	245.2	329.4	117.1	28.4	10.1	9.8	13.0	28.2	80.3	130.7	1308.3	1309.8
s	75.5	91.6	104.3	135.5	86.3	33.6	20.3	25.7	28.7	39.4	92.7	70.3	284.3	218.2
C_v	0.52	0.55	0.43	0.41	0.74	1.18	2.01	2.62	2.21	1.40	1.15	0.54	0.22	6.00

Monthly Rainfall (mm) for Station: KIENZEMA MISSION (MOROGORO)

Registration Number: 97.3713

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1950	240.5	147.3	348.0	317.0	96.0	11.9	24.1	5.6	10.7	65.0	116.8	131.3	1514.3	*
1951	147.6	188.5	130.6	246.9	103.6	61.2	2.5	8.4	0.3	67.8	213.4	159.5	1330.3	1105.5
1952	169.7	256.8	199.4	310.9	106.4	0.0	0.0	0.0	29.7	55.9	51.3	3.0	1183.1	1501.7
1953	173.2	44.7	219.7	319.8	162.1	0.0	13.5	13.5	18.5	60.2	32.0	200.9	1258.1	1079.5
1954	164.6	120.1	129.3	223.8	152.4	1.8	1.8	3.0	5.6	40.9	111.0	117.3	1071.6	1076.2
1955	98.6	320.5	150.4	284.5	213.6	82.8	8.6	2.8	0.8	17.3	75.4	156.5	1411.7	1408.2
1956	404.9	129.5	207.5	307.3	75.9	6.1	1.8	0.0	16.0	32.8	51.8	158.2	1391.9	1413.7
1957	183.6	74.4	252.0	400.3	211.3	78.7	10.7	2.3	107.4	38.1	82.6	197.1	1638.6	1568.8
1958	31.0	164.6	452.4	254.3	66.5	17.8	10.2	3.0	3.6	8.4	104.1	172.2	1288.0	1291.5
1959	105.4	105.7	124.0	170.4	26.4	0.0	32.8	64.8	7.1	23.6	86.1	103.9	850.1	936.5
1960	152.4	93.5	251.5	362.2	57.2	48.3	3.0	3.6	8.6	42.4	4.8	18.3	1045.7	1212.7
1961	85.3	358.4	190.2	251.2	99.6	51.6	110.5	0.0	33.8	257.6	246.4	278.9	1963.4	1461.3
1962	168.9	140.0	219.2	218.7	38.9	0.0	0.0	36.1	5.8	16.3	98.3	212.3	1154.4	1369.2
1963	333.0	203.8	198.8	400.8	32.2	86.3	0.0	0.0	0.0	8.9	359.8	215.2	1838.8	1574.4
1964	104.0	154.0	417.0	449.0	43.5	0.0	6.0	6.0	0.0	36.5	15.5	102.5	1334.0	1791.0
1965	149.0	207.5	159.0	391.0	98.0	0.0	8.0	3.0	23.0	53.0	126.0	238.5	1456.0	1209.5
1966	64.0	185.0	339.0	210.3	153.0	30.0	0.0	6.0	13.0	57.0	57.0	151.0	1265.3	1421.8
1967	82.0	169.0	151.0	280.0	220.0	38.0	130.0	38.0	102.0	46.0	170.0	153.0	1579.0	1464.0
1968	177.0	191.0	414.0	507.6	92.7	38.0	0.2	2.6	5.7	14.0	128.0	108.0	1678.8	1752.8
1969	126.0	67.0	302.0	196.0	155.0	12.0	5.5	0.8	28.0	18.9	95.9	80.2	1087.3	1147.2
1970	199.8	383.2	202.2	171.1	72.8	0.0	2.1	0.0	67.2	11.6	187.5	187.5	1485.9	1286.1
1971	233.6	152.0	91.9	256.3	126.9	46.6	19.3	0.0	17.3	14.4	20.8	145.2	1124.3	1333.3
1972	199.8	125.1	252.2	435.5	154.0	0.0	9.9	2.4	40.3	120.9	96.3	180.1	1616.5	1506.1
1973	450.4	274.7	104.2	440.7	36.1	17.8	6.6	0.0	7.0	8.3	83.6	87.3	1516.7	1622.2
1974	129.8	39.7	82.3	526.1	145.0	28.6	33.8	9.0	37.8	29.5	42.2	121.2	1225.0	1232.5
1975	206.4	77.5	195.6	304.1	243.1	27.2	2.5	0.0	44.2	4.3	83.7	154.1	1342.7	1268.3
1976	*141.7*	*120.8*	*211.2*	*209.9*	*96.0*	75.1	15.3	*0.0*	*21.0*	*14.0*	*28.0*	*28.0*	*961.0*	*1142.8*
1977	165.2	91.3	114.2	283.3	81.7	7.5	7.9	20.3	55.9	53.2	158.1	148.2	1186.8	936.5
1978	*	95.1	131.6	*	42.2	*	0.7	5.0	0.0	7.5	326.7	273.2	*	*
n(1953-77)	25	25	25	25	25	25	25	25	25	25	25	25	25	25
m	173.2	159.7	217.3	314.2	114.2	27.8	17.6	8.7	26.8	41.1	101.8	148.6	1350.9	1340.2
s	98.3	91.8	101.7	104.6	64.2	29.1	32.3	15.6	29.5	51.6	78.5	61.0	272.5	226.3
C_v	0.57	0.57	0.47	0.33	0.56	1.05	1.84	1.79	1.10	1.26	0.77	0.41	0.20	0.17
C_s													0.37	0.12

Monthly Rainfall (mm) for Station: MVUHA

Registration Number: 97.3714

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1950	*	99.6	200.9	265.2	153.2	5.1	14.5	26.9	94.0	75.2	0.0	71.6	*	*
1951	104.9	309.6	146.3	323.1	137.4	73.4	18.5	20.6	0.0	73.9	167.6	152.7	1528.0	1279.3
1952	78.0	263.1	208.3	242.1	52.8	14.5	9.4	14.5	70.1	77.2	99.1	9.7	1138.8	1350.3
1953	57.9	43.2	213.9	145.5	188.2	8.9	4.3	39.9	30.2	91.7	53.3	128.0	1005.0	833.4
1954	95.0	123.7	96.8	241.6	110.7	0.0	0.0	2.8	11.4	79.8	17.5	84.8	779.3	943.1
1955	85.6	271.8	161.5	372.4	195.6	54.9	7.6	13.0	77.2	127.0	23.1	64.5	1454.2	1468.9
1956	431.8	155.7	225.0	310.4	14.0	9.1	0.0	0.0	34.8	0.0	18.5	77.0	1276.3	1268.4
1957	*	87.1	223.0	94.5	*	20.6	6.6	2.5	11.7	101.9	85.6	62.7	*	(1008.8)
1958	51.3	190.0	268.2	212.1	62.2	37.1	5.1	19.1	31.8	6.4	80.0	199.4	1162.7	1031.6
1959	185.4	262.9	242.6	203.2	82.6	0.0	46.2	309.9	0.0	36.8	21.6	96.5	1487.7	1649.0
1960	236.2	72.4	104.1	294.6	27.9	50.3	2.0	7.6	8.9	10.2	0.0	0.0	814.2	932.3
1961	57.9	285.5	201.4	207.3	52.8	55.6	85.9	5.3	41.9	221.7	169.9	354.8	1740.0	1215.3
1962	133.6	133.6	214.4	233.2	31.0	11.2	17.3	85.1	46.2	0.0	50.8	108.5	1064.9	1430.3
1963	181.4	130.0	254.8	178.2	42.9	*	*	*	*	*	*	*	*	(1421.3)
1964	*	*	298.9	173.1	25.8	4.3	14.0	7.8	92.5	78.0	*	87.6	*	(1839.6)
1965	238.6	204.8	194.5	215.2	101.0	0.0	10.2	14.0	0.0	69.8	200.6	*	*	(1622.9)
1966	0.0	355.6	575.6	711.7	63.5	64.8	0.0	0.0	0.0	3.1	55.9	0.0	1830.2	(1545.2)
1967	69.3	94.0	68.1	251.1	162.1	40.6	34.3	28.0	85.1	85.1	246.4	524.4	1688.5	973.6
1968	92.7	30.5	316.4	259.9	100.4	60.4	0.0	1.3	0.0	36.3	(347.4)	44.5	1289.8	1668.7
1969	26.7	47.0	264.3	139.5	62.5	0.0	86.6	36.6	7.1	26.7	276.5	0.0	973.5	(1088.9)
1970	407.7	202.5	176.6	76.8	22.9	0.0	8.9	8.9	107.9	23.1	0.0	134.4	1169.7	1311.8
1971	159.1	65.1	180.4	169.3	112.1	60.2	49.0	0.0	25.1	14.1	2.2	11.9	848.5	968.8
1972	*	13.7	31.8	32.9	*	*	*	*	*	*	*	*	*	(1108.3)
1973	*	*	*	249.1	156.2	4.6	6.9	16.2	10.0	0.8	49.6	33.7	*	(1234.0)
1974	217.1	11.1	112.1	320.9	88.8	19.0	57.1	13.0	25.7	126.7	12.2	109.3	1113.0	1074.8
1975	128.8	24.5	167.1	202.6	174.5	0.0	0.0	0.0	110.0	18.3	58.0	193.3	1077.1	947.3
1976	90.0	103.5	309.0	123.1	62.5	44.0	23.0	0.0	21.2	28.9	0.0	2.5	807.7	1056.5
1977	59.0	109.0	196.3	145.1	150.0	(20.0)	(10.0)	28.0	0.0	47.0	225.5	240.5	1230.4	766.9
1978														
n(1951-56, 1958-62, 1966-71, 1974-78)	21	21	21	21	21	21	21	21	21	21	21	21	21	21
m	131.1	150.2	212.0	246.9	93.1	29.7	22.2	30.2	35.0	54.0	91.7	120.8	1213.3	1181.2
s	112.6	105.7	106.4	130.2	56.2	25.7	27.5	67.2	35.5	55.3	104.7	130.3	310.9	265.5
C_v	0.86	0.70	0.50	0.53	0.60	0.87	1.24	2.23	1.01	1.02	1.14	1.08	0.26	0.22

Monthly Rainfall (mm) for Station: BUNDUKI (MOROGORO)

Registration Number: 97.3715

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1951	*	*	*	*	205.2	0.0	0.0	14.5	8.9	225.3	373.6	224.3	*	*
1952	31.5	271.3	124.0	302.8	93.5	27.2	0.0	6.4	151.8	115.8	83.8	69.1	1327.4	1721.8
1953	143.5	54.1	291.6	372.1	260.4	0.0	45.2	87.1	81.3	141.5	211.1	273.6	1961.4	1629.7
1954	178.3	140.7	259.3	305.6	182.1	0.0	1.3	93.5	31.8	220.7	276.1	37.8	1727.2	1898.0
1955	60.5	250.2	72.6	260.6	411.0	58.2	26.7	18.8	9.1	142.7	348.5	471.2	2129.8	1624.0
1956	343.2	188.7	220.2	395.7	45.2	8.1	0.0	4.6	14.5	96.3	285.5	244.3	1847.9	2136.2
1957	190.0	54.4	359.9	260.9	356.6	0.5	*	27.2	72.9	*	*	*	*	*
1958	27.7	182.6	318.5	325.1	82.0	29.5	1.0	36.8	76.2	60.7	192.5	265.4	1598.2	*
1959	167.4	102.4	171.5	411.7	68.1	18.8	0.0	113.3	26.4	162.6	169.4	41.7	1453.	1700.1
1960	260.1	146.8	452.1	486.4	76.5	44.2	0.0	34.8	20.6	257.3	58.4	7.6	1847.9	1992.9
1961	188.0	511.3	337.1	526.3	167.4	7.6	85.6	24.6	258.1	651.8	1255.3	400.3	4413.3	2823.8
1962	380.8	142.0	219.3	257.3	55.9	12.7	27.7	181.4	91.4	40.9	31.7	277.6	2075.9	3065.0
1963	257.6	178.6	256.5	358.1	28.1	44.3	29.4	15.2	53.3	27.9	442.4	137.0	1828.4	1558.3
1964	190.2	116.7	325.2	147.4	21.0	42.7	3.8	52.6	11.5	106.2	21.6	255.8	1294.7	1596.7
1965	93.6	135.4	173.3	195.0	109.4	1.3	8.9	54.7	152.1	148.2	364.5	246.4	1682.8	1349.3
1966	269.3	299.6	237.7	335.3	170.2	40.6	0.0	6.4	57.2	141.6	114.7	131.0	1803.6	2168.8
1967	14.0	152.9	82.1	315.7	186.5	38.7	94.7	181.0	250.4	155.0	374.6	85.1	1930.7	1716.7
1968	121.3	198.3	330.0	436.0	106.3	104.1	0.0	30.0	5.6	87.2	347.4	160.5	1916.7	1878.5
1969	85.2	148.5	329.1	518.7	106.0	17.8	7.6	66.0	63.7	152.3	373.4	172.7	2041.0	2002.8
1970	202.6	251.3	168.9	192.8	33.1	0.0	0.0	11.4	119.2	48.4	115.2	621.1	1763.9	1573.8
1971	168.2	164.1	355.9	344.4	77.3	73.7	14.4	5.4	52.0	67.4	133.2	211.1	1667.1	2059.1
1972	235.4	230.1	235.3	361.2	356.3	0.0	19.1	94.0	250.3	373.7	244.5	274.5	2429.9	2499.7
1973	349.7	121.7	215.8	563.6	143.2	52.2	56.9	57.4	50.0	52.8	499.0	271.0	2233.3	2182.3
1974	162.4	24.5	264.0	435.1	168.7	12.7	11.9	42.8	23.7	112.3	84.6	79.4	1422.1	2027.9
1975	229.1	52.9	369.7	408.4	151.4	15.6	50.8	12.0	83.2	86.2	168.9	254.6	1882.8	1623.3
1976	125.4	199.1	413.0	425.8	87.8	105.7	22.6	4.4	144.4	195.8	97.4	217.2	2038.6	2147.5
1977	257.1	141.0	228.2	211.7	147.5	8.0	15.9	34.2	198.6	283.5	458.8	420.2	2404.7	1840.3
1978														
n(1952-56, 1958-77)	25	25	25	25	25	25	25	25	25	25	25	25	25	24
m	181.7	176.2	258.0	355.7	133.4	30.6	20.9	50.8	91.1	157.2	270.1	225.1	1948.9	1950.7
s	100.0	96.7	96.2	109.0	95.5	30.4	26.8	50.3	79.5	131.4	249.3	145.1	592.2	406.0
C_v	0.55	0.55	0.37	0.31	0.72	0.99	1.28	0.99	0.85	0.84	0.92	0.64	0.30	0.21

Monthly Rainfall (mm) for Station: MIZUNGU MGETA (MOROGORO)

Registration Number: 97.3716

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1951	*	*	*	*	*	*	*	2.8	1.3	68.3	208.5	188.5	*	*
1952	130.0	183.4	187.7	454.7	108.5	3.0	0.0	0.0	27.7	29.2	65.3	9.7	1199.2	1521.2
1953	134.5	50.3	170.2	260.1	114.0	0.0	8.4	17.0	17.8	45.7	52.6	157.2	1027.8	893.0
1954	118.4	90.4	82.8	139.2	108.0	11.9	0.0	3.6	1.8	45.2	64.5	54.1	719.9	811.1
1955	64.3	219.7	161.3	169.7	138.4	22.6	3.3	0.0	0.0	8.1	113.8	141.2	1042.4	906.0
1956	230.1	104.9	144.3	299.5	50.3	0.0	(0.0)	0.0	2.5	(20.0)	54.4	95.8	1001.8	1106.6
1957	161.3	78.5	184.4	330.7	111.5	1.3	3.6	3.6	110.0	28.4	128.3	96.3	1237.9	1163.5
1958	5.1	188.0	279.4	236.2	46.7	7.9	0.8	10.4	12.4	21.1	56.4	167.9	1032.3	1032.6
1959	141.5	110.0	151.9	150.9	19.6	0.0	5.1	35.3	2.0	23.1	49.3	72.6	761.3	863.7
1960	275.6	100.6	223.8	323.9	20.6	21.6	2.0	0.0	4.1	36.8	13.5	3.6	1026.1	1130.9
1961	57.9	333.5	126.7	168.4	86.6	3.6	28.4	0.0	22.4	205.2	213.9	334.3	1580.9	1049.8
1962	140.2	85.3	108.5	269.5	5.1	0.0	4.1	(18.0)	5.3	21.8	32.0	155.7	845.5	1206.0
1963	199.1	162.0	171.0	210.3	0.0	0.0	0.0	0.0	3.1	14.0	238.6	96.5	1094.6	947.2
1964	72.6	119.0	265.3	198.6	30.2	1.8	0.0	(3.0)	0.0	55.9	6.8	78.5	831.7	1081.5
1965	140.0	109.4	160.3	301.6	49.2	0.0	0.0	23.6	(10.2)	31.8	83.7	134.9	1044.7	911.4
1966	86.8	164.3	187.9	110.9	30.2	15.0	0.0	0.0	3.1	88.7	78.6	80.9	846.4	905.5
1967	47.3	127.8	65.5	289.8	135.1	34.0	50.1	0.0	61.8	91.5	185.5	131.4	1219.8	1062.4
1968	121.0	86.3	232.4	210.3	45.8	20.0	0.0	0.0	0.0	7.6	178.2	85.0	986.6	1040.3
1969	55.6	129.8	176.9	181.5	98.7	0.0	0.0	0.0	22.6	19.8	119.1	79.5	883.5	948.1
1970	187.8	329.2	41.8	229.9	5.0	5.0	0.0	0.0	170.0	19.0	9.0	107.3	1104.0	1186.3
1971	0.0	0.0	88.1	593.7	26.5	28.0	38.5	0.0	3.7	18.0	33.9	91.1	921.5	912.8
1972	111.7	179.9	190.7	237.4	91.3	0.0	0.0	0.0	65.2	105.6	124.0	158.9	1264.7	1106.8
1973	149.3	383.8	127.1	167.2	11.1	0.0	4.5	4.7	0.0	0.0	50.0	77.4	975.1	1130.6
1974	226.3	30.7	92.3	295.9	112.1	35.0	27.8	9.6	6.1	25.5	17.7	7.6	886.6	988.7
1975	(200.0)	70.3	175.9	298.7	83.5	13.6	0.4	0.0	22.6	0.0	72.9	173.2	1111.1	890.3
1976	88.4	90.0	201.9	233.7	30.9	30.1	8.0	0.0	22.9	18.9	13.2	90.6	828.4	970.7
1977	139.6	259.9	149.6	175.8	78.2	0.4	5.8	2.4	51.6	64.9	138.6	*	*	1032.0
1978														
n(1952-76)	25	25	25	25	25	25	25	25	25	25	25	25	25	26
m	125.8	141.1	159.9	250.5	62.4	10.2	7.4	5.2	23.9	39.2	82.2	107.3	1019.0	1030.7
s	69.7	93.6	59.2	104.6	44.7	12.1	13.6	9.2	40.0	44.1	65.4	67.2	188.8	150.3
C_v	0.55	0.66	0.37	0.42	0.72	1.19	1.84	1.77	1.67	1.31	0.61	0.63	0.19	0.15

Monthly Rainfall (mm) for Station: MTAMBA (MOROGORO)

Registration Number: 97.3717

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1951	*	*	*	*	*	*	*	48.3	4.9	109.0	274.1	180.6	*	*
1952	74.7	348.7	282.2	236.5	71.9	83.8	16.5	54.6	44.7	194.3	76.7	48.5	1533.1	1862.6
1953	122.9	52.1	262.1	235.5	314.2	14.5	23.4	97.5	61.2	87.6	107.2	402.8	1781.0	1396.2
1954	130.6	127.3	210.3	230.1	237.2	15.2	9.7	5.1	19.1	144.0	76.5	105.4	1318.8	1638.6
1955	166.4	393.4	151.4	569.2	265.7	55.6	87.1	90.7	0.0	10.2	113.8	320.3	2223.8	1971.6
1956	380.0	173.7	259.8	333.0	246.1	146.8	(15.0)	1.3	20.8	21.3	46.0	41.4	1685.2	2032.2
1957	193.5	120.7	116.1	384.6	73.9	36.3	68.8	59.7	56.4	153.9	(50.0)	202.4	1516.3	1351.3
1958	15.5	436.1	323.3	190.7	194.1	113.0	16.5	77.7	21.8	46.7	74.9	243.6	1753.9	1888.9
1959	171.7	153.4	326.1	240.5	120.7	18.8	21.3	62.0	21.6	119.6	48.0	75.4	1379.1	1574.2
1960	253.2	117.1	438.4	376.4	38.1	54.0	32.5	8.1	14.0	83.6	32.3	47.0	1494.7	1538.8
1961	41.4	194.6	102.1	229.1	129.3	81.3	193.5	83.1	161.3	298.5	276.9	299.7	2090.8	1693.5
1962	271.8	181.6	366.3	404.4	54.6	34.3	*	*	*	*	80.8	210.8	*	*
1963	443.7	54.6	120.5	*	*	*	*	*	*	*	*	*	*	*
1964	*	*	277.1	359.7	*	*	76.6	22.9	30.5	48.3	*	*	*	*
1965	196.0	*	*	*	*	*	*	*	*	*	*	*	*	*
			(no data available)											
1974	*	*	*	*	*	*	*	29.8	47.7	85.7	37.8	*	*	*
1975	128.0	30.8	289.8	280.9	159.2	104.9	68.7	15.9	81.6	184.6	16.5	202.2	1563.1	*
1976	105.3	124.4	410.4	142.4	92.4	72.5	18.6	1.4	57.4	79.2	32.6	52.6	1189.2	1322.7
1977	241.8	163.9	239.9	213.3	168.2	12.6	58.9	41.4	181.1	89.3	250.5	462.5	2123.4	1495.6
1978														
n(1952-61, 1975-77)	13	13	13	13	13	13	13	13	13	13	13	13	13	12
m	155.8	187.4	262.5	281.7	162.4	62.3	48.5	46.0	57.0	116.4	92.5	192.6	1664.9	1647.2
s	97.2	126.5	101.8	111.3	84.9	42.9	50.5	36.0	55.8	79.2	81.3	145.3	321.2	244.3
C_v	0.62	0.68	0.39	0.40	0.52	0.69	1.04	0.78	0.98	0.68	0.88	0.75	0.19	0.15

Monthly Rainfall (mm) for Station: BWAKIRA JUU (MOROGORO)

Registration Number: 97.3719

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1952	*	*	*	*	*	*	*	*	*	0.0	59.7	0.0	*	*
1953	82.0	0.0	234.4	264.7	0.0	0.0	4.6	27.4	10.9	45.0	25.9	179.1	874.0	728.7
1954	204.5	143.8	189.2	*	458.7	165.1	72.7	4.8	0.0	11.9	59.2	7.1	*	*
1955	66.5	276.9	242.8	548.6	371.9	293.1	166.1	0.0	0.0	0.0	0.0	297.4	1163.4	2032.2
1956	308.6	*	*	*	*	*	*	*	*	*	*	*	*	*
1957	452.1	0.0	127.0	541.0	191.8	0.0	0.0	0.0	68.6	0.0	26.7	68.6	1475.7	*
1958	0.0	227.3	472.4	266.7	78.0	40.6	0.0	0.0	15.2	0.0	0.0	149.9	1250.2	1195.5
1959	215.9	74.9	138.4	177.8	49.5	20.3	3.8	47.0	0.0	30.5	0.0	0.0	758.2	908.0
1960	228.6	101.6	175.3	370.8	20.3	109.2	0.0	2.5	5.1	12.7	(0.0)	(0.0)	1026.1	1026.1
1961	45.7	346.7	158.8	303.5	99.1	63.5	78.7	16.5	53.3	248.9	294.6	285.8	1995.1	1414.8
1962	193.0	348.0	145.0	272.3	149.6	0.0	45.5	60.2	5.1	38.1	160.3	102.9	1519.9	1837.2
1963	255.6	82.6	461.7	330.3	57.4	60.9	25.3	0.0	0.0	32.3	446.7	133.2	1886.0	1569.3
1964	*	*	382.0	1183.2	85.9	*	25.1	22.9	12.7	37.1	0.0	32.5	*	*
1965	140.9	81.3	135.1	421.6	151.5	0.0	4.3	3.8	50.0	38.7	216.7	209.0	1452.9	1059.7
1966	69.1	158.4	222.9	228.3	134.7	81.2	15.5	5.3	5.8	20.3	22.8	16.5	980.8	1367.2
1967	0.0	57.9	170.1	306.8	260.6	34.5	83.8	(70.0)	(50.0)	57.1	175.8	234.3	1500.9	1130.1
1968	155.0	157.6	341.6	414.0	129.5	67.4	0.0	(5.0)	67.2	16.4	254.2	53.4	1661.3	1763.8
1969	44.5	95.3	306.9	325.2	58.4	45.6	2.5	17.7	22.9	31.8	91.6	(40.0)	1082.4	1258.4
1970	261.7	226.2	281.9	105.5	36.8	0.0	8.9	0.0	64.8	16.5	25.9	(150.0)	1178.2	1133.9
1971	97.5	93.8	125.5	296.2	77.7	49.7	15.0	0.0	0.0	77.6	28.0	140.6	1001.6	1008.9
1972	83.9	117.8	154.3	445.7	344.7	0.0	18.3	0.0	54.3	69.9	128.8	179.1	1417.7	1457.5
1973	137.2	259.8	226.9	500.9	49.8	15.5	0.0	11.0	0.0	0.0	45.0	25.0	1271.0	1508.9
1974	26.0	76.0	30.0	149.0	84.0	37.2	47.2	0.0	7.0	19.0	0.0	2.0	477.2	545.2
1975	166.0	5.5	269.3	205.0	111.0	17.0	0.0	4.0	*	*	*	*	*	*
1976	90.0	112.2	168.0	138.0	62.0	58.0	40.0	130.0	11.0	94.0	29.0	142.0	1074.2	*
1977	*	*	*	*	*	0.0	*	130.0	125.0	35.0	485.0	9.0	*	*
1978														
n(1957-63, 1965-74)	17	17	17	17	17	17	17	17	17	17	17	17	17	16
m	141.7	141.2	216.1	320.9	116.1	36.8	20.5	14.1	27.6	41.8	112.8	105.3	1290.3	1261.5
s	117.9	109.6	120.9	119.7	85.6	32.8	27.3	22.6	27.6	58.0	129.4	89.1	388.5	331.5
C_v	0.83	0.78	0.56	0.37	0.74	0.89	1.33	1.60	1.00	1.39	1.16	0.85	0.30	0.26

Monthly Rainfall (mm) for Station: STIEGLERS GORGE (MOROGORO)

Registration Number: 97.3721

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1955	*	*	*	*	179.8	61.5	0.0	0.0	2.5	0.8	62.0	76.2	*	*
1956	258.8	115.1	94.5	512.6	45.5	7.4	0.0	0.5	9.9	26.2	22.9	197.1	1290.3	1208.7
1957	*	71.6	148.8	417.8	*	*	61.0	*	61.2	33.8	70.1	143.8	*	*
1958	12.7	157.2	243.6	224.5	32.5	8.6	0.0	0.0	7.9	0.8	*	*	*	901.7
1959	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1960	(200.0)	97.5	275.3	204.0	25.1	21.3	0.0	0.0	0.0	25.7	0.0	0.0	848.9	*
1961	77.0	195.6	61.0	178.8	74.9	35.8	39.9	5.1	8.1	119.1	147.3	573.0	1515.6	795.3
1962	375.4	135.1	64.5	169.7	41.4	10.7	1.0	81.0	13.7	13.5	32.8	33.5	972.3	1626.3
1963	123.0	82.4	222.3	295.0	0.0	14.1	10.4	0.0	*	*	*	*	*	*
1964	174.1	161.9	237.3	153.9	29.8	0.0	0.0	9.4	0.0	24.1	1.3	46.8	838.6	*
1965	164.0	134.9	119.0	232.3	34.2	0.0	0.0	3.8	4.8	59.8	53.2	81.2	887.3	801.0
1966	64.4	123.0	227.5	144.2	55.8	15.7	0.0	4.6	26.2	27.7	69.0	13.7	771.8	823.5
1967	0.0	52.5	99.8	181.0	235.1	58.0	73.8	9.4	*	*	*	*	*	*
1968	213.6	73.2	237.2	196.6	69.0	64.8	0.0	0.0	0.0	23.6	129.6	66.4	1074.0	*
1969	49.1	87.8	202.5	272.5	86.5	6.2	6.8	1.7	0.4	20.8	56.7	10.4	801.4	930.3
1970	289.9	278.9	251.4	124.5	4.6	0.0	5.1	0.0	62.8	12.5	9.0	71.6	1110.3	996.8
1971	124.0	104.1	164.0	297.8	84.0	44.7	6.0	0.0	2.8	24.6	45.5	180.5	1078.0	932.6
1972	112.0	140.6	186.8	185.6	198.6	0.0	5.2	3.1	35.4	111.2	108.9	66.3	1153.7	1204.7
1973	192.6	126.3	37.5	173.3	104.7	0.0	7.1	0.0	0.0	1.0	51.5	38.8	732.8	817.7
1974	186.7	17.3	121.5	422.9	82.2	111.4	31.4	4.6	1.8	47.8	7.3	64.5	1099.4	1117.9
1975	99.2	37.1	274.7	222.0	125.0	22.2	0.0	4.5	29.6	5.8	14.9	130.8	965.8	828.1
1976	*	*	70.9	145.1	132.5	37.4	0.0	0.0	3.7	1.7	14.4	65.7	*	*
1977	82.6	132.7	96.1	130.5	49.8	0.0	4.0	8.0	59.3	43.4	147.3	179.1	932.8	686.5
1978														
n(1960-62, 1964-66, 1968-75,77)	15	15	15	15	15	15	15	15	15	15	15	15	15	12
m	160.3	123.1	170.4	207.2	71.0	22.2	7.1	8.4	16.3	37.4	58.3	103.8	985.5	963.4
s	89.2	62.7	81.7	77.2	47.8	31.5	12.0	20.3	21.6	35.4	52.1	141.0	198.4	255.0
C_v	0.56	0.51	0.48	0.37	0.67	1.42	1.69	2.42	1.33	0.95	0.89	1.36	0.20	0.26

Monthly Rainfall (mm) for Station: KIBUNGO MISSION (MOROGORO)

Registration Number: 97.3724

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1957	*	*	*	*	*	*	*	60.7	105.9	33.5	201.2	445.8	*	*
1958	150.4	324.9	539.2	501.1	110.1	97.0	1.8	67.3	54.9	117.6	238.8	288.5	2491.6	2611.8
1959	352.6	152.1	186.9	360.2	145.8	19.8	12.2	93.5	147.3	300.5	217.9	168.7	2157.5	2298.2
1960	356.9	130.0	375.2	498.9	57.4	153.2	18.0	18.5	50.8	246.6	119.9	50.5	2075.9	2292.1
1961	177.0	620.5	345.2	382.5	95.3	77.0	167.1	67.3	297.7	468.6	289.6	3346.7	2868.9	
1962	286.0	191.5	400.3	378.2	95.3	14.0	23.1	291.9	89.7	358.4	444.3	320.0	2892.7	2779.6
1963	387.4	210.5	302.6	410.5	22.4	55.4	26.2	10.3	16.3	28.6	593.6	322.5	2386.3	2234.5
1964	235.2	90.7	393.6	275.8	138.2	0.0	3.8	39.4	89.2	297.0	43.3	223.1	1829.3	2479.0
1965	155.0	297.5	186.3	392.7	98.2	2.8	21.4	41.9	228.5	357.1	580.6	592.7	2954.7	2047.8
1966	*	*	*	*	*	*	87.1	120.3	257.7	436.3	*	*	*	(2508)
1967	*	*	*	*	*	*	*	*	*	*	*	*	*	(2548)
1968	*	*	*	*	*	*	*	94.0	134.6	117.3	519.7	300.4	*	(2626)
1969	171.5	202.8	330.7	321.5	80.3	40.0	47.6	141.1	187.8	99.6	414.6	387.2	2424.7	2443.0
1970	386.8	297.6	232.1	253.2	64.3	0.4	15.9	55.9	192.2	79.5	111.2	707.0	2395.8	2379.4
1971	155.1	60.0	209.0	298.7	89.3	81.2	97.8	12.1	86.4	227.9	184.7	265.3	1767.5	2135.7
1972	259.2	81.5	359.6	269.7	226.1	0.0	53.4	65.7	260.7	320.7	472.1	404.6	2873.3	2446.6
1973	233.7	176.3	260.9	536.1	118.0	71.0	131.6	91.5	70.0	29.0	356.2	287.3	2361.6	2594.8
1974	186.7	75.2	264.0	555.1	296.8	23.1	32.6	33.6	78.3	104.0	132.2	209.1	1990.7	2282.9
1975	289.2	40.8	314.5	404.1	133.5	10.8	32.4	134.7	151.8	255.2	85.8	545.1	2398.5	2108.9
1976	287.2	412.2	541.1	445.3	129.6	126.9	27.2	46.2	199.5	404.6	115.5	247.1	2982.3	3250.6
1977	529.4	166.0	362.6	244.6	107.6	7.3	44.5	52.9	277.4	233.9	370.8	776.3	3173.3	2388.8
1978														
n(1958-65, 1969-77)	17	17	17	17	17	17	17	17	17	17	17	17	17	17
m	270.6	207.7	329.6	389.9	118.1	45.9	44.5	74.3	145.8	231.1	284.7	357.9	2500.1	2449.6
s	105.7	148.1	105.2	94.8	63.6	47.9	45.8	67.5	87.2	134.2	177.1	193.5	468.1	304.3
C_v	0.39	0.71	0.32	0.24	0.54	1.04	1.03	0.91	0.60	0.58	0.62	0.54	0.19	0.12

Monthly Rainfall (mm) for Station: KIBUKO COFFEE PLOT (MOROGORO)

Registration Number: 97.3725

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1959	*	*	*	*	*	*	*	*	*	29.2	60.2	150.1	*	*
1960	160.5	93.0	225.8	465.1	77.2	26.9	24.9	7.9	0.0	22.4	5.1	9.7	1118.4	1314.0
1961	74.4	276.6	171.7	236.2	87.1	15.7	81.3	1.8	23.6	161.8	302.0	358.1	1790.4	1145.0
1962	201.9	138.5	244.9	255.3	50.6	0.0	8.6	0.0	5.1	6.4	34.8	158.8	1104.9	1571.4
1963	222.4	161.3	144.5	376.1	31.4	39.2	0.0	0.0	0.8	10.7	387.8	199.8	1514.0	1180.0
1964	154.4	139.8	407.8	445.8	21.6	3.3	2.5	11.7	0.0	31.5	6.6	190.5	1415.5	1806.0
1965	115.9	140.6	247.8	324.2	97.1	0.0	10.7	0.0	51.8	16.3	123.2	248.8	1376.4	1201.5
1966	72.3	112.8	300.5	241.2	129.4	58.6	0.0	8.1	0.0	67.9	67.3	89.0	1147.1	1362.8
1967	100.6	108.0	186.5	270.8	186.2	39.1	78.0	26.2	86.8	32.5	150.1	177.8	1442.6	1271.0
1968	222.9	174.8	341.8	356.8	113.4	44.9	0.0	4.1	0.0	8.1	129.6	94.6	1491.3	1594.7
1969	142.2	123.6	296.3	302.5	129.4	0.0	0.0	0.0	16.7	16.2	92.2	60.3	1179.4	1251.4
1970	194.3	359.4	153.8	153.2	44.5	0.0	0.0	0.0	114.2	0.0	35.1	172.5	1227.0	1171.9
1971	133.4	150.4	154.3	148.7	83.7	28.9	21.2	(0.0)	9.2	12.5	15.4	(150.0)	907.7	949.9
1972	225.6	130.6	238.5	344.2	152.1	0.0	8.3	0.0	50.6	127.8	94.1	210.5	1582.3	1443.1
1973	401.4	*	120.9	462.4	91.4	9.0	7.2	6.2	0.0	7.2	93.7	*	*	*
1974	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1975	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1976	165.9	50.3	40.8	181.6	98.9	36.9	0.0	0.0	20.0	5.1	12.5	34.5	646.5	*
1977	*	95.0	195.4	130.5	72.2	7.8	8.3	*	71.7	36.9	160.8	*	*	*
1978														
n(1960-72)	13	13	13	13	13	13	13	13	13	13	13	13	13	13
m	155.5	162.3	239.6	301.6	92.6	19.7	18.1	4.6	27.6	39.6	111.0	163.1	1330.5	1327.9
s	55.1	74.4	80.1	97.8	48.9	21.0	28.5	7.6	37.5	50.2	115.7	88.7	241.2	227.5
C_v	0.35	0.46	0.33	0.32	0.53	1.07	1.57	1.66	1.36	1.27	1.04	0.54	0.18	0.17

Monthly Rainfall (mm) for Station: KIBUNGO, WATER DEPARTMENT AND IRRIGATION (MOROGORO)

Registration Number: 97.3726

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1956	782.3	742.2	*	*	98.0	47.0	19.1	44.5	17.8	27.9	109.2	175.3	*	*
1957	147.3	137.2	236.2	944.9	(150.0)	20.3	27.9	2.5	29.2	120.7	130.8	204.5	2151.5	2100.7
1958	6.4	218.4	284.5	286.5	262.9	113.0	33.0	27.9	34.3	2.5	66.0	(200.0)	1469.4	1538.7
1959	246.4	251.5	453.4	203.2	99.1	24.1	12.7	71.1	70.9	135.9	52.1	105.4	1725.7	1834.2
1960	322.6	83.8	419.1	327.7	36.8	72.4	16.5	7.6	29.2	83.8	21.6	11.4	1432.6	1557.0
1961	64.8	227.3	141.0	251.5	134.6	137.2	88.9	27.9	99.6	311.2	315.0	453.6	2252.5	1517.0
1962	303.0	170.5	295.7	256.3	61.7	21.3	37.1	135.4	22.1	78.0	65.3	154.4	1601.2	2149.7
1963	395.2	200.0	335.5	218.9	27.1	53.8	48.2	(5.0)	(10.0)	(20.0)	(500.0)	(100.0)	1913.7	1533.4
1964	257.5	135.3	359.3	102.5	51.3	13.0	45.7	38.5	2.1	171.0	1.3	151.0	1328.5	1776.2
1965	204.8	153.0	251.6	284.3	149.8	0.0	29.2	14.7	28.0	94.5	307.6	332.6	1850.1	1361.7
1966	166.5	214.9	243.9	190.2	97.7	56.2	19.8	8.7	56.2	79.8	177.2	61.3	1372.4	1774.1
1967	0.0	237.7	89.7	333.6	214.0	63.1	92.2	74.7	105.8	97.1	437.0	799.2	2544.2	1546.4
1968	138.9	123.5	417.8	574.0	105.7	77.2	16.4	8.1	20.5	53.8	283.2	134.9	1954.0	2772.2
1969	86.7	32.0	203.9	280.7	111.5	29.7	17.1	41.5	30.3	61.5	43.8	34.3	973.0	1313.0
1970	378.0	326.0	144.7	200.6	43.0	18.5	27.3	26.0	166.0	31.5	4.0	295.6	1661.2	1439.7
1971	60.2	135.5	138.2	291.5	125.3	44.5	77.0	13.9	13.0	38.3	18.6	83.2	1039.2	1237.0
1972	165.3	115.3	285.5	319.5	197.4	7.2	29.4	41.5	88.5	183.0	360.0	357.0	2149.6	1574.4
1973	361.5	327.0	135.0	605.5	134.0	81.5	56.0	63.5	21.0	17.0	161.0	179.5	2142.5	2519.0
1974	249.5	30.0	309.4	549.0	201.0	117.2	90.0	6.0	75.0	85.0	27.0	72.5	1811.6	2052.6
1975	181.5	28.5	515.0	400.0	118.0	151.0	52.5	9.5	64.5	89.5	62.0	479.0	2151.0	1709.5
1976	125.5	178.2	483.5	215.3	82.2	84.3	32.9	2.3	30.5	61.0	42.0	83.2	1420.9	1836.7
1977	186.1	210.3	162.6	170.0	180.0	7.0	52.0	68.4	136.9	69.3	205.1	373.4	1821.1	1367.8
1978														
n(1957-77)	21	21	21	21	21	21	21	21	21	21	21	21	21	21
m	192.8	168.4	281.2	333.6	123.0	56.8	42.9	33.1	54.0	89.7	156.2	222.2	1750.8	1738.6
s	116.5	85.3	125.3	192.5	63.1	44.9	25.4	33.6	44.3	68.9	153.1	190.6	409.5	395.5
C_v	0.60	0.51	0.45	0.58	0.51	0.79	0.59	1.02	0.82	0.77	0.98	0.86	0.23	0.23

Monthly Rainfall (mm) for Station: BWAKIRA ESTATE (MOROGORO)

Registration Number: 97.3727

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1956	136.7	182.1	232.4	229.4	157.0	0.0	18.0	7.9	0.0	9.9	0.0	30.5	1003.9	*
1957	223.8	445.0	185.2	212.9	120.1	0.0	24.4	0.0	50.0	78.0	85.1	67.1	1491.6	1369.9
1958	2.5	213.6	331.7	169.4	57.2	81.3	2.0	10.2	15.0	0.0	13.0	130.3	1026.2	1035.1
1959	159.0	192.3	107.7	216.7	66.0	25.4	16.0	27.7	0.0	29.0	8.9	20.1	868.8	1175.4
1960	163.1	73.2	197.9	261.6	63.8	111.8	23.1	7.1	5.1	31.2	0.0	0.0	937.9	966.9
1961	22.1	196.1	121.4	236.2	116.8	25.1	42.2	7.6	77.5	113.5	236.0	164.8	1359.3	958.5
1962	86.4	148.8	59.2	92.5	63.0	3.1	21.1	62.2	21.1	0.0	113.3	53.1	723.7	958.2
1963	126.0	60.5	74.0	191.0	15.0	26.0	4.0	0.0	4.0	41.0	397.0	89.5	1028.0	707.9
1964	36.0	*	*	24.4	14.0	0.0	4.1	0.0	0.0	17.5	2.3	5.6	*	*
1965	10.4	42.2	207.5	298.4	124.5	0.0	19.2	13.0	24.7	25.7	123.7	117.2	1006.5	773.5
1966	103.7	56.9	247.4	179.6	101.2	66.9	12.7	0.0	12.2	13.2	38.2	14.2	846.3	1034.7
1967	11.2	51.9	94.4	288.1	323.0	47.3	109.8	60.9	64.1	53.3	97.0	149.0	1350.0	1156.4
1968	106.7	100.4	216.8	259.1	80.8	66.6	0.0	2.0	6.1	10.2	189.4	99.0	1137.1	1094.7
1969	66.8	25.4	205.2	214.0	55.3	2.0	0.0	0.0	10.2	20.3	0.0	0.0	598.9	887.6
1970	333.2	62.5	*	*	*	*	*	*	*	*	*	155.8	*	*
1971	73.9	74.0	77.2	255.4	43.1	17.2	15.5	0.0	13.9	16.6	15.0	107.5	709.3	*
1972	94.2	140.6	271.2	372.9	223.2	0.0	26.3	(10.0)	(50.0)	147.6	217.6	49.3	1602.9	1458.5
1973	173.6	94.7	143.4	199.7	*	*	*	*	*	*	162.5	109.8	*	*
1974	216.9	*	103.8	*	*	*	*	*	*	*	0.0	15.2	*	*
(* no data available)														
n(1956-63, 1965-69, 1971-73)	15	15	15	15	15	15	15	15	15	15	15	15	15	13
m	92.4	133.5	171.7	231.8	107.3	31.5	22.3	13.9	23.6	39.3	102.3	72.8	1046.0	1044.4
s	64.1	106.8	78.4	64.5	78.9	35.5	26.8	20.7	24.7	42.8	115.4	54.3	294.2	212.5
C_v	0.69	0.80	0.46	0.28	0.74	1.13	1.20	1.49	1.05	1.09	1.13	0.75	0.28	0.20

Monthly Rainfall (mm) for Station: **TAWA HEALTH CENTRE**

Registration Number: 97.3728

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1963	445.4	141.8	271.6	318.5	22.9	97.4	46.5	21.6	26.6	53.0	666.9	263.6	2375.8	*
1964	177.1	126.8	604.6	268.3	113.7	26.5	43.8	134.4	123.5	222.4	109.0	173.8	2123.9	2771.6
1965	149.4	313.9	238.8	385.0	171.7	0.0	84.1	29.4	144.3	164.3	339.5	646.5	2667.4	1964.2
1966	245.3	133.9	381.1	228.2	146.9	126.3	17.9	67.2	79.8	196.1	133.6	50.9	1807.2	2608.7
1967	53.1	246.9	85.0	357.1	294.8	53.8	169.2	156.0	291.4	85.5	486.5	404.0	2683.3	2335.4
1968	129.5	185.3	345.0	623.4	199.7	103.6	67.3	52.0	25.7	88.9	386.0	50.8	2257.2	2710.9
1969	49.0	48.0	320.3	396.8	89.1	86.5	53.1	160.8	45.5	179.1	243.9	115.7	1787.8	1865.0
1970	207.1	221.9	308.2	302.9	135.0	36.9	3.8	21.6	180.0	81.2	0.0	55.4	1554.0	1858.2
1971	19.5	295.7	380.9	866.1	346.5	99.1	110.7	0.0	122.7	53.7	51.1	178.1	2524.1	2350.3
1972	89.0	346.4	365.2	334.2	223.0	0.0	59.7	231.4	61.5	108.5	0.0	0.0	1818.9	2048.1
1973	*	*	*	*	*	*	*	*	*	*	*	*	(2192.0)	(2040.0)
1974	*	*	*	*	*	*	*	*	82.5	63.5	27.0	36.7	(2059.0)	(1785.0)
1975	98.1	31.5	516.5	425.4	192.4	117.7	118.9	19.8	101.3	261.8	24.0	226.6	2134.0	1883.4
1976	256.2	440.7	427.2	324.5	68.0	123.7	23.8	8.7	66.6	142.6	59.0	73.1	2033.1	1882.0
1977	319.5	231.0	164.2	*	178.6	50.4	*	*	*	141.9	0.0	174.3	*	*
1978														
n(1963-72, 1975-76)	12	12	12	12	12	12	12	12	12	12	12	12	12	13
m	159.9	211.1	353.7	402.5	167.0	72.6	66.6	75.2	105.7	136.4	208.3	186.5	2147.2	2161.0
s	118.3	123.4	132.1	176.6	92.6	47.0	47.5	75.9	75.4	68.6	217.6	184.2	367.1	351.1
C_v	0.74	0.58	0.37	0.44	0.55	0.65	0.71	1.01	0.71	0.50	1.04	0.99	0.17	0.16

Monthly Rainfall (mm) for Station: KILOMBERO SUGAR ESTATE

Registration Number: 97.3729

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1962	227.1	146.3	278.4	293.6	87.4	6.3	8.9	52.8	15.2	38.1	40.1	115.3	1309.5	*
1963	186.0	196.0	490.0	356.0	45.0	58.0	5.0	1.0	1.0	18.0	393.0	118.	1867.0	1511.4
1964	207.0	196.0	367.0	388.0	48.0	5.0	4.0	18.0	1.0	22.0	9.0	62.0	1327.0	1767.0
1965	261.0	194.0	316.0	283.0	73.0	1.0	15.0	12.0	33.0	49.0	108.0	224.0	1569.0	1308.0
1966	112.0	193.0	207.0	298.0	129.0	33.0	3.0	5.0	15.0	22.0	95.0	66.0	1178.0	1349.0
1967	92.0	128.0	167.0	298.0	224.0	60.0	56.0	12.0	84.0	57.0	325.0	507.0	2010.0	1339.0
1968	170.0	189.0	245.0	825.0	129.0	72.0	0.0	4.0	8.0	10.0	159.0	142.0	1953.0	2484.0
1969	90.0	162.0	170.0	244.6	119.0	21.0	5.0	8.0	1.0	14.0	96.0	9.0	939.6	1135.6
1970	400.0	188.0	274.0	213.0	23.0	5.0	8.0	9.0	56.0	11.0	0.0	139.0	1326.0	1292.0
1971	135.0	100.0	236.0	378.0	131.0	34.0	30.0	0.0	3.0	18.0	25.0	100.0	1190.0	1204.0
1972	166.0	246.0	302.0	356.0	234.0	0.0	13.0	3.0	120.1	36.0	368.0	132.2	1976.3	1601.1
1973	220.3	201.4	167.1	455.3	100.0	15.4	2.2	0.0	4.0	0.0	105.6	55.7	1327.0	1665.9
1974	221.0	132.2	98.1	515.6	162.1	34.2	68.9	1.8	13.6	77.6	1.9	55.3	1381.3	1486.4
1975	144.2	108.0	201.6	344.9	159.6	40.8	12.1	5.7	23.3	22.6	6.7	205.4	1275.1	1120.3
1976	200.9	142.6	240.4	235.8	66.6	54.3	10.0	25.4	4.4	3.8	4.6	96.7	1085.5	1196.3
1977	168.2	177.2	266.4	234.1	106.9	0.0	27.6	14.8	39.3	113.4	184.6	220.5	1553.0	1249.2
1978	156.8	38.4	313.6	231.9	30.9	19.1	5.7	5.2	6.3	4.3	246.8	354.7	1413.7	913.5
n(1962-78)	17	17	17	17	17	17	17	17	17	17	17	17	17	16
m	185.7	161.1	255.3	350.1	109.9	27.0	16.1	10.5	25.2	30.4	127.6	153.1	1451.8	1413.9
s	73.3	49.5	90.6	147.9	61.5	23.6	19.4	12.9	33.4	39.7	132.9	123.3	324.0	360.7
C_v	0.39	0.31	0.35	0.42	0.56	0.87	1.20	0.23	1.33	1.31	1.04	0.81	0.22	0.26

Monthly Rainfall (mm) for Station: KIKOBOGA MIKUMI

Registration Number: 97.3730

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1964	94.0	143.9	289.4	175.3	15.6	(5.0)	3.0	0.0	0.0	22.4	0.0	72.2	820.8	*
1965	96.4	237.0	134.7	93.2	23.4	0.0	0.0	0.0	0.0	8.9	39.4	192.2	825.2	665.8
1966	83.9	94.8	120.0	163.7	20.1	34.8	2.5	0.0	8.6	4.8	66.7	99.7	699.6	764.7
1967	44.2	63.9	119.1	186.7	98.8	19.3	37.2	6.9	35.6	90.7	103.6	204.7	1010.7	868.4
1968	226.2	181.1	290.4	295.7	33.8	28.7	0.0	0.0	3.6	0.8	67.0	48.7	1176.0	1368.6
1969	63.0	168.2	143.4	172.2	53.4	12.2	0.0	0.0	3.5	8.9	60.9	34.8	720.5	740.5
1970	395.6	146.9	153.4	61.4	33.8	1.0	0.0	0.0	31.9	0.0	2.3	220.0	1046.3	919.7
1971	141.9	157.6	102.7	211.4	41.9	14.5	7.2	0.3	3.4	0.0	23.3	95.0	799.2	903.2
1972	93.0	167.9	269.6	182.5	130.7	0.0	14.1	0.0	29.0	21.1	112.6	53.2	1073.7	1026.2
1973	200.5	179.2	122.4	145.8	91.2	11.7	0.0	0.0	0.5	0.0	27.3	87.5	866.1	917.1
1974	120.2	104.3	29.7	333.1	90.2	18.5	30.5	0.0	0.0	23.9	17.2	66.2	833.8	865.0
1975	92.0	33.3	172.5	100.9	11.7	0.0	0.0	0.0	3.6	0.0	0.0	78.6	492.6	497.4
1976	92.2	139.2	148.5	93.3	64.8	12.7	12.2	0.0	2.0	0.0	0.0	58.0	620.9	641.5
1977	274.0	83.8	109.6	65.3	40.7	0.0	0.0	0.0	11.0	7.3	46.7	196.4	834.8	649.7
1978														
n(1964-77)	14	14	14	14	14	14	14	14	14	14	14	14	14	13
m	144.0	135.8	157.5	162.9	53.6	11.3	7.6	0.5	9.5	13.5	40.5	107.7	856.7	832.9
s	97.5	54.1	75.7	80.3	36.4	11.2	12.1	1.8	12.8	23.9	37.6	65.5	180.6	218.0
C_v	0.68	0.40	0.48	0.49	0.68	0.99	1.59	3.60	1.35	1.77	0.93	0.61	0.21	0.26

Monthly Rainfall (mm) for Station: MKATA SETTLEMENT

Registration Number: 97.3731

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1969	78.2	51.4	119.2	230.5	12.4	0.8	0.0	2.7	20.7	18.1	190.0	20.4	744.4	*
1970	212.1	195.0	107.9	54.3	7.2	0.0	0.0	0.0	18.0	1.7	0.0	163.7	759.9	806.6
1971	128.9	78.7	156.5	199.6	6.6	0.0	0.0	0.0	2.0	8.7	23.1	96.1	700.2	744.7
1972	168.6	95.8	177.8	61.8	39.6	(0.0)	(0.0)	(0.0)	62.2	*	158.6	40.4	*	*
1973	126.0	146.1	26.5	83.5	73.2	0.0	0.0	1.0	0.0	0.0	48.7	63.0	568.0	*
1974	68.0	168.8	70.1	218.2	62.4	9.4	3.5	0.0	0.0	2.5	0.0	126.5	751.9	714.6
1975	49.5	47.0	84.2	86.7	45.0	0.0	0.0	0.0	5.3	28.5	20.4	107.9	474.2	472.7
1976	67.7	112.1	123.3	55.2	42.4	0.0	0.0	0.0	0.0	0.0	10.0	43.2	453.9	529.0
1977	182.6													
1978			(no data available)											

Monthly Rainfall (mm) for Station: TINDIGA

Registration Number: 97.3732

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1970	290.0	115.2	114.5	34.5	8.0	0.0	0.0	4.1	34.2	52.8	0.0	109.9	793.2	*
1971	177.7	40.6	155.3	153.4	20.4	11.2	0.0	5.5	0.1	0.1	22.7	73.9	660.9	674.2
1972	70.0	133.7	167.6	36.3	57.8	0.0	0.0	0.0	57.0	137.8	137.8	109.6	907.2	756.8
1973	145.6	111.1	17.8	172.7	46.1	0.0	7.7	5.2	0.0	0.0	0.0	110.1	638.0	753.6
1974	183.9	50.7	105.1	160.7	159.7	50.6	0.7	0.9	20.6	10.0	10.0	15.0	757.9	853.0
1975	69.0	39.0	154.9	92.2	28.1	8.4	0.0	0.0	20.7	1.0	1.0	148.5	563.6	438.3
1976	142.0													
			(no data available)											

Monthly Rainfall (mm) for Station: KIDUNDA (MOROGORO)

Registration Number: 97.3808

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1956	262.9	112.8	131.6	379.0	42.4	0.3	0.0	0.0	3.3	8.9	73.9	106.9	1122.0	*
1957	161.8	69.3	(175.0)	295.4	76.2	0.0	0.0	0.0	51.3	112.3	228.9	249.4	1419.6	947.1
1958	0.0	100.1	223.3	103.1	15.0	4.3	0.0	59.7	8.6	13.7	12.7	88.6	629.2	1006.1
1959	402.5	235.5	111.0	113.0	31.5	0.0	2.5	27.7	1.8	80.8	38.4	52.1	1096.8	1107.6
1960	203.7	23.1	165.1	199.9	41.9	29.7	0.0	0.0	17.0	34.8	0.0	13.2	728.4	805.7
1961	6.4	189.5	65.0	79.5	83.3	2.3	45.7	1.3	23.4	237.0	155.4	306.1	1194.9	746.6
1962	85.3	124.2	151.4	136.4	4.3	0.8	4.8	78.0	26.7	0.0	0.0	59.7	671.6	1073.4
1963	176.6	65.7	89.3	261.9	22.3	89.3	*	*	*	*	*	*	*	*
1964	144.0	150.4	256.9	162.9	31.6	6.6	6.9	1.3	3.0	92.7	1.3	66.0	923.6	*
1965	125.2	44.6	(100.0)	258.8	76.8	0.0	0.0	16.1	10.8	(60.0)	55.9	154.4	902.6	759.6
1966	47.7	126.9	154.1	233.1	88.9	57.2	0.8	21.3	26.8	137.6	35.6	105.0	1035.0	1104.7
1967	6.6	87.8	37.3	323.7	148.1	59.2	38.9	28.1	78.8	70.7	110.5	97.2	1086.9	1019.8
1968	166.2	29.1	257.2	251.3	78.0	73.9	0.0	7.0	30.3	20.1	260.5	61.9	1235.5	1120.8
1969	*	72.9	216.8	163.4	108.9	29.2	0.0	12.0	*	*	*	*	*	*
			(station closed)											
n(1956-62, 1964-69)	12	12	12	12	12	12	12	12	12	12	12	12	12	10
m	134.4	107.8	152.3	211.3	59.8	19.5	8.3	20.0	23.5	72.4	81.1	113.4	979.9	969.1
s	119.0	63.8	69.7	94.9	39.8	28.0	16.1	25.5	22.6	67.7	91.1	85.2	244.8	147.8
C_v	0.89	0.59	0.46	0.45	0.67	1.44	1.94	1.27	0.96	0.94	1.12	0.75	0.25	0.15

Monthly Rainfall (mm) for Station: NG'HESSE (UTARI BRIDGE)

Registration Number: 97.3809

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan - Dec Total	Nov - Oct Total
1956	194.3	73.4	225.6	229.1	(70.0)	0.5	0.8	0.0	5.8	21.1	43.2	103.9	967.7	*
1957	113.8	65.8	(125.0)	176.3	121.2	0.3	9.1	6.1	8.9	93.7	150.6	41.7	912.5	867.3
1958	2.8	125.7	253.7	35.8	35.8	8.6	0.0	7.1	11.7	1.8	41.1	98.6	622.8	675.3
1959	26.4	101.3	60.7	94.2	78.0	6.6	2.8	34.5	18.8	31.0	31.5	182.1	657.9	594.0
1960	95.3	22.6	173.2	191.0	53.6	47.5	0.3	4.8	6.9	47.0	0.0	8.1	650.3	855.8
1961	27.4	175.3	57.9	124.2	92.7	19.1	50.0	0.0	53.8	282.4	259.8	277.9	1420.5	890.9
1962	103.6	59.2	201.9	131.1	4.8	0.0	3.3	145.3	14.7	(0)	*	68.6	*	(1201.6)
1963	164.7	148.9	104.5	*	*	*	*	*	*	*	*	*	*	*
1964	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1965	205.4	60.2	101.6	301.3	92.4	0.0	2.5	69.6	18.8	74.2	95.3	71.3	1092.6	*
1966	40.4	170.0	159.7	180.2	*	*	*	*	*	*	(49.2)	(111.1)	*	*
1967	0.0	50.2	42.8	272.7	286.5	53.9	43.5	20.8	54.9	32.4	118.9	79.9	1056.5	(1018.0)
1968	13.7	16.2	240.2	348.8	170.2	65.6	0.0	0.0	50.2	47.2	282.4	12.7	1247.2	1150.9
1969	66.8	105.4	227.6	150.4	85.0	36.6	2.5	19.3	76.3	180.4	301.1	28.4	1279.8	1245.4
1970	274.2	260.1	121.3	162.3	10.2	0.0	5.1	0.0	50.2	7.5	0.0	150.9	1041.8	1220.4
1971	24.8	10.5	87.6	355.0	230.0	14.5	11.8	6.0	0.0	1.8	0.0	133.0	875.0	892.9
1972	74.5	41.0	23.0	89.0	115.1	0.0	5.5	8.0	4.6	188.9	95.1	56.7	701.4	682.6
1973	19.3	12.9	38.3	56.1	28.4	0.0	0.0	2.5	7.0	0.0	2.0	19.1	185.6	316.3
1974	14.1	0.0	14.0	43.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.6	79.9	78.3
1975	35.7	9.1	52.7	51.8	25.8	*	*	*	*	*	*	*	*	*
1976	60.5	90.1	98.0	105.0	96.0	5.2	4.0	0.0	49.0	0.0	47.0	9.4	564.2	*
1977	147.0	107.7	193.0	110.0	57.0	0.0	(0.0)	0.0	64.0	51.0	170.5	107.0	1007.2	786.1
1978														
n(1956-61, 1967-74, 1976-77)	16	16	16	16	16	16	16	16	16	16	16	16	16	15
m	72.2	78.6	123.9	158.9	95.6	16.2	8.5	6.8	28.9	61.6	96.5	82.4	829.4	831.7
s	77.4	68.9	83.7	99.5	77.5	22.1	15.4	9.9	26.6	83.9	106.7	76.3	369.7	332.0
C_v	1.07	0.88	0.68	0.63	0.81	1.36	1.81	1.46	0.92	1.36	1.11	0.93	0.45	0.40

Data CD 2

Meteorology

Meteorological stations in and close to the project area

Station (organization) [1] Station number	longitude	latitude	altitude m a.MSL	start of station		B	C	D	E	F	G	H	I	J	K	L	M	N	Remarks
Wami Prison Farm (Maji) (963756)	6° 30'	37° 33'	580	16/6/62		x	x	x	x	x	x	x	x	x	x	x		x	
Mikula (Maji) (900064)	7° 15'	38° 15'	-	30/8/66		x	x	x	x	x		x	x	x	x	x		x	
Ilonga (Agriculture) (963732)	6° 46'	37° 02'	500	-		up to 5/1975	x	x	x	x			x	x	x	x		x	
Morogoro (EAMO) (963776)	6° 50'	37° 39'	530	1968 [2]		x	x	x	x	x		x	x	x	x	up to 10/1974	from 7/75	x	
Kongwa (Agriculture) (963603)	6° 12'	36° 25'	1021	-			x	x	x	x		x	x	x	x				Data can only be obtained at the stations itself and not at the Dept. of Agriculture in Dar es Salaam
Kilombero (Agriculture) (973729)	7° 40'	37° 00'	300	-	x	x	x	x	x	x				x	x			x	

[1]) Organizations involved are Ministry of Water Development and Power (Maji), Ministry of Agriculture (Agr.) and the East African Meteorological Department (EAMD)

[2]) before 1968 station a meteorological station was runned by the Ministry of Agriculture

A - Class A pan, no screen
B - Class A pan, screen
C - Dry bulb thermometer
D - Wet bulb thermometer
E - Max. temperature
F - Min. temperature
G - Piche-Evaporimeter
H - Thermohygrograph
I - Anemometer
J - Automatic Rainfall Recorder
K - Standard Raingauge
L - Gunn Bellani Radiation-integrator
M - Kipp Solarimeter
N - Sunshine recorder

Legend (meteorological data)

°C	=	degree celcius (centigrade)
%	=	per cent
hrs	=	hours
l	=	langley
mi/hr	=	miles per hour
mi/day	=	miles per day
km/day	=	kilometers per day
mm	=	millimeter

Wami Prison Farm (963756)

1970	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.
Mean Temp. (°C)	23.4	26.9	27.0	26.0	24.8	22.3*	23.5	24.1	23.8	24.8	28.0	25.4
Dew Point (°C)	21.6	22.8	22.1	21.6	19.9	17.6*	18.2	17.9	17.7	18.4	20.3	22.0
Rel. Hum. (%)	81.1	87.3	84.6	86.4	82.8	80.0*	79.0	76.3	70.5	68.7	68.2	79.6
Sunshine (hrs)	-	-	-	-	-	-	-	-	-	-	-	-
Radiation (l)	440.3	446.2	522.2	373.1	415.6	398.0*	386.6	372.5	412.0	465.3	543.8	451.7
Wind (mi/day)	62	51	51	34	32	34 *	55	76	86	103	121	82
Total Evap. (mm)	174.5	141.5	142.2	95.0	114.3	140 *	151.2	145.6	190.0	228.2	312.4	192.5
Total Rainfall (mm)	230.4	176.6	238.1	163.4	29.8	1.1*	6.9	0.0	58.7	11.1	0.4	269.2

* Monthly values estimated, because of some missing days

1971	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.
Mean Temp. (°C)	26.9	26.2	26.6	25.1	23.6	21.9	23.6	19.2	21.1	22.1	24.0	24.1
Dew Point (°C)	21.8	21.5	21.7	21.3	19.5	17.3	18.2	17.7	18.6	19.8	20.7	21.6
Rel. Hum. (%)	83.5	85.6	82.8	84.3	82.4	79.9	81.0	79.3	75.3	73.4	69.9	78.3
Sunshine (hrs)	-	-	-	-	-	-	-	-	-	-	-	-
Radiation (l)	492.1	431.9	512.7	381.0	399.1	428.2	348.8	435.6	413.1	502.8	568.3	521.8
Wind (mi/day)	63	43	51	27	24	26	32	59	85	101	103	85
Total Evap. (mm)	253.5	118.9	187.4	117.8	130.9	127.4	105.5	163.8	188.9	219.7	266.2	232.4
Total Rainfall (mm)	173.5	80.5	112.5	246.1	83.9	28.4	12.8	0.0	3.5	34.3	3.3	81.3

Note: Relative Humidity at 9.00 hrs

Wami Prison Farm (continued)

1972	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.
Mean Temp. (°C)	23.1	23.8	26.5	25.6	23.9	22.3	22.5	22.4	24.7	25.8	25.3	26.9
Dew Point (°C)	22.0	21.3	21.8	21.7	20.6	17.8	17.8	17.2	18.8	21.0	21.0	21.6
Rel. Hum. (%)	82.5	83.3	85.0	85.0	87.2	82.6	83.1	78.8	76.7	82.2	79.6	80.0
Sunshine (hrs)	-	-	-	-	-	-	-	-				
Radiation (l)	538.4	401.8	434.2	381.1	351.4	382.2	373.7	418.9	445.3	456.2	450.0	496.3
Wind (mi/day)	70	64	64	39	32	37	40	59	78	77	66	63
Total Evap. (mm)	191.5	199.3	244.1	179.5	*	*	*	*	*	*	*	*
Total Rainfall (mm)	75.8	35.5	145.3	174.4	146.9	0.0	9.7	0.3	21.7	135.4	68.2	93.4

1973	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.
Mean Temp. (°C)	26.8	26.1	pp [2])	pp	pp	pp	pp	pp	pp	26.3	27.9	26.9
Dew Point (°C)	22.4	pp	"	"	"	"	"	"	"	20.8	21.6	21.9
Rel. Hum. (%)	90	"	"	"	"	"	"	"	"	74.1	76.0	82.9
Sunshine (hrs)	-	"	"	"	"	"	"	"	"		*	
Radiation (l)	443.5	"	"	"	"	"	"	"	"		*	*
Wind (mi/day)	49	"	"	"	"	"	"	"	"	105	101	77
Total Evap. (mm)	*	201.3	"	"	"	"	"	"	"	250.4	268.4	140.4
Total Rainfall (mm)	241.3	189.4	19.3	547.0	112.7	3.55	1.8	11.6	0.0	57.2	57.3	31.0

[2]) pp = partly processed
* missing

Wami Prison Farm (continued)

1974	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.
Mean Temp. (°C)	26.9	30.8	27.6	25.5	24.5	22.9	22.4	23.5	23.7	24.7	27.1	28.3
Dew Point (°C)	21.4	21.4	21.9	22.2	21.1	19.2	19.3	18.5	18.7	19.2	20.5	22.0
Rel. Hum. (%)	81.4	76.7	80.0	90.2	87.6	88.2	91.8	83.7	75.2	72.6	71.4	77.3
Sunshine (hrs)	*	*	*	*	*	*	*	*	*	*	*	*
Radiation (l)	*	*	*	*	*	*	*	*	*	*	*	*
Wind (mi/day)	77	86	77	37	34	33	36	63	89	95	121	105
Total Evap. (mm)	184.2	180.7	171.8	232.4	134.1	110.3	97.3	120.5	188.9	196.9	225.8	300.1
Total Rainfall (mm)	151.2	48.0	79.0	244.0	128.0	34.5	50.5	2.5	4.0	44.0	1.3	166.5

1975	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.
Av. Max.Temp. (°C)	-	-	-	-	-	-	-	-	-	-	-	-
Av. Min.Temp. (°C)	-	-	-	-	-	-	-	-	-	-	-	-
Mean Temp. (°C)	27.1	28.6	26.5	*	23.9	21.8	21.4	22.0	23.1	24.0	28.0	27.0
Dew Point (°C)	21.5	20.5	22.4	*	21.0	18.7	17.1	17.0	18.7	np	20.6	21.3
Rel. Hum. (%)	81.2	73.1	89.1	*		91.0	87.2	58.7	76.7	54.2	49.7	71.0
Sunshine (hrs)	*	*	*	*		*	6.15	*	5.8	*	*	6.8
Radiation (l)	*	*	*	*	*	*	392.3	*	393.6	pp	549.4	534.4
Wind (mi/day)	79	106	55	*	32	33	48	57	74	103	117	83
Total Evap. (mm)	186.3	214.1	271.4	*	121.6	119.5	147.6	238.8	186.6	207.2	236.7	218.7
Total Rainfall (mm)	124.0	22.4	410.0	300.0	57.0	19.0	3.0	0.0	6.0	14.0	0.0	3.2

* Missing

Mikula (900064)

1970	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.
Mean Temp. (°C)	28.0	28.3	28.3	27.1	26.2	26.3	25.2	26.2	24.9	27.1	28.5	28.9
Dew Point (°C)	23.3	24.2	24.2	23.4	21.9	20.0	19.6	19.9	20.5	20.4	21.5	22.2
Rel. Hum. (%) *	81.0	82.6	81.7	81.8	78.7	71.7	73.6	70.9	75.7	66.8	64.2	70.7
Sunshine (hrs)	-	-	-	-	-	-	-	-	-	-	-	-
Radiation (l)	424.1	460.5	536.2	455.0	443.2	419.3	372.0	414.6	463.6	524.1	481.5	503.8
Wind (km/day)	-	-	-	-	-	-	-	-	-	-	-	-
Total Evap. (mm)	152.2	121.7	176.6	130.0	123.3	148.2	140.4	153.0	126.1	179.6	223.6	184.6
Total Rainfall (mm)	170.4	120.4	232.4	90.7	8.1	0.0	13.0	1.0	137.0	16.5	0.0	111.9

* Relative Humidity at 9.00 hours only

1971	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.
Mean Temp. (°C)	27.9	27.5	28.9	26.9	26.3	25.6	25.5	25.0	26.1	27.1	29.4	-
Dew Point (°C)	15.8	22.5	22.7	23.4	22.0	20.2	20.3	19.4	19.2	19.7	18.2	21.0
Rel. Hum. (%) *	76.5	78.9	79.5	86.6	84.3	83.6	53.6	53.2	53.0	53.1	50.0	-
Sunshine (hrs)	-	-	-									
Radiation (l)	489.0	461.8	483.7	405.1	448.3	452.5	361.1	407.7	410.7	443.3	547.4	-
Wind (km/day)	-	98	83	46	56	67	62	80	91	104	157	133
Total Evap. (mm)	151.2	177.3	200.5	128.1	122.2	137.1	122.9	146.0	144.8	156.3	224.3	230.9
Total Rainfall (mm)	125.2	47.2	145.4	253.8	50.7	13.7	14.0	0.0	28.0	19.9	0.8	144.8

* Rel. Humidity up to June, reading at 9.00 hours, thereafter daily mean

Mikula (continued)

1972	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.
Mean Temp. (°C)	28.2	28.3	28.6	26.6	26.0	23.9	24.4	25.1	26.6	27.4	27.6	28.2
Dew Point (°C)	22.1	22.3	22.9	24.0	23.7	19.8	20.0	19.8	20.2	21.9	23.5	22.4
Rel. Hum. (%)	56.5	56.7	*	60.9	60.0	*	51.8	50.1	51.2	*	-	-
Sunshine (hrs)	-	-	-	-	-	-	-	-	-	-	-	-
Radiation (l)	510.0	424.4	494.4	390.9	405.0	434.2	390.2	407.0	459.1	496.4	489.6	534.0
Wind (km/day)	108.0	93.6	60.8	39.4	43.1	47.7	57.3	70.0	79.0	71	69.5	90.2
Total Evap. (mm)	217.1	143.2	150.8	129.0	111.8	158.8	100.6	106.7	150.0	165.1	141.2	235.7
Total Rainfall (mm)	112.5	117.9	114.4	302.0	179.0	0.0	1.5	0.0	66.1	121.6	100.7	171.8

1973	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.
Mean Temp. (°C)	28.2	29.0	29.4									
Dew Point (°C)	np	np	np			Processing not finished						
Rel. Hum. (%)	np	np	np									
Sunshine (hrs)	-	-										
Radiation (l)	515.1	492.5	551			or						
Wind (km/day)	93.6	69.9	64.8			data could not be traced						
Total Evap. (mm)	np	np	np									
Total Rainfall (mm)	248.6	149.4	71.7									

Note: np = Data not processed

Ilonga (963732)

1970	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.
Av. Max.Temp. (°C)	30.0	31.0	30.6	29.3	29.1	28.6	28.4	28.4	29.3	31.1	34.1	31.8
Av. Min.Temp. (°C)	20.7	21.0	20.6	20.6	18.2	16.2	16.6	17.1	17.8	19.2	21.0	21.0
Mean Temp. (°C)	25.4	26.0	25.6	25.0	23.7	22.4	22.5	22.8	23.6	25.2	27.6	26.4
Wet Bulb (°C)	22.1	22.9	22.6	22.0	20.6	19.0	18.6	19.0	19.0	19.9	22.6	22.3
Dew Point (°C)	21.6	22.3	22.0	21.2	19.2	17.4	17.1	17.5	17.3	18.1	21.4	21.4
Rel. Hum. (%)	-	-	-	-	-	-	-	-	-	-	-	-
Sunshine (hrs)	4.6	6.9	5.1	5.8	7.3	7.9	6.6	6.8	6.9	8.5	9.3	6.7
Radiation (l)	431.6	532.4	524.6	447.2	451.3	445.6	405.8	420.6	478.5	532.8	579.4	498.0
Wind (mi/hr)	2.6	2.3	2.7	2.6	3.4	3.9	3.7	4.1	4.2	4.9	5.7	4.0
Total Evap. (mm)	3.7	3.5	4.0	3.7	5.9	7.1	6.8	7.1	7.0	8.2	10.5	6.0
Total Rainfall (mm)	249.7	119.9	271.4	45.7	7.3	9.2	3.4	10.1	55.2	17.7	6.3	196.3
A-pan (mm)	4.1	4.8	5.2	4.3	4.7	5.1	4.8	5.2	5.8	6.9	8.9	6.7

1971	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.
Av. Max.Temp. (°C)	31.0	29.6	30.4	29.1	28.0	27.3	27.2	28.5	29.6	31.3	34.0	32.4
Av. Min.Temp. (°C)	20.4	19.7	19.9	19.8	18.0	14.8	16.4	15.5	18.1	19.3	20.5	20.7
Mean Temp. (°C)	25.7	24.7	25.2	24.5	23.0	21.1	21.8	22.0	23.9	25.3	27.3	26.6
Wet Bulb (°C)	22.1	21.6	21.8	22.2	20.4	18.0	18.6	17.7	18.8	20.3	21.7	22.1
Dew Point (°C)	21.6	21.1	21.1	21.6	19.2	-	17.2	-	-	-	-	-
Rel. Hum. (%)	-	-	-	-	-	-	-	-	-	-	-	-
Sunshine (hrs)	6.4	6.4	7.8	6.5	7.1	8.2	5.4	7.8	6.7	8.0	9.4	7.2
Radiation (l)	500.6	497.0	528.7	444.1	439.8	456.0	377.5	457.3	457.5	519.8	591.6	515.0
Wind (mi/hr)	3.1	2.2	2.7	2.5	2.9	3.3	3.2	3.7	4.4	5.3	5.4	4.0
Total Evap. (mm)	4.6	3.4	4.5	3.0	4.6	6.4	5.7	7.7	8.4	9.9	10.9	6.8
Total Rainfall (mm)	101.9	113.4	170.5	224.9	26.7	17.1	9.1	2.5	10.7	23.0	26.7	55.5
A-pan (mm)	5.1	4.6	5.2	4.1	4.1	4.6	3.9	5.2	5.7	7.3	9.2	6.6

Ilonga (continued)

1972	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.
Av. Max.Temp. (°C)	31.2	30.1	30.1	29.5	28.4	27.4	27.8	29.1	29.9	30.5	30.8	31.6
Av. Min.Temp. (°C)	20.7	19.8	20.2	19.9	18.8	15.0	15.0	15.5	19.0	20.2	20.6	21.0
Mean Temp. (°C)	26.0	25.0	25.2	24.7	23.6	21.2	21.4	22.3	24.5	25.4	25.7	26.3
Wet Bulb (°C)	22.2	21.5	22.2	22.3	21.7	18.8	18.5	18.4	19.7	21.1	22.0	22.6
Dew Point (°C)	21.6	20.9	21.5	21.6	21.0	17.4	17.0	17.0	18.1	20.0	21.0	21.6
Rel. Hum. (%)	-	-	-	-	-	-	-	-	-	-	-	-
Sunshine (hrs)	7.5	4.8	6.3	6.5	6.7	7.4	7.2	7.4	7.8	7.3	6.8	7.1
Radiation (l)	558.7	447.7	493.6	456.3	407.5	432.6	409.3	443.0	492.2	504.1	506.3	519.2
Wind (mi/hr)	3.4	2.3	2.5	2.4	2.6	2.8	3.1	3.3	3.9	4.4	3.3	3.0
Total Evap. (mm)	5.4	3.7	3.6	3.1	3.4	5.2	5.8	6.8	7.0	6.5	4.7	4.9
Total Rainfall (mm)	147.7	97.5	302.7	137.8	126.8	0	1.5	0.6	51.3	80.0	130.4	113.3
A-pan (mm)	6.0	4.1	6.1	4.1	3.7	4.1	4.2	4.8	5.6	5.5	5.1	5.5

1973	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.
Av. Max.Temp. (°C)	30.7	31.0	32.0	30.0	29.0	28.2	28.2	28.7	30.7	32.6	33.1	32.0
Av. Min.Temp. (°C)	20.7	21.0	21.2	20.4	19.2	14.9	13.8	16.2	17.9	19.6	20.5	20.0
Mean Temp. (°C)	25.7	26.0	26.6	25.2	24.1	21.6	21.0	22.5	24.3	26.1	26.8	26.0
Wet Bulb (°C)	22.6	22.9	23.3	22.5	21.2	18.5	17.7	18.4	19.3	20.2	21.7	21.7
Dew Point (°C)	22.1	22.4	22.6	21.7	20.3	16.5	15.6	16.7	17.6	18.4	20.3	20.6
Rel. Hum. (%)	-	-	-	-	-	-	-	-	-	-	-	-
Sunshine (hrs)	5.3	6.3	8.6	6.0	6.3	7.2	8.0	6.2	7.4	8.7	8.5	8.3
Radiation (l)	461.0	449.3	452.6	416.2	419.5	421.4	431.7	431.5	481.3	524.9	558.4	542.1
Wind (mi/hr)	2.4	2.1	2.3	2.3	2.4	3.3	3.6	3.3	3.9	4.8	4.6	3.9
Total Evap. (mm)	3.2	3.6	4.0	3.2	4.0	6.1	7.2	6.7	7.6	9.1	8.3	6.2
Total Rainfall (mm)	251.8	132.7	105.0	223.6	44.3	0.9	3.4	1.7	0	2.7	57.3	157.2
A-pan (mm)	4.3	4.5	5.0	3.9	3.8	4.4	4.7	4.4	5.8	7.0	7.3	6.5

Ilonga (continued)

1974	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.
Av. Max.Temp. (°C)	32.5	33.4	32.1	29.1	28.7	27.3	26.3	28.7	30.3	30.9	33.5	34.2
Av. Min.Temp. (°C)	20.3	20.8	20.2	19.6	18.1	15.6	15.1	14.6	15.4	17.6	20.3	20.8
Mean Temp. (°C)	26.4	27.1	26.2	24.4	23.4	21.5	20.7	21.7	22.9	24.3	26.9	27.5
Wet Bulb (°C)	21.8	21.9	21.7	22.2	21.4	19.4	18.2	18.4	18.5	19.5	21.3	22.4
Dew Point (°C)	20.8	20.1	21.4	21.6	20.7	18.3	16.9	17.0	16.5	17.6	19.5	20.8
Rel. Hum. (%)	-	-	-	-	-	-	-	-	-	-	-	-
Sunshine (hrs)	7.7	9.4	8.3	5.6	7.0	6.0	5.6	8.3	7.8	7.9	8.6	8.8
Radiation (l)	541.3	593.6	534.9	410.0	412.8	358.0	363.8	441.6	497.1	494.2	528.5	541.3
Wind (mi/hr)	3.8	3.6	3.7	2.2	2.0	2.3	3.0	3.6	4.0	4.8	5.8	5.2
Total Evap. (mm)	6.9	7.0	6.4	2.5	3.0	3.8	4.8	6.3	7.9	8.7	11.6	10.6
Total Rainfall (mm)	113.5	30.5	230.5	302.6	150.8	11.0	22.3	22.4	9.6	18.1	2.1	71.5
A-pan (mm)	6.5	7.3	6.1	3.7	3.4	3.0	3.4	4.6	5.9	6.4	8.2	8.4

1975	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.
Av. Max.Temp. (°C)	31.9	34.6	30.5	29.3	28.7	27.3	28.0	27.9	29.2	30.8	33.7	32.4
Av. Min.Temp. (°C)	20.0	20.9	20.0	19.1	18.0	15.1	14.4	15.2	16.8	17.9	19.4	12.5
Mean Temp. (°C)	25.1	27.8	25.3	24.2	23.4	21.2	21.2	21.6	23.0	24.4	26.6	22.7
Wet Bulb (°C)	22.0	21.7	22.6	22.2	21.4	19.3	18.3	17.8	18.9	19.5	21.1	22.3
Dew Point (°C)	21.2	20.4	22.0	21.8	20.7	18.4	17.0	16.2	17.6	18.0	19.5	21.2
Rel. Hum. (%)	-	-	-	-	-	-	-	-	-	-	-	-
Sunshine (hrs)	6.8	8.2	6.7	6.8	6.4	6.1	7.3	6.1	6.2	7.3	9.3	7.0
Radiation (l)	505.3	587.9	501.3	446.0	368.2	353.5	432.5	402.8	450.5	491.7	575.1	2027.2*
Wind (mi/hr)	3.8	5.3	3.1	2.2	1.9	2.4	3.2	4.5	4.6	4.6	5.6	4.1
Total Evap. (mm)	7.5	9.9	3.8	2.6	2.8	3.7	5.8	7.3	7.1	8.5	7.9	4.8
Total Rainfall (mm)	84.2	46.6	245.9	297.7	91.6	6.0	1.2	1.8	19.2	12.4	0.1	187.1
A-pan (mm)	6.2	8.7	-	-	-	-	-	-	-	-	-	-

* Figure not considered reliable

Ilonga (continued)

1976	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.
Av. Max.Temp. (°C)	31.8	30.6	30.8	30.0	28.4	27.3	28.0	28.7	30.2	31.6	-	35
Av. Min.Temp. (°C)	19.4	17.7	19.5	19.3	17.2	15.0	13.2	14.2	17.4	19.0	-	21.5
Mean Temp. (°C)	26.5	24.2	25.2	24.7	22.8	21.0	20.6	21.5	23.8	25.3	-	28.5
Wet Bulb (°C)	22.0	22.5	22.7	22.0	20.7	19.2	18.1	18.2	19.4	20.8	-	22.4
Dew Point (°C)	20.5	21.6	21.2	21.4	19.8	18.2	16.4	16.8	17.7	19.1	-	22.0
Rel. Hum. (%)	-	-	-	-	-	-	-	-	-	-	-	-
Sunshine (hrs)	7.8	7.0	6.8	6.6	6.7	6.8	8.1	7.3	6.4	8.0	-	8.8
Radiation (l)	511.2	545.9	475.4	446.1	374.6	400.4	433.6	423.9	404.7	470.1	-	604.1
Wind (mi/hr)	3.5	2.7	2.5	2.5	2.9	3.0	3.4	3.6	5.3	5.1	-	-
Total Evap. (mm)	6.7	5.2	4.1	3.2	4.0	7.4	6.4	6.8	8.0	8.6	-	10.6
Total Rainfall (mm)	89.5	156.4	148.6	220.5	89.2	0	5.8	23.6	0	12.3	-	10.3

1977	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.
Av. Max.Temp. (°C)	31.1	29.6	30.8	27.9	28.8	28.4	29.0	29.1	29.6	31.7	30.9	31.1
Av. Min.Temp. (°C)	20.3	19.6	20.1	20.7	19.2	15.7	16.6	17.6	19.3	20.0	20.9	20.9
Mean Temp. (°C)	25.7	-	-	-	-	-	-	-	-	-	-	-
Wet Bulb (°C)	22.7	22.0	22.7	22.2	21.4	19.3	18.6	19.0	19.7	20.8	22.1	22.4
Dew Point (°C)	21.0	20.6	22.0	21.5	20.6	17.8	17.0	17.8	18.4	19.0	21.2	21.7
Rel. Hum. (%)	-	-	-	-	-	-	-	-	-	-	-	-
Sunshine (hrs)	6.5	6.6	7.6	4.0	6.1	8.5	8.4	5.4	6.8	8.2	7.4	7.7
Radiation (l)	454.5	-	-	-	-	-	-	-	-	-	-	-
Wind (mi/hr)	3.3	-	-	-	-	-	-	-	-	-	-	-
Total Evap. (mm)	5.1	5.6	4.0	2.9	-	-	-	-	-	-	-	-
Total Rainfall (mm)	306.4	130.8	72.4	154.1	32.8	1.6	3.5	17.4	103.8	23.0	153.8	346.4

Ilonga (continued)

1978	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.
Av. Max.Temp. (°C)	30.7	31.6	30.7	29.8	28.6	26.9	27.6	28.7				
Av. Min.Temp. (°C)	21.1	21.3	21.7	19.9	17.5	15.9	15.2	16.9				
Mean Temp. (°C)	-	-	-	-	-	-	-	-				
Wet Bulb (°C)	22.5	22.5	22.8	22.2	20.7	19.4	18.1	18.9				
Dew Point (°C)	22.1	21.7	22.3	21.5	19.5	18.3	16.9	17.6				
Rel. Hum. (%)	-	-	-	-	-	-	-	-				
Sunshine (hrs)	6.1	7.7	-	-	-	-	-	-				
Radiation (l)	-	-	-	-	-	-	-	-				
Wind (mi/hr)	-	-	-	-	-	-	-	-				
Total Evap. (mm)	-	-	-	-	-	-	-	-				
Total Rainfall (mm)	143.3	48.9	215.1	275.2	36.1	12.3	5.2	5.8				

Morogoro MET (963776)

1971	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.
Av. Max.Temp. (°C)	30.8	30.3	31.0	28.2	27.7	27.1	26.5	27.5	29.3	30.7	33.3	32.5
Av. Min.Temp. (°C)	20.6	20.3	20.1	20.0	18.0	14.7	15.7	14.5	16.5	16.8	19.8	20.7
Wet Bulb (°C)	21.2	21.2	21.3	21.5	19.9	17.3	17.7	17.1	18.4	18.9	20.2	21.0
Dew Point (°C)												
Rel. Hum. (%)	78	84	70	89	90	81	87	81	81	69	64	73
Sunshine (hrs)	7.0	7.2	7.8	4.9	6.6	8.0	6.5	7.0	6.8	8.4	7.7	8.1
Radiation (l)	-	-	-	-	315.5	334.8	321.2	349.1	362.9	412.9	456.5	408.1
Wind (mi/day)	-	-	-	-	62.7	85.6	97.9	121.6	140.6	146.3	205.5	192.3
Total Evap. (mm)	185.6	-	187.9	99.4	103.9	120.6	124.4	190.0	155.4	210.5	301.2	244.5
Total Rainfall (mm)	124.6	37.6	63.9	226.7	55.4	36.5	7.4	0.0	3.9	6.0	3.7	34.5

1972	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.
Av. Max.Temp. (°C)	31.5	27.6	29.7	28.7	28.1	26.4	26.6	28.2	29.4	30.2	31.6	31.6
Av. Min.Temp. (°C)	21.1	20.7	20.3	20.0	19.5	15.0	15.2	14.2	16.7	19.0	20.3	21.0
Wet Bulb (°C)	21.6	21.4	21.6	21.5	20.9	18.1	17.6	17.7	18.9	20.9	21.6	22.2
Dew Point (°C)												
Rel. Hum. (%)	79	83	87	90	92	85	87	83	79	81	81	78
Sunshine (hrs)	8.3	5.4	6.3	5.5	5.9	6.0	5.6	7.7	7.6	7.4	6.4	7.4
Radiation (l)	433.4	342.7	355.0	324.5	303.5	293.2	275.6	348.2	346.9	370.3	376.8	410.0
Wind (mi/day)	176.7	132.3	95.4	61.2	60.6	57.0	77.3	108.6	128.3	120.8	102.9	135.7
Total Evap. (mm)	242.8	163.2	162.0	116.4	92.9	95.0	94.1	144.7	167.8	172.4	147.7	193.3
Total Rainfall (mm)	109.3	116.4	177.0	165.9	152.8	0.0	26.1	14.2	22.8	83.0	71.3	107.2

Morogoro MET (continued)

1973	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.
Av. Max.Temp. (°C)	30.5	-	-	-	-	-	-	-	-	31.8	32.1	31.2
Av. Min.Temp. (°C)	21.3	21.0	21.4	20.4	18.6	15.4	14.1	15.8	16.5	17.8	19.8	20.6
Wet Bulb (°C)	22.2	22.5	22.6	22.0	20.7	18.0	16.5	17.7	18.8	19.9	21.0	21.5
Dew Point (°C)												
Rel. Hum. (%)	85	85	84	94	89	85	83	81	76	72	71	76
Sunshine (hrs)	6.4	7.0	7.9	4.9	5.4	6.9	7.5	6.1	6.9	9.0	9.1	8.6
Radiation (l)	380.0	383.3	376.7	301.5	296.3	297.2	327.9	320.9	361.7	414.9	430.9	425.2
Wind (mi/day)	114.7	97.9	63.5	63.2	58.8	68.3	82.7	102.1	196.9	149.5	193.3	183.7
Total Evap. (mm)	116.7	138.7	169.5	101.5	87.3	95.7	114.6	145.0	176.0	226.7	221.0	216.5
Total Rainfall (mm)	248.7	85.7	41.7	291.0	61.3	14.7	9.6	8.9	3.5	18.1	48.3	125.5

1974	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.
Av. Max.Temp. (°C)	31.8	33.9	31.6	28.6	28.2	26.8	26.4	28.1	29.0	30.3	32.8	34.1
Av. Min.Temp. (°C)	20.9	21.4	20.3	20.5	18.9	16.4	15.5	15.0	15.4	17.2	20.3	22.0
Wet Bulb (°C)	21.3	21.6	21.6	21.7	20.9	18.8	17.9	17.7	16.7	19.3	20.8	21.7
Dew Point (°C)												
Rel. Hum. (%)	75	73	80	90	90	88	89	83	78	74	66	67
Sunshine (hrs)	7.5	9.3	8.0	4.6	-	6.4	5.3	7.5	7.0	7.8	8.5	8.5
Radiation (l)	130.1	440.5	405.3	311.3	335.0	310.2	244.2	335.1	366.2	395.5	-	-
Wind (mi/day)	192.7	214.0	150.0	69.4	56.6	57.7	70.8	117.2	143.6	149.2	-	-
Total Evap. (mm)	237.5	254.8	228.4	115.4	106.6	94.0	96.0	147.6	170.9	205.7	253.9	300.0
Total Rainfall (mm)	26.6	12.3	86.5	278.8	102.4	22.5	14.3	3.6	4.4	25.0	1.4	9.5

Morogoro MET (continued)

1975	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.
Av. Max.Temp. (°C)	31.7	34.4	31.1	28.9	28.0	27.3	27.6	27.3	28.6	30.5	33.0	32.0
Av. Min.Temp. (°C)	21.0	21.8	21.1	20.2	18.8	15.9	15.1	14.9	16.5	17.2	19.0	21.1
Wet Bulb (°C)	21.4	21.3	22.3	21.9	20.9	18.6	17.6	17.2	18.9	19.4	20.6	21.6
Dew Point (°C)												
Rel. Hum. (%)	78	72	84	91	90	90	85	80	80	74	66	73
Sunshine (hrs)	-	-	-	5.8	5.8	5.7	6.9	6.1	5.8	7.4	9.5	7.3
Radiation (l)	-	-	-	-	-	323	367	-	385	461	549	499
Wind (mi/day)	-	-	-	61.7	48.1	563.4*	84.1	110.4	107.2	137.2	174.1	141.8
Total Evap. (mm)	205.1	284.0	158.8	131.2	99.0	84.0	112.8	136.4	-	209.7	254.7	229.3
Total Rainfall (mm)	104.1	38.0	163.3	197.7	102.7	25.3	2.3	0.4	11.3	21.7	29.7	78.3

1976	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.
Av. Max.Temp. (°C)	31.5	32.0	31.2	29.4	28.2	27.2	27.4	28.0	29.5	30.8	33.6	33.8
Av. Min.Temp. (°C)	20.9	20.8	20.9	20.9	18.2	15.6	13.9	14.8	16.6	18.1	19.4	21.9
Wet Bulb (°C)	21.5	22.4	22.2	24.6	20.6	18.6	17.1	17.4	18.9	19.5	21.1	21.9
Dew Point (°C)												
Rel. Hum. (%)	77	81	81	87	90	88	81	78	77	73	64	67
Sunshine (hrs)	-	6.9	6.5	6.2	5.5	6.2	7.3	6.7	7.2	8.7	9.9	9.0
Radiation (l)	479	489	441	394	342	354	373	381	415	516	523	541
Wind (mi/day)	-	177.5	111.4	81.1	52.8	65.3	96.5	128.9	141.2	171.7	176.2	253.7
Total Evap. (mm)	215.1	191.6	163.3	-	-	-	-	-	-	245.0	276.4	312.1
Total Rainfall (mm)	106.4	22.3	118.3	156.7	41.5	54.0	7.5	3.9	28.9	7.5	9.4	61.6

*   Figure not considered reliable

Morogoro MET (continued)

1977	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.
Av. Max.Temp. (°C)	31.5	31.4	29.0	28.1	28.8	27.0	28.4	28.5	33.0	32.3	30.2	32.7
Av. Min.Temp. (°C)	22.0	21.9	19.6	19.1	19.1	15.0	15.2	15.6	16.2	18.6	20.2	21.5
Wet Bulb (°C)	22.3	22.0	21.4	21.0	20.9	18.1	17.8	18.1	18.7	20.1	27.6	21.8
Dew Point (°C)	-	-	-	-	-	-	-	-	-	-	-	-
Rel. Hum. (%)	79	76	84	90	89	84	82	83	79	75	78	79
Sunshine (hrs)	7.3	8.3	7.2	4.1	6.2	7.5	7.8	6.1	-	7.7	7.2	6.9
Radiation (1)	485	515	460	347	372	365	391	344	-	468	467	492
Wind (mi/day)	-	-	-	-	-	-	-	-	-	-	-	-
Total Evap. (mm)	200.2	228.4	153.6	-	-	-	-	-	-	-	88.3	171.2
Total Rainfall (mm)	136.6	166.4	128.5	123.3	84.0	2.9	23.7	9.4	22.9	50.3	45.0	152.2

1978	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.
Av. Max.Temp. (°C)	30.4	31.9	31.1	29.9	28.4	27.6	28.1	28.4	31.0	32.5	31.7	27.1
Av. Min.Temp. (°C)	21.3	21.3	21.3	20.0	17.8	16.3	14.4	15.8	16.5	18.4	20.1	20.7
Dew Point (°C)	19.6	19.7	21.1	21.2	18.0	16.5	14.4	13.2	12.7	15.1	18.2	21.2
Rel. Hum. (%)	55	53	61	64	58	54	46	41	36	37	52	66
Sunshine (hrs)	6.8	8.1	5.7	6.8	6.7	5.3	7.5	7.0	8.3	8.7	7.2	5.3
Radiation (1)	476	532	458	422	354	386	382	396	468	504	446	428
Wind (mi/day)	142.2	136.4	90.4	58.2	59.3	61.8	83.0	124.7	140.3	149.8	118.4	116.6
Total Evap. (mm)	172.5	204.0	185.3	141.4	108.1	93.1	125.5	174.8	198.6	232.5	199.3	140.1
Total Rainfall (mm)	202.1	62.0	204.8	191.4	37.6	12.1	15.0	3.3	3.1	5.0	173.6	255.7

Data CD 3

Hydrometry

CD 3.1 Hydrometric stations, monthly data

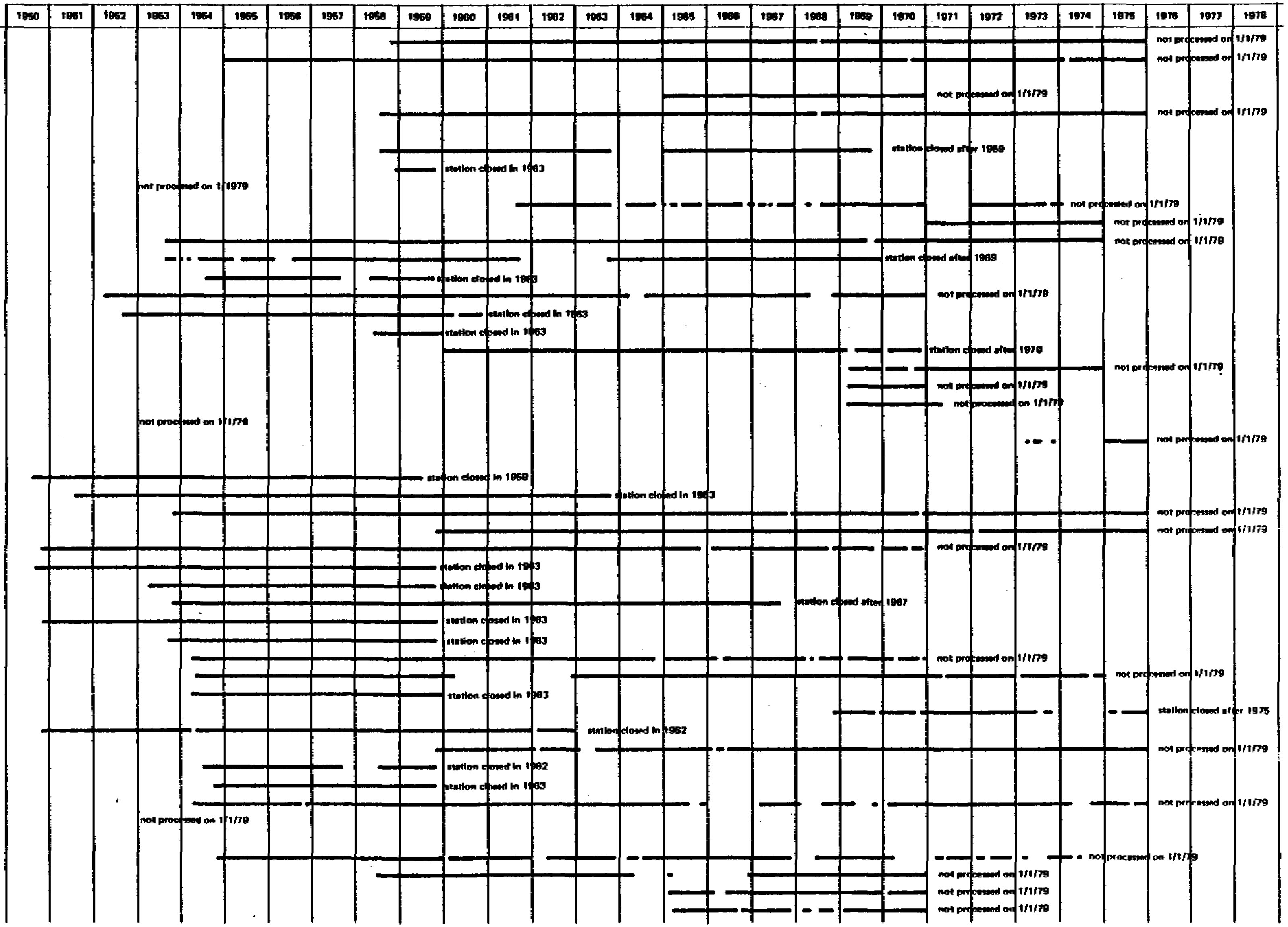
Hydrometric Stations

River	Station number	Location	Latitude S	Longitude E	Altitude m a.MSL[1]	Catchment area, km²
Wami	1G1	Dakawa	6° 07'	37° 02'	380	28 500
Wami	1G2	Mandera	6° 15'	38° 23'	168	36 450
Tami	1G5A	Msowero	6° 32'	37° 13'	457	907
Kisangate	1G6	Mvumi	6° 37'	37° 11'	-	404
Wami	1G8	Rudewa	6° 41'	37° 07'	466	320
Mkundi	1G10	Mtale	6° 15'	37° 20'	600	1 326
Difulu	1G11	Chogoali	-	-	-	-
Lukigura	1GA1A	Kimamba	6° 49'	37° 47'	520	100
Mziha	1GA2	Mziha	-	-	-	-
Diwale	1GB1A	Turiani	6° 10'	37° 37'	350	3 290
Mkindu	1GB2	Mkindu	6° 15'	37° 52'	360	101
Chazi	1GB3	Chazi	6° 12'	37° 34'	457	6,2
Mkondoa	1GD2	Kilosa	6° 48'	36° 59'	490	17 550
Mkombola	1GD5	Lukando	-	-	914	266
Miyombo	1GD6	Ulaya	7° 04'	36° 53'	580	300
Kinyasungwe	1GD14	Gulwe	6° 27'	36° 26'	820	10 750
Mkondoa	1GD29	Mbasawe	6° 36'	36° 47'	1 520	290
Lumuma	1GD30	Kilamalulu	6° 41'	36° 40'	1 050	502
Mdukwe	1GD31	Mdukwe	6° 49'	36° 53'	767	516
Miyombo	1GD35	Kivanga	-	-	-	-
Mkata	1GD36	Mkata	-	-	-	-
Ruvu	1H2	Ruvu Sisal Estate	6° 48'	38° 43'	27	12 488
Ruvu	1H3	Kidunda	7° 16'	38° 18'	76	6 697
Ruvu	1H5	Kibungo	7° 01'	37° 48'	473	420
Ruvu	1H8	Morogoro Road Bridge	6° 41'	38° 42'	15	15 190
Ngerengere	1HA1 (A)	Utari Bridge	7° 02'	38° 22'	90	2 840
Ngerengere	1HA3	Kingolwira	6° 45'	37° 48'	425	690
Ngerengere	1HA4	Kilimanjaro	6° 46'	37° 42'	457	630
Ngerengere	1HA5	Kiluwa	6° 44'	38° 06'	198	1 646
Ngerengere	1HA6	Kihonda	6° 47'	37° 39'	466	461
Mlali	1HA7	Mlali	6° 58'	37° 32'	518	18,1
Morogoro	1HA8	Morogoro	6° 51'	37° 40'	543	23,3
Ngerengere	1HA9 (A)	Konga	6° 54'	37° 37'	530	20,5
Mgera	1HA10	Mgera	6° 56'	37° 34'	518	15,4
Ngerengere	1HA15	Mgude	6° 48'	38° 09'	95	2 370
Mgeta	1HB1	Kisaki	7° 28'	37° 42'	152	963
Mgeta	1HB2	Mgeta	7° 03'	37° 34'	975	85,2
Mgeta	1HB3	Bunduki	7° 02'	37° 37'	1 220	46,0
Mwarazi	1HB4	Luhuela	7° 01'	37° 38'	1 493	5,0
Mvuha	1HC2	Mvuha	7° 12'	37° 51'	274	251
Mvuha	1HC2A	Tulo	-	-	-	-
Great Ruaha	1KA3	Kidatu	7° 40'	36° 57'	100	80 040
Great Ruaha	1KA38A	Yovi	7° 23'	36° 46'	610	630
Mwega	1KA57A	Malolo	-	-	-	-
Chali	1KA58A	Chali	7° 23'	36° 32'	1 294	559

[1]) m a.MSL = meters above mean sea level

Hydrometric Stations, periods of processed records

River	Station number	Location	Remarks
Wami	1G1	Dakawa	not processed on 1/1/79
Wami	1G2	Mandera	not processed on 1/1/79
Tami	1G5A	Msowero	not processed on 1/1/79
Kisangata	1G8	Mvumi	not processed on 1/1/79
Wami	1G8	Rudewa	station closed after 1969
Mkundi	1G10	Mtale	station closed in 1963
Difulu	1G11	Chognali	not processed on 1/1979
Lukigura	1GA1(A)	Kimamba	not processed on 1/1/79
Mzihe	1GA2	Mzihe	not processed on 1/1/79
Diwale	1GB1(A)	Turiani	not processed on 1/1/78
Mkindu	1GB2	Mkindu	station closed after 1969
Chazi	1GB3	Chazi	station closed in 1963
Mkondoa	1GD2	Kilosa	not processed on 1/1/79
Mkombola	1GD5	Lukando	station closed in 1963
Miyombo	1GD6	Ulaya	station closed in 1963
Kinyasungwe	1GD14	Gulwe	station closed after 1970
Mkondoa	1GD29	Mhasawe	not processed on 1/1/79
Lumuma	1GD30	Kilangaluke	not processed on 1/1/79
Mdukwe	1GD31	Mdukwe	not processed on 1/1/79
Miyombo	1GD35	Kiwanga	not processed on 1/1/79
Mkata	1GD36	Mkata	not processed on 1/1/79
Ruvu	1H2	Ruvu Sisal Estate	station closed in 1959
Ruvu	1H3	Kidunda	station closed in 1963
Ruvu	1H5	Kibungu	not processed on 1/1/79
Ruvu	1H8	Morogoro Road Bridge	not processed on 1/1/79
Ngerengere	1HA1 (A)	Utari Bridge	not processed on 1/1/79
Ngerengere	1HA3	Kingolwira	station closed in 1963
Ngerengere	1HA4	Kilimanjaro	station closed in 1963
Ngerengere	1HA5	Kiluwa	station closed after 1967
Ngerengere	1HA6	Kihonda	station closed in 1963
Mlali	1HA7	Mlali	station closed in 1963
Morogoro	1HA8	Morogoro	not processed on 1/1/79
Ngerengere	1HA9 (A)	Konga	not processed on 1/1/79
Mgera	1HA10	Mgera	station closed in 1963
Ngerengere	1HA15	Mgude	station closed after 1975
Mgeta	1HB1	Khaki	station closed in 1962
Mgeta	1HB2	Mgeta	not processed on 1/1/79
Mgeta	1HB3	Bunduki	station closed in 1962
Mwarazi	1HB4	Luhuele	station closed in 1963
Mvuha	1HC2	Mvuha	not processed on 1/1/79
Mvuha	1HC2A	Tulo	not processed on 1/1/79
Great Ruaha	1KA3	Kidatu	not processed on 1/1/79
Great Ruaha	1KA38A	Yovi	not processed on 1/1/79
Mwega	1KA57A	Malolo	not processed on 1/1/79
Chali	1KA58A	Chali	not processed on 1/1/79



Legend (discharge volumes tables)

*	=	not available, or missing data
-	=	not relevant, or not calculated
( )	=	estimated value
(p)	=	maximum flow or minimum flow from continuous record
n	=	number of years involved in the determination of m, s and C_v
m_1	=	mean (m^3/s)
m_2	=	mean (10^6 m^3)
s	=	standard deviation (10^6 m^3)
C_v	=	coefficient of variation (-)

Note that maximum and minimum flows, if not followed by (p) are average daily discharges, usually calculated from two waterlevel-observations a day.

Monthly discharge volumes (10^6 m^3) for river: WAMI

Station: DAKAWA Station number: 1G1

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan-Dec Total	Nov-Oct Total	Max. Flow Nov-Oct year m^3/s	Min. Flow Nov-Oct year m^3/s
1958	*	*	*	*	*	*	*	*	*	*	8.7	18.6	*	*	*	*
1959	20.7	27.9	61.8	69.6	52.0	26.5	12.1	14.5	11.0	8.0	5.7	10.4	320.2	331.4	49.80	2.41
1960	37.0	19.2	46.1	351.0	94.3	40.7	29.1	20.6	14.5	11.0	9.1	5.7	678.3	679.6	314.03	1.00
1961	4.8	23.4	33.0	57.2	101.9	29.9	24.0	17.0	12.2	16.7	111.3	242.3	673.7	334.9	75.09	1.44
1962	678.6	140.4	229.2	192.7	212.4	78.2	56.3	47.1	35.8	24.7	18.0	19.1	1732.5	2049.0	608.81	8.10
1963	64.3	67.0	147.5	425.5	186.6	75.1	57.8	40.1	30.3	21.9	52.5	112.3	1280.9	1153.2	383.98	4.57
1964	165.7	159.7	167.4	671.7	207.8	95.4	65.5	52.2	37.5	29.4	20.1	16.6	1691.0	1817.1	523.86	6.39
1965	51.1	27.8	53.1	148.8	64.1	42.9	25.3	20.2	14.2	16.2	16.6	29.5	509.8	500.4	109.87	4.81
1966	64.2	75.0	132.0	269.2	152.0	83.4	51.8	34.9	26.2	21.5	21.8	25.8	957.8	956.3	154.05	5.19
1967	18.2	23.5	32.6	160.5	272.2	150.6	71.0	50.4	45.5	38.0	44.0	369.0	1275.5	910.1	171.83	5.14
1968	299.7	137.6	337.7	773.1	278.9	226.9	(117.5)	91.5	57.2	41.2	45.0	98.5	(2504.8)	(2774.3)	702.50	12.41
1969	39.6	53.3	69.2	115.8	234.0	70.4	45.2	34.0	25.3	20.1	18.4	16.9	742.2	850.4	164.56	6.06
1970	100.2	145.1	167.3	219.8	87.2	39.9	29.8	22.6	20.1	15.7	9.9	21.3	878.9	883.0	170.46	3.71
1971	45.6	76.5	28.8	128.3	103.1	39.4	32.1	21.8	16.3	12.6	30.1	102.5	637.1	537.7	112.05	2.99
1972	40.9	23.2	73.6	184.7	206.6	97.1	44.0	29.8	26.7	27.4	30.1	102.5	887.2	887.2	98.63	3.08
1973	192.3	143.2	118.0	152.7	285.1	92.1	55.6	41.5	26.4	19.6	15.2	20.5	1162.2	1259.1	173.80	5.48
1974	14.3	18.0	10.0	115.2	261.5	69.7	41.8	26.8	18.6	15.6	10.7	8.3	610.5	627.2	165.02	4.22
1975	17.7	5.7	33.7	52.9	56.2	22.0	15.5	10.6	9.0	7.1	*	*	*	249.4	39.45	1.55
			(not processed on 1/1/79)													
n (1959-74)	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16
m_1	42.9	24.5	39.8	91.1	65.3	28.4	17.7	18.2	9.4	7.9	10.4	28.0	32.8	32.8	236.3	4.62
m_2	114.8	72.6	106.7	252.2	175.0	78.6	47.4	35.3	26.1	21.2	28.7	75.1	1033.9	1034.4	-	-
s	169.8	54.3	87.8	208.1	81.5	51.0	24.9	19.2	12.8	9.2	26.0	100.5	561.7	665.4	200.9	2.77
C_v	1.48	0.75	0.82	0.83	0.47	0.65	0.52	0.54	0.49	0.43	0.91	1.34	0.54	0.64	0.85	0.60

Monthly discharge volumes (10^6 m^3) for river: WAMI

Station: MANDERA Station number: 1G2

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan-Dec Total	Nov-Oct Total	Max. Flow Nov-Oct year m^3/s	Min. Flow Nov-Oct year m^3/s
1954	*	*	*	*	*	*	*	*	*	*	8.9	13.1	*	*	*	*
1955	11.3	190.5	93.0	270.8	*	131.5	49.1	31.1	18.9	14.1	15.5	30.7	*	*	204.73 (p)	1.22 (p)
1956	71.3	153.6	94.9	313.0	329.9	145.8	58.2	48.9	26.0	19.7	22.6	33.6	1317.5	1307.5	223.85 (p)	2.41 (p)
1957	75.9	98.2	59.7	477.7	910.4	126.8	66.7	47.4	31.0	23.7	32.4	67.6	2017.5	1973.7	570.98 (p)	4.87 (p)
1958	40.4	47.1	202.5	374.5	385.4	133.4	55.9	35.9	24.7	16.9	11.9	46.4	1375.0	1416.7	305.82 (p)	4.87 (p)
1959	35.5	55.5	185.8	137.1	222.3	35.4	28.3	33.5	25.2	23.3	20.5	32.0	834.4	840.2	526.69 (p)	4.07 (p)
1960	58.0	47.5	104.3	662.0	202.5	73.5	48.4	31.8	21.8	18.2	16.0	9.4	1293.4	1320.5	414.11	4.28
1961	7.9	74.6	78.2	111.6	173.5	40.3	77.4	40.2	39.3	93.5	741.5	472.0	1950.0	761.9	129.50	2.09
1962	1058.3	242.2	412.3	354.7	375.2	115.4	82.5	76.5	60.7	42.5	44.1	62.7	2927.1	4033.8	468.98	14.07
1963	121.0	104.4	298.7	692.3	347.1	105.3	83.7	58.7	40.1	14.0	148.3	227.7	2241.3	1972.1	406.48	9.34
1964	267.0	200.4	253.5	941.5	363.6	130.9	88.6	81.1	57.8	52.5	28.9	23.2	2489.0	2812.9	530.94	9.10
1965	103.6	42.7	79.5	264.2	144.2	103.2	57.1	41.1	23.7	46.2	79.4	116.3	1101.2	957.6	173.30 (p)	6.34 (p)
1966	153.9	111.0	371.4	802.6	288.6	134.4	88.4	65.0	42.0	33.8	33.0	48.1	2172.2	2175.8	656.95 (p)	9.25 (p)
1967	36.2	39.2	72.2	385.3	714.8	274.9	105.7	99.0	125.2	92.4	141.7	709.0	2795.6	2026.0	420.51 (p)	8.58 (p)
1968	631.5	148.2	544.5	2345.6	747.3	606.1	202.5	106.4	77.4	71.7	135.8	217.7	5834.8	6332.0	1798.02 (p)	21.65 (p)
1969	88.7	157.2	161.2	133.2	505.8	135.9	95.4	95.2	50.8	37.5	43.4	58.9	1563.2	1814.4	430.58 (p)	8.94 (p)
1970	160.5	234.8	301.7	560.8	158.0	76.8	57.5	(45.2)	35.6	27.7	15.6	56.7	(1730.9)	(1760.9)	430.58 (p)	7.78 (p)
1971	114.1	121.1	42.0	259.6	246.8	66.2	78.2	27.7	16.1	10.5	6.8	22.9	1012.0	1054.6	199.84 (p)	3.29 (p)
1972	82.1	22.2	139.6	355.1	475.0	181.6	79.0	48.7	60.7	97.2	134.4	225.0	1900.6	1570.9	265.76 (p)	1.74 (p)
1973	395.5	246.3	238.1	385.5	783.9	190.3	123.9	95.6	33.0	17.2	21.2	51.3	2581.8	2868.7	513.04 (p)	4.41 (p)
1974	32.8	35.8	(19.9)	260.9	721.9	136.1	92.9	48.0	32.5	22.1	15.4	8.7	(1427.0)	(1475.4)	562.45 (p)	2.06 (p)
1975	27.8	11.9	81.6	180.5	182.2	58.8	51.5	21.6	32.2	18.1	7.0	23.2	696.4	690.3	146.47 (p)	0.71 (p)
			(not processed on 1/1/79)													
n (1956-75)	20	20	20	20	20	20	20	20	20	20	20	20	20	20	-	20
m_1	66.5	45.4	69.9	191.7	154.5	55.4	30.3	21.4	16.5	14.5	32.8	46.9	62.3	62.1	-	6.49
m_2	178.1	109.7	187.1	496.9	413.9	143.6	81.1	57.4	42.8	38.9	85.0	125.6	1963.1	1958.3	-	-
s	254.9	76.1	140.8	491.3	238.8	122.4	36.2	26.1	25.0	28.2	162.1	177.6	1115.4	1312.3	-	4.94
C_v	1.43	0.69	0.75	0.99	0.58	0.85	0.45	0.45	0.58	0.72	1.91	1.41	0.57	0.67	-	0.76

Monthly discharge volumes (10^6 m^3) for river: TAMI

Station: MSOWERO Station number: 1G5A

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan-Dec Total	Nov-Oct Total	Max. Flow Nov-Oct year m^3/s	Min. Flow Nov-Oct year m^3/s
1965	7.5	4.6	5.4	19.6	6.9	4.1	3.2	2.8	2.1	3.4	3.0	7.6	70.2	*	42.68 (p)	0.59 (p)
1966	5.7	9.6	21.8	31.9	19.2	11.3	8.0	6.6	5.8	5.8	5.5	5.1	136.3	136.3	28.64 (p)	0.73 (p)
1967	3.9	7.7	9.4	50.6	130.6	35.3	13.7	10.0	11.9	9.9	10.9	156.4	450.3	293.6	504.68 (p)	0.86 (p)
1968	22.5	18.9	56.5	297.4	77.4	83.3	43.5	16.8	12.3	12.3	15.5	16.0	672.4	808.2	1134.62 (p)	2.89 (p)
1969	8.8	10.2	14.4	27.1	30.9	14.9	11.1	9.9	7.8	7.1	6.3	6.0	154.5	173.7	84.49 (p)	1.99 (p)
1970	21.5	17.8	28.6	25.1	14.1	8.8	7.5	6.8	6.6	5.7	3.4	9.4	155.3	154.8	209.33 (p)	1.54 (p)
1971			(not processed on 1/1/79)													0.36
1972																0.33
1973																1.00
1974																0.19
1975																0.10
1976																0.14
1977																0.11
n (1965-70)	6	6	6	6	6	6	6	6	6	6	6	6	6	5	6	13
m_1	4.4	4.4	8.5	42.2	17.4	10.2	5.4	3.3	3.0	2.8	2.9	12.5	8.7	9.9	334.0	0.66
m_2	11.7	11.5	22.7	75.3	46.5	26.3	14.5	8.8	7.8	7.4	7.4	33.4	273.2	313.3	-	-
s	8.2	5.7	18.6	104.3	48.2	29.9	14.6	4.7	3.9	3.2	4.9	60.4	236.1	283.4	430.1	0.58
C_v	0.70	0.50	0.82	1.45	1.04	1.14	1.01	0.54	0.50	0.44	0.65	1.81	0.83	0.90	1.29	0.89

Monthly discharge volumes (10^6 m^3) for river: KISANGATE

Station: MVUMI Station number: 1G6

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan-Dec Total	Nov-Oct Total	Max. Flow Nov-Oct year m^3/s	Min. Flow Nov-Oct year m^3/s
1958	*	*	*	*	*	*	*	4.6	3.4	2.6	1.8	1.8	*	*	*	*
1959	1.9	2.3	4.3	4.7	6.7	2.5	2.1	1.7	1.4	1.3	1.1	1.2	31.2	32.5	7.73	0.45
1960	0.6	1.0	2.7	17.5	8.9	4.5	2.9	1.9	1.2	1.1	0.9	0.7	43.9	44.6	18.75	0.29
1961	0.7	1.6	4.4	10.8	13.7	5.0	4.7	3.0	2.3	2.6	8.8	9.4	67.0	50.4	15.68	0.19
1962	21.6	8.7	23.3	21.0	20.8	7.4	5.2	3.9	2.8	2.1	1.7	1.9	120.6	135.0	43.07	0.71
1963	2.6	3.1	10.5	23.1	13.8	7.2	5.8	3.9	3.0	2.4	4.9	4.9	85.2	79.0	22.92	0.44
1964	5.4	6.0	19.8	40.8	16.4	8.2	6.0	4.5	3.5	2.8	2.1	2.1	117.6	123.2	35.89	0.75
1965	3.2	2.3	2.6	15.9	9.1	6.0	4.1	3.2	2.3	2.6	2.1	4.0	57.4	55.5	18.13	0.59
1966	3.4	4.3	16.9	21.0	*	*	4.6	3.4	2.6	2.3	2.4	1.9	*	*	23.65	0.62
1967	1.1	2.2	2.1	11.3	25.0	15.7	9.0	6.9	6.2	*	*	*	*	*	49.29	0.31
1968	15.3	9.2	18.8	59.8	29.7	11.6	15.1	6.0	4.1	3.0	4.1	7.4	184.1	*	49.19	0.87
1969	3.9	4.6	8.4	16.3	25.0	9.4	6.3	4.8	3.5	2.8	4.8	19.8	109.6	96.5	41.44	0.83
1970	4.5	6.2	24.3	28.8	12.6	5.5	4.0	3.2	2.5	2.1	1.5	3.0	98.2	118.3	67.35	0.58
1971	2.6	2.1	2.2	16.5	14.0	6.8	5.5	3.3	2.4	0.7	1.4	1.7	59.2	60.6	46.98 (p)	0.63 (p)
1972	3.0	2.1	7.7	14.1	24.0	10.8	6.4	4.4	3.6	4.0	3.8	9.4	93.3	83.2	62.45 (p)	0.36 (p)
1973	19.2	9.5	6.6	18.8	26.1	8.3	5.3	3.8	3.8	3.1	1.8	2.6	108.9	117.7	54.08 (p)	0.59 (p)
1974	1.8	1.1	1.2	14.3	35.6	*	5.1	4.2	2.8	2.3	1.6	1.6	*	*	119.45 (p)	0.22 (p)
1975	1.9	1.1	2.3	5.6	6.5	3.5	2.3	1.7	1.6	1.2	*	*	*	30.9	7.62 (p)	0.18 (p)
			(not processed on 1/1/79)													
n (1959-65, 1968-75)	13	13	13	13	13	13	13	13	13	13	13	13	13	13	-	17
m_1	2.4	1.9	3.4	8.6	6.6	2.8	2.1	1.4	1.1	0.9	1.2	1.9	2.8	2.5	-	0.51
m_2	6.5	4.5	10.4	22.2	17.6	7.2	5.6	3.7	2.8	2.4	3.0	5.2	88.9	79.0	-	-
s	7.2	3.1	8.2	14.3	7.4	2.6	3.1	1.2	0.9	0.9	2.2	5.3	36.7	36.3	-	0.22
C_V	1.11	0.68	0.79	0.64	0.42	0.36	0.55	0.32	0.32	0.38	0.74	1.01	0.41	0.46	-	0.44

Monthly discharge volumes (10^6 m^3) for river: WAMI

Station: RUDEWA Station number: 1G8

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan-Dec Total	Nov-Oct Total	Max. Flow Nov-Oct year m^3/s	Min. Flow Nov-Oct year m^3/s
1958	*	*	*	*	*	*	*	10.7	8.2	6.8	5.5	6.5	*	*	*	*
1959	7.8	7.9	13.0	11.7	13.7	7.9	7.0	6.9	5.4	4.8	3.7	5.2	95.0	98.1	29.73	1.59
1960	5.7	4.1	12.0	63.8	19.2	12.0	9.6	7.5	6.1	5.8	4.9	4.1	150.7	154.7	76.91	1.18
1961	4.1	6.9	15.3	33.1	23.2	10.7	9.2	8.0	7.0	10.9	27.6	27.1	183.1	137.4	44.24	1.30
1962	44.4	20.7	49.5	47.9	33.7	18.8	13.4	11.8	8.9	7.9	6.1	7.8	270.9	257.0	112.91	2.79
1963	14.0	14.4	39.4	82.9	35.9	21.1	15.3	10.9	9.0	7.7	*	*	*	264.5	87.36	1.79
1964	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1965	10.0	7.8	9.6	20.6	14.7	12.0	10.9	10.0	8.8	9.3	8.5	11.8	134.0	*	15.70	2.66
1966	11.1	11.6	23.9	36.3	23.2	16.9	14.1	11.9	10.8	10.8	9.7	10.4	190.7	190.9	34.42	2.96
1967	6.5	6.5	7.3	29.1	23.9	16.6	13.0	11.4	11.1	9.7	10.6	31.2	176.9	155.2	34.29	2.10
1968	22.7	18.1	25.6	58.9	39.7	31.4	22.7	(20.2)	(18.0)	16.0	18.7	24.4	(316.4)	(315.1)	44.55	3.46
1969	17.0	16.8	23.4	8.9	29.7	20.2	17.3	16.1	13.7	(12.5)	*	*	*	(218.7)	22.41	4.95
			(station closed after 1969)													
n (1959-62, 1965-68)	8	8	8	8	8	8	8	8	8	8	8	8	8	8	10	10
m_1	5.2	4.3	7.3	14.5	8.9	6.1	4.7	4.1	3.7	3.5	4.3	5.7	6.0	6.2	50.25	2.48
m_2	14.0	10.5	19.5	37.7	23.9	15.8	12.5	11.0	9.5	9.4	11.2	15.3	189.7	196.6	-	-
s	13.6	5.9	13.7	18.1	8.9	7.3	4.8	4.2	4.0	3.5	8.1	10.7	72.1	74.7	31.58	1.15
C_v	0.97	0.56	0.70	0.48	0.37	0.46	0.38	0.38	0.42	0.37	0.72	0.70	0.38	0.38	0.63	0.46

Monthly discharge volumes (10^6 m^3) for river: MKUNDI

Station: MTALE Station number: 1G10

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan-Dec Total	Nov-Oct Total	Max. Flow Nov-Oct year m^3/s	Min. Flow Nov-Oct year m^3/s
1958	*	*	*	*	*	*	*	*	*	*	*	0.5	*	*	*	*
1959	0.5	6.8	3.3	1.8	2.7	1.5	1.3	1.2	0.9	0.5	*	*	*	*	53.80	0.08

(station closed in 1963)

Monthly discharge volumes (10^6 m^3) for river: LUKIGURA

Station: *KIMAMBA* *Station number:* 1GA1A

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan-Dec Total	Nov-Oct Total	Max. Flow Nov-Oct year m^3/s	Min. Flow Nov-Oct year m^3/s
1961	*	*	*	*	*	*	*	0.3	0.4	2.8	45.3	32.9	*	*	*	*
1962	83.9	26.5	31.2	15.4	9.0	3.4	2.7	2.5	2.0	1.0	0.5	1.3	179.4	255.8	96.45	0.08
1963	2.2	2.2	5.8	10.1	6.3	2.4	2.0	1.1	0.3	0.1	*	*	*	34.3	9.50	0.03
1964	*	*	11.4	17.5	7.5	4.4	2.2	1.8	1.2	0.6	*	*	*	*	*	*
1965	7.5	*	0.0	0.0	*	0.5	0.0	1.3	0.0	0.0	0.0	*	*	*	15.32	0.01
1966	0.1	0.0	1.1	23.2	7.4	3.0	1.1	0.5	0.1	0.1	*	0.1	*	*	*	*
1967	0.0	*	0.0	8.5	*	15.2	*	2.4	5.4	8.3	10.4	140.3	*	*	49.80	0.00
1968	*	*	*	185.5	*	*	*	8.0	4.9	3.7	7.5	15.2	*	*	467.70	1.01
1969	2.3	10.9	9.8	6.3	8.0	5.1	2.9	2.5	1.3	1.7	1.4	1.5	53.7	73.5	50.85	0.43
1970	1.6	6.6	5.5	12.5	7.8	2.6	1.4	0.7	0.7	0.3	0.0	0.0	39.7	42.6	12.14	0.07
1971	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1972	0.0	0.0	0.0	1.6	26.3	9.9	1.8	0.7	1.7	7.4	13.8	4.2	67.4	*	29.94	0.00
1973	34.4	16.8	9.5	4.8	39.8	3.6	1.1	0.5	0.2	*	0.0	0.0	*	*	99.96	0.00
1974	0.0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
		(not processed on 1/1/79)														
n (1962, 63, 65, 67-70, 72, 73)															9	9
m_1															92.4	0.18
m_2															-	-
s															144.8	0.34
C_v															1.57	1.87

Monthly discharge volumes (10^6 m^3) for river: MZIHA

Station: MZILIA Station number: 1GA2

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan-Dec Total	Nov-Oct Total	Max. Flow Nov-Oct year m^3/s	Min. Flow Nov-Oct year m^3/s
1971	1.0	0.1	1.0	2.1	72.4	0.4	0.9	403.0	97.1	0.1	7.7	1.2	587.0	*	851.78 (p)	0.00 (p)
1972	3.3	0.1	0.2	1.1	3.0	0.7	0.2	0.1	0.9	1.4	4.4	2.7	18.1	19.9	18.04 (p)	0.00 (p)
1973	0.9	2.4	0.4	2.2	3.8	0.3	0.2	0.2	0.2	0.1	0.1	0.4	11.2	17.8	12.04 (p)	0.02 (p)
1974	2.7	4.7	5.3	0.6	1.6	1.6	0.4	0.2	0.3	0.1	0.2	0.1	17.8	18.0	14.82 (p)	0.00 (p)
		(not processed on 1/1/79)														

Monthly discharge volumes (10^6 m^3) for river: DIWALE

Station: TURIANI Station number: 1GB1 up to 1964 and 1GB1A onwards from 1964

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan-Dec Total	Nov-Oct Total	Max. Flow Nov-Oct year m^3/s	Min. Flow Nov-Oct year m^3/s
1953	*	*	*	*	*	*	*	*	13.1	9.0	8.2	10.7	*	*	-	-
1954	8.8	6.0	10.4	25.0	33.8	15.1	8.4	7.4	5.7	7.2	2.7	3.6	134.1	146.7	16.99	1.05
1955	5.5	23.9	12.7	38.9	48.2	24.7	13.0	9.6	5.4	3.4	4.5	9.4	199.2	191.6	59.47	0.34
1956	11.8	10.2	17.1	46.2	37.7	27.2	10.3	10.3	5.1	4.3	5.1	15.7	201.0	194.1	51.54	0.76
1957	32.9	10.6	21.1	43.9	43.3	16.5	13.9	12.7	9.3	8.4	11.9	14.9	239.4	233.4	38.23	0.62
1958	7.1	7.0	17.0	32.6	30.7	28.1	8.6	7.1	5.6	4.4	3.3	3.6	155.1	175.0	52.67	0.93
1959	6.8	6.1	13.8	16.8	27.5	6.4	5.4	18.1	8.6	10.2	8.8	7.6	136.1	126.6	45.87	0.34
1960	6.0	4.5	15.3	62.5	20.4	15.0	8.2	3.7	2.6	4.6	2.3	1.6	146.7	159.2	57.25	0.57
1961	0.7	10.1	12.6	26.5	18.2	7.2	24.5	13.2	21.9	25.9	59.6	35.3	255.7	164.7	49.27	0.23
1962	65.5	17.8	27.3	40.7	36.3	16.8	19.0	26.8	16.9	13.3	17.5	23.6	321.5	375.3	58.10	2.46
1963	23.7	8.5	41.5	47.3	33.6	14.3	12.0	11.7	4.6	4.5	28.2	18.2	248.1	242.8	46.86	0.85
1964	27.4	9.4	30.9	52.8	32.7	14.0	10.3	13.4	4.0	8.6	2.7	4.5	210.7	249.9	52.64	0.82
1965	7.6	5.7	4.9	27.8	31.5	11.3	10.6	6.8	6.4	14.8	17.3	18.3	163.0	134.6	58.08	0.54
1966	11.9	6.2	8.2	26.4	42.9	26.6	20.0	16.7	23.9	14.4	24.3	43.6	253.2	195.6	50.97	0.62
n (1954-67)	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	
m_1	5.8	3.8	6.8	14.7	12.4	6.6	4.6	4.4	3.5	3.6	5.3	5.5	6.4	6.3	48.46	0.82
m_2	15.6	9.2	18.3	38.1	33.2	17.1	12.4	11.9	9.1	9.5	13.7	14.7	202.7	199.5	-	-
s	17.2	5.6	9.8	12.7	8.3	7.0	5.3	5.8	6.8	6.1	15.7	12.5	55.4	66.0	11.11	0.55
C_v	1.10	0.60	0.54	0.33	0.25	0.41	0.43	0.49	0.74	0.64	1.14	0.85	0.27	0.33	0.23	0.68
			River MJONGA joined river DIWALE in 1968													
1968	21.7	12.2	60.7	339.1	183.7	168.5	29.9	18.1	12.6	14.5	57.5	38.9	957.4	928.9	177.34	1.86
1969	12.7	53.2	47.8	48.2	58.7	27.9	17.3	21.9	(16.0)	18.6	15.3	10.9	(342.5)	(412.7)	93.84	1.58
1970	29.6	38.5	58.1	77.7	34.5	17.0	9.0	9.0	9.5	9.1	4.5	12.7	309.2	318.2	-	0.68
1971	11.0	9.9	8.8	39.0	53.1	18.1	19.6	9.2	7.3	5.4	3.3	7.1	191.8	198.6	-	0.45
1972	12.9	5.5	22.5	53.3	83.4	26.2	18.0	9.7	16.6	28.2	29.1	37.7	343.1	286.7	-	0.90
1973	30.3	24.6	21.8	73.6	91.4	24.9	20.5	14.6	6.9	5.1	7.7	10.3	331.7	380.5	-	0.21
1974	6.6	3.3	9.1	54.4	57.3	30.9	26.3	10.4	8.3	8.2	4.5	3.4	223.1	233.2	-	0.41
1975	3.5	2.2	18.9	35.7	29.8	*	*	*	*	*	*	*	*	*	-	0.67
1976			(not processed on 1/1/79)													
n (1968-74)	7	7	7	7	7	7	7	7	7	7	7	7	7	7	-	8
m_1	6.7	8.9	12.2	37.8	30.0	17.2	7.5	5.0	4.2	3.6	6.7	6.5	12.2	12.5	-	0.85
m_2	17.8	21.5	32.7	97.9	80.3	44.7	20.1	13.3	11.0	9.6	17.4	17.3	385.5	394.1	-	-
s	9.4	18.9	22.4	107.2	49.4	54.8	6.7	5.1	4.1	3.7	19.9	14.7	259.3	247.6	-	0.58
C_v	0.53	0.88	0.69	1.09	0.62	1.23	0.33	0.38	0.37	0.39	1.14	0.85	0.67	0.63	-	0.69

Monthly discharge volumes (10^6 m^3) for river: MKINDU

Station: MKINDU Station number: 1GB2

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan-Dec Total	Nov-Oct Total	Max. Flow Nov-Oct year m^3/s	Min. Flow Nov-Oct year m^3/s
1953	*	*	*	*	*	*	*	*	4.3	4.0	4.0	*	*	*	*	*
1954	8.6	*	10.3	*	*	8.6	5.0	4.0	3.1	2.9	2.7	3.9	*	*	*	0.54
1955	5.2	6.4	4.7	*	*	17.1	6.9	4.4	2.6	2.1	2.5	8.9	*	*	22.58	0.37
1956	6.6	11.2	*	*	*	*	*	3.7	2.6	2.0	2.1	12.0	*	*	*	0.54
1957	11.0	5.3	12.8	58.9	54.1	9.3	5.0	3.4	3.0	3.0	2.7	9.0	177.5	179.9	43.27	0.40
1958	4.5	3.8	9.8	4.2	19.5	15.6	5.4	3.6	2.4	1.7	1.6	3.5	75.6	82.2	37.00	0.49
1959	8.2	6.2	8.4	14.3	27.7	6.1	4.5	6.2	3.5	3.8	4.1	4.9	97.9	94.0	31.27	0.40
1960	4.3	3.8	12.3	44.5	15.3	8.8	5.0	3.3	2.4	2.8	1.7	2.7	106.9	111.5	65.68	0.62
1961	1.5	11.0	14.5	25.6	13.4	6.0	13.5	5.6	7.2	*	*	*	*	*	*	*
1962	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1963	*	*	*	*	*	*	*	*	*	1.5	19.0	14.4	*	*	*	*
1964	21.1	10.5	20.7	36.8	20.1	10.1	7.1	6.2	3.6	5.5	2.5	4.8	149.0	175.1	30.40	0.27
1965	7.6	4.7	8.5	24.9	20.5	11.0	6.7	4.9	3.7	8.7	12.6	17.1	130.9	108.5	30.40	0.61
1966	15.7	9.1	18.1	38.1	21.3	11.5	7.3	5.4	3.9	3.7	3.2	7.6	144.9	163.8	35.52	0.70
1967	5.1	6.5	9.3	25.9	30.6	19.4	10.6	11.4	17.8	10.3	17.8	30.5	195.2	157.7	40.89	0.70
1968	18.3	9.1	16.0	57.3	33.1	28.3	8.5	5.5	3.5	4.3	19.5	16.9	216.8	228.7	47.17	0.86
1969	12.2	8.9	21.6	34.2	25.7	11.4	7.1	8.3	5.8	5.9	*	*	*	177.5	38.34	0.89
			(station closed after 1969)													
n (1957-60, 1964-68)	9	9	9	9	9	9	9	9	9	9	9	9	9	9	12	14
m_1	4.0	2.7	4.8	13.1	10.0	5.1	2.5	2.1	1.9	1.8	2.8	4.0	4.6	4.6	40.18	0.56
m_2	10.6	6.6	12.9	33.9	26.9	13.3	6.7	5.5	4.9	4.9	7.3	10.8	143.9	144.6	-	-
s	6.3	2.5	4.5	18.5	11.7	6.8	2.0	2.5	4.9	2.9	7.3	9.1	46.7	48.3	11.25	0.19
C_v	0.6	0.4	0.4	0.6	0.4	0.5	0.3	0.5	1.0	0.6	1.0	0.8	0.3	0.3	0.28	0.34

Monthly discharge volumes (10^6 m^3) for river: CHAZI

Station: CHAZI Station number: 1GB3

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan-Dec Total	Nov-Oct Total	Max. Flow Nov-Oct year m^3/s	Min. Flow Nov-Oct year m^3/s
1954	*	*	*	*	*	*	*	*	0.0	0.1	0.0	0.0	*	*	*	*
1955	0.4	0.4	0.5	1.2	1.3	0.6	0.3	0.2	0.1	0.1	0.1	0.2	5.4	5.1	1.52	0.01
1956	0.5	0.6	1.0	1.2	1.0	0.6	0.2	0.1	1.1	0.1	0.1	0.1	6.6	6.6	2.15	0.01
1957	0.2	0.2	0.5	2.1	1.7	0.4	0.2	0.1	*	*	*	*	*	*	2.83	0.01
1958	*	*	*	*	0.6	0.4	0.2	1.4	0.1	0.1	0.1	0.1	*	*	*	0.01
1959	0.2	0.2	0.4	0.4	1.2	0.2	0.1	0.1	0.1	0.1	*	*	*	3.2	1.04	0.00

(station closed in 1963)

Monthly discharge volumes (10^6 m^3) for river: MKONDOA

Station: KILOSA Station number: 1GD2

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan-Dec Total	Nov-Oct Total	Max. Flow Nov-Oct year m^3/s	Min. Flow Nov-Oct year m^3/s
1952	*	*	*	54.2	64.8	32.7	24.4	19.4	13.7	11.5	13.5	9.2	*	*	*	*
1953	18.8	6.9	8.9	24.1	41.8	21.0	14.4	11.1	9.6	9.8	9.6	14.5	190.5	189.1	39.64	1.47
1954	41.8	19.8	22.5	19.7	28.8	15.7	12.1	9.8	7.4	8.5	7.0	9.8	202.9	210.2	22.65	2.41
1955	7.8	27.4	33.5	47.6	49.8	27.4	20.0	14.5	9.3	8.1	9.5	20.2	275.1	262.2	49.55	1.98
1956	47.5	39.9	28.2	43.9	40.8	24.3	18.6	14.8	11.8	11.0	11.0	16.3	308.1	310.5	39.36	1.98
1957	28.9	22.2	20.4	56.0	57.4	24.7	19.0	15.4	11.9	9.9	10.7	24.3	300.8	293.1	86.09	3.17
1958	15.1	44.0	38.7	37.2	37.5	23.6	18.1	15.2	12.2	10.4	8.6	14.8	275.4	287.0	31.15	3.17
1959	16.0	16.4	36.1	21.3	22.5	12.1	11.5	9.9	8.2	7.0	7.1	10.7	178.8	184.4	32.00	2.35
1960	13.3	11.4	25.3	63.8	30.8	19.3	14.9	10.2	8.7	8.1	6.4	4.7	216.9	223.6	64.26	2.12
1961	4.9	17.2	20.3	35.6	22.2	9.7	9.0	5.5	4.1	8.0	68.8	63.4	268.7	147.6	102.68	1.25
1962	156.1	69.1	86.2	85.4	70.9	40.4	28.7	26.9	18.0	13.8	12.3	29.8	637.6	727.7	113.27	4.39
1963	57.1	39.1	86.8	107.1	128.4	67.6	37.2	28.0	23.5	20.4	14.9	47.4	657.5	637.3	110.08	2.83
1964	69.6	36.8	61.4	*	*	*	*	14.4	10.8	10.1	7.2	7.2	*	*	134.51	2.87
1965	11.3	9.6	14.6	20.9	13.2	10.7	8.3	7.1	6.1	7.7	11.4	26.7	147.6	123.9	28.47	0.91
1966	20.8	20.3	31.6	66.1	24.1	18.5	13.0	9.1	7.1	5.5	5.6	9.2	230.9	254.2	103.36	0.62
1967	1.3	2.6	4.0	48.7	63.3	48.6	26.2	25.9	24.9	24.4	34.1	92.1	396.1	284.7	75.41	0.27
1968	101.0	79.0	112.8	335.3	*	*	*	*	*	*	38.3	40.7	*	*	*	*
1969	31.6	36.5	39.7	48.2	35.9	23.9	25.0	26.1	23.0	25.0	31.2	25.4	371.5	393.9	41.27	2.12
1970	43.1	43.5	38.6	38.3	26.8	23.7	21.9	22.9	22.0	21.3	17.2	35.2	354.5	358.7	39.20	5.30
			(not processed on 1/1/79)													
n (1953-63, 1965-67, 1969-70)	16	16	16	16	16	16	16	16	16	16	16	16	16	16	17	17
m_1	12.0	11.0	12.5	17.8	16.2	9.9	6.9	5.9	5.0	4.6	6.4	10.4	9.9	9.7	61.15	2.27
m_2	32.2	26.6	33.5	47.7	43.4	25.7	18.6	15.8	13.0	12.4	16.6	27.8	313.3	305.5	-	-
s	36.9	17.5	23.3	24.7	27.7	15.0	7.8	7.7	6.9	6.5	16.2	22.9	148.2	164.6	32.35	1.32
C_v	1.2	0.7	0.7	0.5	0.6	0.6	0.4	0.5	0.5	0.5	1.0	0.8	0.5	0.54	0.53	0.58

Monthly discharge volumes (10^6 m^3) for river: MKOMBOLA

Station: LUKANDO Station number: 1GD5

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan-Dec Total	Nov-Oct Total	Max. Flow Nov-Oct year m^3/s	Min. Flow Nov-Oct year m^3/s
1952	*	*	*	*	*	*	*	*	3.0	3.8	3.8	3.2	*	*	*	*
1953	4.4	2.3	2.8	5.7	15.3	4.9	3.7	3.4	3.0	2.7	2.2	5.1	55.5	55.2	19.82	0.78
1954	6.4	2.3	2.5	5.3	7.2	3.7	2.9	2.7	2.2	2.1	1.9	2.1	41.3	44.6	16.34	0.70
1955	1.9	10.4	6.9	7.3	9.3	5.3	3.4	2.7	2.2	2.0	2.4	3.6	57.4	55.4	31.15	0.50
1956	4.8	4.7	3.4	15.5	9.8	6.0	5.1	3.8	3.1	3.3	2.4	2.9	64.8	65.5	45.59	0.50
1957	10.4	4.3	3.4	8.8	18.2	6.2	5.0	4.0	3.1	2.9	3.3	4.4	74.0	71.6	19.11	0.79
1958	3.2	5.2	7.3	8.8	12.4	5.8	4.5	4.0	3.3	2.9	2.4	3.5	63.3	65.1	13.45	0.90
1959	4.2	3.5	5.5	3.8	4.3	2.7	2.7	3.0	2.2	2.1	1.9	2.7	38.6	39.9	8.35	0.65
1960	3.7	2.2	6.7	*	10.2	5.9	5.0	4.1	3.6	3.6	3.5	*	*	*	2.08	0.65
			(station closed in 1963)													
n (1953-59)	7	7	7	7	7	7	7	7	7	7	7	7	7	7	8	8
m_1	1.9	1.9	1.7	3.1	4.1	1.9	1.5	1.3	1.0	1.0	0.9	1.3	1.8	1.8	21.97	0.69
m_2	5.0	4.7	4.5	7.9	10.9	4.9	3.9	3.4	2.7	2.6	2.4	3.5	56.4	56.8	-	-
s	2.7	2.8	2.0	3.8	4.8	1.3	1.0	0.6	0.5	0.5	0.5	1.0	12.7	11.6	12.56	0.15
C_v	0.5	0.6	0.4	0.5	0.4	0.3	0.3	0.2	0.2	0.2	0.2	0.3	0.2	0.20	0.57	0.22

Monthly discharge volumes (10^6 m^3) for river: MIYOMBO

Station: ULAYA Station number: 1GD6

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan-Dec Total	Nov-Oct Total	Max. Flow Nov-Oct year m^3/s	Min. Flow Nov-Oct year m^3/s
1958	*	*	*	*	*	13.1	9.8	7.5	5.5	4.2	3.8	6.3	*	*	*	1.30
1959	7.0	8.5	19.5	9.8	7.3	4.9	3.7	3.6	2.9	2.3	3.4	9.8	82.7	79.6	16.65	0.76
			(station closed in 1963)													

Monthly discharge volumes (10^6 m^3) for river: KINYASUNGWE

Station: GULWE Station number: 1GD14

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan-Dec Total	Nov-Oct Total	Max. Flow Nov-Oct year m^3/s	Min. Flow Nov-Oct year m^3/s
1965	*	*	*	*	*	*	*	*	*	*	0.0	0.8	*	*	5.69	0.00
1966	0.3	0.2	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	1.1	1.5	12.53	0.00
1967	0.2	1.9	1.9	13.7	0.0	0.0	0.0	0.0	0.0	0.0	0.7	11.1	29.5	18.0	25.73	0.00
1968	24.1	10.9	28.9	32.9	2.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	99.6	111.4	0.00	0.00
1969	*	48.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	*	*	*	71.68	0.00

(station closed after 1970)

Monthly discharge volumes (10^6 m^3) for river: MKONDOA

Station: MBASAWE Station number: 1GD29

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan-Dec Total	Nov-Oct Total	Max. Flow Nov-Oct year m^3/s	Min. Flow Nov-Oct year m^3/s
1969	*	*	*	12.9	17.6	10.4	9.1	8.6	7.4	7.0	6.7	5.8	*	*	*	*
1970	*	9.9	10.3	11.5	10.5	7.7	6.9	*	*	4.8	3.7	7.8	*	*	*	*
1971	6.2	8.2	6.4	13.1	11.3	8.0	7.4	6.0	5.2	4.7	3.6	4.8	93.2	88.0	42.15 (p)	1.04 (p)
1972	7.6	5.9	7.8	10.7	16.6	9.6	7.5	6.0	5.7	6.1	6.0	10.7	100.2	91.9	56.02 (p)	1.04 (p)
1973	18.5	11.4	9.7	15.8	23.9	11.2	9.8	8.8	7.4	6.6	6.3	6.9	136.3	139.8	134.97 (p)	1.77 (p)
1974	9.2	5.1	4.8	11.1	8.4	5.4	5.1	4.2	3.6	3.5	2.7	3.2	66.3	73.6	12.31 (p)	0.96 (p)
			(not processed on 1/1/79)													

Monthly discharge volumes (10^6 m^3) for river: LUMUMA

Station: KILAMALULU Station number: 1GD30

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan-Dec Total	Nov-Oct Total	Max. Flow Nov-Oct year m^3/s	Min. Flow Nov-Oct year m^3/s
1969	*	*	3.9	3.7	3.4	2.1	1.8	1.8	1.3	1.2	1.3	1.5	*	*	3.05	0.35
1970	3.8	5.1	4.0	3.4	1.6	1.1	0.9	0.8	0.9	0.8	0.5	1.8	24.7	25.2	3.74	0.23
			(not processed on 1/1/79)													

Monthly discharge volumes (10^6 m^3) for river: MDUKWE

Station: MDUKWE Station number: 1GD31

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan-Dec Total	Nov-Oct Total	Max. Flow Nov-Oct year m^3/s	Min. Flow Nov-Oct year m^3/s
1969	*	*	2.1	17.3	20.7	9.7	7.8	7.2	6.2	5.6	7.4	5.3	*	*	18.30	*
1970	9.8	19.7	23.3	20.6	10.5	7.3	6.5	6.1	5.8	4.9	3.2	9.1	126.8	127.2	51.74	1.42
1971	5.3	2.5	2.3	13.4	*	*	*	*	*	*	*	*	*	*	*	*

(not processed on 1/1/79)

Monthly discharge volumes (10^6 m^3) for river: MKATA

Station: MKATA Station number: 1GD36

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan-Dec Total	Nov-Oct Total	Max. Flow Nov-Oct year m^3/s	Min. Flow Nov-Oct year m^3/s
1973	*	*	*	61.2	*	25.7	5.3	*	*	*	12.0	*	*	*	*	*
1974	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1975	11.3	3.8	16.9	27.4	29.2	19.0	12.0	7.2	6.6	5.1	3.2	*	*	*	17.12	0.33

(not processed on 1/1/79)

Monthly discharge volumes (10^6 m^3) for river: RUVU

Station: RUVU SISAL ESTATE Station number: 1H2

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan-Dec Total	Nov-Oct Total	Max. Flow Nov-Oct year m^3/s	Min. Flow Nov-Oct year m^3/s
1950	*	*	*	*	*	*	*	64.8	80.1	65.5	56.1	117.7	*	*	56.92	14.87
1951	65.4	132.2	109.1	285.2	341.6	137.2	95.8	51.7	32.9	41.0	178.4	184.5	1655.0	1465.9	159.14	7.96
1952	165.6	121.3	124.4	364.4	473.6	91.8	50.8	35.6	27.8	29.8	74.2	34.7	1593.5	1847.5	284.59	1.93
1953	34.1	15.9	36.6	200.7	564.5	146.5	62.0	44.0	49.6	44.6	47.6	52.1	1298.2	1307.4	259.10	4.56
1954	106.5	52.7	101.7	156.2	499.6	138.1	60.3	37.8	27.1	35.2	43.0	44.3	1302.2	1314.6	239.85	8.92
1955	22.9	125.9	94.2	494.2	727.0	343.7	115.0	65.2	34.2	28.1	55.1	64.9	2170.4	2137.7	317.15	5.55
1956	243.9	274.8	301.8	606.6	539.7	182.5	74.6	47.6	33.0	24.6	53.2	28.2	2410.5	2449.1	311.49	8.50
1957	81.5	227.8	131.7	376.9	808.1	149.8	84.6	62.7	44.6	55.9	98.1	182.1	2303.8	2105.0	424.76	5.66
1958	74.5	92.4	163.7	334.8	540.4	190.4	91.4	53.3	35.7	22.4	19.3	53.9	1672.2	1879.2	305.82	6.60
1959	47.7	81.2	118.4	135.6	215.5	55.5	*	*	*	*	*	*	*	*	161.97	5.92
			(station closed in 1959)													
n (1951-58)	8	8	8	8	8	8	8	8	8	8	8	8	8	8	10	10
m_1	37.1	53.9	49.6	136.0	209.8	66.6	29.6	18.6	13.7	13.1	27.4	30.1	57.1	57.5	252.08	7.05
m_2	99.3	130.4	132.9	352.4	561.8	172.5	79.3	49.7	35.6	35.1	71.1	80.6	1800.7	1813.3	-	-
s	73.2	85.4	77.3	147.3	145.9	75.5	21.4	10.7	7.8	11.4	49.1	64.4	438.1	418.4	103.59	3.43
C_v	0.74	0.65	0.58	0.42	0.26	0.44	0.27	0.22	0.22	0.32	0.69	0.80	0.24	0.23	0.41	0.49

Monthly discharge volumes (10^6 m^3) for river: RUVU

Station: KIDUNDA Station number: 1H3

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan-Dec Total	Nov-Oct Total	Max. Flow Nov-Oct year m^3/s	Min. Flow Nov-Oct year m^3/s
1951	*	*	*	*	*	*	*	40.9	25.0	41.6	161.6	174.3	*	*	50.97	6.37
1952	135.3	125.2	115.2	362.4	404.7	88.4	48.9	34.9	28.8	30.0	89.4	31.0	1494.2	1709.7	311.49	6.37
1953	35.1	15.7	50.8	202.4	371.8	115.4	50.8	41.3	47.6	49.2	50.2	62.5	1092.8	1100.5	236.45	3.68
1954	104.2	53.8	122.8	156.9	308.5	93.4	47.0	32.1	21.5	33.7	43.5	48.6	1066.0	1086.6	196.52	6.94
1955	31.2	167.4	85.2	395.5	625.2	217.9	114.4	68.6	40.9	38.0	71.5	81.1	1936.9	1876.4	379.45	5.95
1956	155.8	221.6	234.7	538.7	363.2	143.9	72.1	45.6	32.0	24.2	59.0	47.9	1938.7	1984.4	314.32	6.94
1957	96.1	124.8	116.8	497.4	581.0	124.7	72.0	57.9	50.7	47.0	72.1	92.5	1933.0	1875.3	351.13	6.94
1958	48.4	85.9	176.5	403.4	379.6	141.8	64.3	42.8	28.8	21.6	23.9	73.7	1490.7	1557.7	322.81	6.23
1959	50.4	91.4	96.7	111.2	129.9	41.5	31.6	32.6	25.8	26.6	37.7	31.6	707.0	735.3	182.93	5.10
1960	111.7	44.6	180.3	550.1	187.7	88.9	53.1	33.0	21.8	25.2	20.9	9.4	1326.7	1365.7	323.66	4.98
1961	12.9	115.5	117.9	156.6	208.3	54.5	93.1	48.1	49.6	94.8	488.9	357.8	1798.0	981.6	175.03	0.96
1962	583.5	162.6	377.6	317.1	353.6	94.7	61.6	69.7	54.5	33.6	49.7	85.4	2243.6	2955.2	376.93	9.47
1963	188.5	105.6	270.4	591.3	259.0	93.2	63.4	40.8	24.6	17.1	*	*	*	1789.0	281.75	4.70
			(station closed in 1963)													
n (1952-62)	11	11	11	11	11	11	11	11	11	11	11	11	11	11	13	13
m_1	46.3	45.4	56.8	129.5	132.8	42.3	24.1	17.2	14.1	24.6	35.3	31.3	49.1	49.7	269.50	5.74
m_2	124.1	109.9	152.2	335.6	355.8	109.6	64.5	46.1	36.6	38.5	91.5	83.8	1548.0	1566.2	-	-
s	159.3	60.2	90.3	159.6	151.6	48.2	23.2	13.8	12.4	20.7	133.4	94.5	469.1	619.4	96.00	2.01
C_v	1.28	0.55	0.59	0.48	0.43	0.44	0.36	0.30	0.34	0.54	1.46	1.13	0.30	0.40	0.36	0.35

Monthly discharge volumes (10^6 m^3) for river: RUVU

Station: KIBUNGO Station number: 1H5

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan-Dec Total	Nov-Oct Total	Max. Flow Nov-Oct year m^3/s	Min. Flow Nov-Oct year m^3/s
1953	*	*	*	*	*	*	*	*	*	*	52.5	67.5	*	*	*	*
1954	52.0	38.5	56.1	83.4	113.1	42.6	23.1	16.4	13.4	20.9	29.8	31.7	521.0	579.5	721.51 (p)	4.11 (p)
1955	16.9	43.4	27.1	94.5	136.8	63.4	45.1	28.0	17.5	18.7	40.3	49.3	581.0	552.9	514.68 (p)	4.10 (p)
1956	61.8	57.6	76.2	109.8	97.7	55.5	28.1	18.2	13.7	11.6	29.0	24.8	584.0	619.8	919.74 (p)	3.11 (p)
1957	30.4	38.6	27.2	133.6	121.8	36.7	24.7	23.9	19.7	19.8	26.6	36.0	539.0	530.2	2183.22 (p)	3.11 (p)
1958	27.3	32.8	57.2	101.6	85.9	43.2	21.3	16.0	13.4	9.4	14.8	24.0	446.9	470.7	1088.82 (p)	2.35 (p)
1959	27.1	22.3	27.9	50.0	54.8	18.3	13.8	16.8	13.0	21.6	22.7	18.6	306.9	304.4	596.44 (p)	3.11 (p)
1960	29.1	17.7	64.9	151.7	51.6	34.1	20.6	14.8	11.5	15.4	12.7	9.4	433.5	452.7	119.92	3.11
1961	9.6	36.1	45.6	57.2	49.3	23.8	49.6	25.0	37.0	62.5	190.6	80.3	666.6	417.8	85.35	1.93
1962	92.4	39.1	75.2	96.0	101.1	33.0	23.7	39.7	32.5	27.9	34.1	52.6	647.3	831.5	230.22	6.29
1963	86.5	45.4	78.4	114.0	60.9	34.1	24.0	17.3	11.8	8.8	136.5	74.8	692.5	567.9	119.16	2.83
1964	68.6	33.9	70.9	130.4	68.6	38.3	21.0	17.8	11.9	30.4	12.2	17.5	521.5	703.1	218.89	2.37
1965	21.9	16.4	27.6	124.5	62.2	38.3	21.0	13.5	16.7	42.1	73.7	75.4	533.3	413.9	111.00	3.40
1966	78.2	71.5	80.0	435.9	71.2	46.6	26.9	17.4	19.7	21.7	36.5	26.6	932.2	1018.2	566.50 (p)	3.81 (p)
1967	14.4	36.6	24.4	67.7	111.3	70.5	50.1	39.2	75.3	39.7	(100.0)	200.1	(829.3)	592.3	169.33 (p)	4.10 (p)
1968	80.1	35.3	73.2	215.9	114.2	96.4	36.3	22.6	16.8	14.4	61.1	58.8	825.1	(1005.3)	466.50 (p)	4.11 (p)
1969	21.8	20.6	60.8	121.5	98.3	42.8	26.7	31.1	22.9	30.7	45.9	36.0	559.1	597.1	433.92 (p)	3.14 (p)
1970	42.1	61.5	71.4	131.2	55.5	25.3	17.0	13.4	25.0	16.3	(10.5)	70.3	(480.9)	540.6	292.85 (p)	4.16 (p)
1971	38.6	27.2	29.0	103.3	85.8	33.0	33.9	18.3	14.0	14.8	11.8	11.7	421.4	(478.7)	272.20 (p)	3.14 (p)
1972	43.7	15.5	37.4	102.5	128.5	41.1	25.3	17.2	29.0	45.1	73.2	68.7	627.2	508.8	100.39	3.09
1973	80.0	56.7	50.2	180.2	141.0	43.0	33.8	31.8	17.3	18.4	35.9	38.5	726.8	794.3	164.56	3.83
1974	26.9	16.3	32.6	147.7	150.0	50.6	36.3	20.6	19.6	19.2	14.5	13.5	547.8	594.2	192.20	3.44
1975	20.9	8.8	29.5	84.9	85.3	35.3	27.7	16.2	19.9	24.9	13.9	33.3	400.6	381.4	98.19	2.32
			(not processed on 1/1/79)													
n (1954-75)	20	20	20	20	20	20	20	20	20	20	20	20	20	20	-	22
m_1	16.4	14.5	19.2	49.3	34.0	15.1	10.2	7.7	7.3	9.0	16.7	14.5	17.7	18.0	-	3.41
m_2	43.8	35.0	51.3	127.7	91.0	39.0	27.2	20.7	19.0	24.0	43.3	39.7	558.5	567.9	-	-
s	25.5	17.4	20.1	78.9	32.2	10.5	8.8	7.1	7.2	13.2	45.9	23.3	137.0	167.5	-	0.92
C_v	0.58	0.50	0.39	0.62	0.35	0.27	0.32	0.34	0.38	0.55	1.06	0.59	0.25	0.29	-	0.27

Monthly discharge volumes (10^6 m^3) for river: RUVU

Station: MOROGORO ROAD BRIDGE Station number: 1H8

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan-Dec Total	Nov-Oct Total	Max. Flow Nov-Oct year m^3/s	Min. Flow Nov-Oct year m^3/s
1959	*	*	*	*	*	*	*	*	*	*	35.5	38.3	*	*	*	*
1960	83.7	67.3	145.6	546.9	379.0	107.5	67.8	40.0	22.9	18.1	23.1	9.0	1510.9	1552.6	363.59	4.93
1961	8.8	117.5	132.5	105.7	273.5	75.6	107.9	68.9	42.2	114.3	1166.8	593.7	2807.4	1070.2	138.30	1.72
1962	950.4	172.6	379.5	334.6	398.4	116.5	71.7	69.9	62.0	40.4	45.3	77.0	2718.3	3406.1	1040.43	13.76
1963	163.0	118.0	200.5	94.6	385.7	115.7	86.2	55.3	36.1	25.0	340.4	548.3	2975.8	2046.4	1176.85	8.07
1964	337.1	108.3	268.1	997.4	305.4	187.6	64.5	53.3	39.7	48.8	34.6	25.4	2475.2	2961.3	934.08	7.74
1965	69.2	48.4	53.7	379.4	177.1	115.1	51.7	36.5	32.8	50.8	114.1	154.9	1278.7	1074.7	272.41	8.27
1966	153.2	178.6	187.4	244.0	240.9	142.6	34.3	55.2	40.1	34.3	55.4	49.5	1515.5	1679.6	351.12 (p)	8.19 (p)
1967	22.7	51.5	65.4	269.9	612.1	282.3	129.5	115.0	147.4	104.8	198.1	776.3	2783.0	1913.5	329.32 (p)	5.80 (p)
1968	426.2	125.5	457.7	1840.3	849.4	389.2	139.7	81.5	52.8	37.5	149.1	421.3	4970.0	5374.2	975.38 (p)	11.79 (p)
1969	68.7	90.4	149.3	305.6	646.6	129.8	75.4	56.4	44.4	39.8	61.3	64.2	1731.9	2176.8	432.08 (p)	10.92 (p)
1970	101.7	264.3	249.5	398.2	178.6	73.7	45.1	27.6	40.5	27.0	15.5	88.5	1560.2	1429.5	192.27 (p)	7.68 (p)
1971	102.5	78.6	52.0	365.2	321.1	98.5	74.4	45.1	26.6	23.2	18.9	31.0	1227.1	1291.2	282.57 (p)	4.22 (p)
1972	99.3	22.1	69.6	468.8	850.7	251.7	57.7	27.4	42.8	71.3	128.0	156.3	2245.7	2011.3	402.22 (p)	5.01 (p)
1973	269.0	(241.6)	214.2	446.9	950.7	148.8	76.6	61.4	35.5	24.2	48.9	67.7	2590.5	2750.2	767.45 (p)	7.39 (p)
1974	45.2	41.5	34.2	236.8	809.1	166.3	86.2	44.2	30.5	29.4	22.1	16.7	1562.2	1640.0	906.87 (p)	5.45 (p)
1975	46.9	17.7	112.0	394.5	401.0	172.5	74.8	39.2	32.9	35.6	23.3	57.8	1408.2	1365.9	223.97 (p)	5.24 (p)
			(not processed on 1/1/79)													
n (1960-75)	16	16	16	16	16	16	16	16	16	16	16	16	16	16	-	16
m_1	68.8	41.1	65.8	199.8	180.9	62.0	29.1	20.5	17.6	17.0	59.0	73.2	70.1	66.9	-	7.29
m_2	184.2	109.2	176.3	517.8	489.4	160.8	78.0	54.8	45.6	45.6	152.8	196.1	2210.0	2109.0	-	-
s	235.2	73.6	123.4	420.0	257.7	83.7	28.1	22.1	28.8	18.1	283.9	244.5	962.0	1098.0	-	3.03
C_v	1.28	0.67	0.70	0.81	0.53	0.52	0.36	0.40	0.63	0.62	1.86	1.25	0.44	0.52	-	0.42

Monthly discharge volumes (10^6 m^3) for river: NGERENGERE

Station: UTARI BRIDGE Station number: 1HA1 (A)

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan-Dec Total	Nov-Oct Total	Max. Flow Nov-Oct year m^3/s	Min. Flow Nov-Oct year m^3/s
1950	*	*	*	*	*	*	*	*	*	*	0.7	1.8	*	*	*	*
1951	2.2	4.2	4.0	23.6	52.7	10.2	6.3	2.5	0.8	0.1	10.5	14.5	131.6	109.1	39.93 (p)	0.00 (p)
1952	18.4	5.3	3.7	27.5	43.4	8.1	3.3	1.6	0.7	1.6	3.4	1.6	118.6	138.6	43.04 (p)	0.11 (p)
1953	1.0	0.0	1.5	14.1	58.3	16.0	4.1	27.3	3.3	1.8	1.2	0.8	129.4	132.4	50.97 (p)	0.00 (p)
1954	6.3	3.6	2.9	10.3	44.7	11.9	4.6	1.8	0.3	8.1	1.8	0.2	96.5	96.5	22.14 (p)	0.02 (p)
1955	0.0	21.6	6.0	28.9	51.0	20.9	11.0	4.4	1.4	0.7	2.0	3.1	151.0	147.9	37.09 (p)	0.00 (p)
1956	13.8	12.5	12.9	45.0	47.7	15.6	5.5	2.1	0.8	0.3	0.7	0.0	156.9	161.3	44.17 (p)	0.03 (p)
1957	2.0	15.7	8.3	19.7	69.5	12.3	4.7	3.0	1.0	3.0	3.8	4.4	147.4	139.9	44.17 (p)	0.00 (p)
1958	1.6	2.9	9.2	19.5	40.1	12.1	3.8	1.7	1.0	0.3	0.0	2.8	95.0	100.4	32.56 (p)	0.00 (p)
1959	3.9	7.8	12.2	6.4	15.7	2.7	1.6	1.3	2.6	1.1	0.8	2.5	58.6	58.1	73.02 (p)	0.00 (p)
1960	5.9	2.5	4.3	56.7	27.6	9.0	4.0	1.9	0.7	0.2	0.6	0.0	113.4	116.1	43.66 (p)	0.00 (p)
1961	0.0	11.3	3.2	6.6	20.4	3.5	11.1	7.1	2.2	8.4	100.5	70.7	245.0	74.4	24.64	0.00
1962	109.5	11.8	24.0	16.6	22.2	6.0	3.6	3.6	3.1	1.3	1.0	0.9	203.6	372.9	104.01	0.25
1963	8.9	4.7	12.3	72.7	26.6	9.6	7.4	3.8	1.7	0.9	47.1	36.4	232.1	150.5	66.40	0.08
1964	18.3	4.4	15.2	106.6	25.5	10.7	4.9	2.6	1.0	1.4	1.0	0.0	191.6	274.1	66.40	0.07
1965	5.0	1.5	0.7	35.7	11.6	12.5	2.4	1.2	9.4	3.3	(8.2)	(7.0)	89.5	75.3	31.05	0.00
1966	(4.3)	13.0	13.9	48.4	28.1	12.4	7.0	3.6	2.1	1.1	2.2	3.0	139.1	149.1	36.17	0.07
1967	0.3	0.2	2.0	40.7	65.7	31.5	12.2	13.7	22.1	14.4	17.6	40.5	260.9	208.0	48.00	0.00
1968	16.2	5.6	42.0	118.3	45.8	34.5	12.8	5.8	3.1	(3.1)	0.9	15.9	304.0	345.3	59.97	0.00
1969	2.1	5.6	10.8	28.6	49.6	5.4	4.2	4.3	3.6	2.6	*	*	*	133.6	47.37	0.00
1970	7.3	14.7	16.5	33.5	15.8	5.7	2.5	(2.0)	2.6	1.7	2.6	*	*	*	24.15	0.09
			(not processed on 1/1/79)													
n (1951-68)	18	18	18	18	18	18	18	18	18	18	18	18	18	18	-	20
m_1	4.5	2.9	3.7	14.9	14.5	5.1	2.3	1.8	1.0	1.1	4.4	4.3	5.1	5.0	-	-
m_2	12.1	7.1	9.9	38.7	38.7	13.3	6.1	4.9	2.7	2.8	11.3	11.4	161.6	158.3	-	0.04
s	25.1	5.9	10.1	32.3	17.2	8.4	3.4	5.3	4.9	3.8	24.9	19.1	84.8	88.8	-	0.06
C_v	2.07	0.83	1.02	0.83	0.44	0.63	0.56	1.08	1.81	1.36	2.20	1.68	0.52	0.56	-	1.50

Monthly discharge volumes (10^6 m^3) for river: NGERENGERE

Station: KINGOLWIRA Station number: 1HA3

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan-Dec Total	Nov-Oct Total	Max. Flow Nov-Oct year m^3/s	Min. Flow Nov-Oct year m^3/s
1950	*	*	*	*	*	*	*	*	4.7	3.0	1.0	3.3	*	*	8.18	0.50
1951	1.8	5.4	5.4	31.9	49.9	9.9	6.3	2.1	1.0	1.6	18.6	17.8	151.7	119.6	35.11	0.24
1952	15.5	6.5	4.4	23.1	36.5	6.4	3.3	2.1	1.8	1.8	4.3	1.3	107.0	137.8	44.46	0.34
1953	1.1	0.2	0.7	14.9	42.9	10.7	4.0	4.1	4.0	2.9	1.5	1.7	97.7	91.1	35.11	0.00
1954	4.7	3.0	6.0	19.3	42.0	7.3	3.3	1.8	1.0	1.8	1.3	0.8	92.3	93.4	24.97	0.14
1955	0.3	8.0	2.9	24.1	44.4	14.6	6.3	2.8	1.5	1.0	3.1	3.8	112.8	108.0	29.73	0.02
1956	6.5	8.7	8.7	31.0	30.6	8.5	2.9	1.7	1.3	1.0	1.9	1.2	104.0	107.8	34.82	0.28
1957	1.7	3.4	2.8	17.5	40.1	4.6	2.0	1.7	2.3	2.0	3.1	3.2	84.4	81.2	33.41	0.18
1958	1.1	1.7	6.9	21.4	21.7	10.5	4.0	2.4	1.2	0.7	0.8	2.1	74.5	77.9	28.88	0.16
1959	1.8	1.4	1.7	7.9	10.8	1.9	1.6	3.3	2.2	1.6	*	*	*	37.1	11.18	0.11
			(station closed in 1963)													
n (1951-58)	8	8	8	8	8	8	8	8	8	8	8	8	8	8	10	10
m_1	1.5	1.9	1.8	8.8	14.4	3.5	1.5	0.9	0.7	0.6	1.7	1.5	3.3	3.2	33.31	0.17
m_2	4.1	4.6	4.7	22.9	38.5	9.1	4.0	2.3	1.8	1.6	4.3	4.0	103.1	102.1	-	-
s	5.1	3.0	2.6	6.1	8.8	3.1	1.6	0.8	1.0	0.7	5.9	5.7	23.3	20.2	5.80	0.12
C_v	1.2	0.7	0.6	0.3	0.2	0.3	0.4	0.4	0.6	0.4	0.4	1.4	0.2	0.2	0.17	0.71

Monthly discharge volumes (10^6 m^3) for river: NGERENGERE

Station: KILIMANJARO Station number: 1HA4

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan-Dec Total	Nov-Oct Total	Max. Flow Nov-Oct year m^3/s	Min. Flow Nov-Oct year m^3/s
1953	*	*	*	10.8	27.6	7.7	3.7	3.5	3.6	2.8	2.1	1.9	*	*	30.84 (p)	0.45 (p)
1954	3.5	2.1	5.2	14.1	24.2	6.3	2.7	1.8	1.2	1.7	1.2	0.8	64.8	66.8	16.14 (p)	0.22 (p)
1955	0.5	5.5	2.8	17.0	26.4	11.2	6.0	3.4	2.1	1.5	3.8	4.0	84.2	78.4	20.95 (p)	0.01 (p)
1956	6.8	7.3	8.9	25.0	20.5	7.9	3.5	1.9	1.3	0.8	1.4	1.1	86.4	91.2	39.36 (p)	0.21 (p)
1957	1.9	2.9	3.9	14.9	32.8	6.4	3.4	2.7	3.1	2.5	4.0	4.1	82.6	77.0	48.71 (p)	0.16 (p)
1958	1.5	2.0	7.0	18.6	17.3	8.0	3.3	2.2	1.2	0.8	0.7	1.5	64.1	69.1	23.93 (p)	0.19 (p)
1959	1.8	1.1	1.8	7.6	9.1	1.9	1.7	3.4	2.1	1.9	*	*	*	39.6	8.12 (p)	0.16 (p)
			(station closed in 1963)													
n (1953-59)														6	7	7
m_1														2.2	26.86	0.20
m_2														69.5	-	-
s														19.1	13.90	0.13
C_v														0.28	0.52	0.65

Monthly discharge volumes (10^6 m^3) for river: NGERENGERE

Station: KOLUWA Station number: 1HA5

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan-Dec Total	Nov-Oct Total	Max. Flow Nov-Oct year m^3/s	Min. Flow Nov-Oct year m^3/s
1953	*	*	*	*	*	*	*	*	*	*	1.5	2.1	*	*	*	*
1955	8.1	4.0	6.4	20.7	49.5	9.5	3.2	1.8	0.9	6.6	0.9	0.4	122.0	114.3	48.14	0.02
1956	0.0	14.4	3.9	25.7	50.1	18.5	7.8	3.4	1.4	1.1	3.4	4.7	134.4	127.6	35.96	0.00
1956	10.0	12.9	13.5	36.4	48.0	12.4	4.3	2.2	1.1	0.7	1.0	0.2	142.7	149.6	57.20	0.05
1957	4.6	7.8	2.5	23.6	58.6	8.2	2.5	1.5	1.8	3.4	4.7	5.4	124.6	115.7	58.33	0.00
1958	2.2	4.8	10.8	28.9	37.8	13.6	4.1	1.9	1.1	0.5	0.1	3.6	109.4	115.8	41.63	0.08
1959	4.4	8.9	12.0	7.5	14.4	2.5	1.7	2.9	2.6	1.3	1.0	1.1	60.3	61.9	27.98	0.00
1960	8.0	1.6	5.8	65.4	21.6	8.4	3.9	1.7	0.9	0.4	1.1	0.0	118.8	119.8	52.10	0.03
1961	0.0	10.3	2.7	7.6	14.2	3.2	14.0	5.6	2.7	10.1	54.4	33.1	157.9	80.5	47.67	0.00
1962	138.1	10.5	12.5	15.4	26.7	5.3	2.9	3.0	2.2	1.2	1.1	1.8	220.7	305.3	173.13	0.30
1963	9.9	3.4	11.6	135.5	30.5	5.6	8.3	2.9	1.2	0.2	23.1	30.5	262.9	212.0	189.72	0.00
1964	19.2	3.8	16.8	51.8	18.1	6.9	1.7	0.6	0.3	1.2	0.2	0.1	120.7	174.0	25.83	0.02
1965	4.1	1.4	0.9	28.0	7.8	8.3	0.5	0.2	0.2	2.7	8.2	7.0	69.3	54.4	25.83	0.00
1966	4.3	13.3	12.0	31.2	11.3	1.0	0.2	0.0	0.0	0.0	0.0	0.4	73.7	88.5	28.37	0.00
1967	0.0	0.1	0.1	23.0	31.5	19.6	8.3	10.2	*	*	*	*	*	*	32.84	0.00
			(station closed after 1967)													
n (1954-66)	13	13	13	13	13	13	13	13	13	13	13	13	13	13	14	14
m_1	6.1	3.1	3.2	14.2	11.2	3.1	1.6	0.7	0.5	0.9	2.9	2.5	4.2	4.2	62.45	0.04
m_2	16.4	7.5	8.6	36.8	29.9	8.0	4.2	2.1	1.3	2.3	7.6	6.8	131.3	132.3	-	-
s	36.9	4.6	5.1	33.8	17.2	4.8	3.8	1.5	0.9	3.0	15.4	11.3	57.4	67.7	54.15	0.08
C_v	2.25	0.61	0.59	0.92	0.58	0.60	0.90	0.71	0.69	1.30	2.03	1.66	0.44	0.51	0.87	2.00

Monthly discharge volumes (10^6 m^3) for river: NGERENGERE

Station: KIHONDA Station number: 1HA6

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan-Dec Total	Nov-Oct Total	Max. Flow Nov-Oct year m^3/s	Min. Flow Nov-Oct year m^3/s
1950	*	*	*	*	*	*	*	*	3.9	2.4	0.8	3.5	*	*	*	*
1951	1.6	3.0	2.9	21.4	29.9	8.6	5.6	1.9	0.9	1.9	15.9	15.1	108.7	82.0	25.49	0.21
1952	9.7	3.7	3.1	17.5	21.2	4.5	2.3	1.5	1.3	1.4	3.1	0.9	70.2	97.2	28.03	0.25
1953	0.6	0.2	0.6	10.6	27.9	5.9	3.2	2.8	2.8	2.1	1.7	1.2	59.6	60.7	30.01	0.08
1954	1.7	1.1	3.5	10.1	23.4	3.9	1.6	1.1	0.8	0.9	0.6	0.4	49.1	51.0	12.12	0.14
1955	0.1	7.5	1.8	19.2	31.2	9.4	4.0	2.1	1.3	1.1	2.9	2.8	83.4	78.7	26.45	0.02
1956	5.5	5.6	8.8	31.5	19.4	4.8	2.0	1.3	1.0	0.7	1.1	0.8	82.5	86.3	34.82	0.26
1957	1.2	1.7	2.8	14.5	30.0	4.0	2.1	1.7	2.1	1.6	2.5	2.3	66.5	63.6	33.41	0.19
1958	0.9	1.3	7.2	22.8	16.6	5.3	2.1	1.7	1.1	0.7	0.8	1.1	61.6	64.5	33.41	0.15
1959	1.4	0.9	1.6	7.4	7.1	1.7	1.4	2.6	1.8	1.5	*	*	*	29.3	12.43	0.15
			(station closed in 1963)													
n (1951-58)	8	8	8	8	8	8	8	8	8	8	8	8	8	8	9	9
m_1	1.0	1.2	1.4	7.1	9.3	2.2	1.1	0.7	0.5	0.5	1.4	1.2	2.3	2.2	26.24	0.16
m_2	2.7	3.0	3.8	18.5	25.0	5.8	2.9	1.8	1.4	1.3	3.6	3.1	72.7	68.1	-	-
s	3.3	2.5	2.8	7.0	5.5	2.1	1.3	0.5	0.7	0.5	5.1	4.9	18.5	20.5	8.55	0.08
C_v	1.24	0.83	0.72	0.38	0.22	0.36	0.47	0.30	0.49	0.41	1.42	1.60	0.25	0.30	0.33	0.48

Monthly discharge volumes (10^6 m^3) for river: MLALI

Station: MLALI Station number: 1HA7

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan-Dec Total	Nov-Oct Total	Max. Flow Nov-Oct year m^3/s	Min. Flow Nov-Oct year m^3/s
1953	*	*	*	*	*	*	*	*	*	0.1	0.1	0.1	*	*	*	*
1954	0.2	0.3	0.2	0.3	0.6	0.2	0.1	0.1	0.1	0.1	0.1	0.0	2.3	2.4	2.55	0.01
1955	0.1	3.2	2.2	3.1	2.4	0.8	0.4	0.3	0.2	0.1	0.2	0.2	13.2	12.9	33.98	0.00
1956	2.2	0.5	1.4	3.1	1.6	0.6	0.4	0.3	0.2	0.2	0.2	0.1	10.8	10.9	21.24	0.03
1957	0.2	0.2	1.0	2.3	2.1	0.6	0.4	0.3	0.3	0.3	0.4	0.5	8.6	8.0	13.88	0.03
1958	0.2	0.5	0.1	1.8	1.5	0.6	0.4	0.2	0.2	0.1	0.1	1.3	7.0	6.5	7.22	0.04
1959	1.4	0.3	0.4	0.6	0.3	0.1	0.1	0.1	0.1	0.0	*	*	*	4.8	27.33	0.01
			(station closed in 1963)													
n (1954-59)														6	6	6
m_1														0.2	17.70	0.02
m_2														7.58	-	-
s														3.88	12.04	0.02
C_v														0.51	0.68	1.00

Monthly discharge volumes (10^6 m^3) for river: MOROGORO

Station: MOROGORO Station number: 1HA8

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan-Dec Total	Nov-Oct Total	Max. Flow Nov-Oct year m^3/s	Min. Flow Nov-Oct year m^3/s
1954	*	*	*	5.1	7.7	1.5	0.8	0.4	0.3	*	0.3	0.5	*	*	11.14 (p)	0.08 (p)
1955	0.2	0.5	0.4	3.6	7.0	3.3	1.6	0.8	0.5	0.5	1.0	2.1	21.5	19.2	9.40 (p)	0.03 (p)
1956	1.6	1.5	2.5	6.2	6.0	2.7	1.0	0.6	0.4	0.3	0.6	0.4	23.8	25.4	21.47 (p)	0.06 (p)
1957	0.5	0.7	1.0	3.2	7.2	1.4	0.8	0.8	0.6	0.6	1.0	0.9	18.7	18.0	2.89 (p)	0.06 (p)
1958	4.9	0.5	1.0	3.3	2.2	1.5	0.3	0.2	0.1	0.0	0.8	0.5	15.3	11.4	8.38 (p)	0.00 (p)
1959	0.4	0.3	0.4	1.0	2.3	0.5	0.7	1.2	0.6	0.8	0.6	0.6	9.4	9.5	4.87 (p)	0.03 (p)
1960	0.7	0.4	1.6	8.2	2.9	2.0	0.8	0.4	0.3	0.4	0.2	0.2	18.1	18.9	6.65	0.07
1961	0.1	2.2	0.5	2.3	2.3	0.8	3.5	1.0	0.9	2.3	9.0	3.0	27.9	16.3	7.72	0.05
1962	2.1	0.6	0.6	2.0	2.6	0.6	0.4	0.8	0.6	0.3	0.2	0.3	11.1	22.6	10.31	0.07
1963	1.2	0.5	2.1	4.9	2.6	1.3	0.7	0.5	0.4	0.2	5.9	2.0	22.3	14.9	5.51	0.06
1964	1.1	0.5	3.2	6.1	2.7	0.4	0.8	0.7	0.4	0.9	0.3	0.4	17.5	24.7	13.93	0.09
1965	0.6	0.3	0.6	6.3	3.2	1.7	0.7	0.5	0.5	1.1	*	*	*	13.0	7.08	0.07
1966	0.2	0.1	0.2	2.4	1.2	0.7	0.3	0.2	0.2	0.4	2.5	1.8	10.2	*	*	*
1967	0.5	0.8	0.7	*	3.4	0.8	0.4	0.3	0.2	0.3	0.9	0.6	*	*	7.56 (p)	0.09 (p)
1968	0.2	0.5	0.5	3.6	7.8	4.3	3.3	1.2	5.0	2.3	3.7	3.8	36.2	30.2	11.67 (p)	0.06 (p)
1969	1.5	0.7	2.7	*	4.1	*	1.5	0.7	0.4	0.3	1.6	2.3	*	*	13.37 (p)	0.06 (p)
1970	0.6	*	2.2	7.7	5.2	0.8	1.3	1.4	1.0	1.1	2.1	1.0	*	*	12.80 (p)	0.07 (p)
1971	0.8	1.4	1.7	*	2.8	1.0	0.6	0.4	0.8	0.5	*	1.4	*	*	11.95 (p)	0.12 (p)
			(not processed on 1/1/79)													
n (1955-64, (1965-67, 1970, 71)	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	17
m_1	0.5	0.3	0.5	1.5	1.6	0.7	0.5	0.3	0.4	0.3	0.8	0.5	0.6	0.6	-	0.06
m_2	1.2	0.8	1.3	4.0	4.2	1.7	1.3	0.8	0.9	0.8	2.1	1.3	20.2	18.7	-	-
s	1.4	0.6	1.0	2.1	2.3	1.3	1.1	0.3	1.4	0.8	2.9	1.2	7.6	6.2	-	0.03
C_v	1.2	0.8	0.8	0.5	0.6	0.8	0.9	0.4	1.6	1.0	1.4	0.9	0.4	0.33	-	0.50

Monthly discharge volumes (10^6 m^3)[1] *for river:* NGERENGERE

Station: KONGA Station number: 1HA9 (A)

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan-Dec Total	Nov-Oct Total	Max. Flow Nov-Oct year m^3/s	Min. Flow Nov-Oct year m^3/s
1954	*	*	*	3.6	5.4	1.5	0.6	*	0.4	0.6	0.7	0.5	*	*	*	0.08
1955	0.4	1.0	1.7	6.0	7.8	2.9	1.6	0.9	0.5	0.5	1.8	1.1	26.2	24.5	*	0.08
1956	1.6	1.5	6.2	7.0	4.5	1.7	0.9	0.5	0.5	0.4	0.7	0.6	26.1	27.7	*	0.08
1957	0.8	0.7	1.1	4.0	9.2	1.5	0.8	0.8	2.8	1.0	2.0	1.1	25.8	24.0	*	0.08
1958	0.6	1.0	2.1	8.3	3.8	2.2	0.8	0.6	0.5	0.3	0.3	0.6	21.1	23.3	*	0.11
1959	0.6	0.4	0.7	3.1	2.7	0.7	0.5	1.2	1.0	0.9	0.8	0.7	13.3	12.7	*	0.08
1960	1.2	0.5	3.3	*	*	*	*	*	*	*	*	*	*	*	*	*
1961	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1962	*	*	*	*	*	*	*	*	*	*	2.2	3.3	*	*	*	*
1963	4.3	2.8	4.5	12.0	7.1	4.1	3.9	3.3	2.6	1.9	9.3	6.4	62.2	52.0	9.96	0.42
1964	3.8	2.2	4.0	8.6	4.4	2.8	1.8	1.3	1.1	1.5	0.9	1.2	33.6	47.2	9.23	0.27
1965	1.1	1.2	1.8	7.9	5.1	3.2	1.7	1.1	1.0	2.9	3.9	2.0	32.9	29.1	12.88	0.16
1966	1.8	2.7	2.8	7.5	4.8	2.8	1.5	0.9	1.0	1.0	0.9	1.0	28.7	32.7	9.96	0.14
1967	0.4	0.5	0.4	2.0	5.9	3.6	1.9	2.1	4.9	2.2	3.1	2.0	29.0	25.8	9.84	0.05
1968	1.0	0.7	3.0	10.2	5.6	5.1	1.8	1.0	0.7	0.7	3.3	3.5	36.6	34.9	8.93	0.14
1969	0.8	1.0	3.1	7.1	6.2	2.1	0.9	1.0	0.5	0.8	1.9	0.6	25.3	29.6	8.93	0.10
1970	0.7	2.6	2.9	5.7	2.8	0.7	0.4	0.3	1.3	0.4	0.2	1.1	19.1	20.3	25.01	0.04
1971	1.2	1.1	0.9	5.6	4.0	1.4	1.1	0.5	0.3	0.2	0.2	2.3	18.8	17.6	6.11	0.03
1972	0.1	0.2	0.6	5.5	10.3	2.5	1.0	0.7	1.1	2.3	3.9	1.9	30.1	26.8	9.20	0.13
1973	2.1	1.3	1.5	9.0	7.8	1.7	2.5	0.6	0.4	0.2	0.8	0.6	28.5	32.9	9.20	0.18
1974	0.2	0.1	*	5.0	4.8	1.7	0.7	0.4	0.6	0.6	0.2	0.3	*	*	33.72	0.12
(not processed on 1/1/79 by Maji Ubunja. Consultant has processed 1975-1978 data (see Annex 4))																
n (1955-69, 1963-73)	16	16	16	16	16	16	16	16	16	16	16	16	16	16	12	22
m_1	0.5	0.5	0.9	2.4	2.1	0.9	0.5	0.1	0.5	0.9	0.8	0.6	0.9	0.9	12.75	0.13
m_2	1.3	1.2	2.3	6.7	5.7	2.4	1.4	1.0	1.2	1.0	2.0	1.6	28.2	29.0	-	-
s	1.2	0.9	1.6	2.5	2.1	1.2	0.9	0.7	1.2	0.8	2.3	1.5	9.2	10.0	8.12	0.08
C_v	0.94	0.70	0.69	0.38	0.38	0.49	0.67	0.72	0.97	0.78	1.13	0.94	0.33	0.35	0.64	0.66

1) An updated and slightly improved version of 1HA9 (A) can be found in Annex 4

Monthly discharge volumes (10^6 m^3) for river: MGERA

Station: MGERA Station number: 1HA10

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan-Dec Total	Nov-Oct Total	Max. Flow Nov-Oct year m^3/s	Min. Flow Nov-Oct year m^3/s
1954	*	*	*	0.4	1.0	0.3	0.1	0.1	0.1	0.1	0.1	0.0	*	*	*	*
1955	0.0	1.9	1.3	2.7	2.1	0.5	0.2	0.1	0.1	0.1	0.1	0.1	9.2	9.1	8.61	0.00
1956	0.5	0.3	0.5	2.0	0.8	0.2	0.1	0.1	0.0	0.0	0.1	0.1	4.7	4.7	3.34	0.01
1957	0.2	0.7	1.2	4.4	3.8	0.3	0.2	0.1	0.1	0.1	0.2	0.3	11.6	11.3	7.70	0.00
1958	0.1	1.0	3.3	2.1	0.8	0.3	0.1	0.1	0.1	0.0	0.0	0.9	8.8	8.4	9.74	0.01
1959	0.3	0.1	0.3	1.0	0.5	0.1	0.1	0.1	0.0	0.0	*	*	*	3.4	5.66	0.00

(station closed in 1963)

Monthly discharge volumes (10^6 m^3) for river: NGERENGERE

Station: MGUDE Station number: 1HA15

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan-Dec Total	Nov-Oct Total	Max. Flow Nov-Oct year m^3/s	Min. Flow Nov-Oct year m^3/s
1968	*	*	*	*	*	*	*	*	*	12.3	12.1	21.0	*	*	*	*
1969	3.0	5.9	14.4	35.9	53.2	10.4	5.3	5.6	3.7	4.1	(4.1)	4.1	(149.70)	174.6	71.51	0.73
1970	9.8	20.1	15.9	33.6	17.2	4.6	2.2	1.1	3.4	(0.6)	0.3	6.0	(114.8)	(116.7)	38.44	0.29
1971	14.8	10.1	2.4	23.9	22.6	7.6	6.7	2.6	1.1	0.5	0.1	0.0	92.4	98.6	28.16	0.01
1972	5.7	0.4	7.4	33.2	55.4	15.1	5.1	2.3	2.6	*	12.3	9.4	*	*	35.04	0.00
1973	28.2	10.2	7.3	36.3	66.7	8.6	*	3.3	1.7	6.3	*	*	*	*	78.77	0.38
1974	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1975	*	6.1	10.7	*	*	10.3	4.0	1.3	1.7	0.3	0.4	0.6	*	*	13.74	*

(station closed after 1975)

Monthly discharge volumes (10^6 m^3) for river: *MGETA*

Station: KISAKI Station number: 1HB1

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan-Dec Total	Nov-Oct Total	Max. Flow Nov-Oct year m^3/s	Min. Flow Nov-Oct year m^3/s
1950	*	*	*	*	*	*	*	*	*	*	10.9	20.0	*	*	*	*
1951	13.7	18.6	16.0	28.1	30.8	15.1	10.0	6.9	7.5	9.3	22.2	22.9	201.1	186.9	44.74	1.64
1952	17.6	16.6	17.3	45.7	51.5	15.6	10.4	7.3	7.0	6.0	7.3	4.3	206.6	241.1	47.57	1.50
1953	10.2	2.9	9.9	34.2	39.0	15.3	9.7	7.9	6.1	6.1	7.3	9.4	158.0	152.9	28.23	0.79
1954	20.8	8.6	14.8	*	36.2	15.2	8.4	5.4	3.6	3.7	8.5	5.6	*	*	37.66	1.07
1955	9.1	29.5	15.9	47.4	55.2	27.5	16.8	10.3	7.5	6.3	10.4	12.6	248.5	239.6	45.82	0.65
1956	32.4	27.6	32.1	58.5	42.9	18.2	12.0	8.3	6.6	5.3	8.7	11.0	263.6	266.9	39.64	1.38
1957	18.4	12.9	16.4	47.7	53.6	20.1	12.8	9.3	10.7	8.8	12.2	15.5	238.4	230.4	40.78	1.47
1958	10.4	15.0	39.5	50.5	35.6	17.2	11.4	8.3	6.2	4.6	5.1	13.7	217.5	226.4	45.87	1.33
1959	10.1	12.8	18.8	18.3	14.6	7.2	6.8	7.4	4.7	3.8	5.5	6.8	116.8	123.3	20.87	0.99
1960	16.8	9.4	28.5	66.4	36.5	12.9	10.3	6.9	4.8	5.3	3.7	1.4	202.9	210.1	38.57	0.93
1961	3.1	26.2	21.3	35.3	33.5	13.7	15.9	10.0	8.3	16.2	53.2	40.6	277.3	188.2	58.54	0.10
1962	*	25.3	26.6	23.4	15.4	8.2	7.3	*	5.2	5.3	5.0	4.7	*	*	39.53	1.86
			(station closed in 1962)													
n (1951-53, 1955-61)	10	10	10	10	10	10	10	10	10	10	10	10	10	10	12	12
m_1	5.3	7.1	8.1	16.7	14.7	6.3	4.3	3.1	2.7	2.7	5.2	5.2	6.8	6.6	41.06	1.08
m_2	14.2	17.2	21.6	43.2	39.3	16.3	11.6	8.3	6.9	7.2	13.6	13.8	213.1	206.6	-	-
s	7.9	8.5	9.0	14.4	12.3	5.3	3.0	1.2	1.8	3.6	14.9	11.2	48.5	44.0	10.48	0.48
C_v	0.56	0.49	0.42	0.33	0.31	0.33	0.26	0.14	0.26	0.50	1.10	0.81	0.23	0.21	0.26	0.44

Monthly discharge volumes (10^6 m^3) for river: MGETA

Station: MGETA Station number: 1HB2

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan-Dec Total	Nov-Oct Total	Max. Flow Nov-Oct year m^3/s	Min. Flow Nov-Oct year m^3/s
1959	*	*	*	*	*	*	*	*	*	*	2.3	3.5	* *	*	*	
1960	9.1	3.6	10.5	18.9	7.9	5.3	3.8	3.0	2.3	3.5	2.4	1.7	72.0	73.7	24.07	0.78
1961	2.0	8.1	7.7	12.6	8.2	4.4	4.2	3.1	3.6	15.0	57.3	13.5	139.7	73.0	44.74	0.58
1962	8.9	*	*	9.2	9.0	5.4	4.5	5.4	4.0	4.4	5.0	6.6	*	*	*	1.32
1963	5.3	*	*	*	*	5.7	3.8	3.0	2.1	2.1	9.3	7.6	*	*	*	0.66
1964	8.9	5.7	8.9	18.5	8.9	5.3	3.8	3.0	2.4	3.3	2.1	3.2	74.0	85.6	13.76	0.66
1965	4.8	3.9	4.4	15.2	8.0	5.1	3.9	3.4	3.4	5.4	10.7	9.0	77.2	62.8	9.72	0.72
1966	10.8	*	14.6	22.7	*	6.8	4.6	3.5	3.0	4.5	4.1	4.5	*	*	30.15 (p)	0.90 (p)
1967	2.5	4.0	3.9	10.2	13.1	9.0	6.3	5.4	10.1	7.3	12.0	10.2	94.0	80.4	27.76 (p)	0.79 (p)
1968	7.5	5.2	12.5	24.9	13.0	10.2	5.4	3.8	2.9	2.5	7.4	7.4	102.7	110.1	20.27 (p)	0.84 (p)
1969	4.5	5.3	13.8	13.2	13.7	5.6	3.7	2.9	2.3	2.2	5.2	4.7	77.1	82.0	115.56 (p)	0.61 (p)
1970	5.8	10.3	9.9	16.3	9.2	5.2	3.8	2.9	4.9	3.4	3.1	13.6	88.4	81.6	55.22 (p)	0.65 (p)
1971	15.4	20.9	17.8	88.6	20.1	5.4	4.1	2.0	1.4	1.2	0.8	6.2	183.9	193.6	320.30 (p)	0.29 (p)
1972	11.7	7.9	3.2	55.6	61.7	5.5	0.5	0.1	2.2	6.0	26.9	6.9	188.2	161.4	269.46 (p)	0.00 (p)
1973	72.4	7.7	5.4	80.6	94.7	9.8	3.2	2.3	1.2	1.6	10.7	11.4	301.0	312.7	320.30 (p)	0.23 (p)
1974	7.3	3.2	7.0	84.6	63.1	9.2	5.3	3.8	2.8	11.2	6.0	5.6	209.1	219.6	320.30 (p)	0.76 (p)
1975	9.6	4.5	9.7	97.2	55.8	19.0	8.2	5.4	4.8	4.1	5.2	8.4	231.9	229.9	209.26 (p)	0.76 (p)
			(not processed on 1/1/79)													
n (1960, 61, 64, 65, 1967-75)	13	13	13	13	13	13	13	13	13	13	13	13	13	13	-	13
m_1	4.6	2.9	3.4	15.9	10.8	2.9	1.6	1.2	1.3	1.9	4.4	2.9	4.5	4.3	-	0.66
m_2	12.4	6.9	9.2	41.3	29.0	7.6	4.3	3.2	3.4	5.1	11.5	7.8	141.5	135.9	-	-
s	18.4	4.7	4.4	34.4	29.2	4.0	1.8	1.4	2.3	4.0	15.3	3.7	74.4	79.8	-	0.30
C_v	1.48	0.68	0.47	0.83	1.00	0.53	0.41	0.43	0.67	0.78	1.33	0.47	0.53	0.59	-	0.45

Monthly discharge volumes (10^6 m^3) for river: MGETA

Station: BUNDUKI Station number: 1HB3

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan-Dec Total	Nov-Oct Total	Max. Flow Nov-Oct year m^3/s	Min. Flow Nov-Oct year m^3/s
1954	*	*	*	*	*	3.8	2.6	2.3	1.7	2.7	4.9	2.4	*	*	*	*
1955	1.9	3.9	2.9	6.3	8.9	4.5	3.1	2.4	1.8	1.9	4.5	4.8	46.9	44.9	10.19	0.54
1956	6.8	5.2	6.3	7.6	6.5	3.7	2.8	2.2	1.9	1.6	4.1	8.8	57.5	53.9	13.03	0.54
1957	3.9	2.7	6.6	10.3	13.5	5.5	3.9	3.1	*	*	*	*	*	*	73.62	0.62
1958	*	*	*	*	*	*	2.5	2.0	1.8	1.6	2.3	4.0	*	*	*	*
1959	2.7	2.2	2.4	7.3	5.3	2.9	2.6	2.8	1.9	2.4	*	*	*	38.8	23.45	0.57

(station closed in 1962)

Monthly discharge volumes (10^6 m^3) for river: MWARAZI

Station: LUHUELA Station number: 1HB4

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan-Dec Total	Nov-Oct Total	Max. Flow Nov-Oct year m^3/s	Min. Flow Nov-Oct year m^3/s
1954	*	*	*	*	*	*	*	*	*	*	*	0.3	*	*	*	*
1955	0.3	0.5	0.5	1.0	1.6	0.8	0.4	0.3	0.3	0.2	0.4	0.5	6.8	*	1.25 (p)	0.06 (p)
1956	0.7	0.6	0.8	1.0	1.0	0.5	0.3	0.3	0.2	0.2	0.3	0.3	6.2	6.5	1.73 (p)	0.06 (p)
1957	0.3	0.3	0.4	1.0	1.0	0.5	0.3	0.3	0.3	0.3	0.5	0.6	5.8	5.3	7.05 (p)	0.05 (p)
1958	0.4	0.4	0.5	1.1	1.0	0.5	0.4	0.3	0.3	0.3	0.3	0.5	6.0	6.3	7.62 (p)	0.08 (p)
1959	0.3	0.3	0.3	0.7	0.9	0.4	0.3	0.3	0.2	0.3	*	*	*	4.8	3.17 (p)	0.08 (p)

(station closed in 1963)

Monthly discharge volumes (10^6 m^3) for river: MVUHA

Station: MVUHA Station number: 1HC2

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan-Dec Total	Nov-Oct Total	Max. Flow Nov-Oct year m^3/s	Min. Flow Nov-Oct year m^3/s
1954	*	*	*	39.9	46.7	13.7	7.8	6.2	5.2	8.0	15.9	9.8	*	*	*	*
1955	16.5	39.7	14.0	97.0	82.7	28.6	15.0	9.4	4.5	15.9	16.9	18.4	358.6	349.0	141.03	0.90
1956	20.3	26.0	47.9	67.1	47.4	27.5	11.3	6.8	5.3	(4.3)	18.0	14.2	(296.1)	(299.2)	96.28	1.47
1957	16.2	22.5	39.6	123.2	114.0	25.7	19.9	22.9	25.9	10.8	49.4	59.0	529.1	452.9	217.49	1.07
1958	35.2	67.5	135.0	142.8	71.7	46.4	14.4	10.4	7.2	7.2	38.3	28.5	604.6	646.2	260.54	1.18
1959	43.9	17.7	40.4	47.2	52.8	9.1	7.8	9.4	5.8	11.9	9.1	8.2	263.3	312.8	79.57	1.50
1960	18.1	11.8	39.0	94.4	26.8	18.9	10.2	8.9	4.7	16.0	5.1	4.5	258.4	266.1	62.35	1.27
1961	16.4	35.3	53.5	52.7	36.4	16.9	52.8	20.9	28.8	65.6	105.9	61.6	546.8	388.9	176.84	0.79
1962	95.8	42.2	104.7	108.5	87.7	47.9	20.9	26.7	17.4	18.8	92.8	66.7	730.1	738.1	423.62	2.76
1963	92.2	47.9	119.5	80.1	41.7	20.1	11.3	7.7	4.5	2.2	225.0	140.1	792.3	586.7	202.75	1.27
1964	126.3	46.0	79.7	99.4	32.4	18.3	10.6	10.6	8.9	32.2	3.8	9.4	477.6	829.5	302.07	0.39
1965	17.5	22.8	26.3	82.5	17.8	7.6	3.9	*	*	*	151.9	326.0	*	*	79.85	1.02
1966	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1967	*	*	18.5	49.4	75.5	27.3	20.0	19.1	35.3	35.5	70.8	159.1	*	*	149.67	3.05
1968	45.7	*	*	*	*	*	*	12.8	10.3	10.0	45.1	61.8	*	*	*	2.91
1969	12.8	12.8	81.6	67.7	*	*	*	*	*	10.8	*	*	*	*	869.83	*
1970	*	44.4	38.5	39.5	15.6	9.4	7.6	6.3	10.7	6.6	6.0	45.8	*	*	*	1.81
1971	10.1	8.2	11.6	44.9	24.2	8.7	11.7	5.6	4.1	12.2	9.5	3.2	154.0	193.1	120.69	1.26
1972	20.1	7.8	10.8	19.5	37.9	12.7	9.5	8.0	12.0	15.5	28.2	26.0	208.0	166.5	132.47	2.08
1973	24.9	23.3	31.3	62.9	34.4	9.3	7.4	9.0	4.3	4.2	16.8	25.6	253.4	265.2	132.47	0.85
1974	18.4	8.7	17.9	63.4	*	*	*	*	10.5	9.5	10.0	8.3	*	*	*	1.02
1975	20.5	6.9	30.8	61.5	35.9	10.7	9.5	(8.4)	7.4	16.8	8.1	18.9	(235.4)	(226.7)	88.61	1.35
1976			(not processed on 1/1/79)													1.75
1977																2.37
1978																
n (1955-64, 1971-73)	14	14	14	14	14	14	14	14	14	14	14	14	14	14	17	21
m_1	14.9	11.9	20.2	30.4	19.4	8.3	5.7	4.4	3.9	6.2	17.3	12.9	12.9	13.0	208.0	1.53
m_2	39.8	28.8	54.1	78.7	51.9	21.5	15.2	11.8	10.1	16.7	44.8	34.6	407.7	408.6	-	-
s	37.0	18.3	40.2	34.0	26.9	12.8	11.6	6.6	8.2	16.0	60.9	37.0	204.8	211.2	194.5	0.73
C_v	0.93	0.64	0.74	0.43	0.52	0.60	0.76	0.56	0.81	0.96	1.36	1.07	0.50	0.52	0.93	0.48

Monthly discharge volumes (10^6 m^3) for river: GREAT RUAHA

Station: KIDATU Station number: 1KA3

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan-Dec Total	Nov-Oct Total	Max. Flow Nov-Oct year m^3/s	Min. Flow Nov-Oct year m^3/s
1954	*	*	*	*	*	*	*	*	*	*	28.3	35.5	*	*	*	*
1955	42.1	371.4	557.5	724.8	679.6	274.2	164.8	80.2	56.4	46.7	40.8	68.7	3107.2	3061.5	1719.96 (p)	9.74 (p)
1956	1000.3	1198.5	1044.4	1131.9	1149.5	332.1	176.5	112.1	71.1	52.3	40.9	51.6	6361.2	6378.2	2353.70 (p)	12.80 (p)
1957	140.0	737.6	705.0	1238.8	1041.5	372.0	189.7	118.4	77.1	57.1	42.6	47.2	4767.0	4769.7	1931.21 (p)	12.80 (p)
1958	83.7	353.6	662.8	1167.7	839.2	263.4	147.7	95.3	67.1	49.6	36.2	100.4	3866.7	3819.9	1928.88 (p)	12.80 (p)
1959	114.0	145.3	802.5	1073.1	637.7	198.3	110.4	69.9	45.6	36.8	42.1	165.7	3441.4	3370.2	2353.70 (p)	9.06 (p)
1960	*	464.1	894.7	1176.8	676.4	325.8	189.0	119.7	82.4	66.5	49.0	38.3	*	*	548.44 (p)	8.78 (p)
1961	63.1	167.2	214.7	250.4	238.3	111.3	105.7	69.8	54.9	54.1	146.3	644.8	2120.6	1416.8	159.70 (p)	12.85 (p)
1962	*	*	*	*	*	289.4	206.0	169.8	121.1	99.4	83.4	119.7	*	*	*	*
1963	510.0	847.1	1218.9	1070.2	647.1	310.9	208.0	146.8	123.1	93.5	305.7	*	*	5378.7	743.60 (p)	23.92 (p)
1964	*	*	1618.6	1328.8	621.9	*	226.7	185.4	138.4	100.6	75.7	79.3	*	*	*	*
1965	159.7	127.9	223.9	476.4	328.7	180.8	124.0	99.9	70.2	61.9	51.9	136.8	2042.1	2008.4	327.62 (p)	13.03 (p)
1966	190.4	248.1	513.3	611.2	387.3	190.2	127.3	95.0	69.3	55.2	53.5	80.3	2621.1	2676.0	463.26 (p)	15.57 (p)
1967	117.9	128.1	219.3	682.8	495.0	324.7	181.0	126.2	101.7	72.4	81.6	*	*	2582.9	662.61 (p)	14.44 (p)
1968	*	*	*	*	*	531.8	342.8	246.1	177.8	142.7	164.8	169.1	*	*	*	(19.11)(p)
1969	200.2	820.4	770.5	550.8	434.1	212.0	118.6	104.0	65.8	42.7	26.1	40.5	3385.7	3653.0	704.92 (p)	11.11 (p)
1970	573.6	829.3	1038.5	*	*	*	*	*	*	*	*	*	*	*	687.36 (p)	(3.96)(p)
1971	*	*	670.2	551.8	*	143.5	112.0	72.1	47.0	42.6	25.3	66.4	*	*	101.90 (p)	(7.56)(p)
1972	*	500.7	860.6	*	*	322.9	178.5	119.1	94.0	64.6	74.0	*	*	*	(543.51)(p)	(6.85)(p)
1973	*	*	804.8	*	*	*	*	*	*	61.0	46.4	85.4	*	*	*	*
1974	131.3	163.6	233.5	*	*	454.3	*	*	*	*	*	*	*	*	*	*
			(not processed on 1/1/79)													
n (1955-59, 1965,66, 1969)	8	8	8	8	8	8	8	8	8	8	8	8	8	8	15	16
m_1	90.1	206.9	246.4	336.3	256.6	97.6	54.1	37.4	25.2	18.8	16.1	32.3	117.3	117.8	1015.36	12.15
m_2	241.3	500.4	660.0	871.8	687.2	252.9	144.9	96.9	65.3	50.3	41.8	86.4	3699.1	3717.1	-	-
s	311.2	380.4	240.4	311.5	304.1	70.5	29.4	15.9	9.9	8.1	8.6	45.1	1345.8	1350.0	799.08	4.83
C_v	1.29	0.76	0.36	0.36	0.44	0.28	0.20	0.16	0.15	0.16	0.21	0.52	0.36	0.36	0.79	0.40

Monthly discharge volumes (10^6 m^3) for river: GREAT RUAHA

Station: YOVI Station number: 1KA38A

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan-Dec Total	Nov-Oct Total	Max. Flow Nov-Oct year m^3/s	Min. Flow Nov-Oct year m^3/s
1958	*	*	*	*	*	12.4	9.0	7.6	5.7	5.1	4.3	5.3	*	*	*	*
1959	5.2	6.2	9.4	9.5	7.8	4.6	4.4	3.1	2.2	2.1	2.5	7.2	64.2	64.1	13.83	0.68
1960	5.6	3.1	12.0	30.7	13.6	9.4	7.3	5.8	4.3	3.9	3.3	2.4	101.5	105.5	23.22	0.46
1961	6.2	14.1	15.9	13.3	18.1	7.2	7.4	5.1	4.5	5.2	23.2	31.5	151.7	102.7	67.89	0.56
1962	53.8	26.1	28.2	25.8	26.3	13.0	10.2	9.4	7.5	5.5	5.5	6.9	218.2	260.5	67.89	1.56
1963	16.4	13.9	27.7	34.5	20.5	12.9	10.1	8.0	2.4	5.0	21.3	25.1	197.8	163.8	36.23	1.22
1964	43.7	28.6	38.6	*	*	*	*	*	*	*	*	*	*	*	*	*
1965	*	6.6	18.5	*	*	*	*	*	*	*	*	*	*	*	*	*
1966	*	*	*	*	*	*	*	*	*	*	*	5.3	*	*	*	*
1967	5.2	4.9	6.4	13.5	18.9	5.8	10.6	8.2	8.2	5.9	11.2	47.6	146.5	*	11.01	1.14
1968	31.5	16.1	28.7	112.7	42.6	35.1	19.1	12.9	9.2	7.0	13.9	14.1	342.9	373.7	95.40	1.94
1969	8.6	10.0	14.3	17.4	31.0	13.4	10.7	9.0	7.1	6.0	5.7	6.5	139.1	154.9	30.67	1.81
1970	43.5	35.6	16.0	19.6	11.6	8.1	6.9	5.7	4.9	3.5	2.3	5.4	167.6	161.1	223.03	0.96
			(not processed on 1/1/79)													
n (1959-63, 1967-70)	9	9	9	9	9	9	9	9	9	9	9	9	9	8	9	9
m_1	7.3	6.0	6.6	11.9	7.9	4.7	3.6	2.8	2.2	1.8	3.8	6.1	5.4	5.5	62.57	1.15
m_2	19.5	14.4	17.6	30.8	21.2	12.2	9.6	7.5	5.6	4.9	9.9	16.4	169.9	173.3	-	-
s	18.8	10.6	8.5	31.8	10.8	9.2	4.2	2.9	2.5	1.5	8.0	15.3	78.6	99.9	66.64	0.54
C_v	0.96	0.74	0.48	1.03	0.51	0.75	0.44	0.39	0.45	0.31	0.81	0.93	0.46	0.58	1.07	0.47

Monthly discharge volumes (10^6 m^3) for river: MWEGA

Station: MALOLO Station number: 1KA57A

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan-Dec Total	Nov-Oct Total	Max. Flow Nov-Oct year m^3/s	Min. Flow Nov-Oct year m^3/s
1965	*	4.6	4.9	5.9	4.6	2.9	3.4	2.6	2.8	2.3	2.7	3.5	*	*	*	*
1966	3.5	3.0	*	*	*	7.3	5.6	4.6	5.2	4.0	3.1	3.4	*	*	6.55 (p)	0.59 (p)
1967	3.3	3.1	4.1	6.0	7.5	6.4	5.3	4.9	4.7	4.1	5.3	10.1	64.8	55.9	9.18 (p)	0.85 (p)
1968	13.6	9.7	11.8	19.4	19.4	16.4	12.9	9.6	8.3	7.2	9.0	7.0	144.3	143.7	28.08 (p)	1.33 (p)
1969	5.4	6.1	7.5	8.5	10.7	7.9	6.6	5.8	5.4	4.9	4.2	4.1	77.1	84.8	22.90 (p)	0.97 (p)
1970	*	5.4	6.2	7.0	5.9	4.6	3.6	3.1	2.9	3.0	2.9	5.0	*	*	14.56 (p)	1.00 (p)
			(not processed on 1/1/79)													

Monthly discharge volumes (10^6 m^3) for river: CHALI

Station: CHALI Station number: 1KA58A

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan-Dec Total	Nov-Oct Total	Max. Flow Nov-Oct year m^3/s	Min. Flow Nov-Oct year m^3/s
1965	*	4.0	2.5	6.7	2.1	1.1	0.6	0.8	0.6	0.8	0.9	5.2	*	*	10.86	0.13
1966	6.3	0.9	2.0	1.7	1.8	1.5	1.2	0.8	0.5	0.6	0.8	1.9	*	23.4	6.97	0.13
1967	2.6	0.9	1.4	3.9	4.7	1.7	1.7	1.4	1.5	1.1	1.6	*	*	23.6	6.50	0.20
1968	*	*	9.6	13.6	*	*	4.3	3.1	2.4	1.9	*	*	*	*	*	0.59
1969	*	2.3	1.9	1.8	2.3	1.5	1.2	1.0	0.8	0.8	0.8	1.0	*	*	*	0.20
1970	3.2	2.2	1.9	1.9	1.0	0.8	0.6	0.6	0.5	0.4	0.3	1.1	14.5	14.9	6.32	0.12

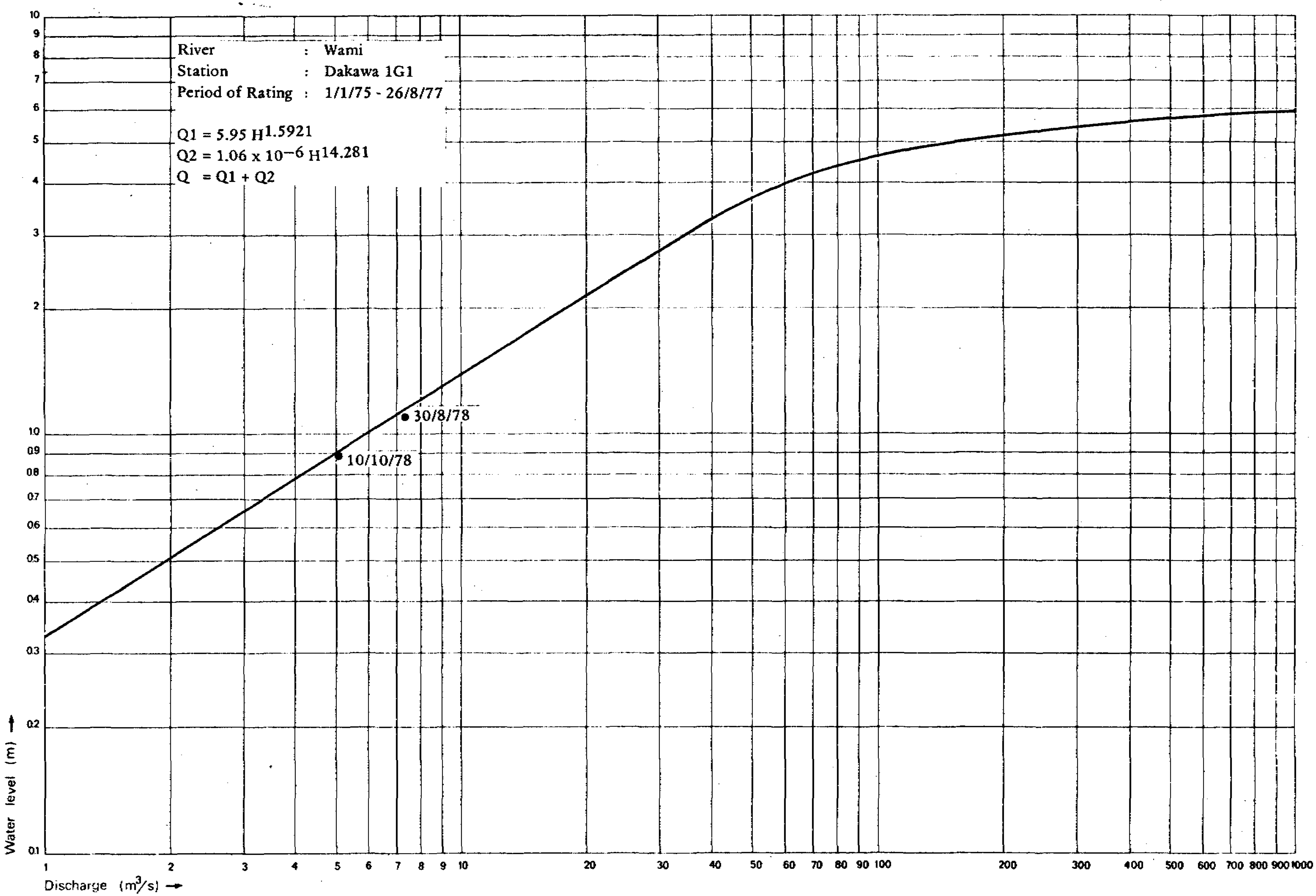
(not processed on 1/1/79)

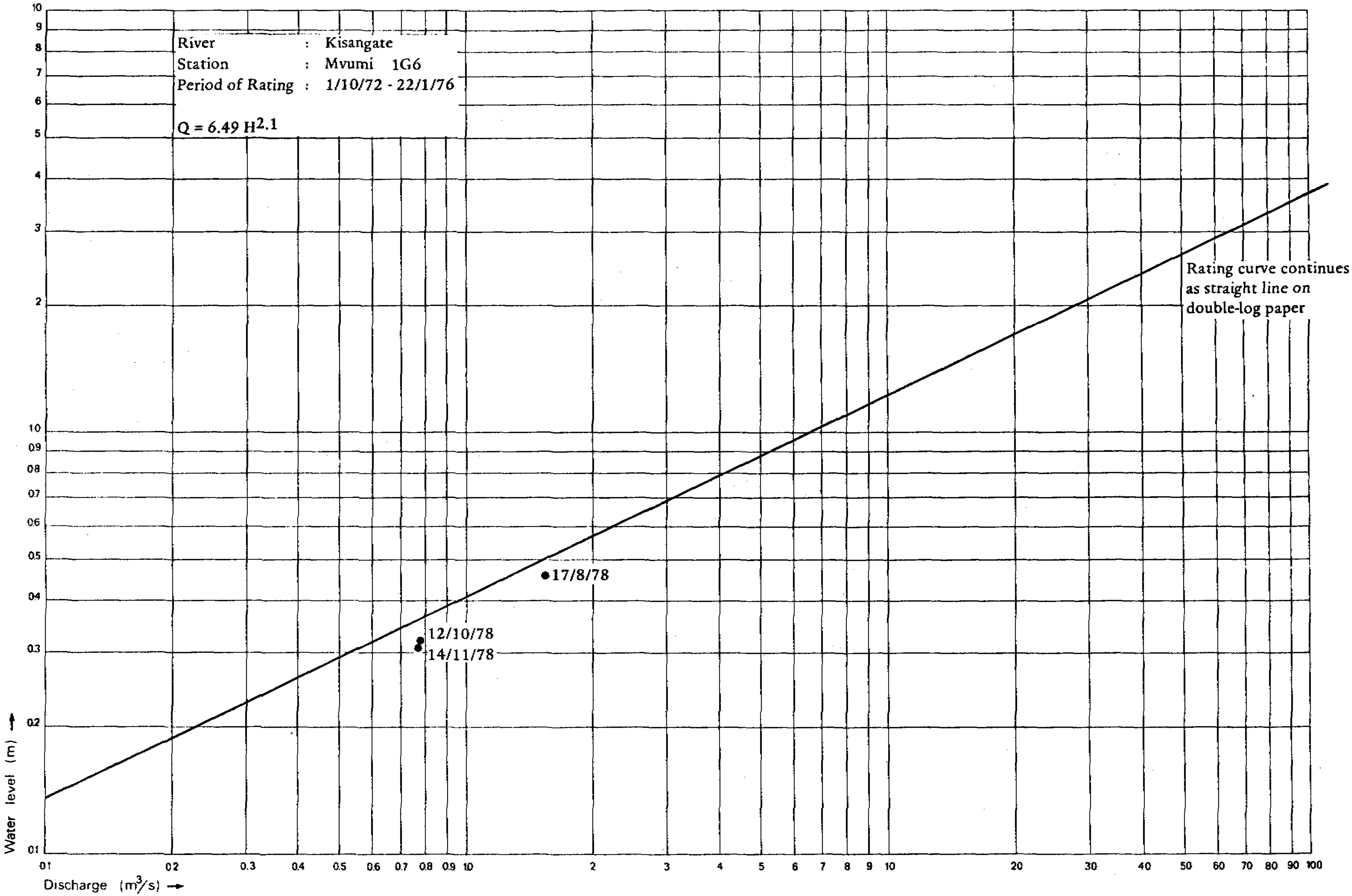
CD 3.2 Rating curves

<u>Legend</u> (rating curves)

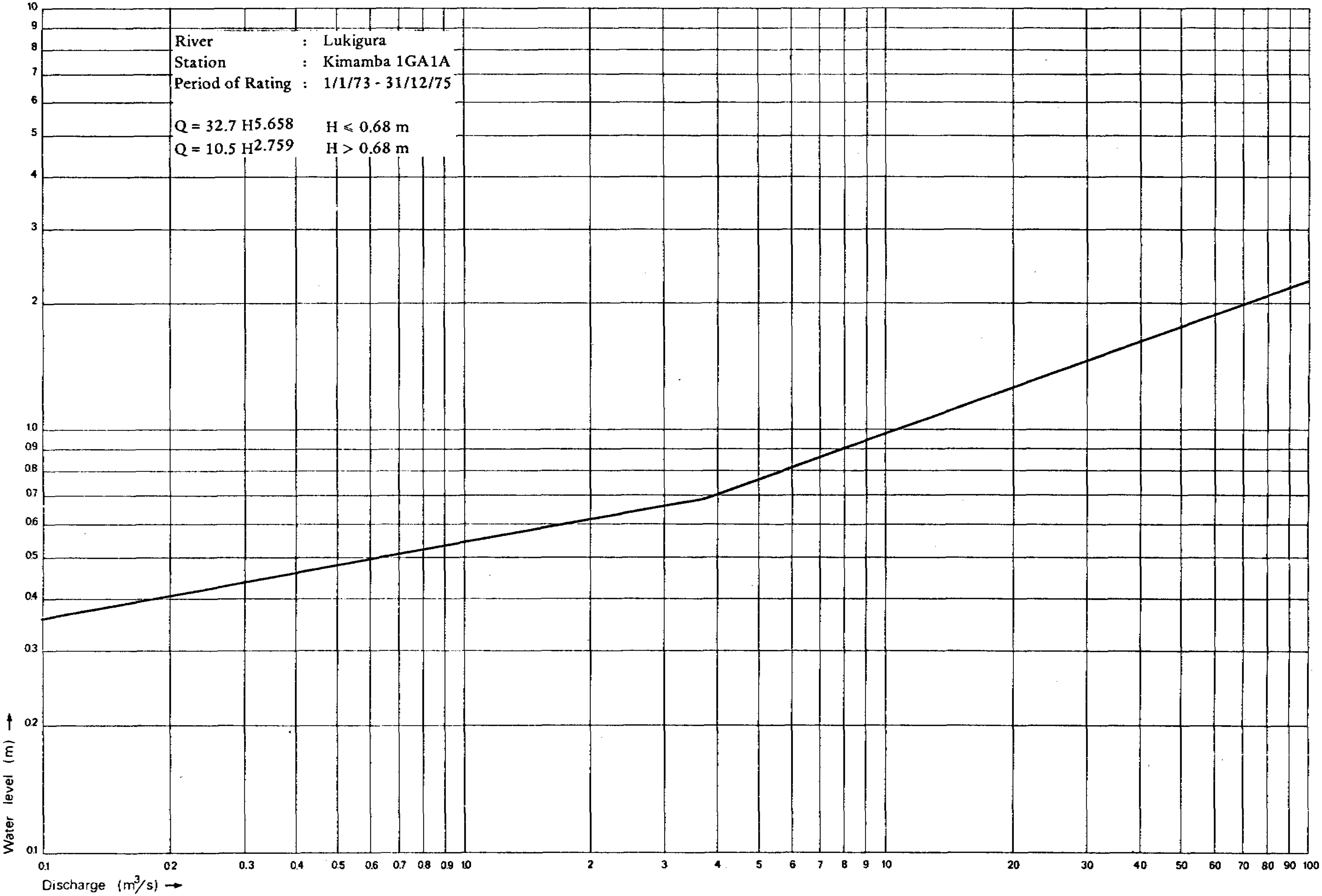
° = measured value
—— = existing rating curve
--- = proposed new rating curve

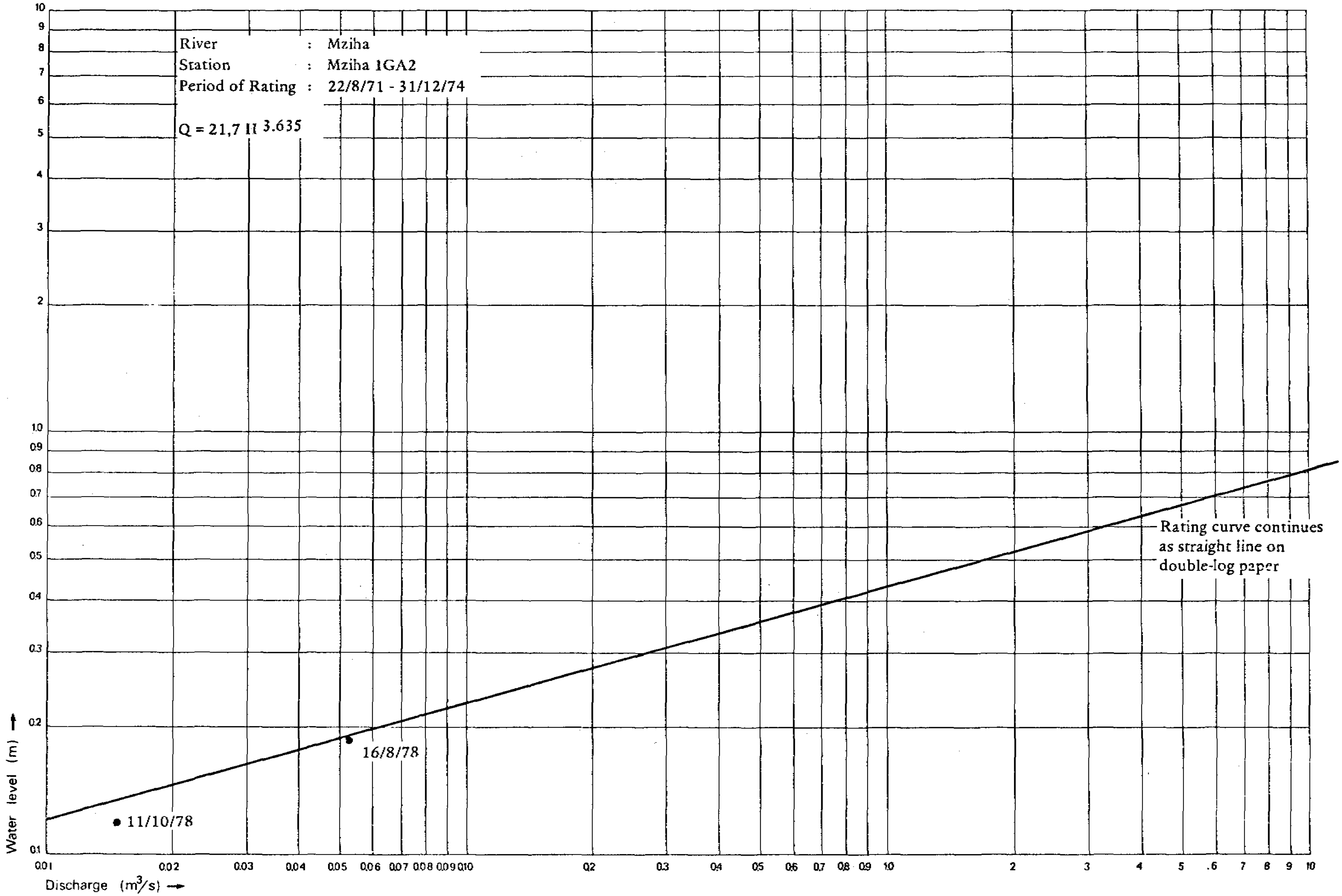
Q = discharge (m^3/s)
H = waterstage (m)

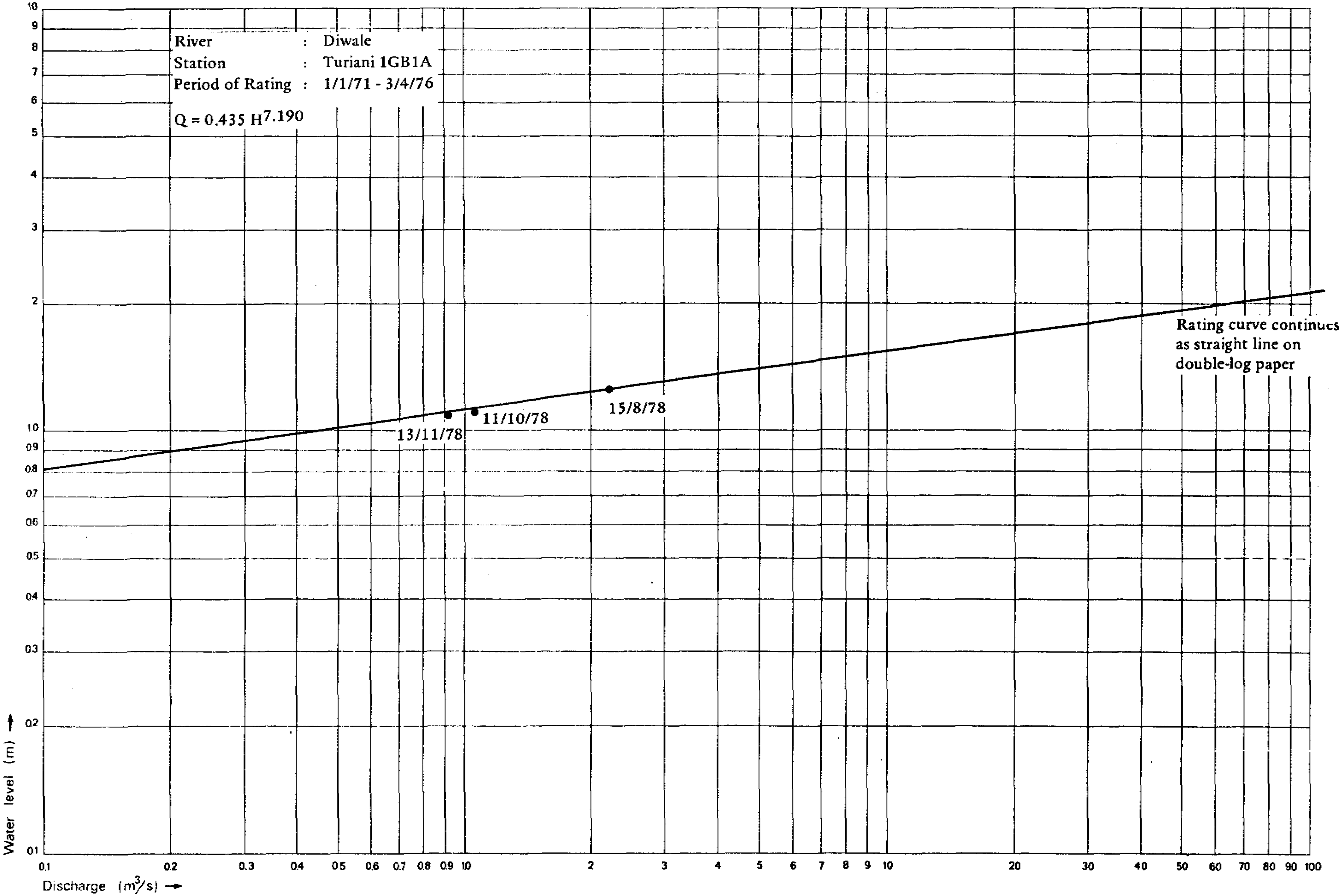

River : Wami
Station : Dakawa 1G1
Period of Rating : 1/1/75 - 26/8/77
Q1 = 5.95 H1.5921
Q2 = 1.06 x 10−6 H14.281
Q = Q1 + Q2
30/8/78
10/10/78
Water level (m)
Discharge (m3/s)

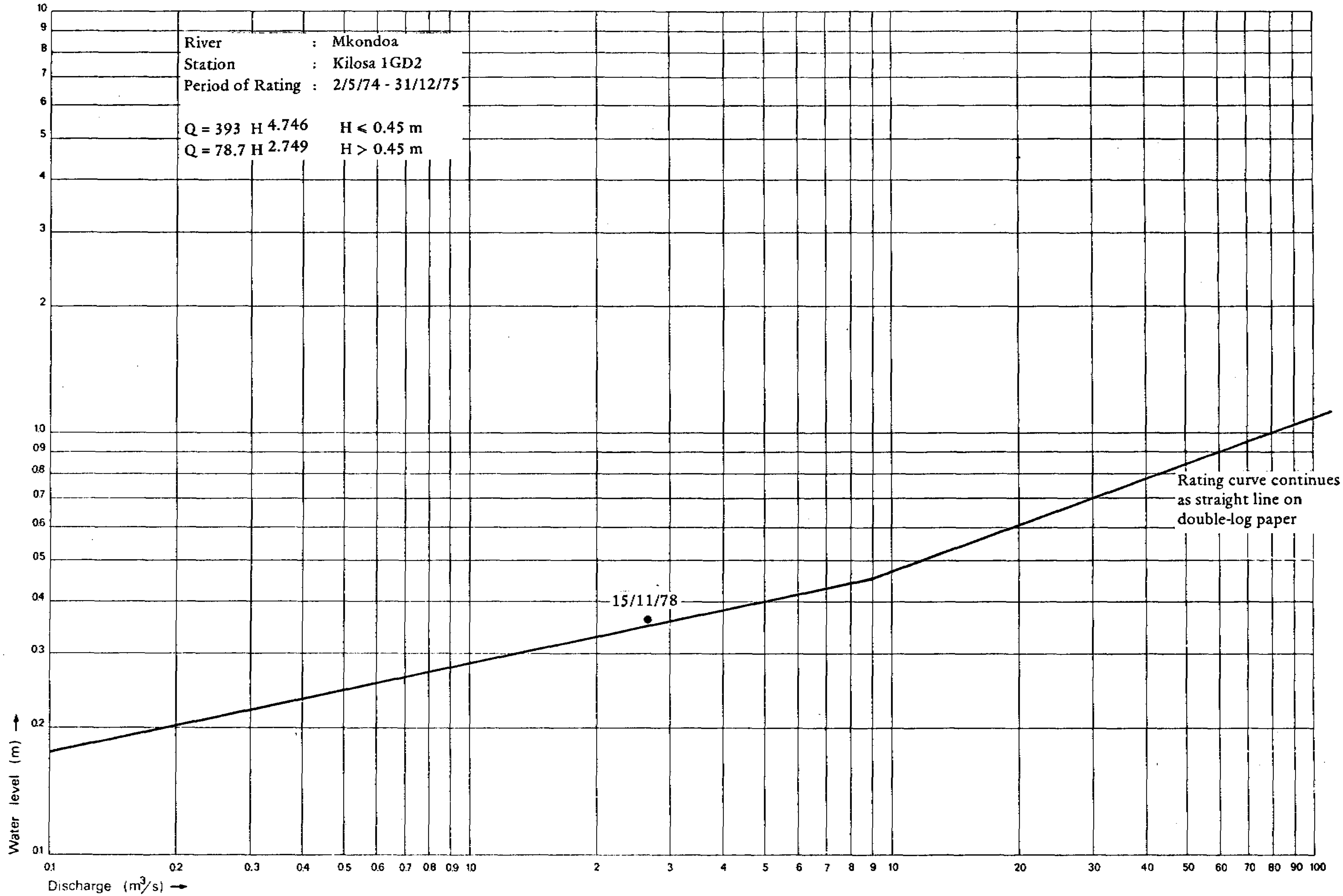


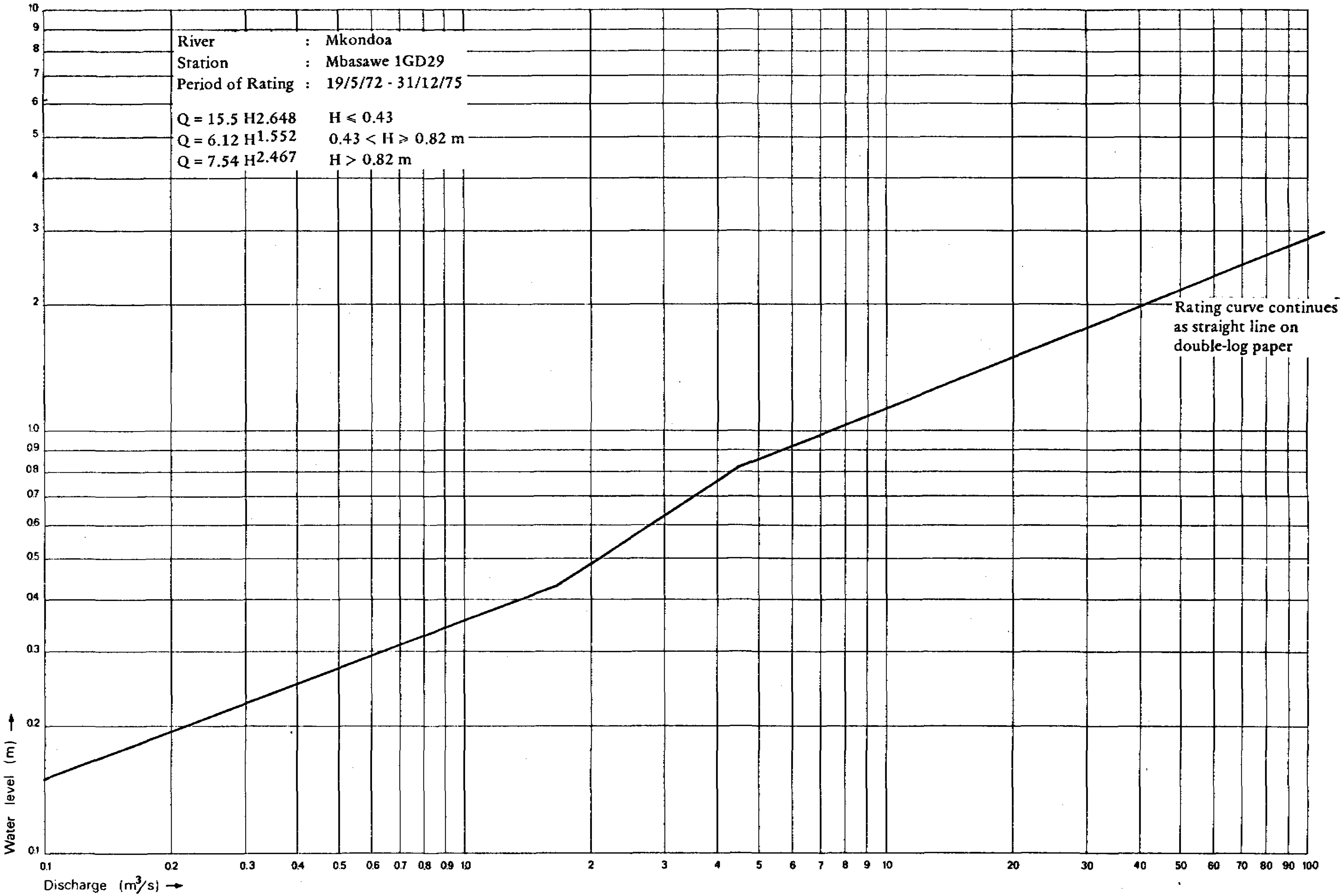
River : Kisangate
Station : Mvumi 1G6
Period of Rating : 1/10/72 - 22/1/76
Q = 6.49 H2.1
Rating curve continues as straight line on double-log paper
17/8/78
12/10/78
14/11/78
Water level (m)
Discharge (m3/s)

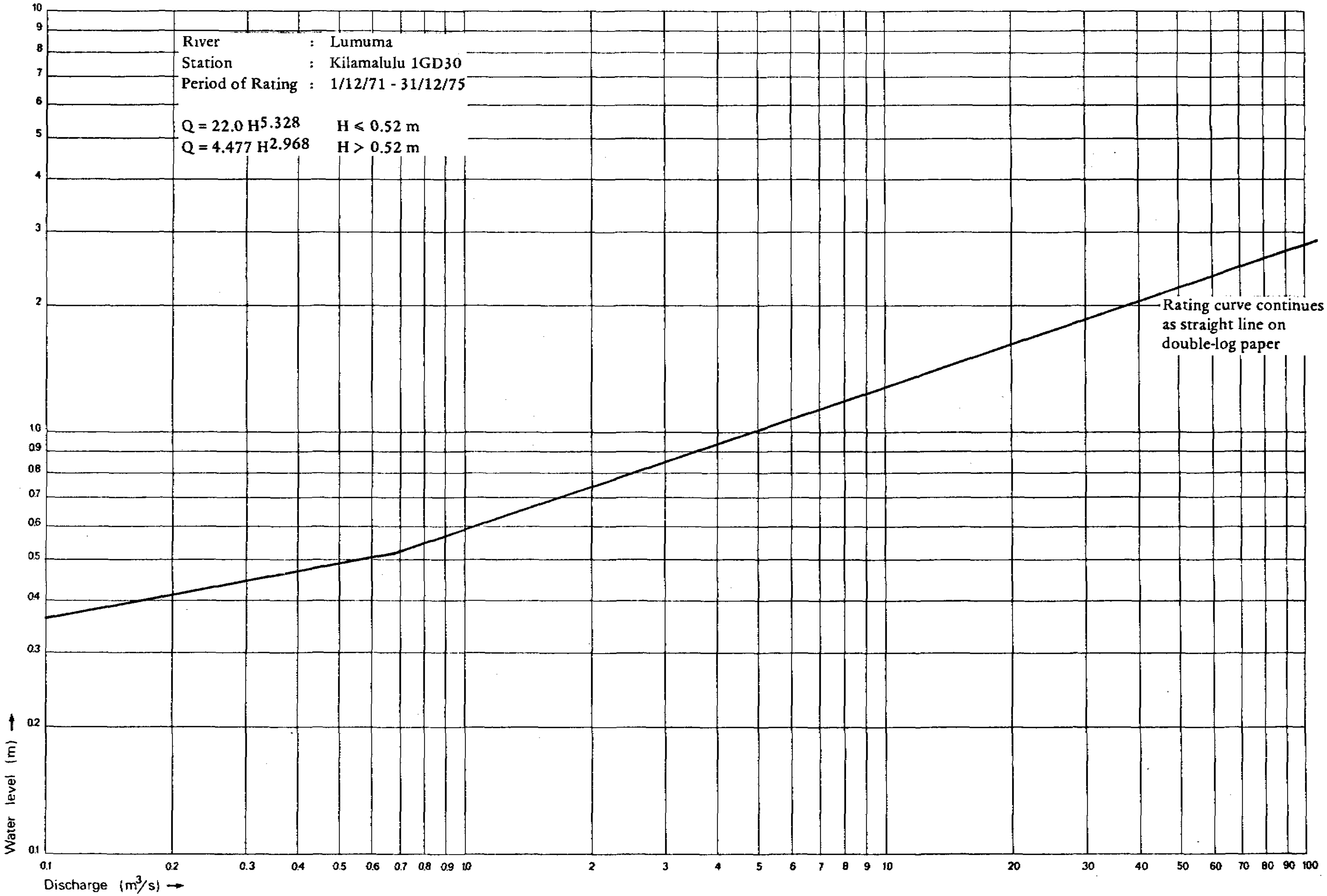

River : Lukigura
Station : Kimamba 1GA1A
Period of Rating : 1/1/73 - 31/12/75
Q = 32.7 H5.658 H ≤ 0.68 m
Q = 10.5 H2.759 H > 0.68 m
Water level (m)
Discharge (m3/s)

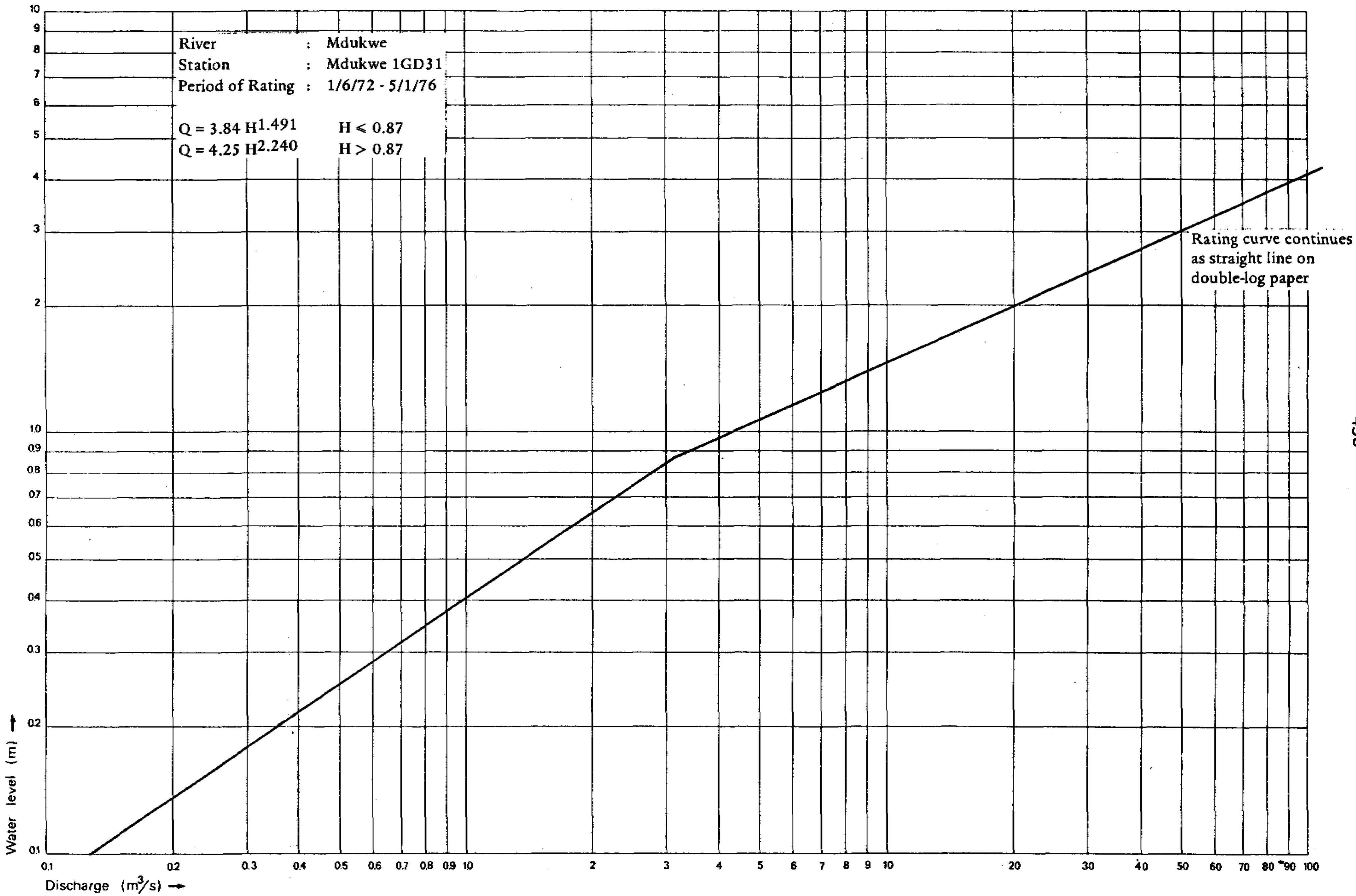

River : Mziha
Station : Mziha 1GA2
Period of Rating : 22/8/71 - 31/12/74
Q = 21,7 H 3.635
Rating curve continues as straight line on double-log paper
16/8/78
11/10/78
Water level (m)
Discharge (m3/s)
0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08 0.09 0.10 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 2 3 4 5 6 7 8 9 10
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 2 3 4 5 6 7 8 9 10

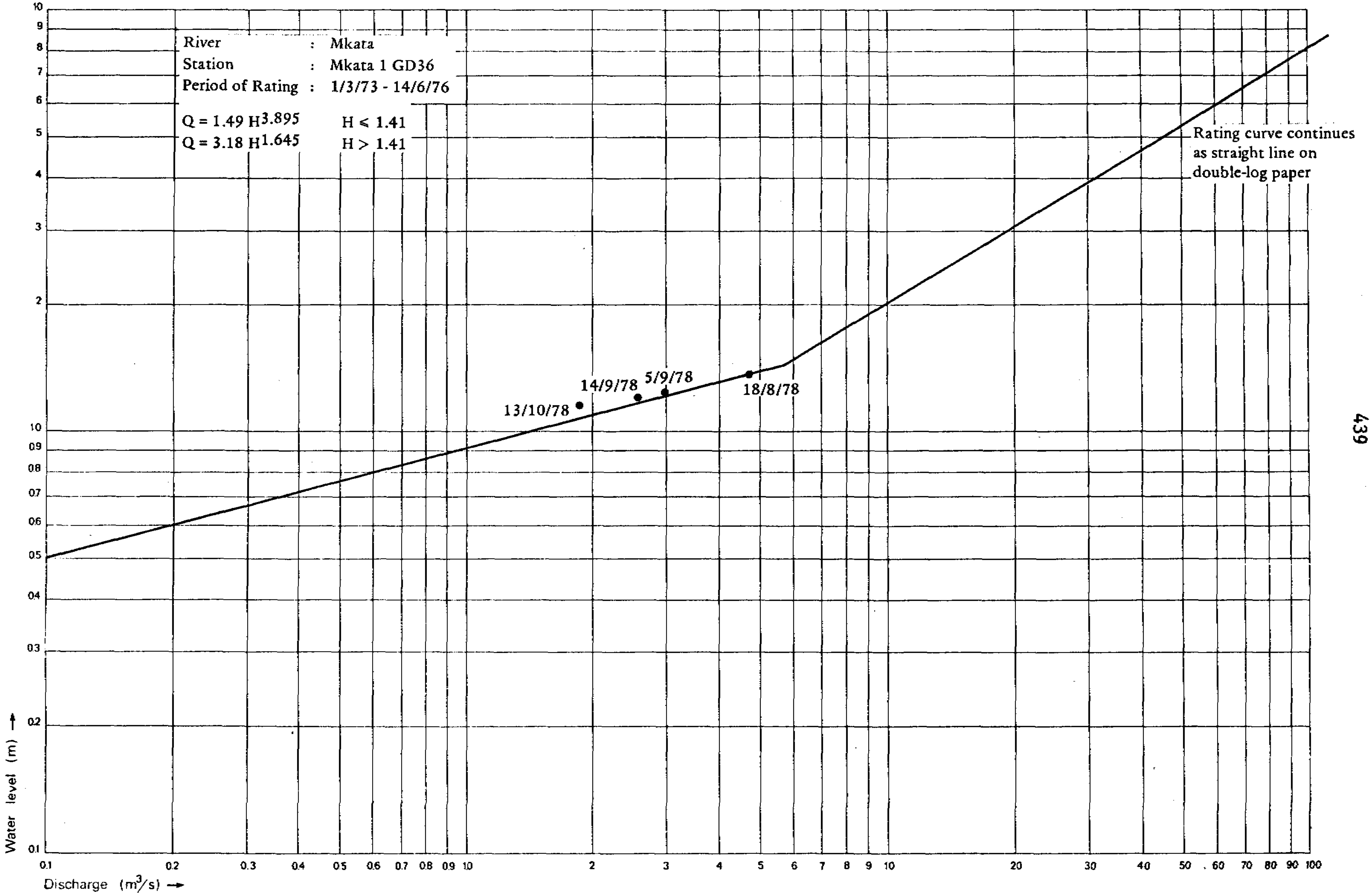

River : Diwale
Station : Turiani 1GB1A
Period of Rating : 1/1/71 - 3/4/76
Q = 0.435 H7.190
13/11/78
11/10/78
15/8/78
Rating curve continues as straight line on double-log paper
Water level (m)
Discharge (m3/s)
10
9
8
7
6
5
4
3
2
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
2
3
4
5
6
7
8
9
10
20
30
40
50
60
70
80
90
100

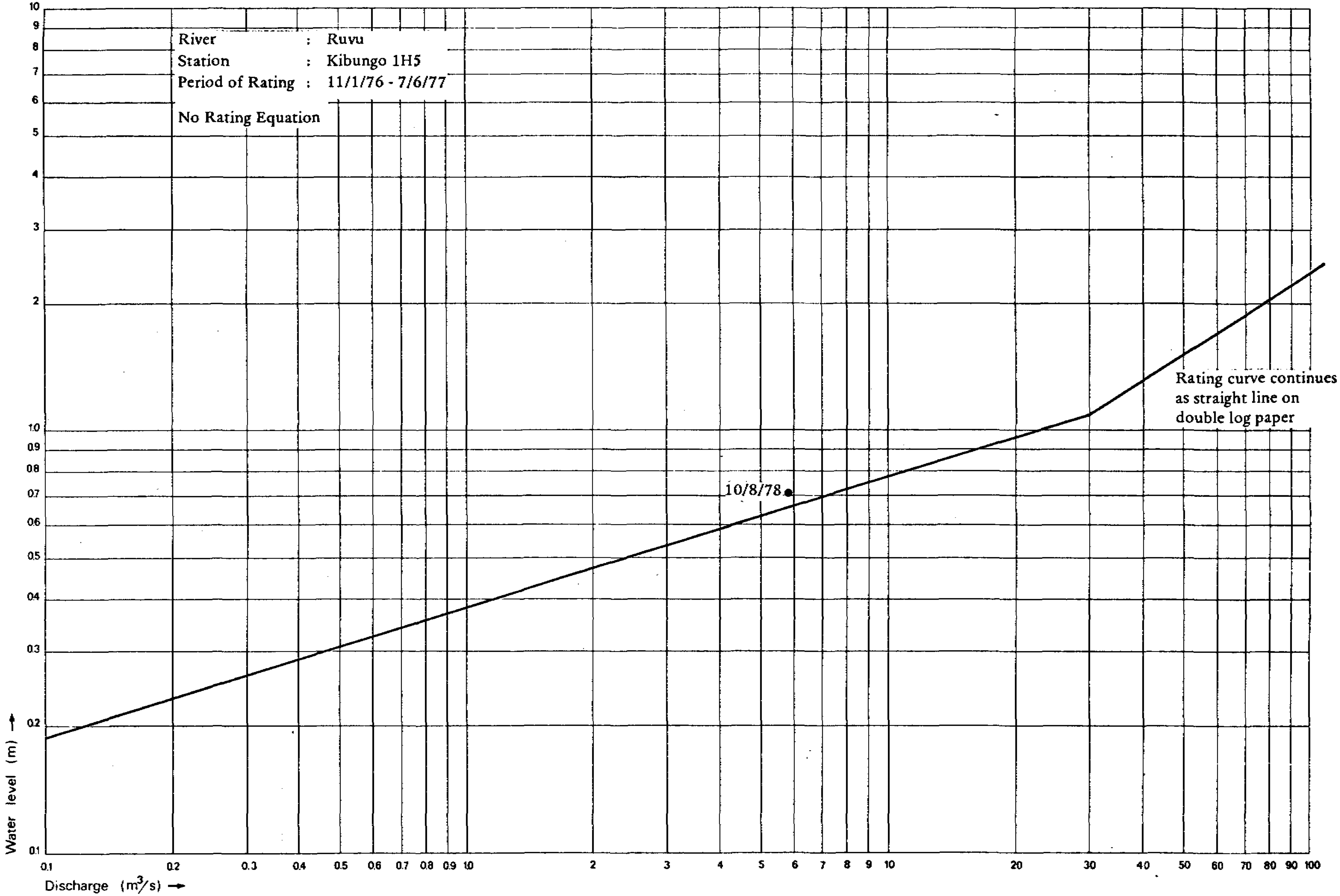

River : Mkondoa
Station : Kilosa 1GD2
Period of Rating : 2/5/74 - 31/12/75
Q = 393 H 4.746 H ≤ 0.45 m
Q = 78.7 H 2.749 H > 0.45 m
15/11/78
Rating curve continues as straight line on double-log paper
Water level (m)
Discharge (m3/s)

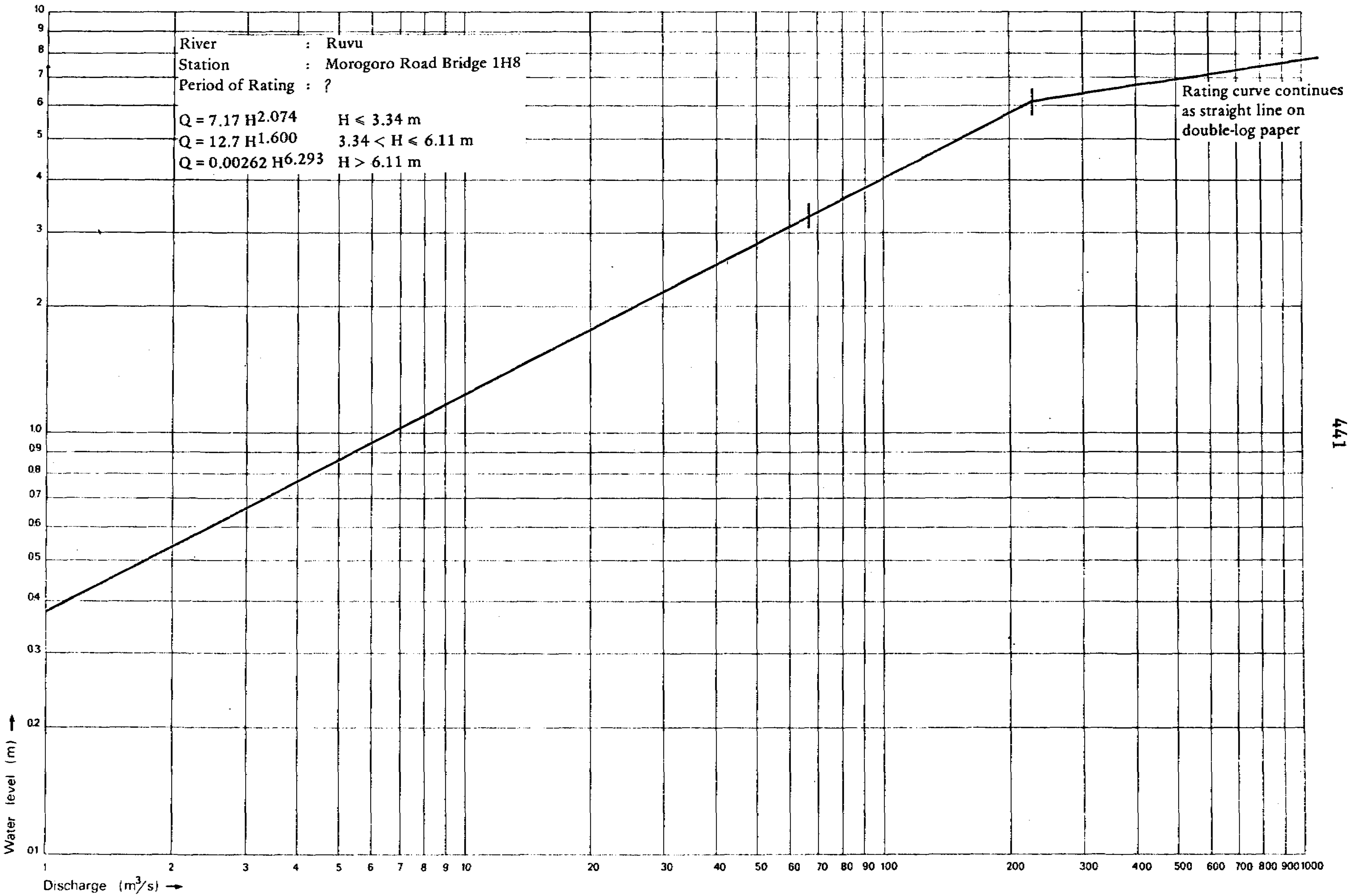

River : Mkondoa
Station : Mbasawe 1GD29
Period of Rating : 19/5/72 - 31/12/75
$Q = 15.5\ H^{2.648}$ $H \leqslant 0.43$
$Q = 6.12\ H^{1.552}$ $0.43 < H \geqslant 0.82$ m
$Q = 7.54\ H^{2.467}$ $H > 0.82$ m
Rating curve continues as straight line on double-log paper
Water level (m) →
Discharge (m^3/s) →
10 9 8 7 6 5 4 3 2 1.0 0.9 0.8 0.7 0.6 0.5 0.4 0.3 0.2 0.1
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 2 3 4 5 6 7 8 9 10 20 30 40 50 60 70 80 90 100

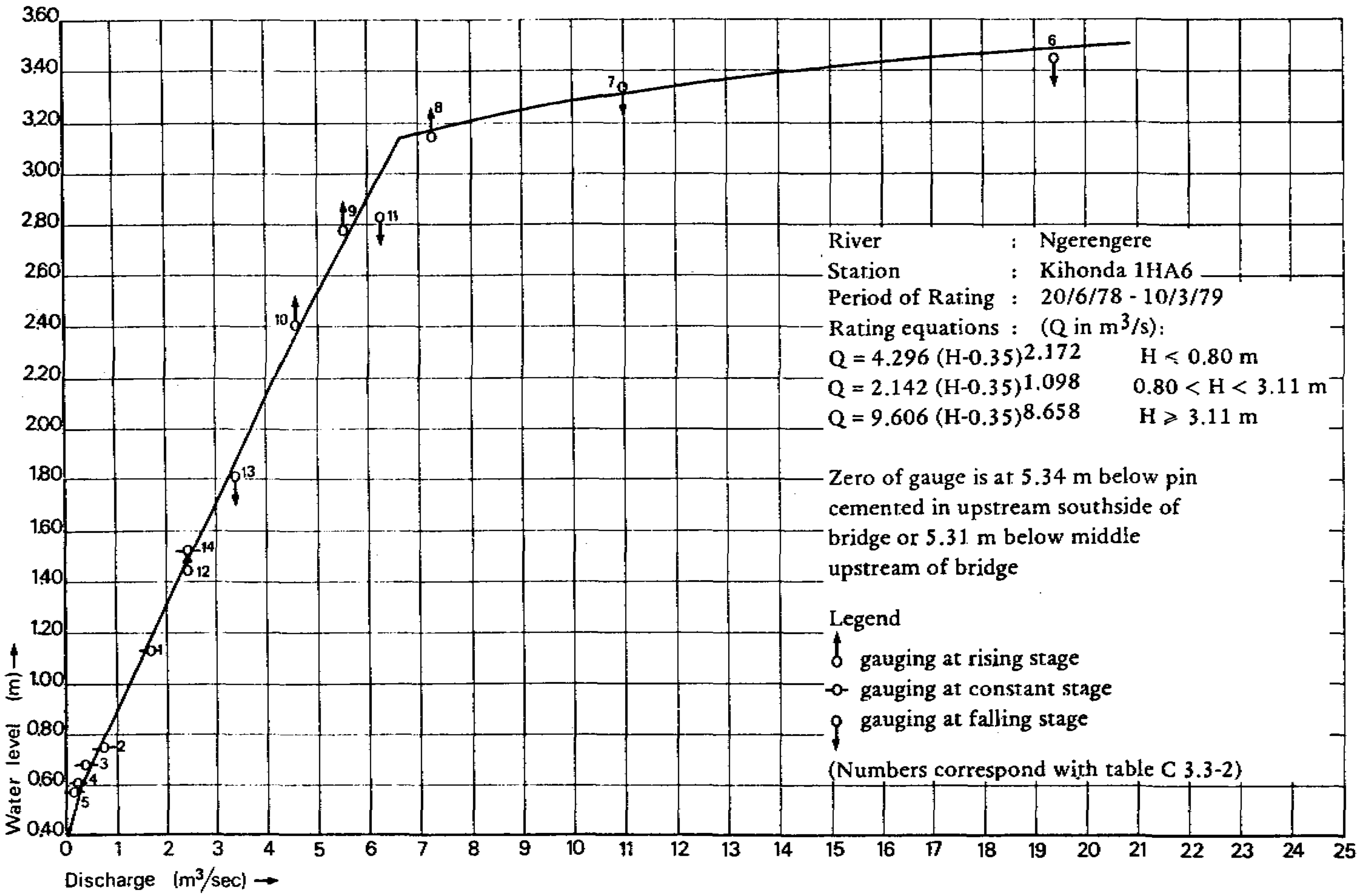

River : Lumuma
Station : Kilamalulu 1GD30
Period of Rating : 1/12/71 - 31/12/75
$Q = 22.0\,H^{5.328}$ $H \leq 0.52$ m
$Q = 4.477\,H^{2.968}$ $H > 0.52$ m
Rating curve continues as straight line on double-log paper
Water level (m)
Discharge (m^3/s)
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 2 3 4 5 6 7 8 9 10 20 30 40 50 60 70 80 90 100
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 2 3 4 5 6 7 8 9 10

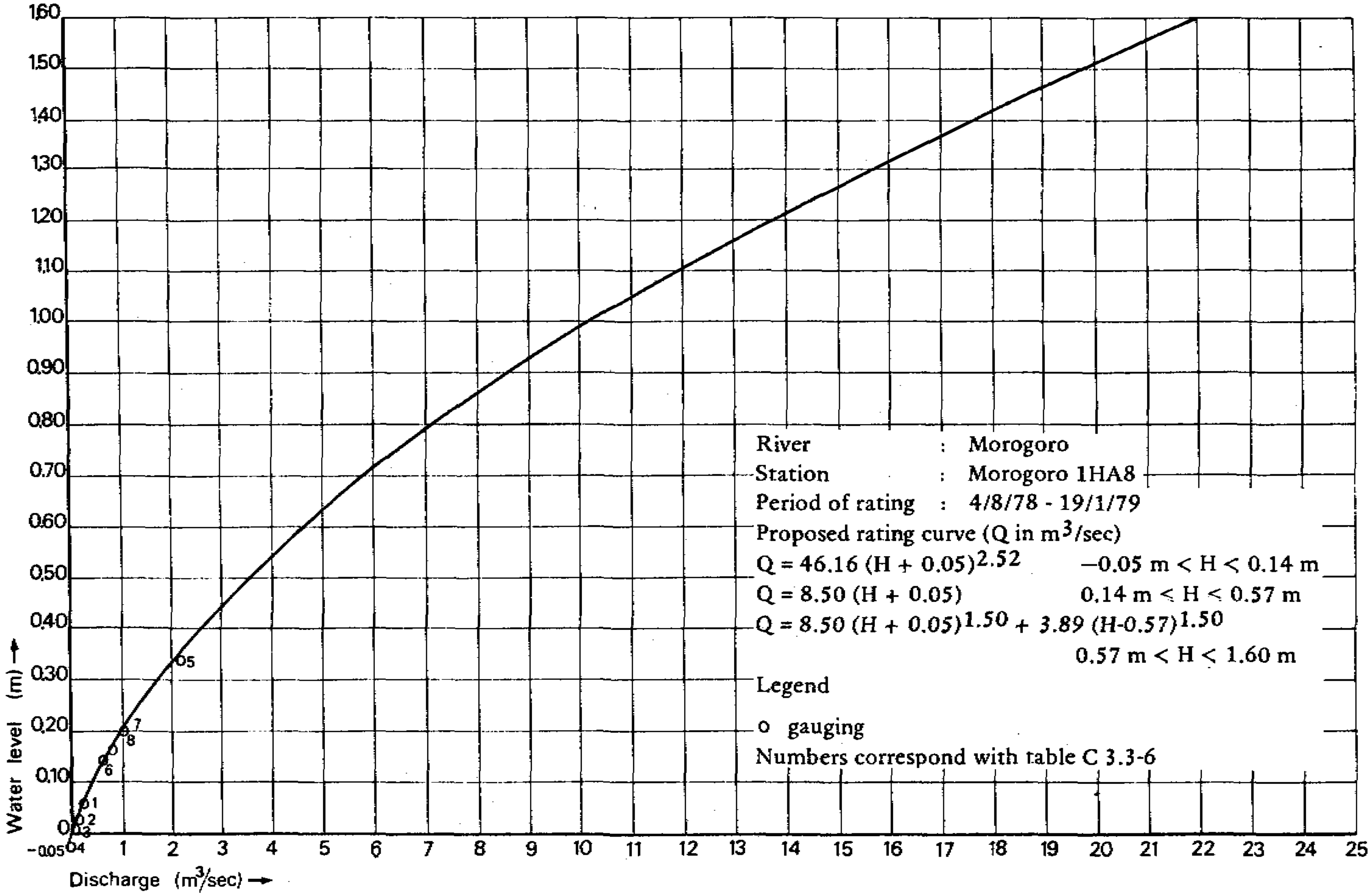

River : Mdukwe
Station : Mdukwe 1GD31
Period of Rating : 1/6/72 - 5/1/76
Q = 3.84 H^1.491 H ⩽ 0.87
Q = 4.25 H^2.240 H > 0.87
Rating curve continues as straight line on double-log paper
Water level (m)
Discharge (m³/s)


River : Mkata
Station : Mkata 1 GD36
Period of Rating : 1/3/73 - 14/6/76
Q = 1.49 H3.895 H ≤ 1.41
Q = 3.18 H1.645 H > 1.41
Rating curve continues as straight line on double-log paper
13/10/78
14/9/78
5/9/78
18/8/78
Water level (m)
Discharge (m3/s)

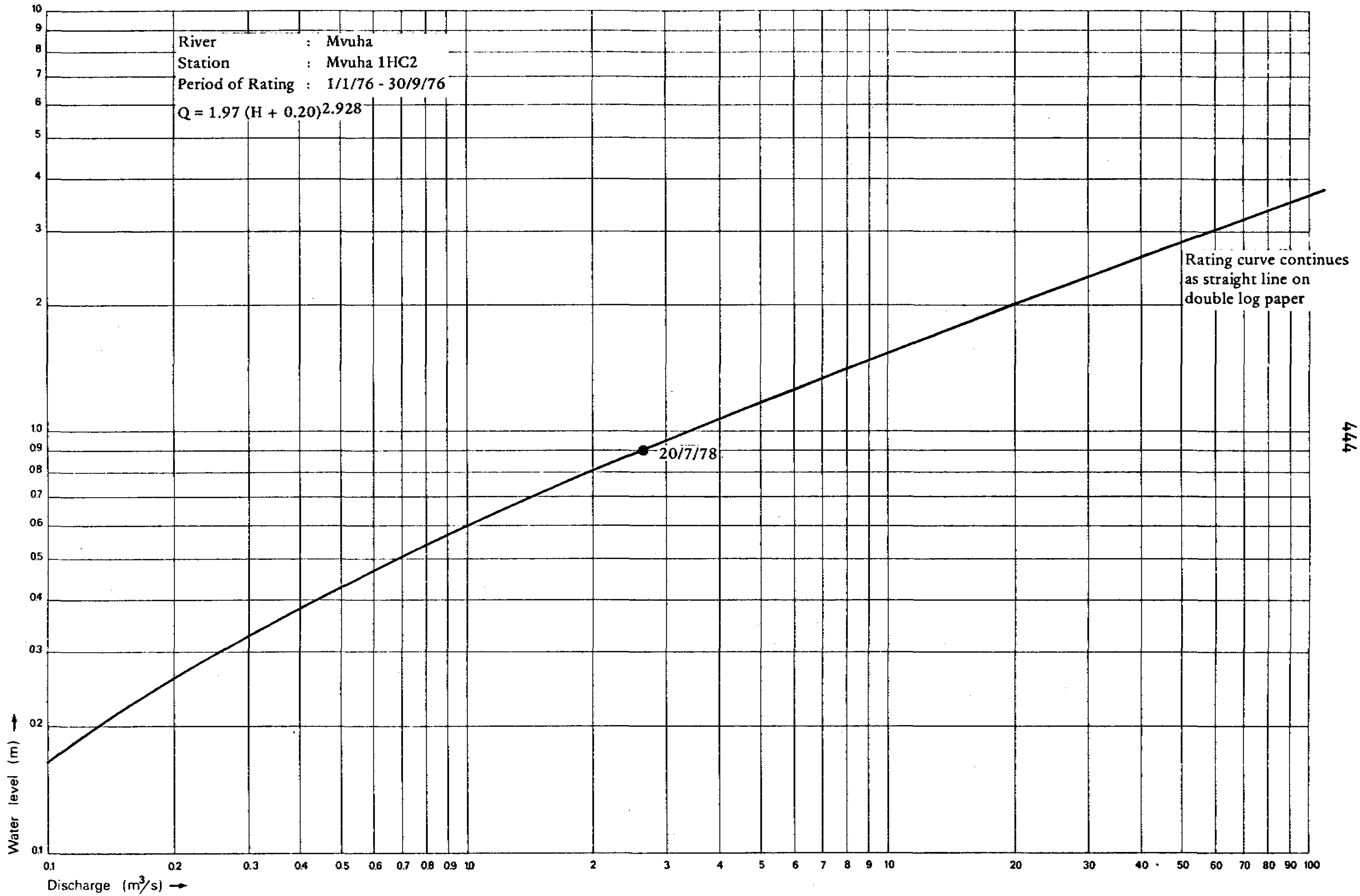

River : Ruvu
Station : Kibungo 1H5
Period of Rating : 11/1/76 - 7/6/77
No Rating Equation
Rating curve continues as straight line on double log paper
10/8/78
Water level (m)
Discharge (m³/s)
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
2
3
4
5
6
7
8
9
10
20
30
40
50
60
70
80
90
100

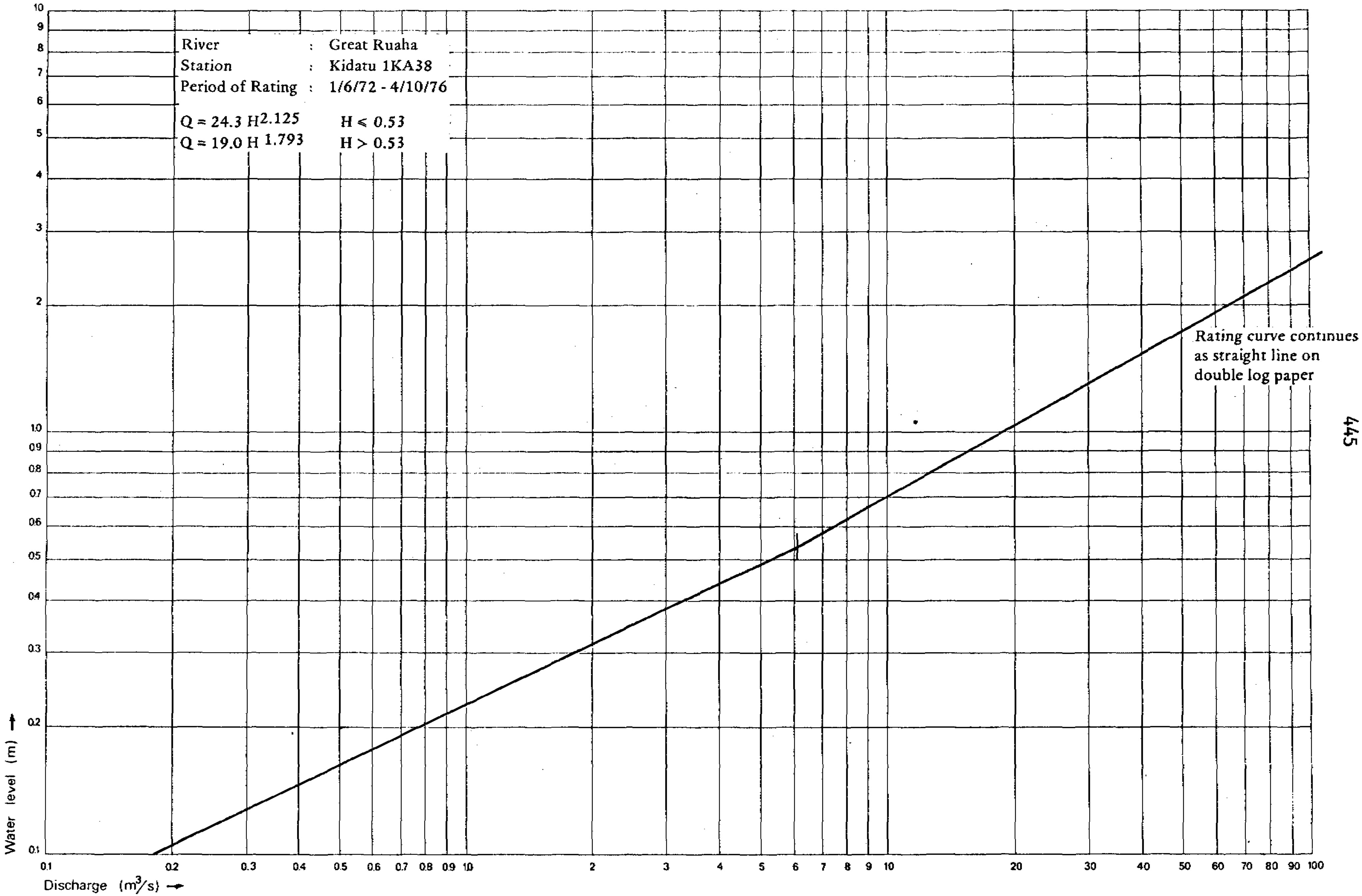

River : Ruvu
Station : Morogoro Road Bridge 1H8
Period of Rating : ?
Q = 7.17 H2.074 H ⩽ 3.34 m
Q = 12.7 H1.600 3.34 < H ⩽ 6.11 m
Q = 0.00262 H6.293 H > 6.11 m
Rating curve continues as straight line on double-log paper
Water level (m)
Discharge (m3/s)

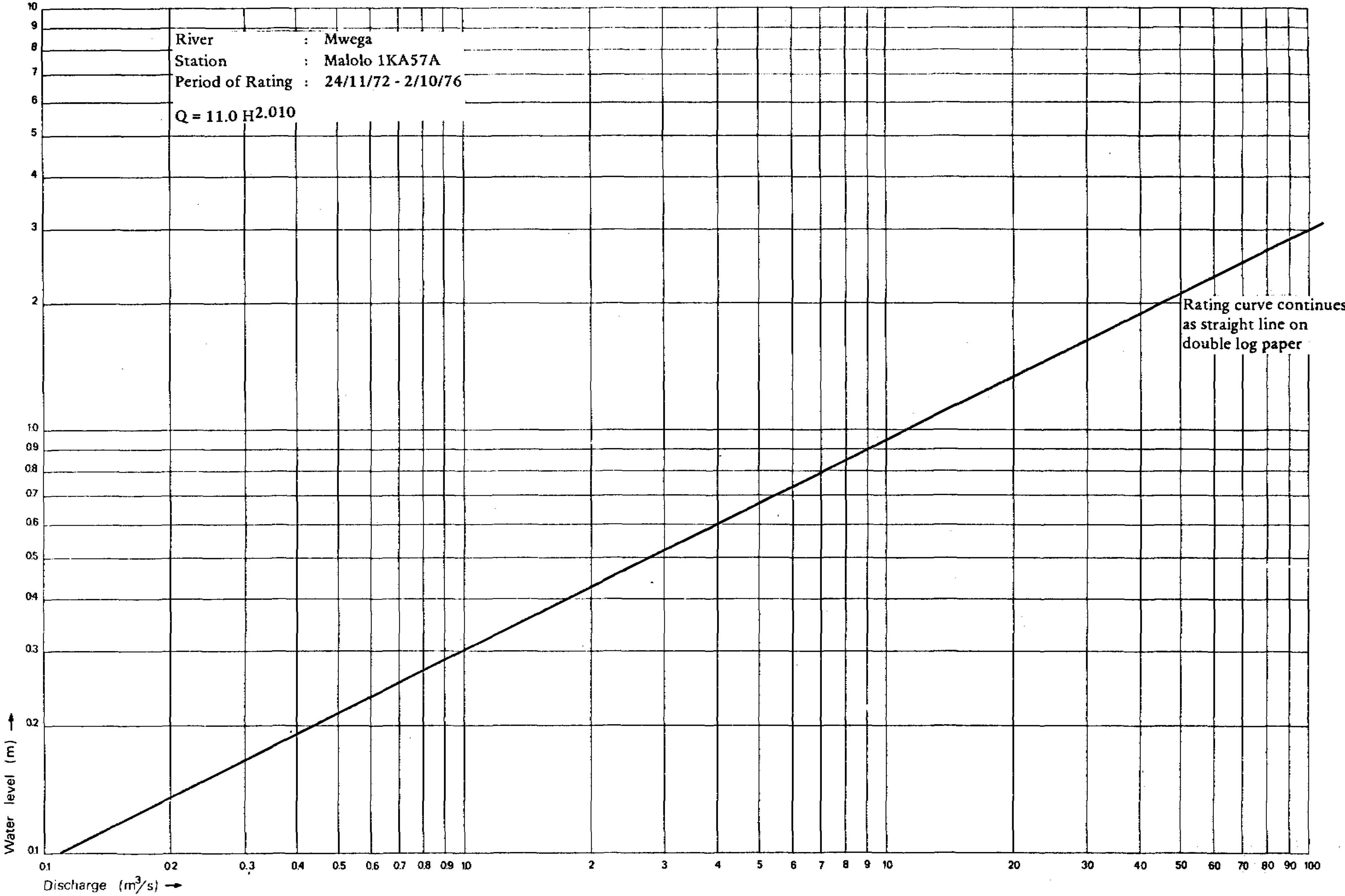

River : Ngerengere
Station : Kihonda 1HA6
Period of Rating : 20/6/78 - 10/3/79
Rating equations : (Q in m³/s):
Q = 4.296 (H-0.35)^2.172 H < 0.80 m
Q = 2.142 (H-0.35)^1.098 0.80 < H < 3.11 m
Q = 9.606 (H-0.35)^8.658 H ≥ 3.11 m
Zero of gauge is at 5.34 m below pin cemented in upstream southside of bridge or 5.31 m below middle upstream of bridge
Legend
gauging at rising stage
gauging at constant stage
gauging at falling stage
(Numbers correspond with table C 3.3-2)
Water level (m)
Discharge (m³/sec)

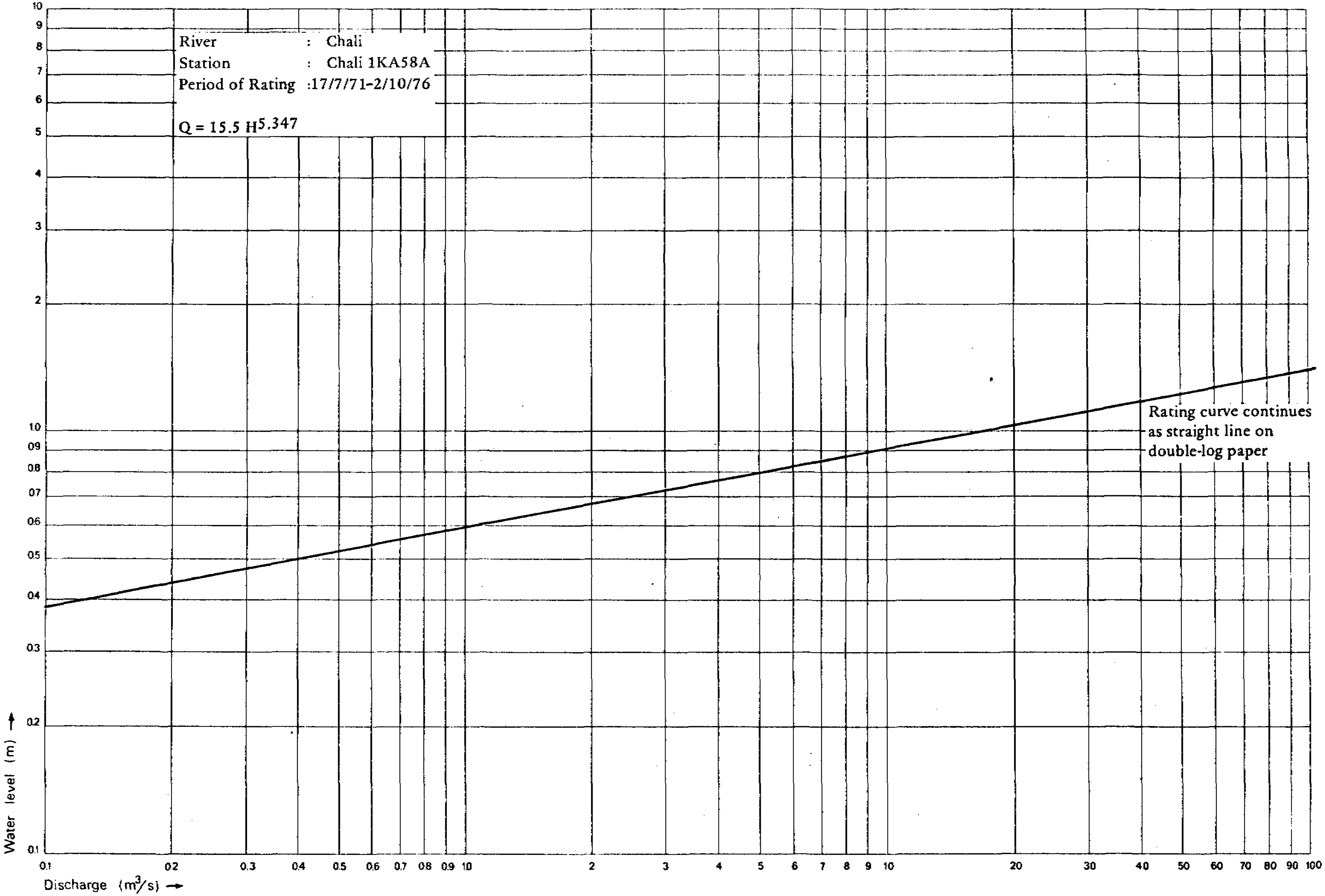


River : Morogoro
Station : Morogoro 1HA8
Period of rating : 4/8/78 - 19/1/79
Proposed rating curve (Q in m3/sec)
Q = 46.16 (H + 0.05)2.52 −0.05 m < H < 0.14 m
Q = 8.50 (H + 0.05) 0.14 m < H < 0.57 m
Q = 8.50 (H + 0.05)1.50 + 3.89 (H-0.57)1.50 0.57 m < H < 1.60 m
Legend
o gauging
Numbers correspond with table C 3.3-6
Water level (m)
Discharge (m3/sec)


River : Mvuha
Station : Mvuha 1HC2
Period of Rating : 1/1/76 - 30/9/76
Q = 1.97 (H + 0.20)^2.928
20/7/78
Rating curve continues as straight line on double log paper
Water level (m)
Discharge (m³/s)
10
9
8
7
6
5
4
3
2
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 2 3 4 5 6 7 8 9 10 20 30 40 50 60 70 80 90 100

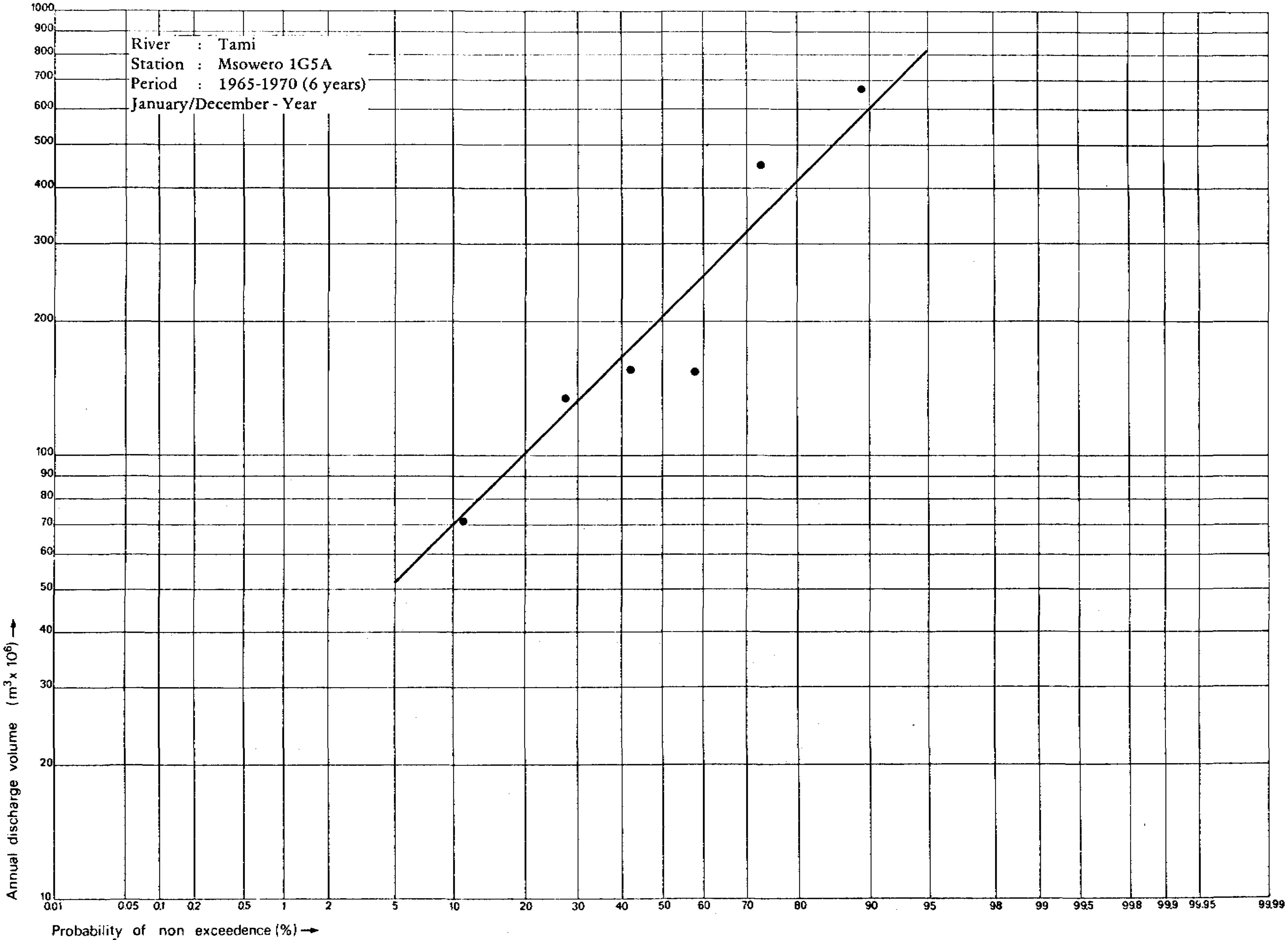

River : Great Ruaha
Station : Kidatu 1KA38
Period of Rating : 1/6/72 - 4/10/76
$Q = 24.3\ H^{2.125}$ $H \leqslant 0.53$
$Q = 19.0\ H^{1.793}$ $H > 0.53$
Rating curve continues as straight line on double log paper
Water level (m)
Discharge (m^3/s)


River : Mwega
Station : Malolo 1KA57A
Period of Rating : 24/11/72 - 2/10/76
$Q = 11.0\ H^{2.010}$
Rating curve continues as straight line on double log paper
Water level (m)
Discharge (m³/s)

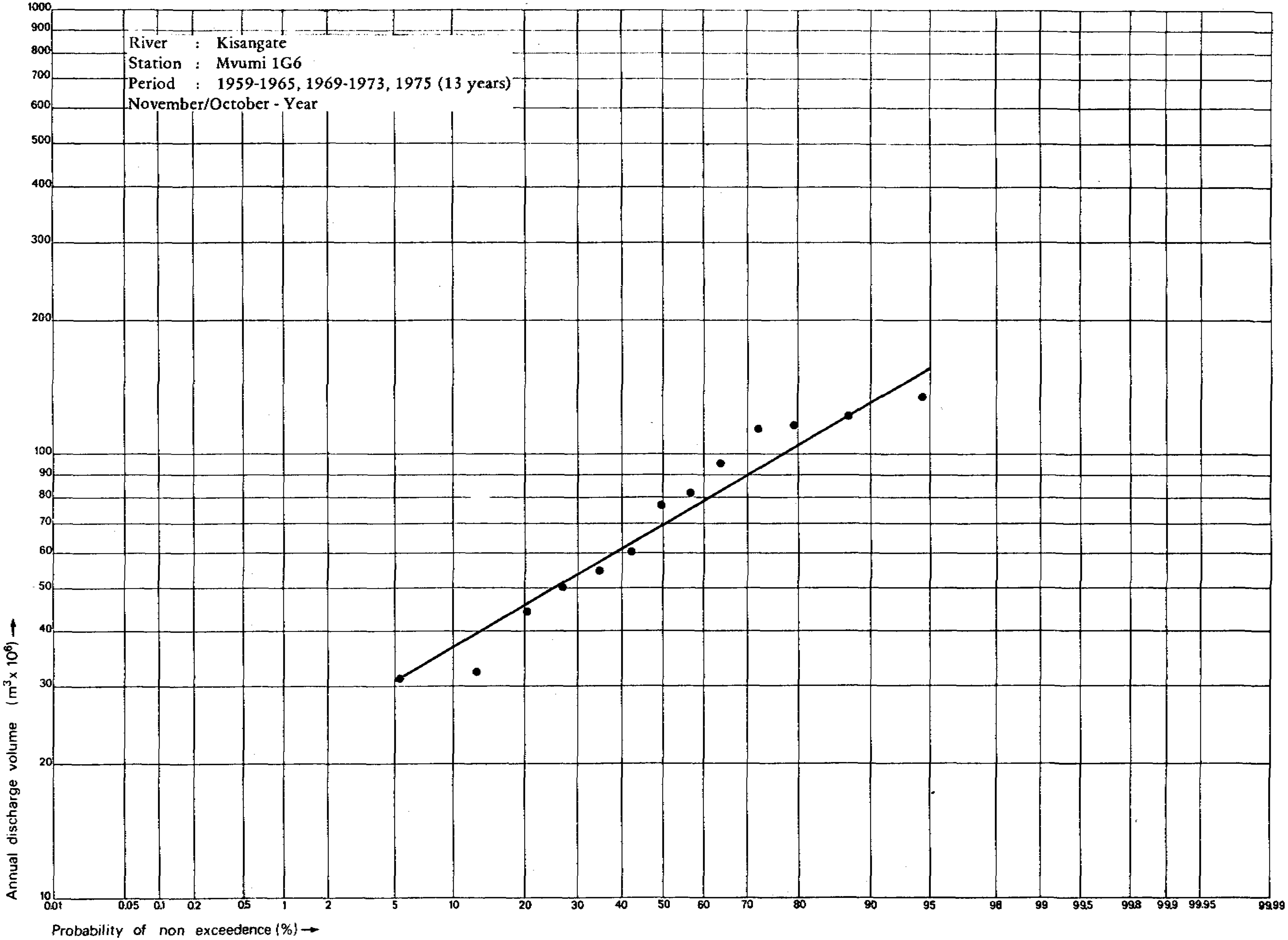


River : Chali
Station : Chali 1KA58A
Period of Rating :17/7/71-2/10/76
Q = 15.5 H5.347
Rating curve continues as straight line on double-log paper
Water level (m)
Discharge (m3/s)

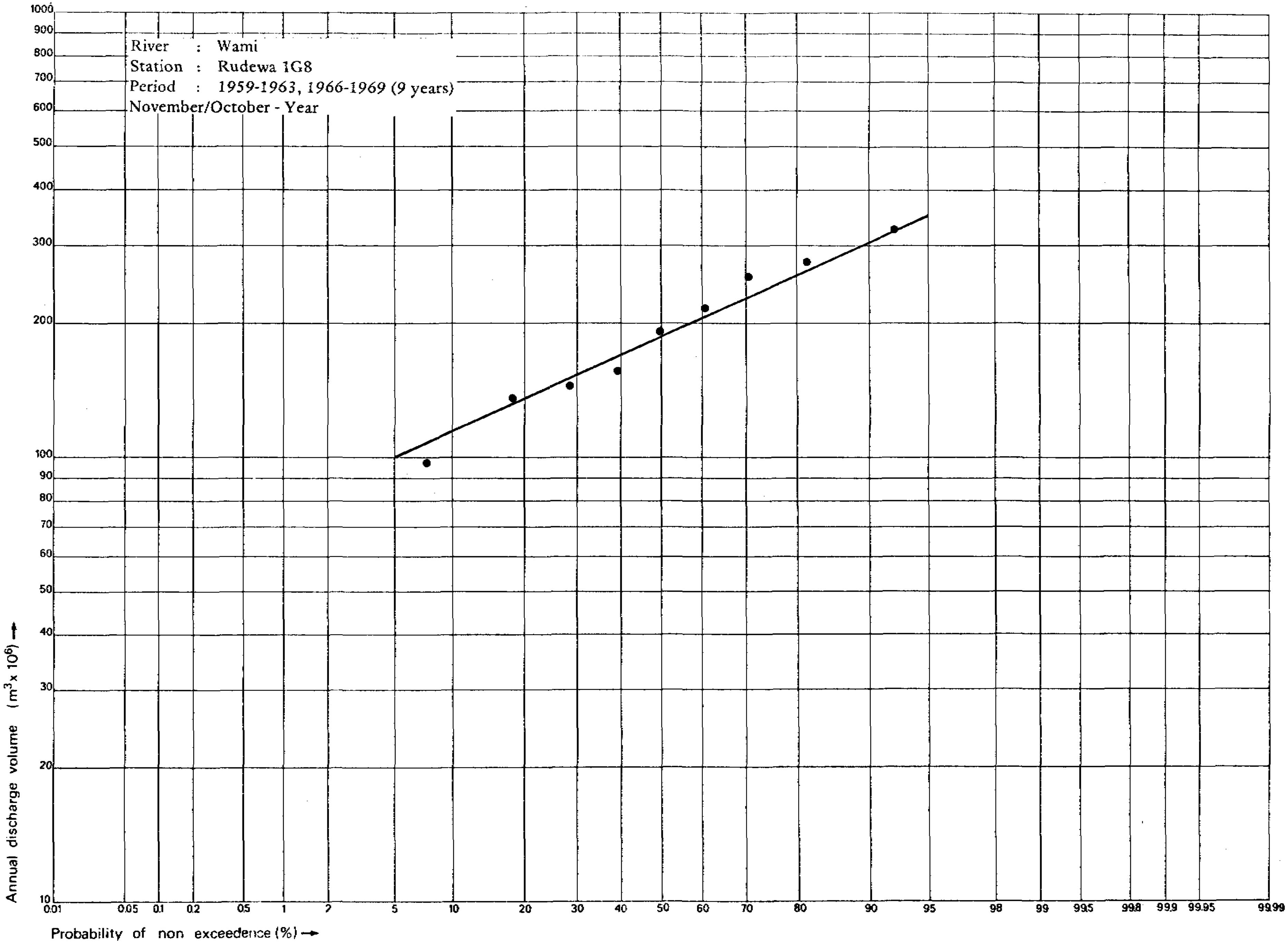
CD 3.3 Probability distributions of annual discharges

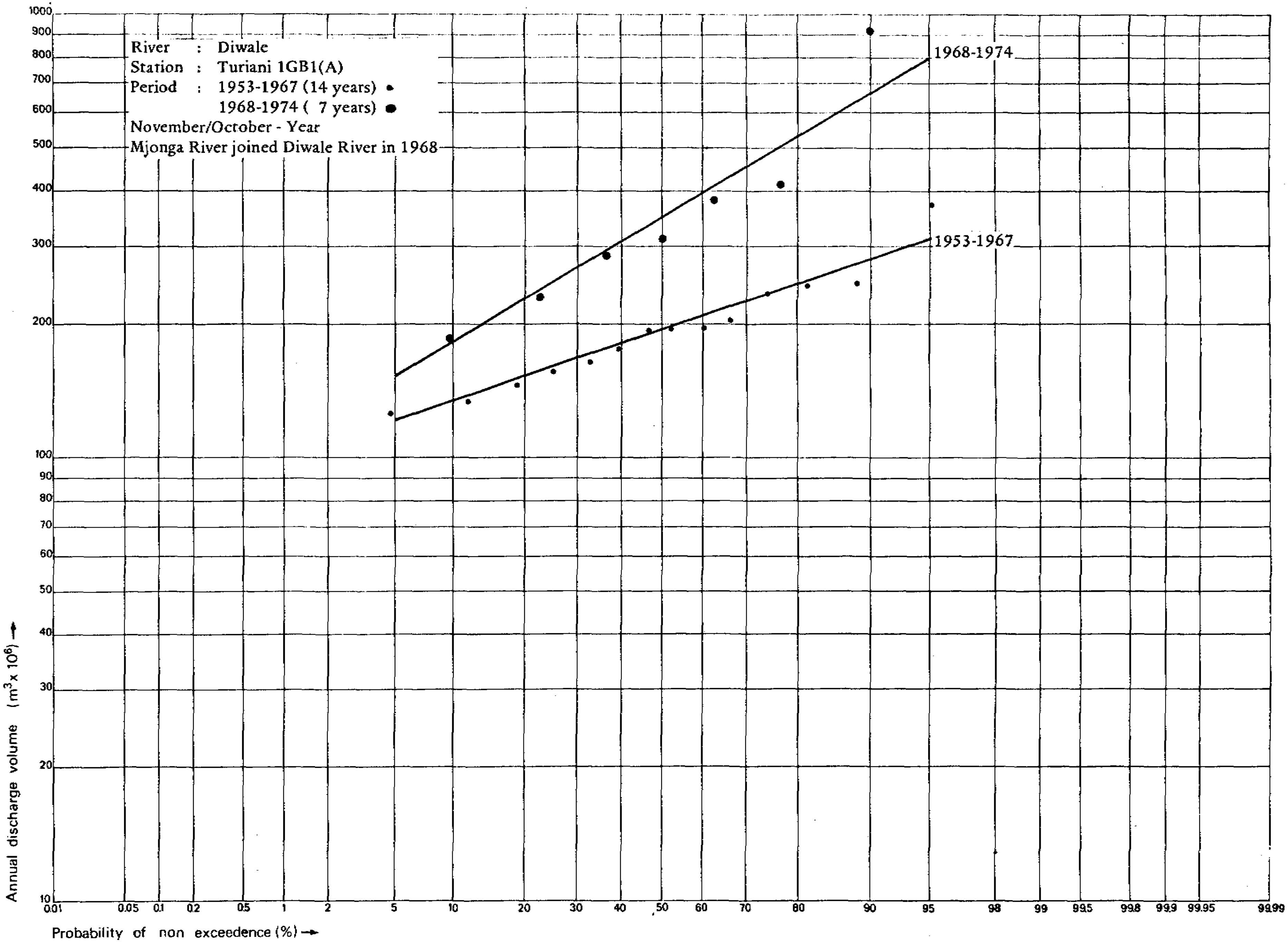


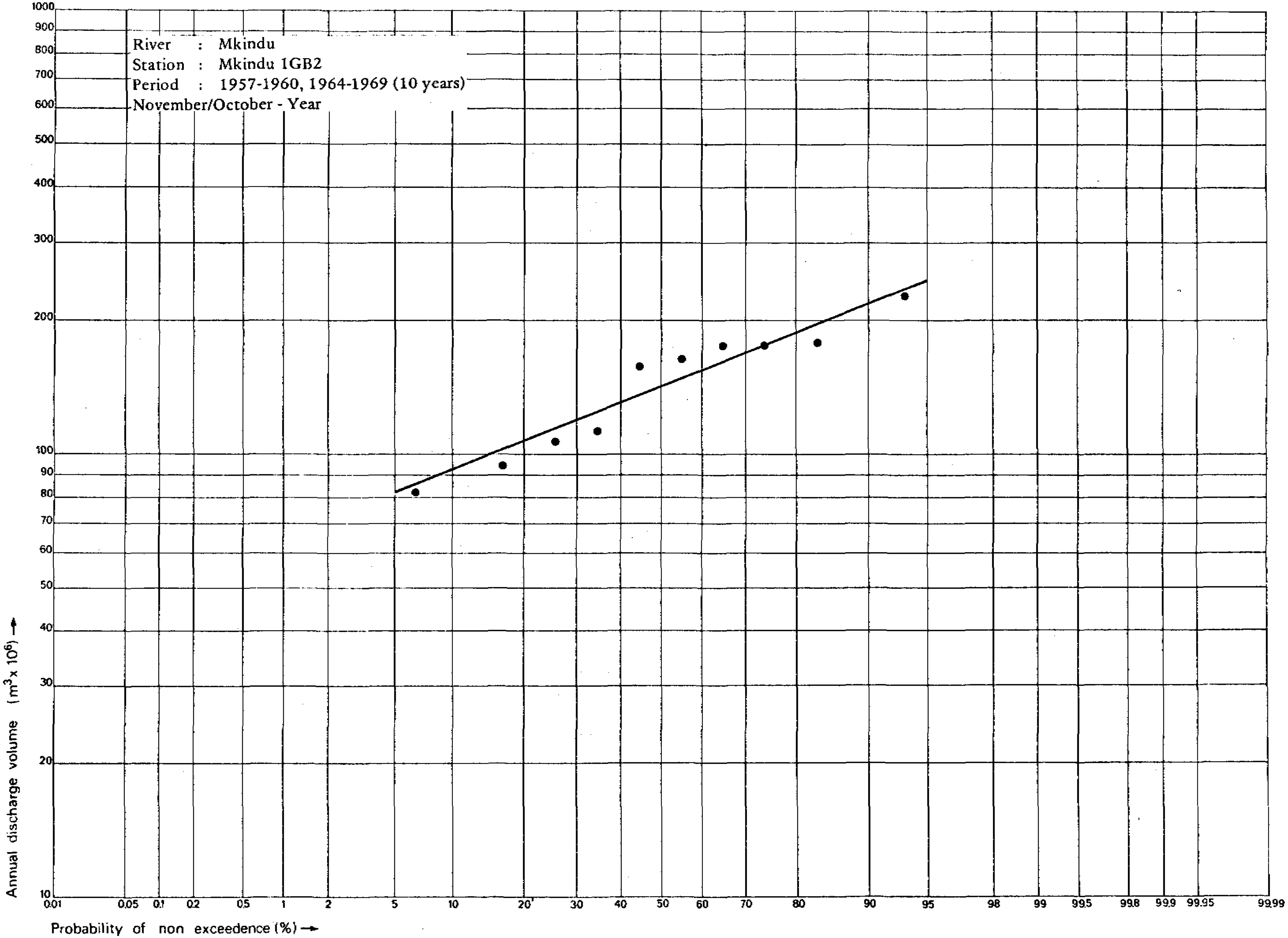
River : Tami
Station : Msowero 1G5A
Period : 1965-1970 (6 years)
January/December - Year
Annual discharge volume ($m^3 \times 10^6$)
Probability of non exceedence (%)
10
20
30
40
50
60
70
80
90
100
200
300
400
500
600
700
800
900
1000
0.01
0.05
0.1
0.2
0.5
1
2
5
10
20
30
40
50
60
70
80
90
95
98
99
99.5
99.8
99.9
99.95
99.99

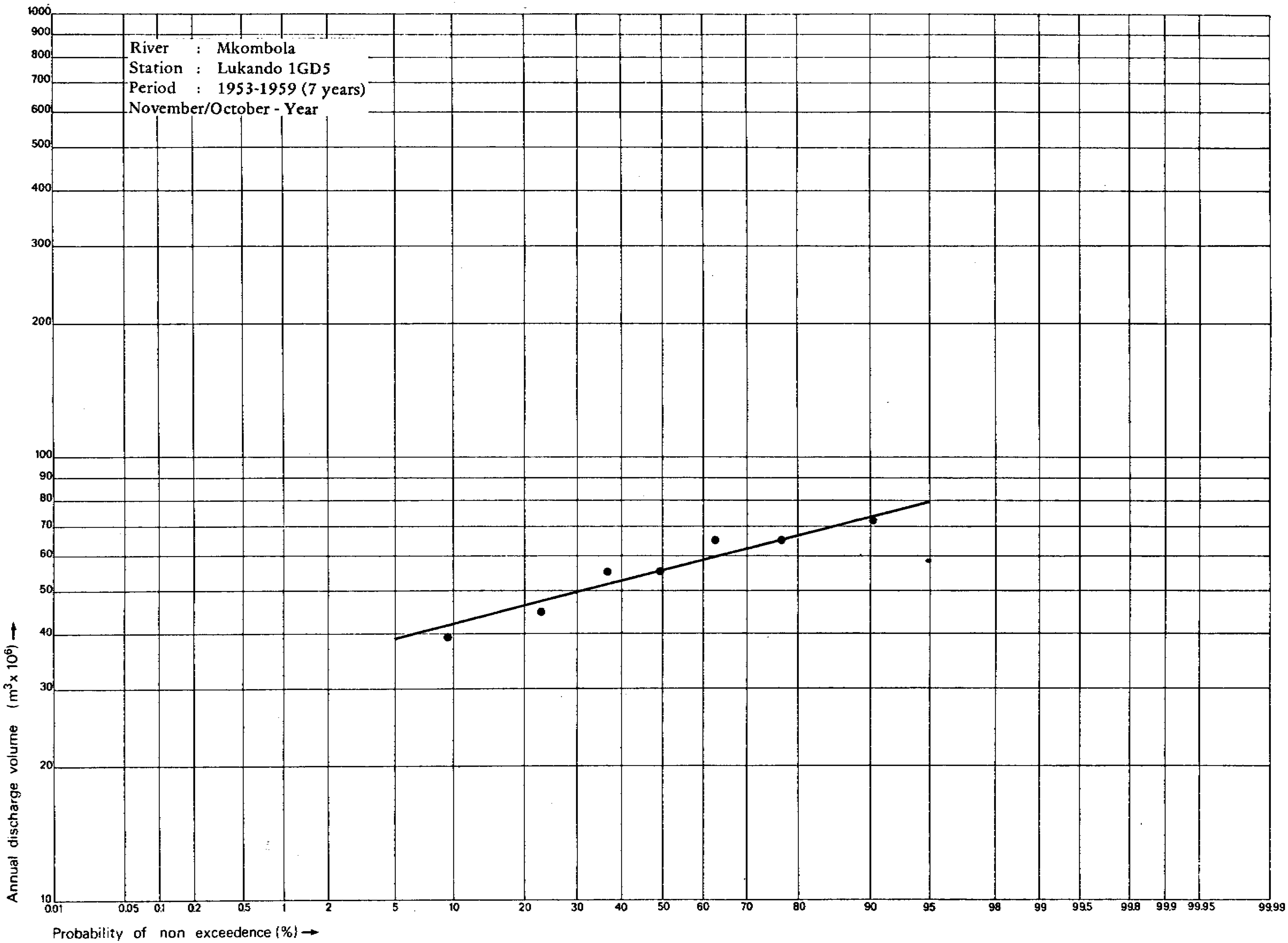


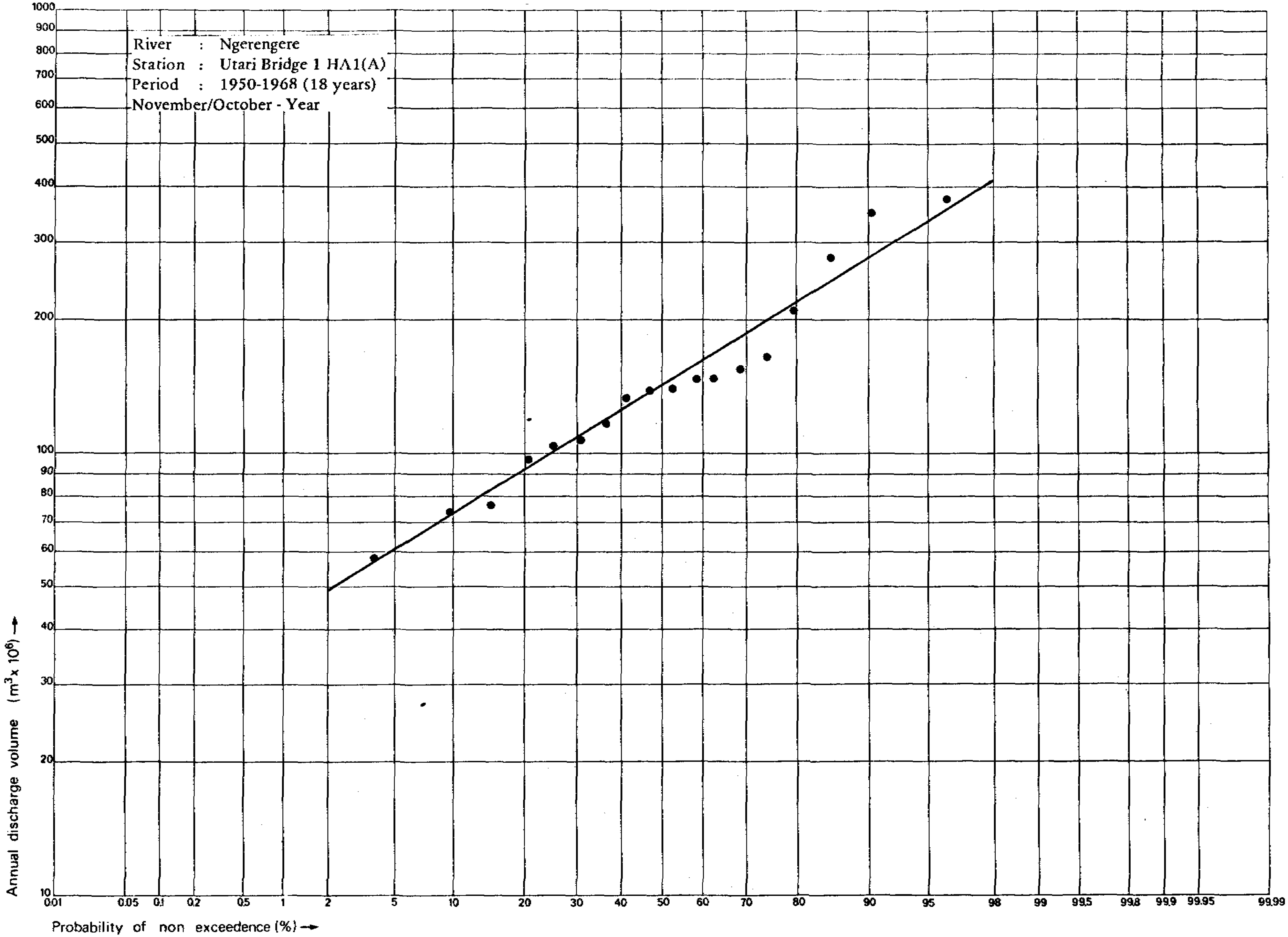
River : Kisangate
Station : Mvumi 1G6
Period : 1959-1965, 1969-1973, 1975 (13 years)
November/October - Year
Annual discharge volume (m³ x 10⁶)
Probability of non exceedence (%)
1000
900
800
700
600
500
400
300
200
100
90
80
70
60
50
40
30
20
10
0.01
0.05
0.1
0.2
0.5
1
2
5
10
20
30
40
50
60
70
80
90
95
98
99
99.5
99.8
99.9
99.95
99.99

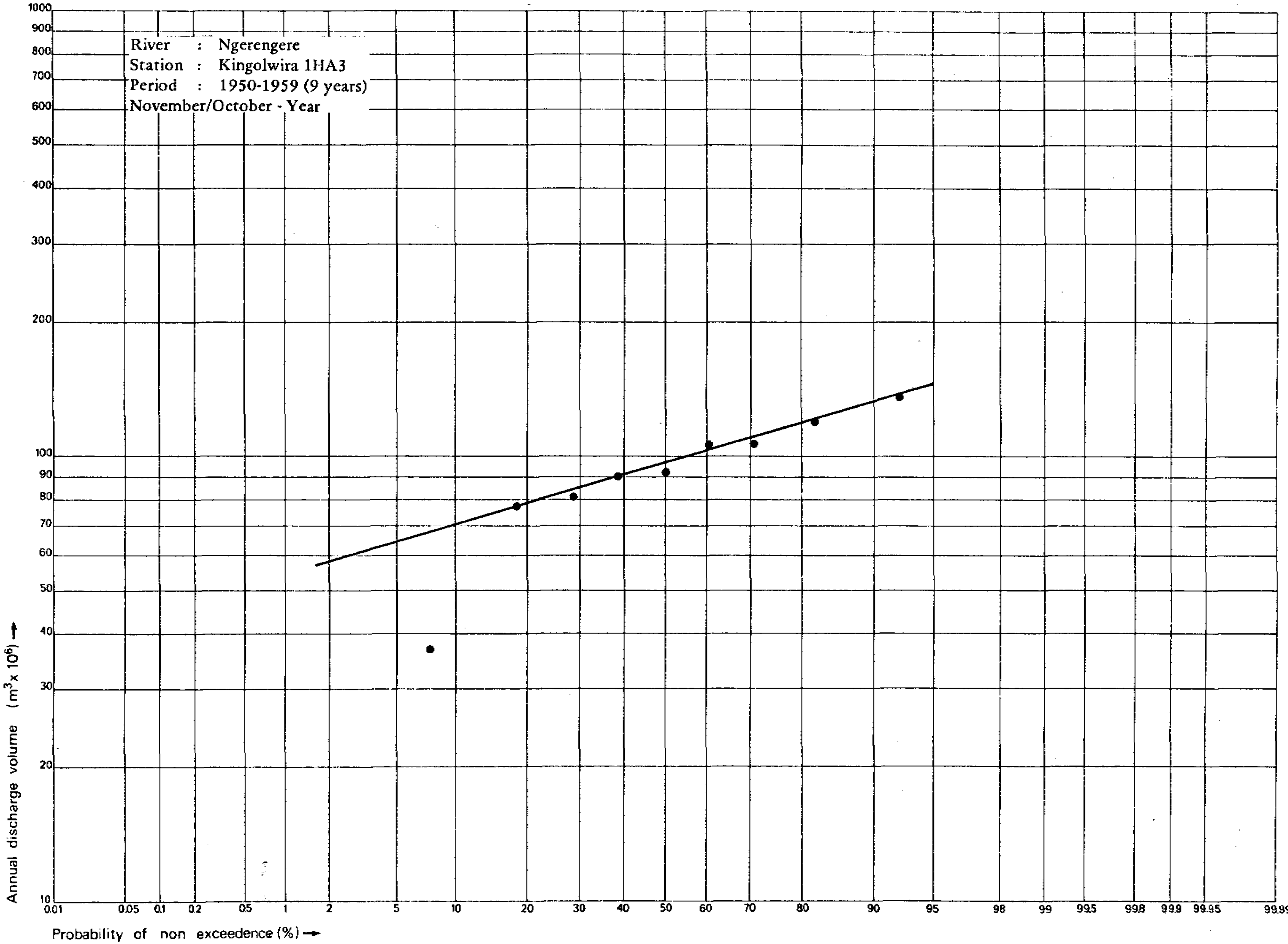

River : Wami
Station : Rudewa 1G8
Period : 1959-1963, 1966-1969 (9 years)
November/October - Year
Annual discharge volume ($m^3 \times 10^6$) →
Probability of non exceedence (%) →
1000
900
800
700
600
500
400
300
200
100
90
80
70
60
50
40
30
20
10
0.01
0.05
0.1
0.2
0.5
1
2
5
10
20
30
40
50
60
70
80
90
95
98
99
99.5
99.8
99.9
99.95
99.99

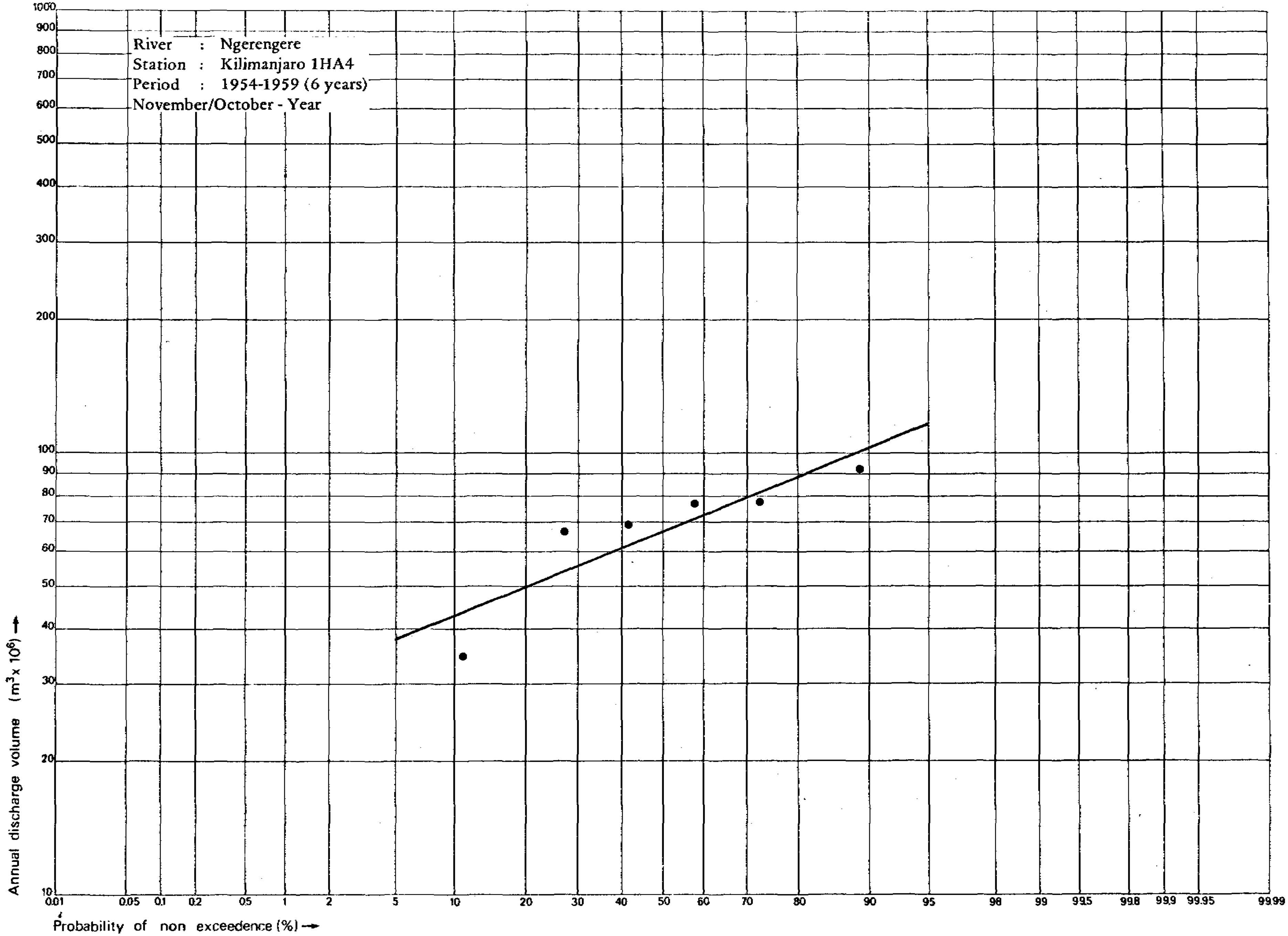

River : Diwale
Station : Turiani 1GB1(A)
Period : 1953-1967 (14 years)
1968-1974 (7 years)
November/October - Year
Mjonga River joined Diwale River in 1968
1968-1974
1953-1967
Annual discharge volume ($m^3 \times 10^6$)
Probability of non exceedence (%)

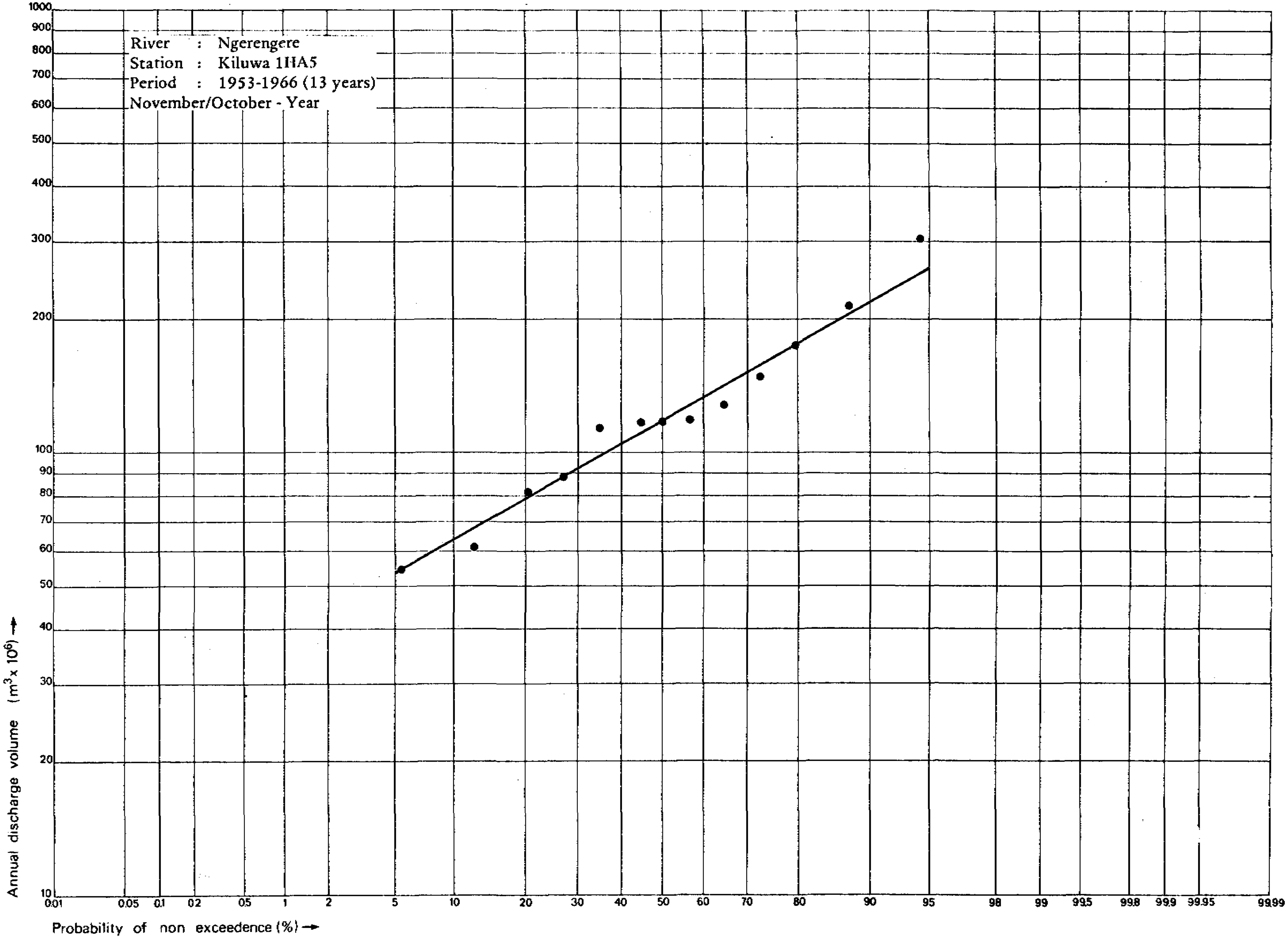

River : Mkindu
Station : Mkindu 1GB2
Period : 1957-1960, 1964-1969 (10 years)
November/October - Year
Annual discharge volume ($m^3 \times 10^6$) →
Probability of non exceedence (%) →
1000
900
800
700
600
500
400
300
200
100
90
80
70
60
50
40
30
20
10
0.01
0.05
0.1
0.2
0.5
1
2
5
10
20
30
40
50
60
70
80
90
95
98
99
99.5
99.8
99.9
99.95
99.99

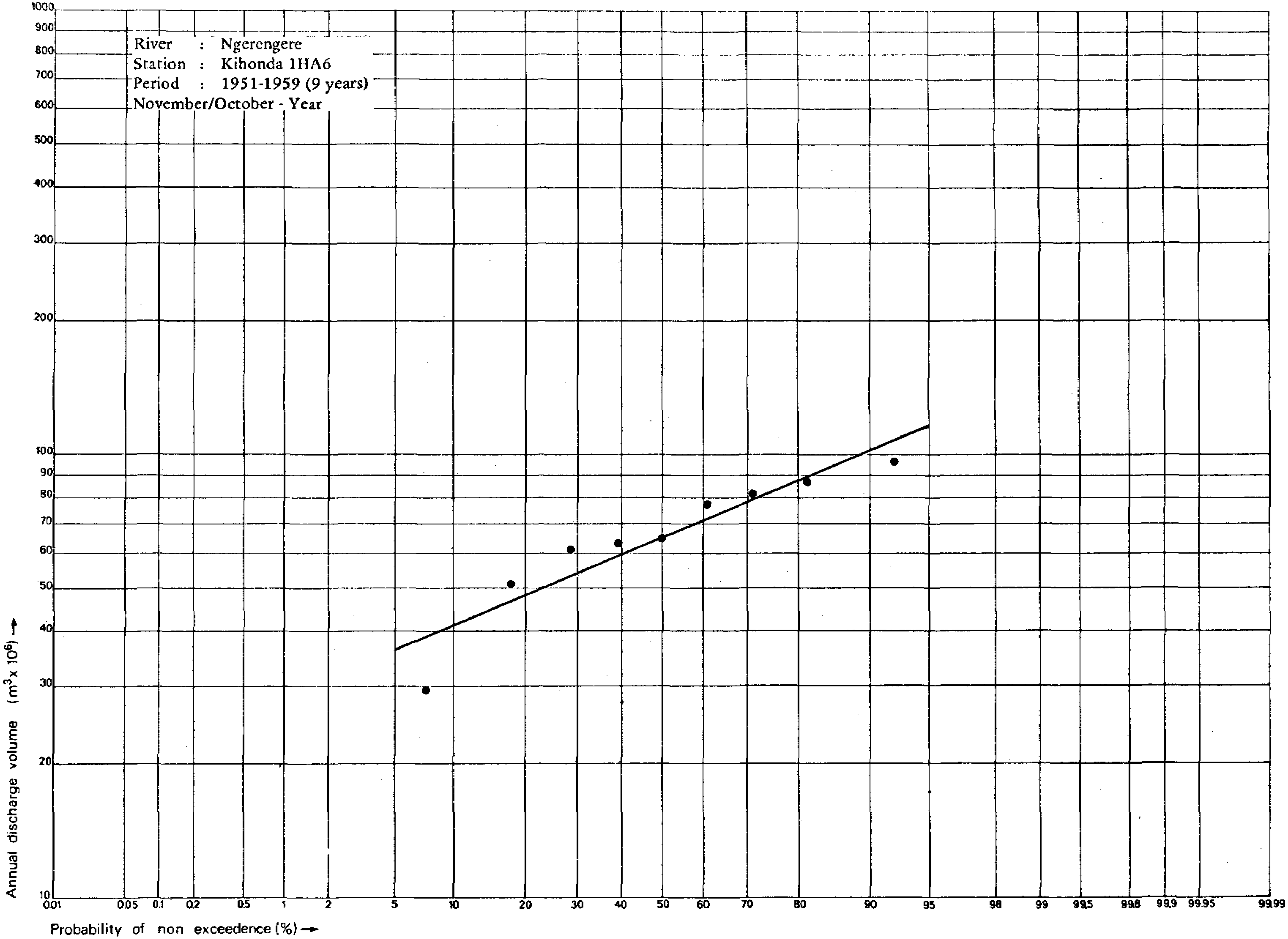

River : Mkombola
Station : Lukando 1GD5
Period : 1953-1959 (7 years)
November/October - Year
Annual discharge volume ($m^3 \times 10^6$) →
Probability of non exceedence (%) →
1000 900 800 700 600 500 400 300 200 100 90 80 70 60 50 40 30 20 10
0.01 0.05 0.1 0.2 0.5 1 2 5 10 20 30 40 50 60 70 80 90 95 98 99 99.5 99.8 99.9 99.95 99.99

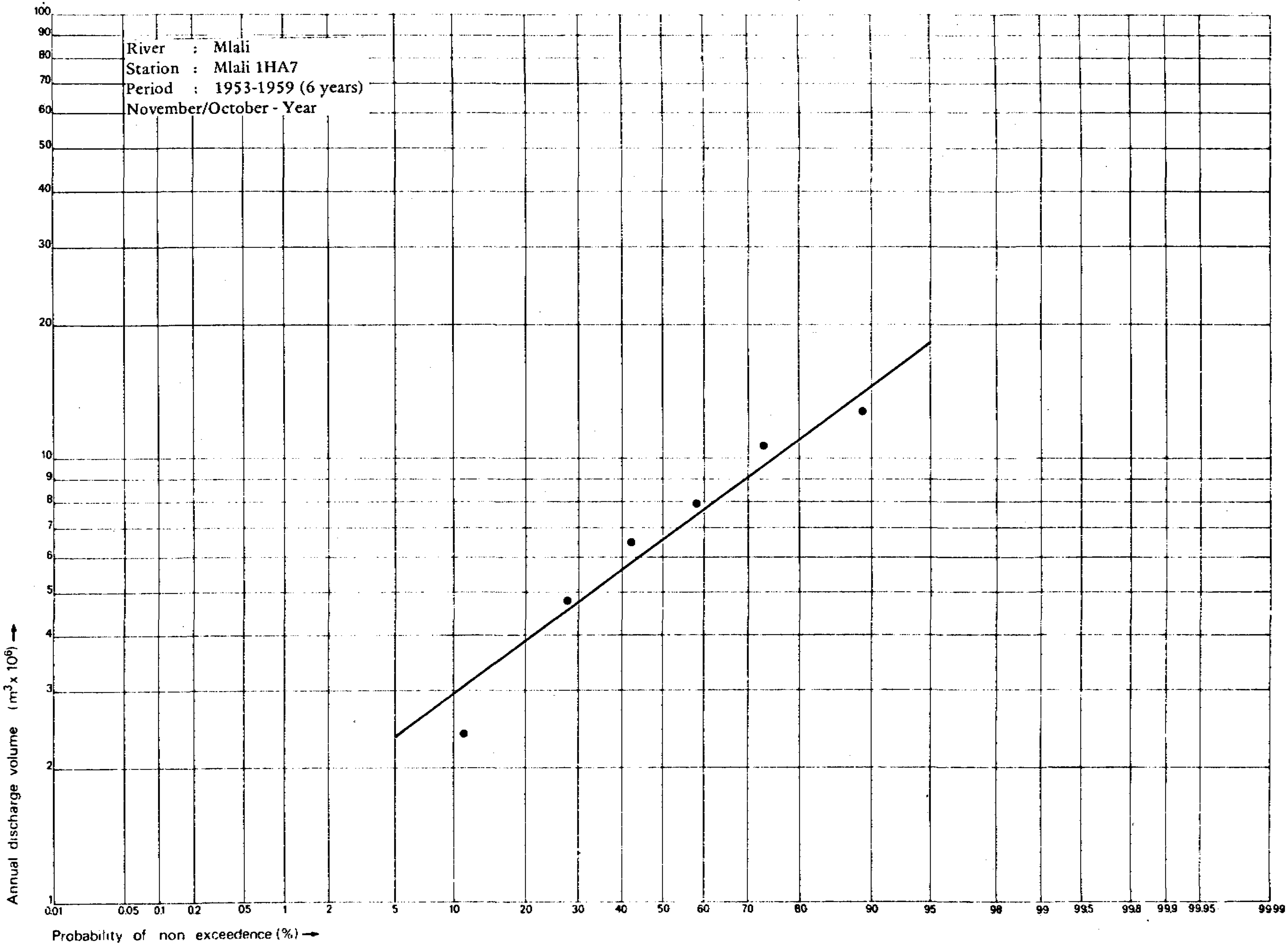

River : Ngerengere
Station : Utari Bridge 1 HA1(A)
Period : 1950-1968 (18 years)
November/October - Year
Annual discharge volume ($m^3 \times 10^6$) →
Probability of non exceedence (%) →
1000
900
800
700
600
500
400
300
200
100
90
80
70
60
50
40
30
20
10
0.01
0.05
0.1
0.2
0.5
1
2
5
10
20
30
40
50
60
70
80
90
95
98
99
99.5
99.8
99.9
99.95
99.99

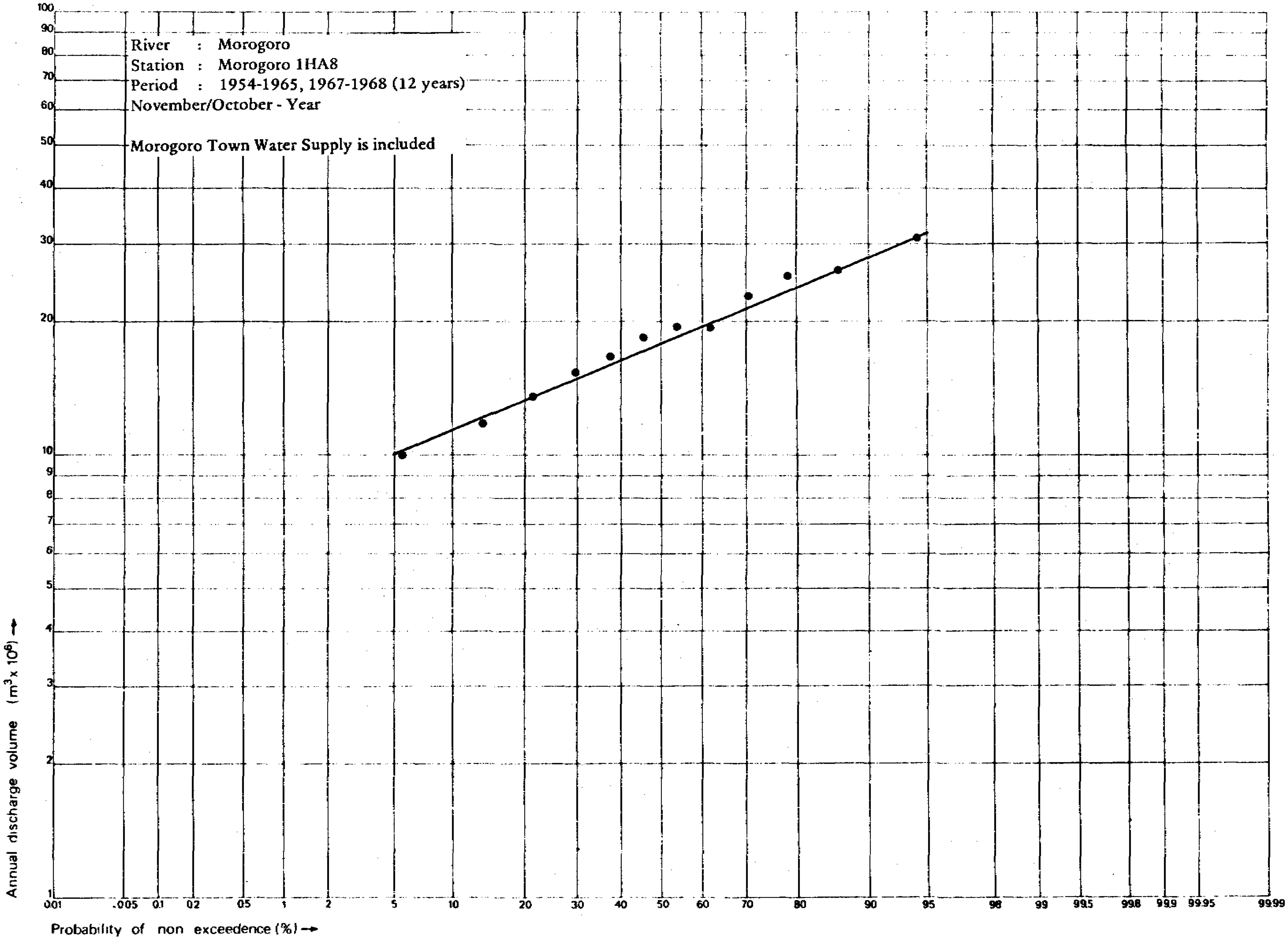

River : Ngerengere
Station : Kingolwira 1HA3
Period : 1950-1959 (9 years)
November/October - Year
Annual discharge volume ($m^3 \times 10^6$) →
Probability of non exceedence (%) →
1000
900
800
700
600
500
400
300
200
100
90
80
70
60
50
40
30
20
10
0.01
0.05
0.1
0.2
0.5
1
2
5
10
20
30
40
50
60
70
80
90
95
98
99
99.5
99.8
99.9
99.95
99.99

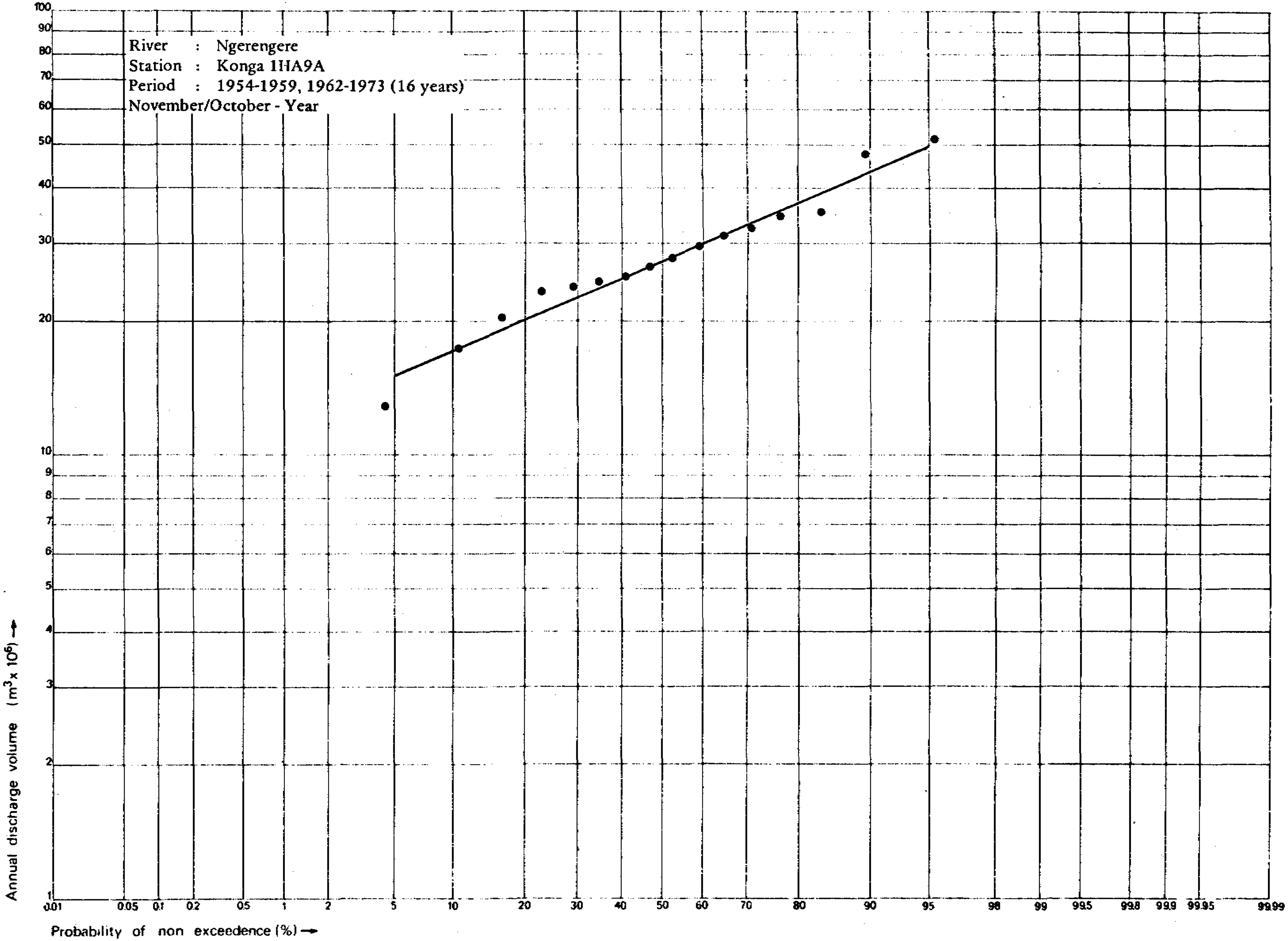

River : Ngerengere
Station : Kilimanjaro 1HA4
Period : 1954-1959 (6 years)
November/October - Year
Annual discharge volume ($m^3 \times 10^6$)
Probability of non exceedence (%)
1000
900
800
700
600
500
400
300
200
100
90
80
70
60
50
40
30
20
10
0.01
0.05
0.1
0.2
0.5
1
2
5
10
20
30
40
50
60
70
80
90
95
98
99
99.5
99.8
99.9
99.95
99.99

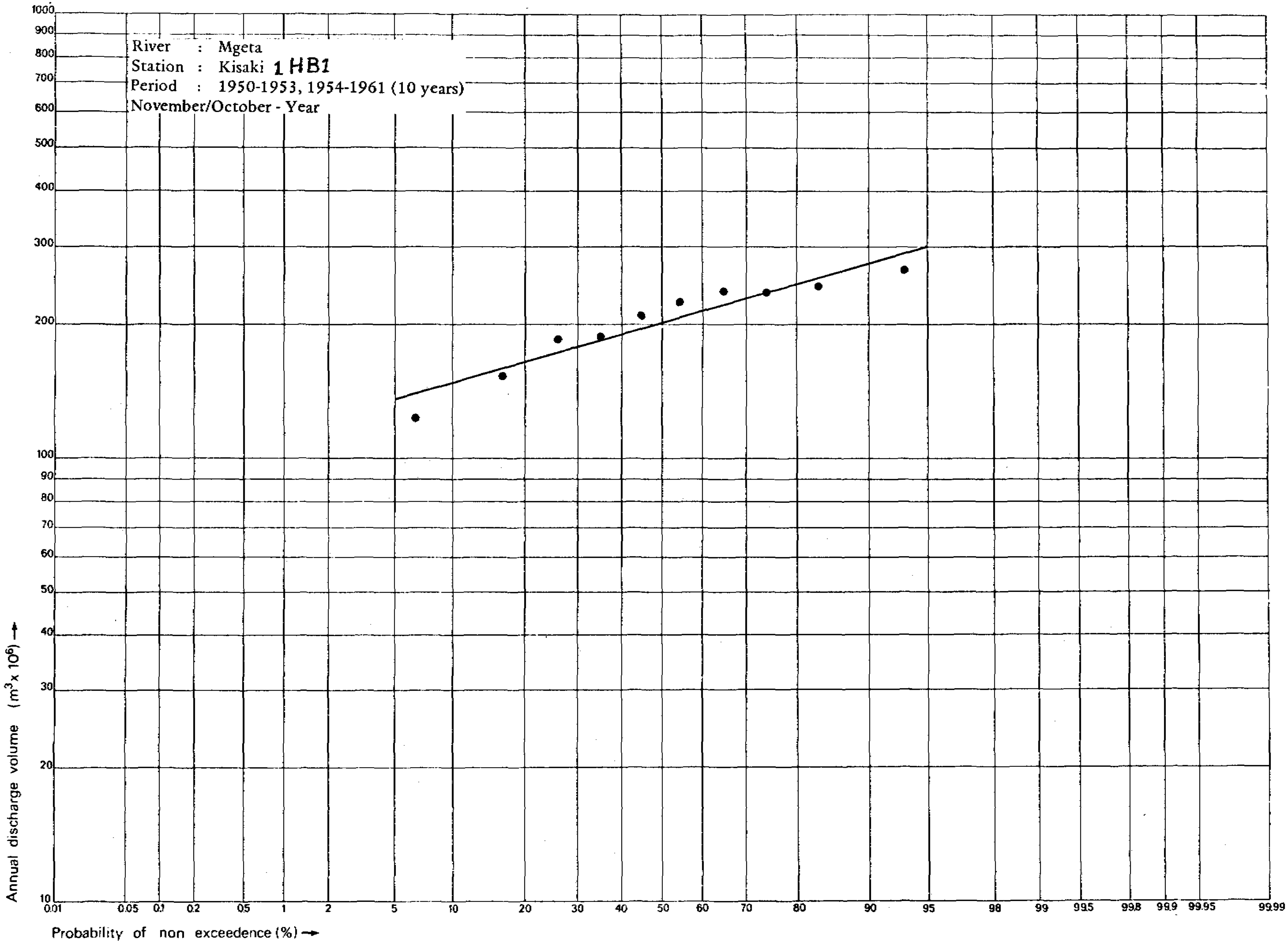

River : Ngerengere
Station : Kiluwa 1HA5
Period : 1953-1966 (13 years)
November/October - Year
Annual discharge volume $(m^3 \times 10^6)$
Probability of non exceedence (%)
1000
900
800
700
600
500
400
300
200
100
90
80
70
60
50
40
30
20
10
0.01
0.05
0.1
0.2
0.5
1
2
5
10
20
30
40
50
60
70
80
90
95
98
99
99.5
99.8
99.9
99.95
99.99

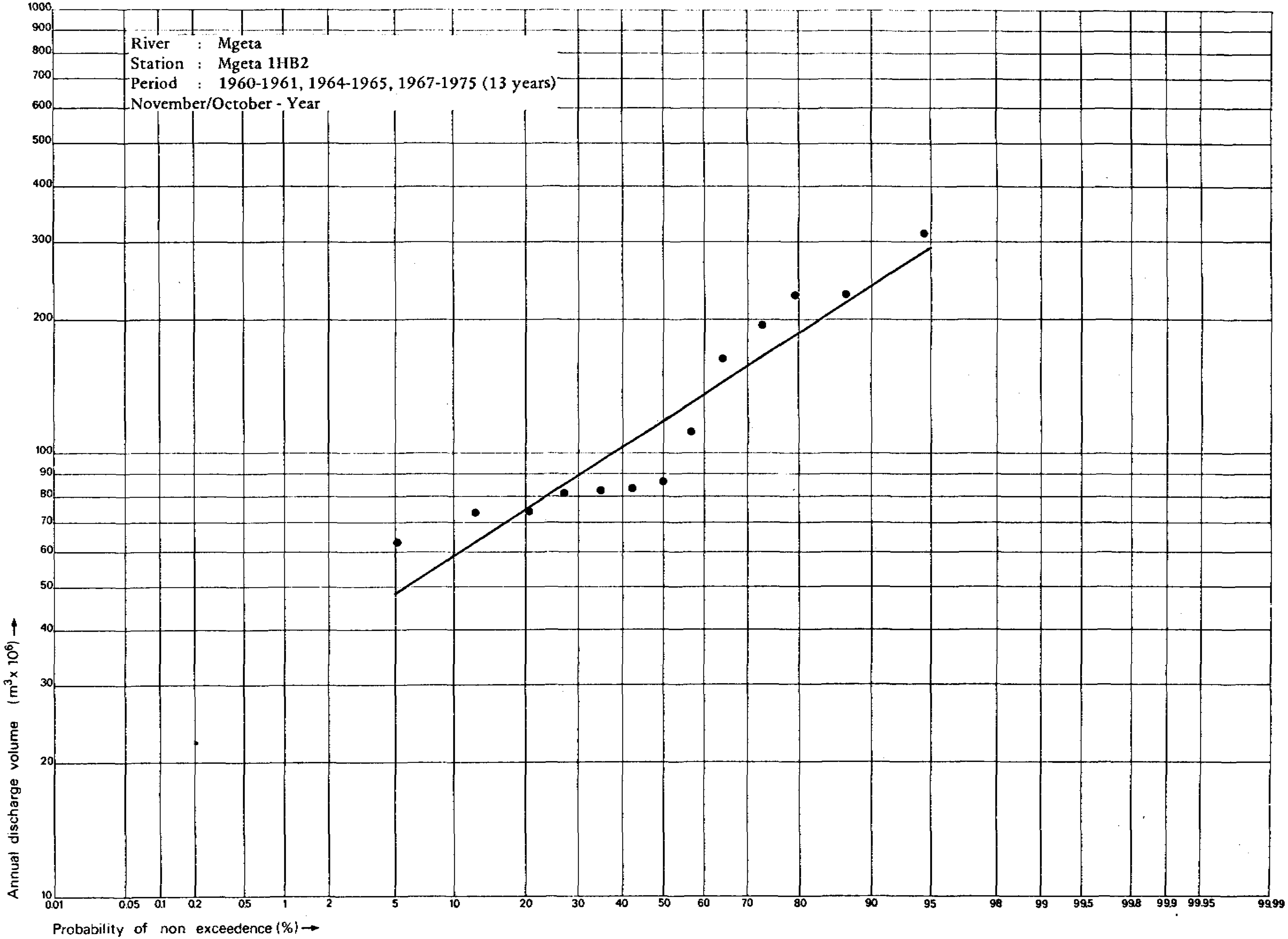

River : Ngerengere
Station : Kihonda 1HA6
Period : 1951-1959 (9 years)
November/October - Year
Annual discharge volume (m³ x 10⁶) →
Probability of non exceedence (%) →
1000
900
800
700
600
500
400
300
200
100
90
80
70
60
50
40
30
20
10
0.01
0.05
0.1
0.2
0.5
1
2
5
10
20
30
40
50
60
70
80
90
95
98
99
99.5
99.8
99.9
99.95
99.99

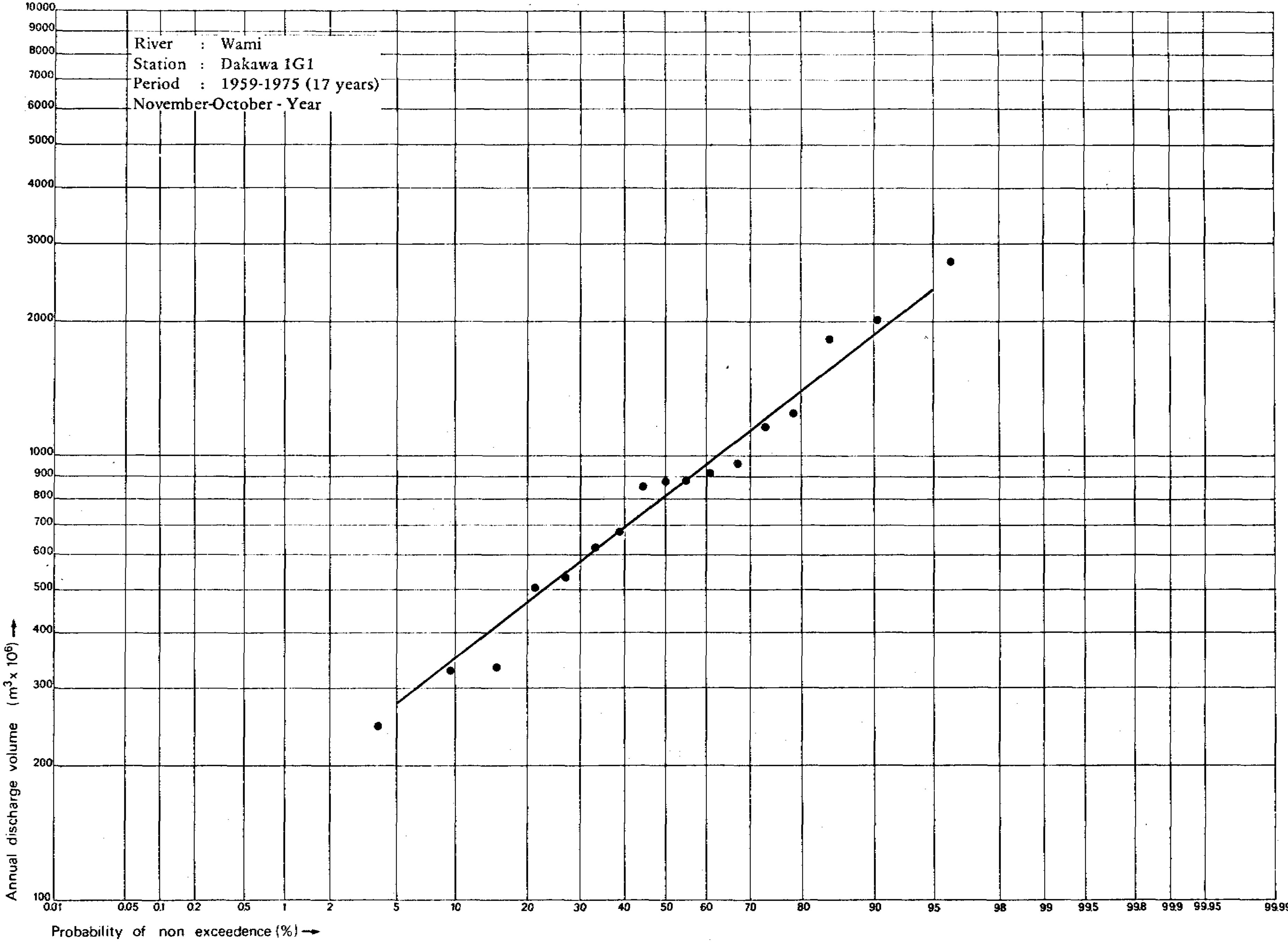

River : Mlali
Station : Mlali 1HA7
Period : 1953-1959 (6 years)
November/October - Year
Annual discharge volume ($m^3 \times 10^6$)
Probability of non exceedence (%)
100
90
80
70
60
50
40
30
20
10
9
8
7
6
5
4
3
2
1
0.01
0.05
0.1
0.2
0.5
1
2
5
10
20
30
40
50
60
70
80
90
95
98
99
99.5
99.8
99.9
99.95
99.99

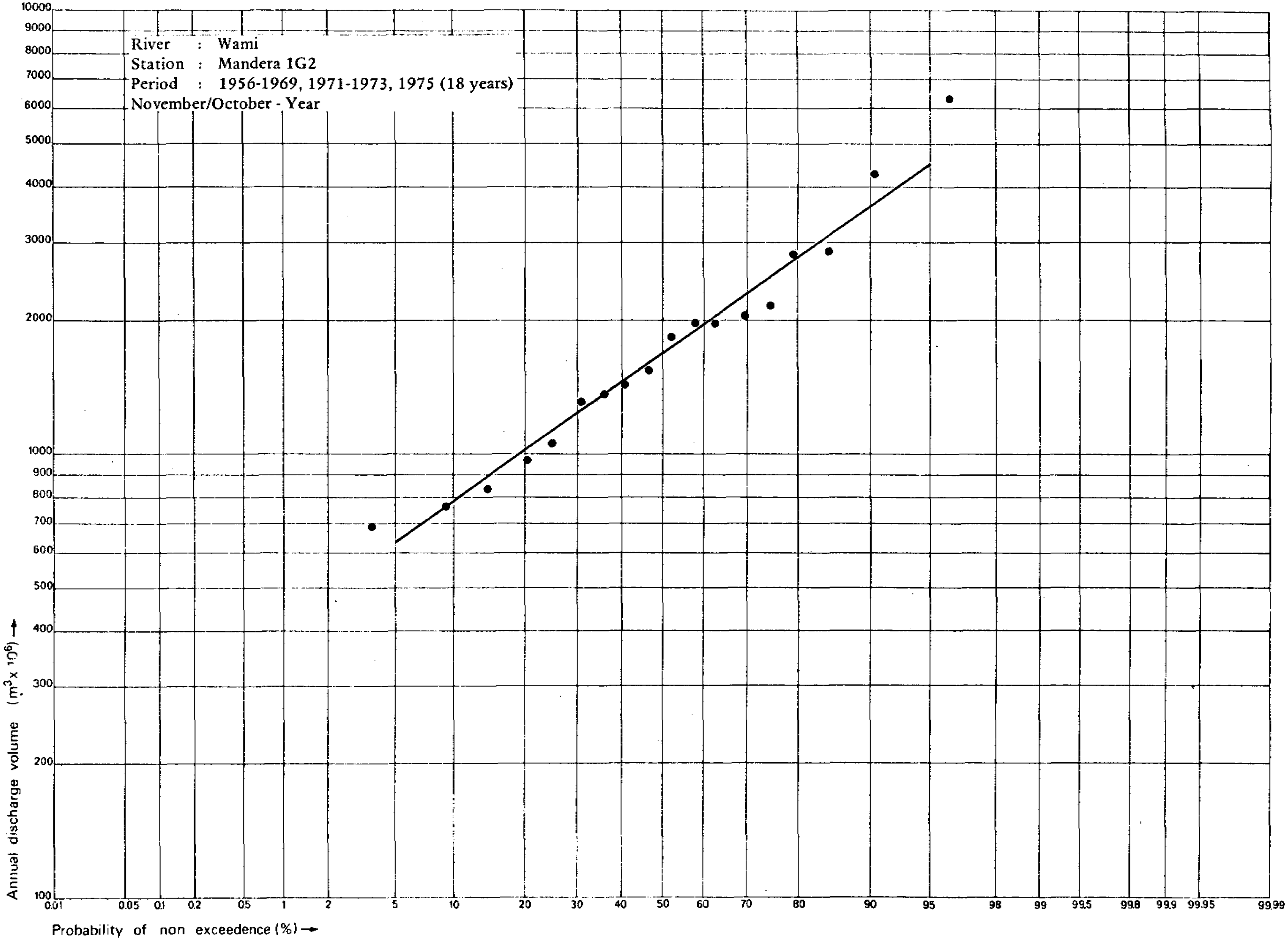

River : Morogoro
Station : Morogoro 1HA8
Period : 1954-1965, 1967-1968 (12 years)
November/October - Year
Morogoro Town Water Supply is included
Annual discharge volume (m3 x 10^6) →
100
90
80
70
60
50
40
30
20
10
9
8
7
6
5
4
3
2
1
Probability of non exceedence (%) →
0.01
.005
0.1
0.2
0.5
1
2
5
10
20
30
40
50
60
70
80
90
95
98
99
99.5
99.8
99.9
99.95
99.99

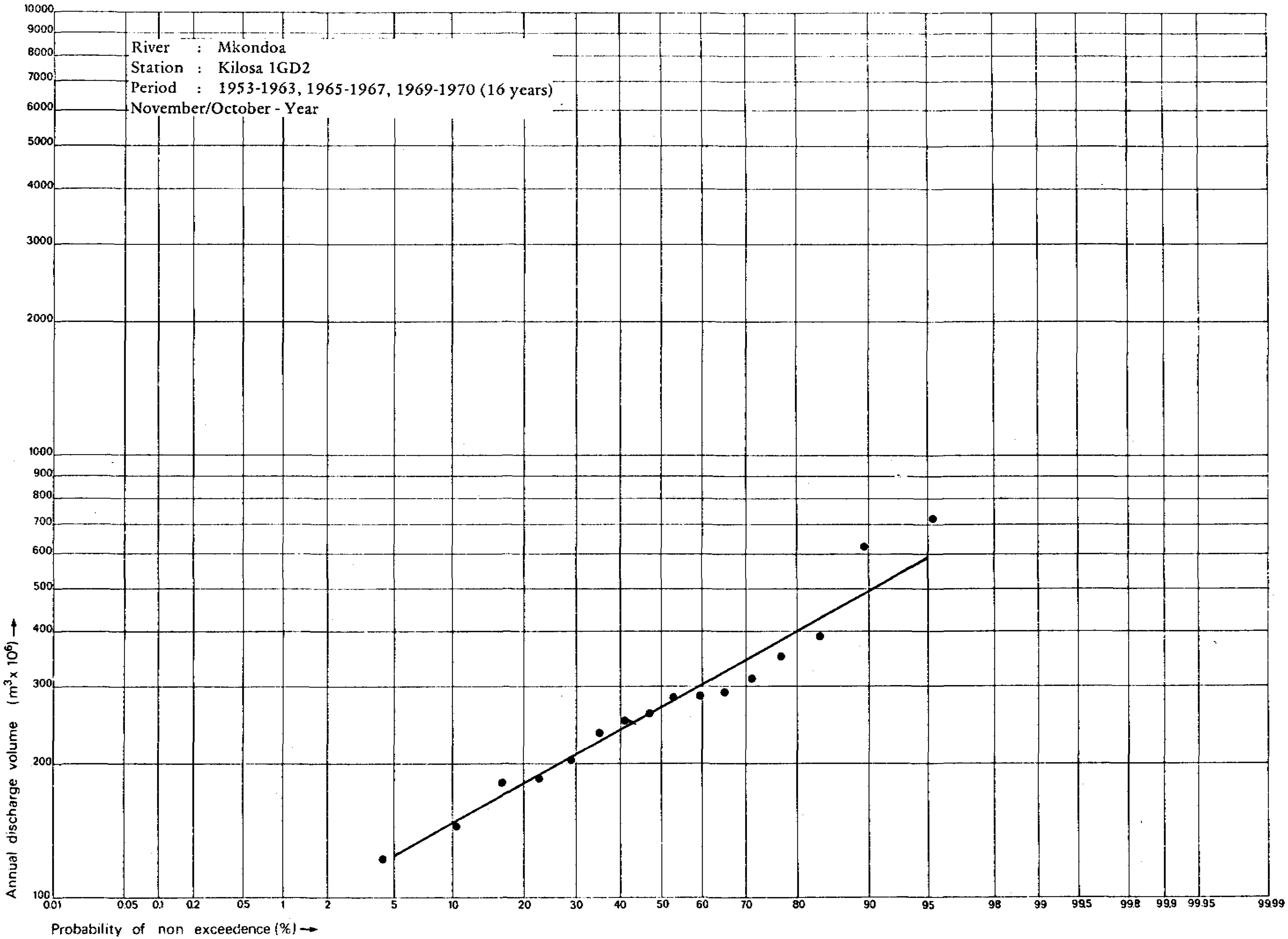

River : Ngerengere
Station : Konga 1HA9A
Period : 1954-1959, 1962-1973 (16 years)
November/October - Year
Annual discharge volume (m³ x 10⁶) →
Probability of non exceedence (%) →

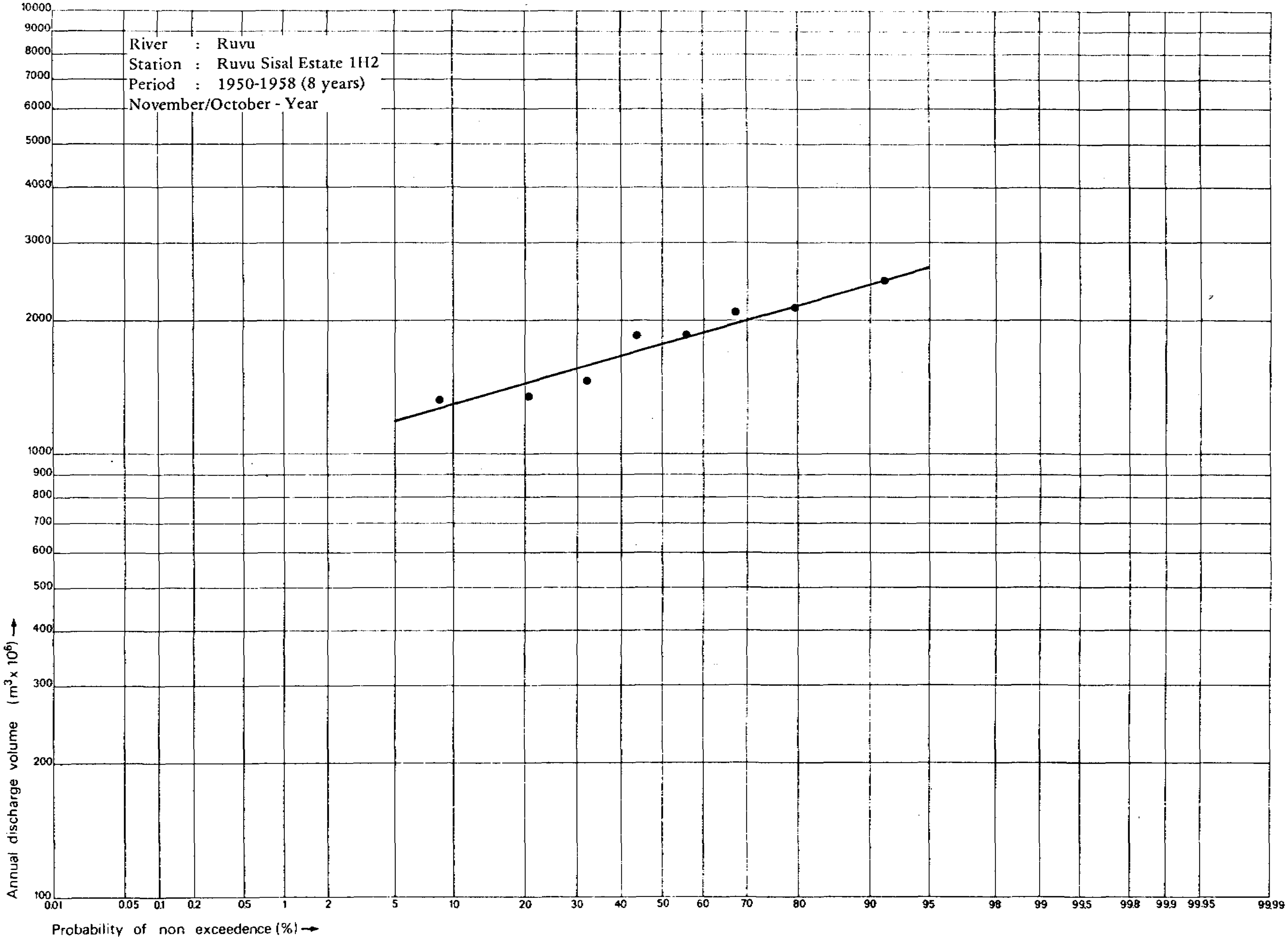

River : Mgeta
Station : Kisaki 1 HB1
Period : 1950-1953, 1954-1961 (10 years)
November/October - Year
Annual discharge volume (m3 x 106)
Probability of non exceedence (%)
1000
900
800
700
600
500
400
300
200
100
90
80
70
60
50
40
30
20
10
0.01
0.05
0.1
0.2
0.5
1
2
5
10
20
30
40
50
60
70
80
90
95
98
99
99.5
99.8
99.9
99.95
99.99

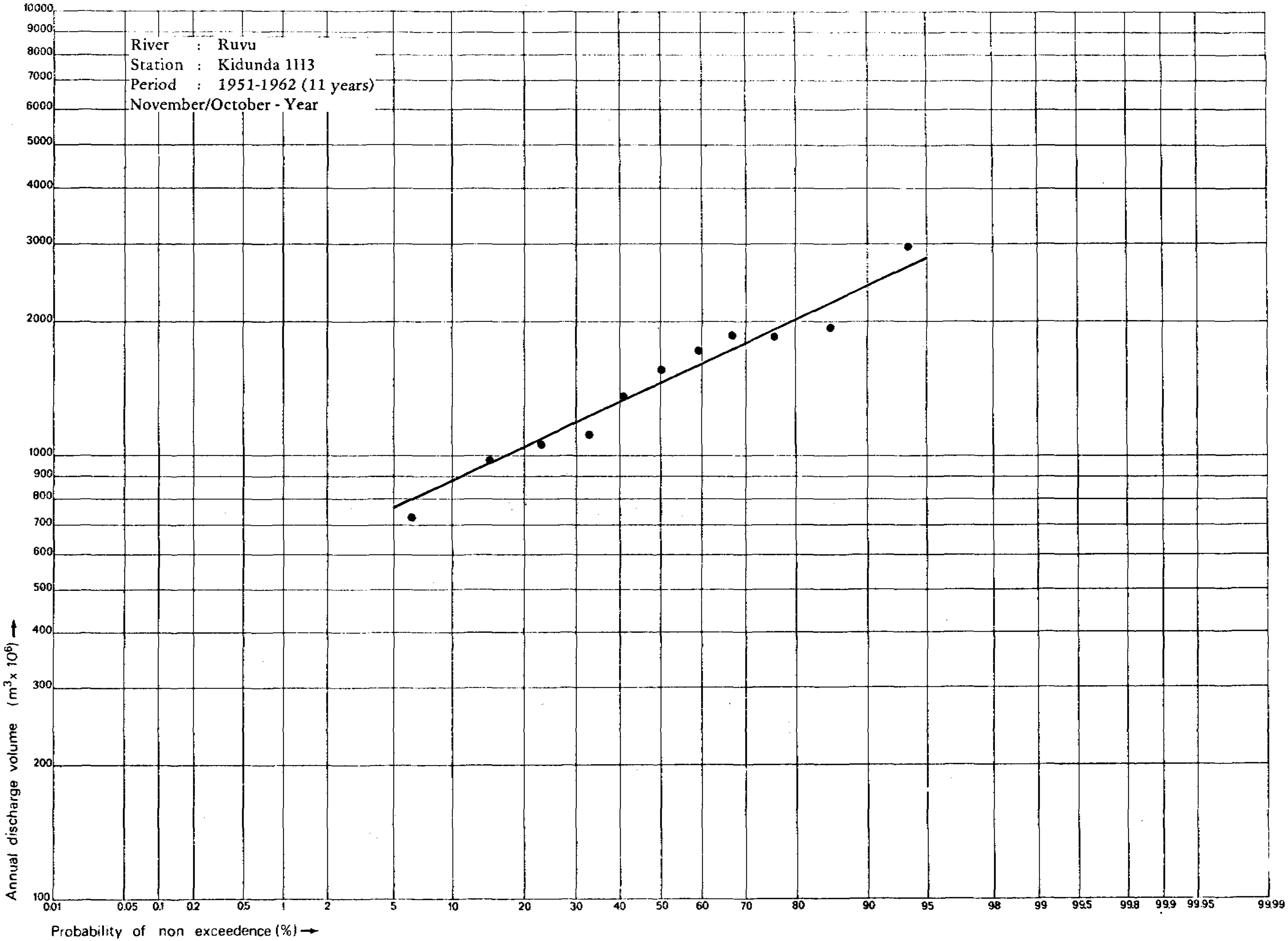

River : Mgeta
Station : Mgeta 1HB2
Period : 1960-1961, 1964-1965, 1967-1975 (13 years)
November/October - Year
Annual discharge volume (m³ x 10⁶) →
Probability of non exceedence (%) →
10
20
30
40
50
60
70
80
90
100
200
300
400
500
600
700
800
900
1000
0.01
0.05
0.1
0.2
0.5
1
2
5
10
20
30
40
50
60
70
80
90
95
98
99
99.5
99.8
99.9
99.95
99.99

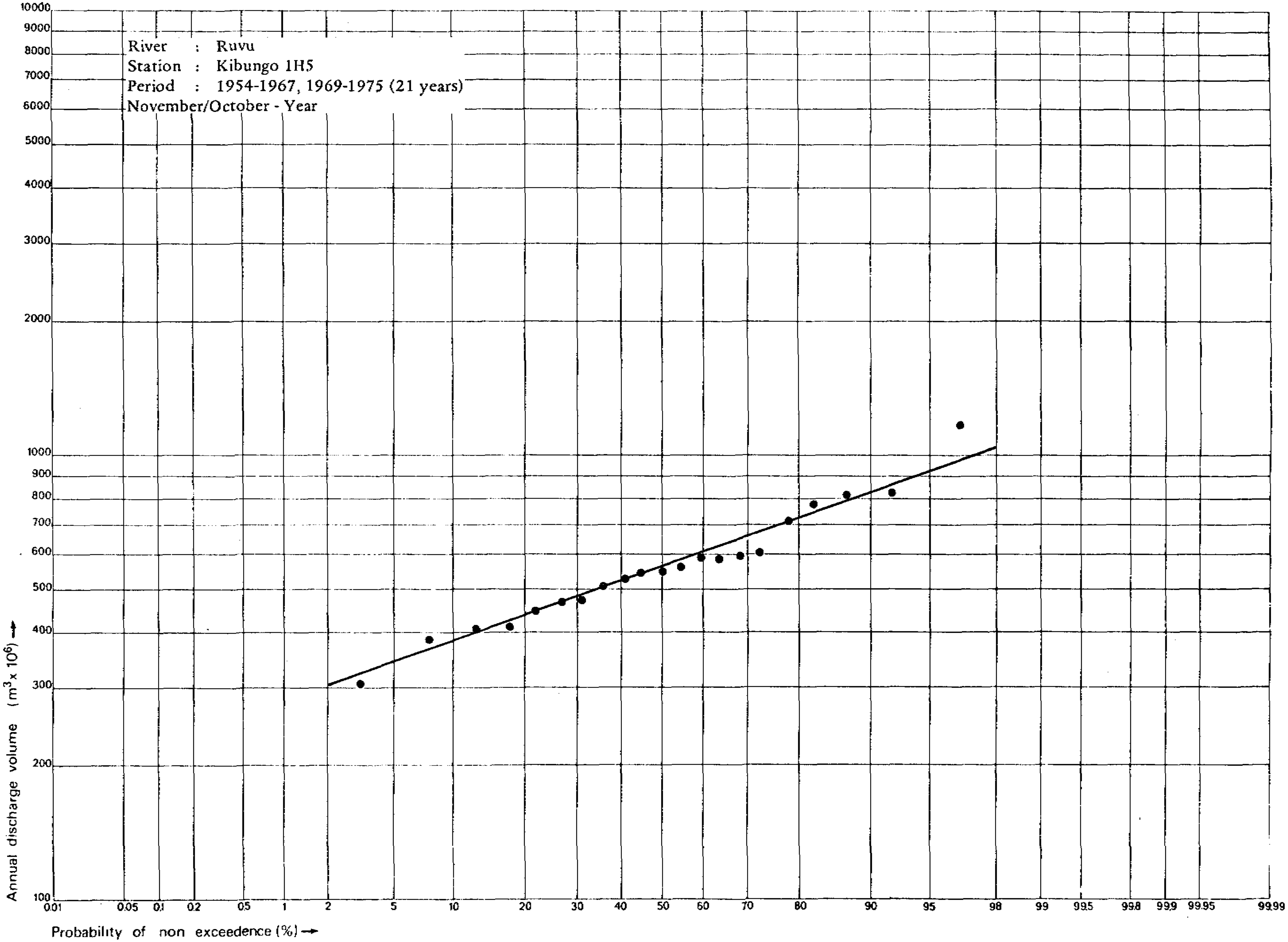

River : Wami
Station : Dakawa 1G1
Period : 1959-1975 (17 years)
November-October - Year
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
900
800
700
600
500
400
300
200
100
Annual discharge volume (m3 x 106)
0.01
0.05
0.1
0.2
0.5
1
2
5
10
20
30
40
50
60
70
80
90
95
98
99
99.5
99.8
99.9
99.95
99.99
Probability of non exceedence (%)

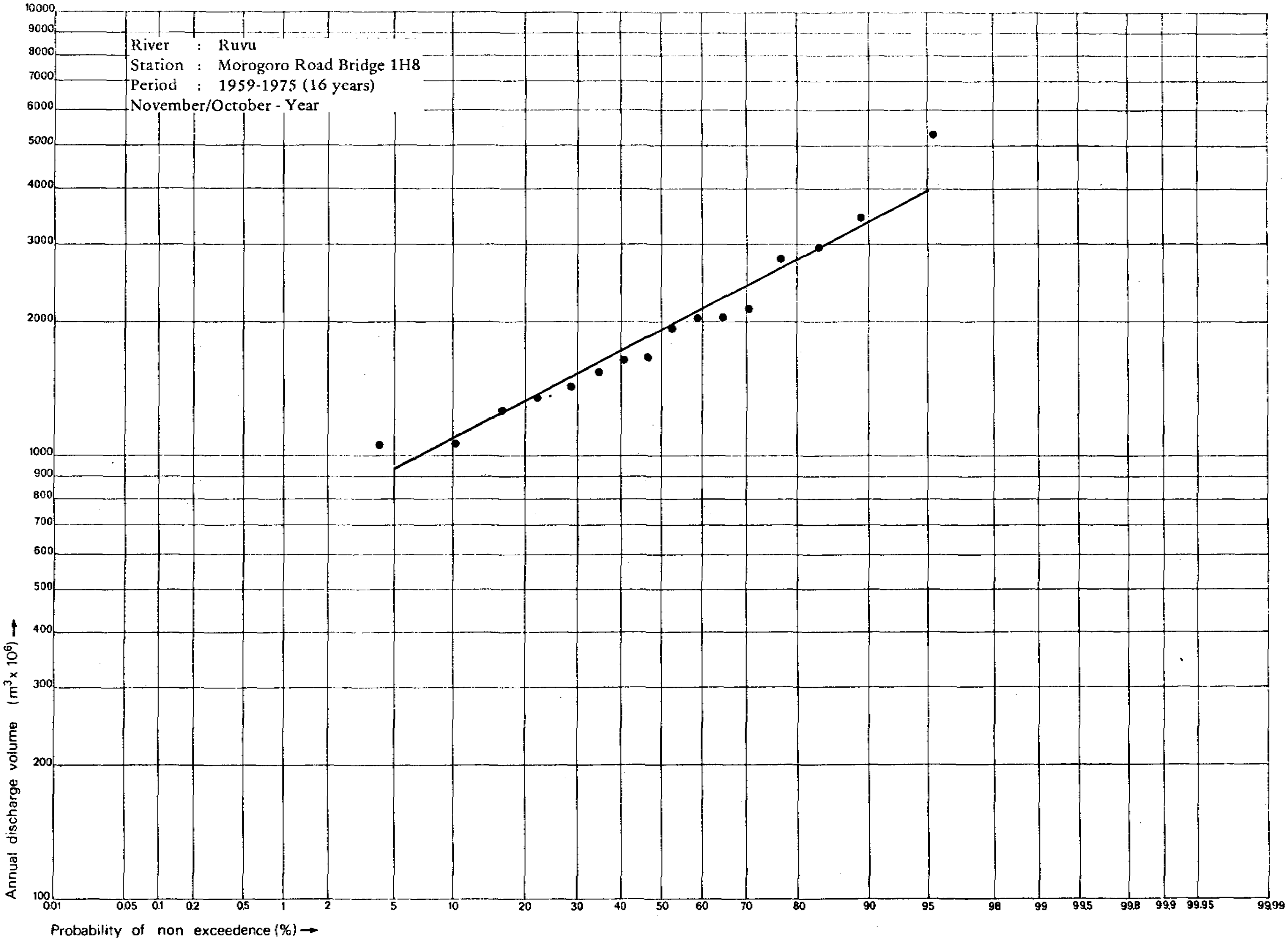

River : Wami
Station : Mandera 1G2
Period : 1956-1969, 1971-1973, 1975 (18 years)
November/October - Year
Annual discharge volume ($m^3 \times 10^6$) →
Probability of non exceedence (%) →
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
900
800
700
600
500
400
300
200
100
0.01
0.05
0.1
0.2
0.5
1
2
5
10
20
30
40
50
60
70
80
90
95
98
99
99.5
99.8
99.9
99.95
99.99

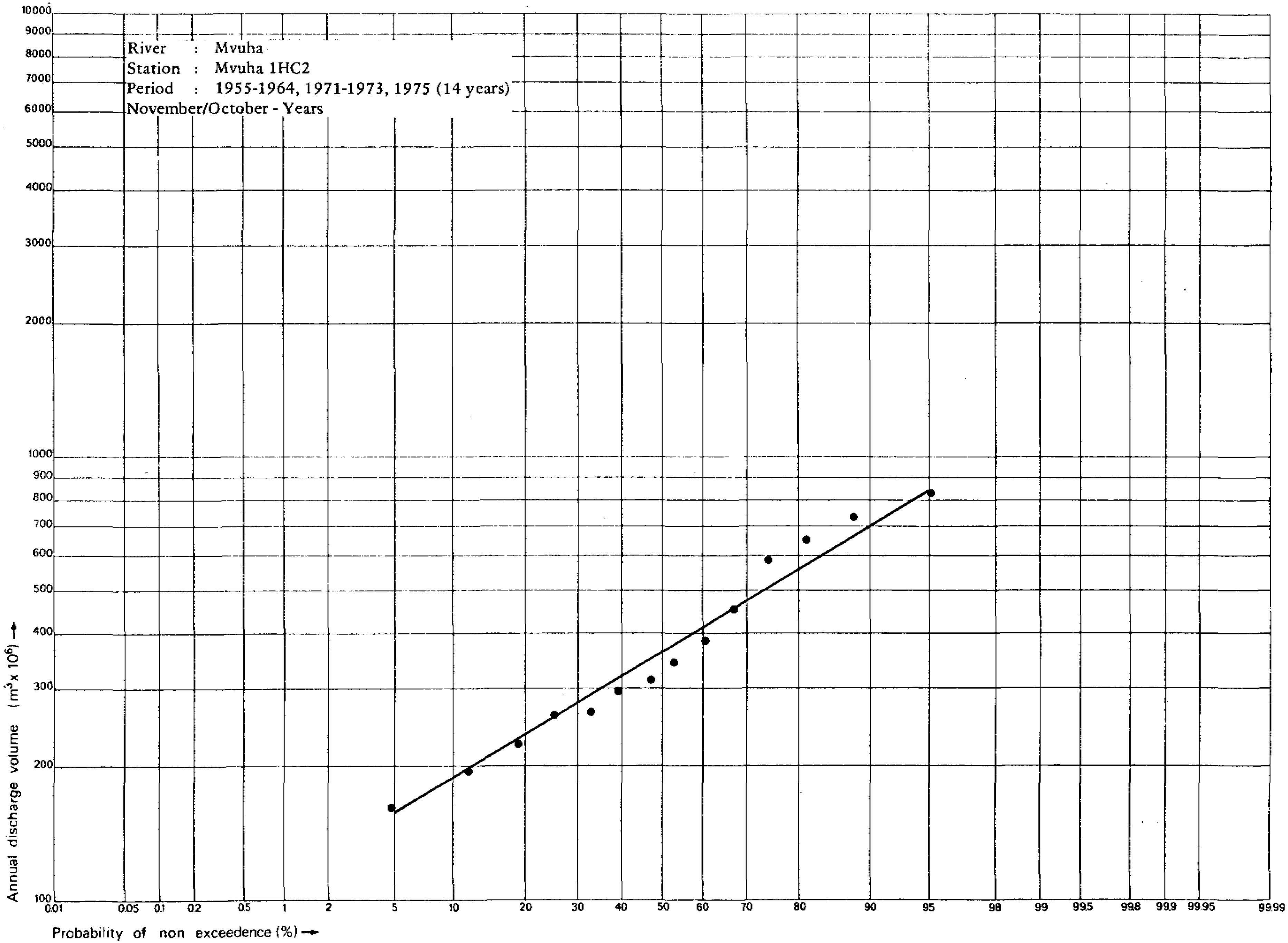

River : Mkondoa
Station : Kilosa 1GD2
Period : 1953-1963, 1965-1967, 1969-1970 (16 years)
November/October - Year
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
900
800
700
600
500
400
300
200
100
0.01
0.05
0.1
0.2
0.5
1
2
5
10
20
30
40
50
60
70
80
90
95
98
99
99.5
99.8
99.9
99.95
99.99
Annual discharge volume ($m^3 \times 10^6$) →
Probability of non exceedence (%) →

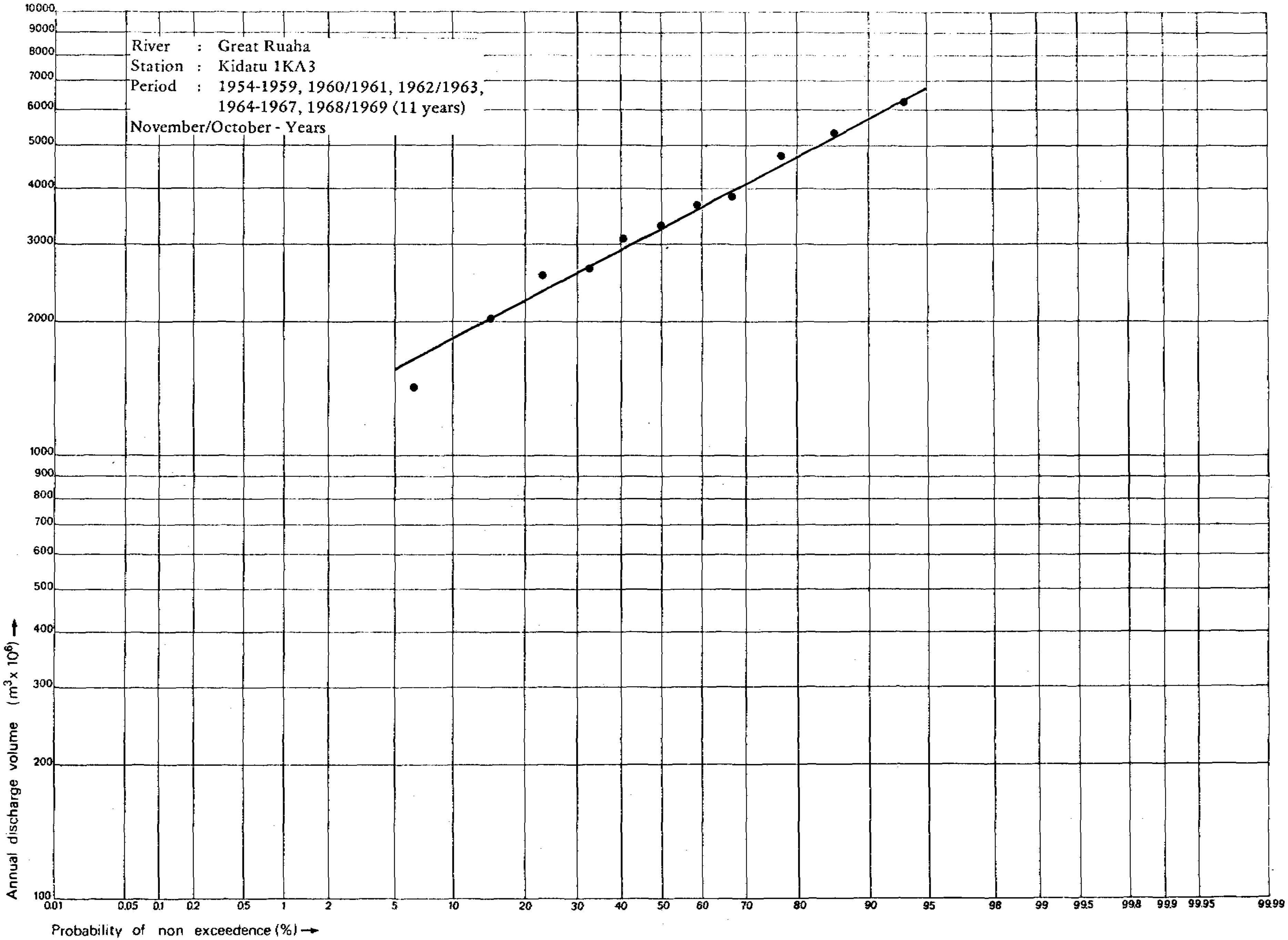

River : Ruvu
Station : Ruvu Sisal Estate 1H2
Period : 1950-1958 (8 years)
November/October - Year
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
900
800
700
600
500
400
300
200
100
0.01
0.05
0.1
0.2
0.5
1
2
5
10
20
30
40
50
60
70
80
90
95
98
99
99.5
99.8
99.9
99.95
99.99
Annual discharge volume ($m^3 \times 10^6$)
Probability of non exceedence (%)

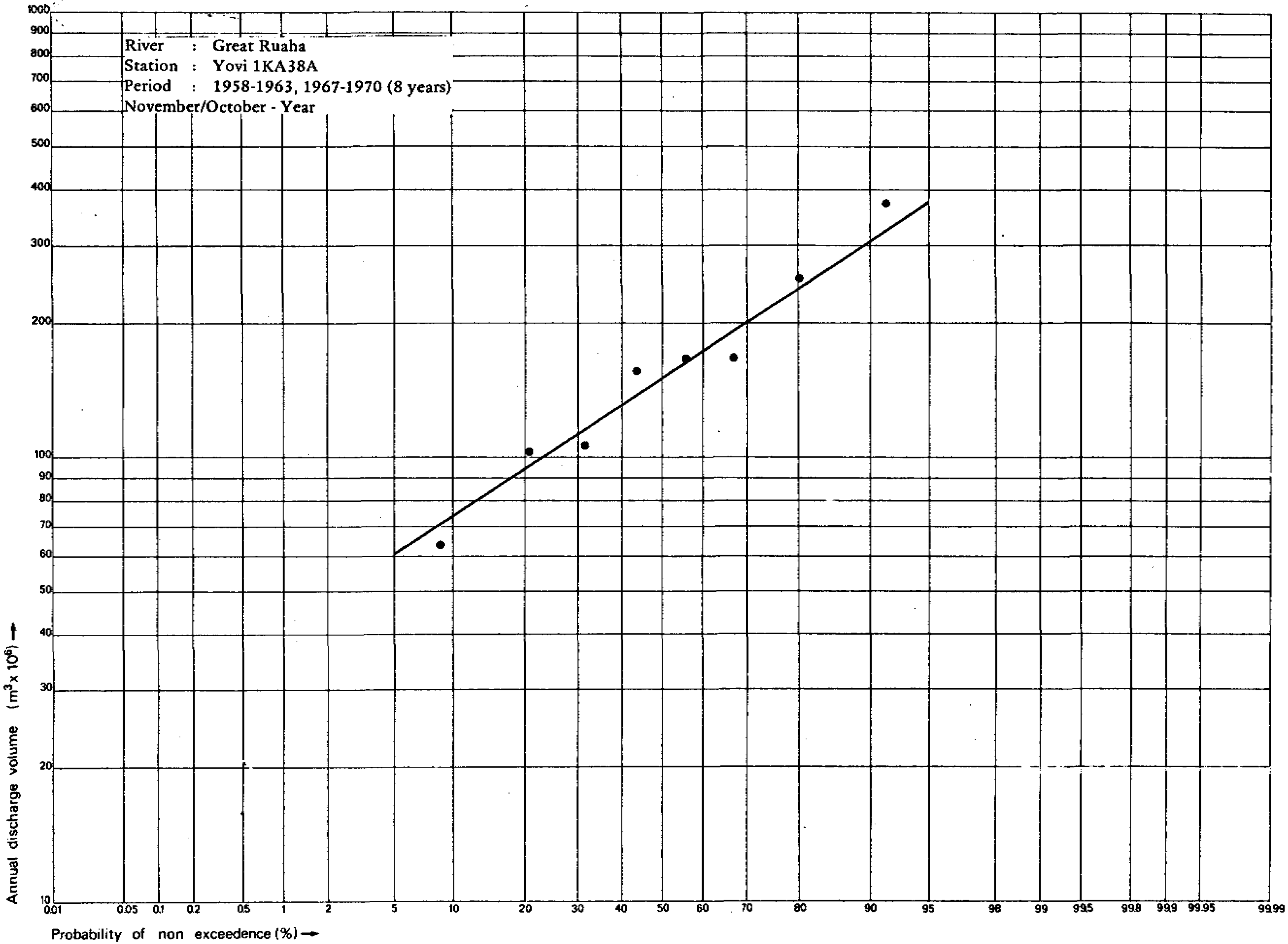

River : Ruvu
Station : Kidunda 1113
Period : 1951-1962 (11 years)
November/October - Year
Annual discharge volume (m3 x 106)
Probability of non exceedence (%)
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
900
800
700
600
500
400
300
200
100
0.01
0.05
0.1
0.2
0.5
1
2
5
10
20
30
40
50
60
70
80
90
95
98
99
99.5
99.8
99.9
99.95
99.99


River : Ruvu
Station : Kibungo 1H5
Period : 1954-1967, 1969-1975 (21 years)
November/October - Year
Annual discharge volume ($m^3 \times 10^6$) →
Probability of non exceedence (%) →
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
900
800
700
600
500
400
300
200
100
0.01
0.05
0.1
0.2
0.5
1
2
5
10
20
30
40
50
60
70
80
90
95
98
99
99.5
99.8
99.9
99.95
99.99

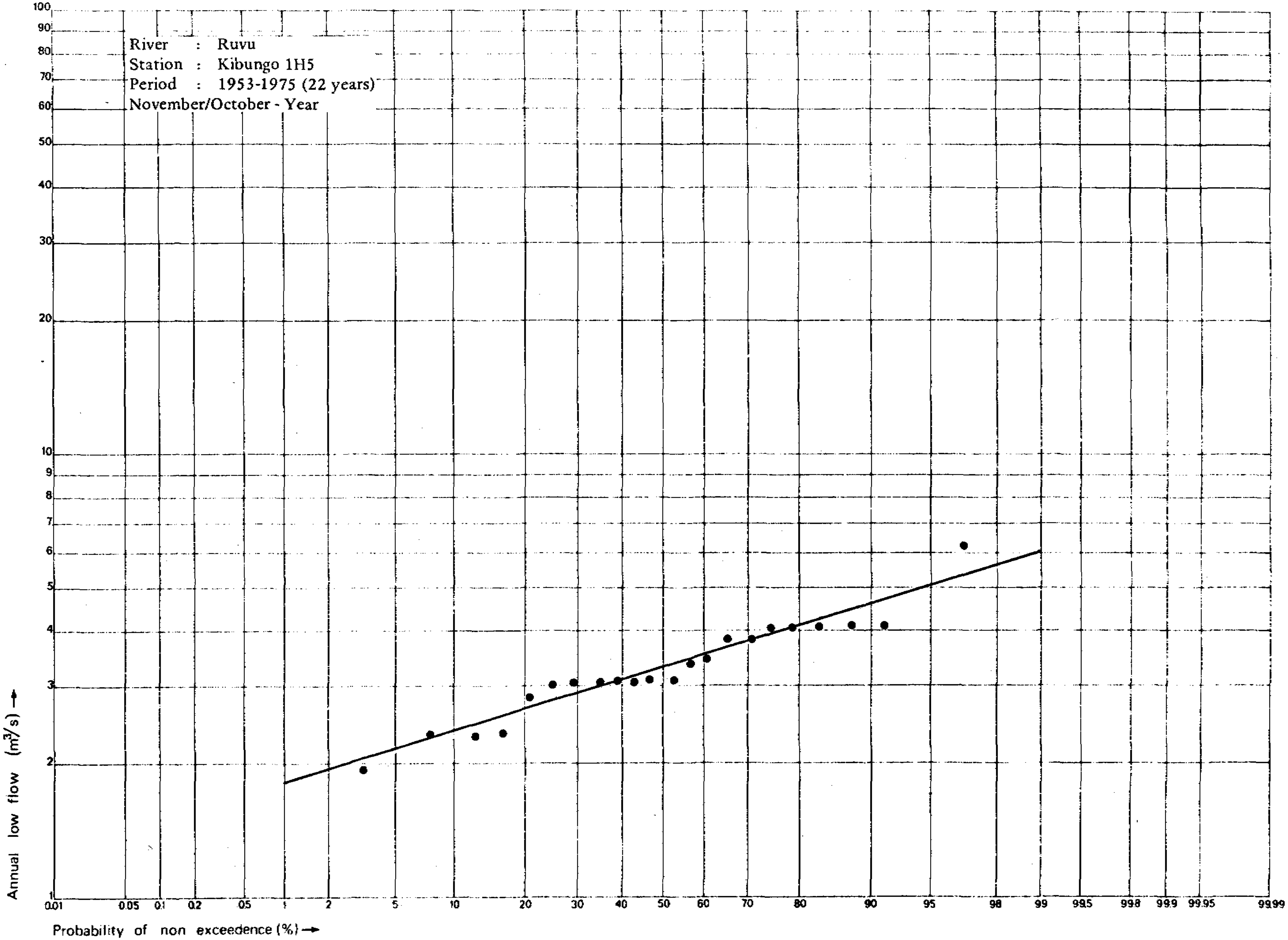

River : Ruvu
Station : Morogoro Road Bridge 1H8
Period : 1959-1975 (16 years)
November/October - Year
Annual discharge volume ($m^3 \times 10^6$) →
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
900
800
700
600
500
400
300
200
100
0.01
0.05
0.1
0.2
0.5
1
2
5
10
20
30
40
50
60
70
80
90
95
98
99
99.5
99.8
99.9
99.95
99.99
Probability of non exceedence (%) →

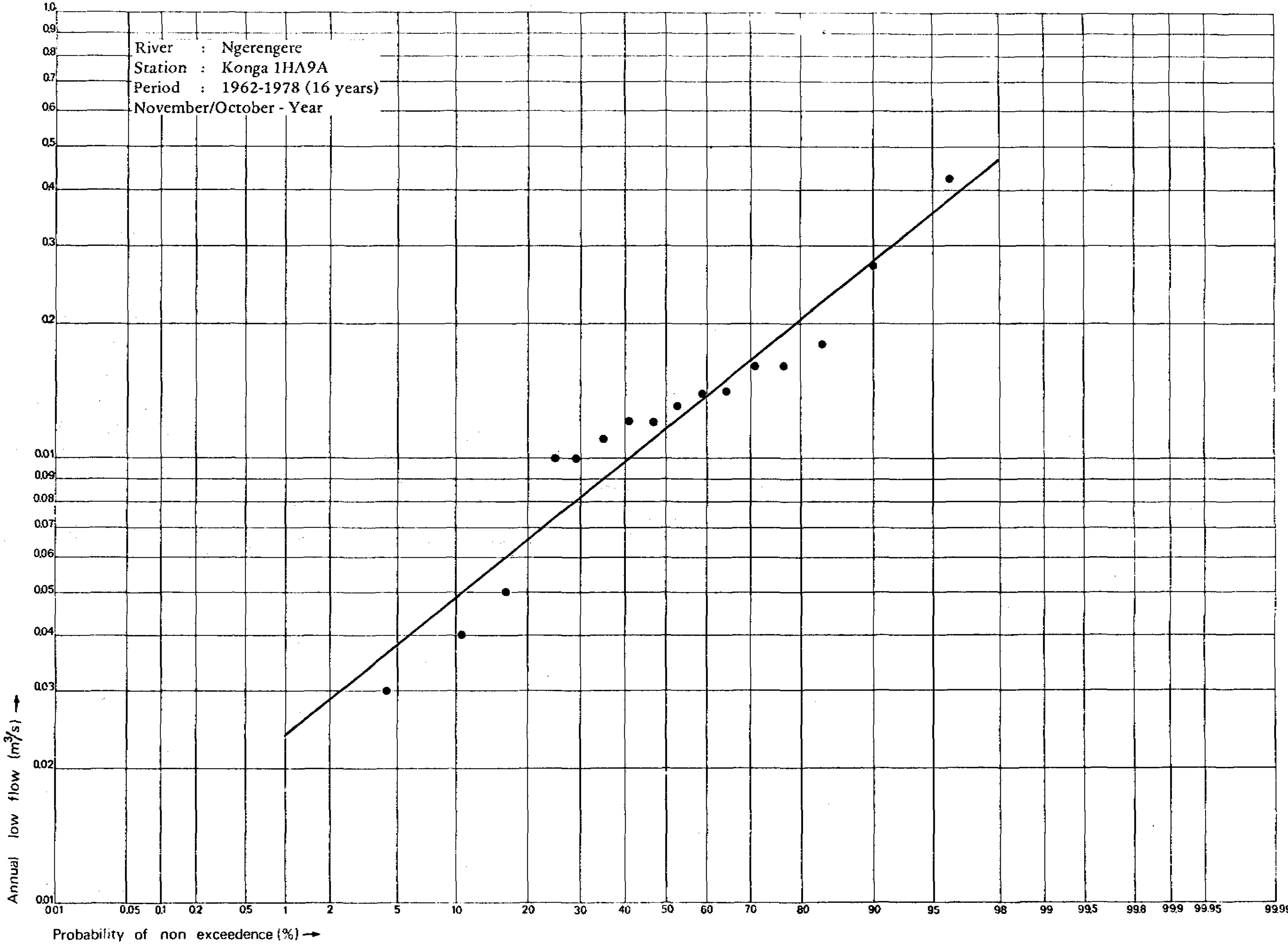

River : Mvuha
Station : Mvuha 1HC2
Period : 1955-1964, 1971-1973, 1975 (14 years)
November/October - Years
Annual discharge volume (m³ x 10⁶)
Probability of non exceedence (%)
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
900
800
700
600
500
400
300
200
100
0.01
0.05
0.1
0.2
0.5
1
2
5
10
20
30
40
50
60
70
80
90
95
98
99
99.5
99.8
99.9
99.95
99.99

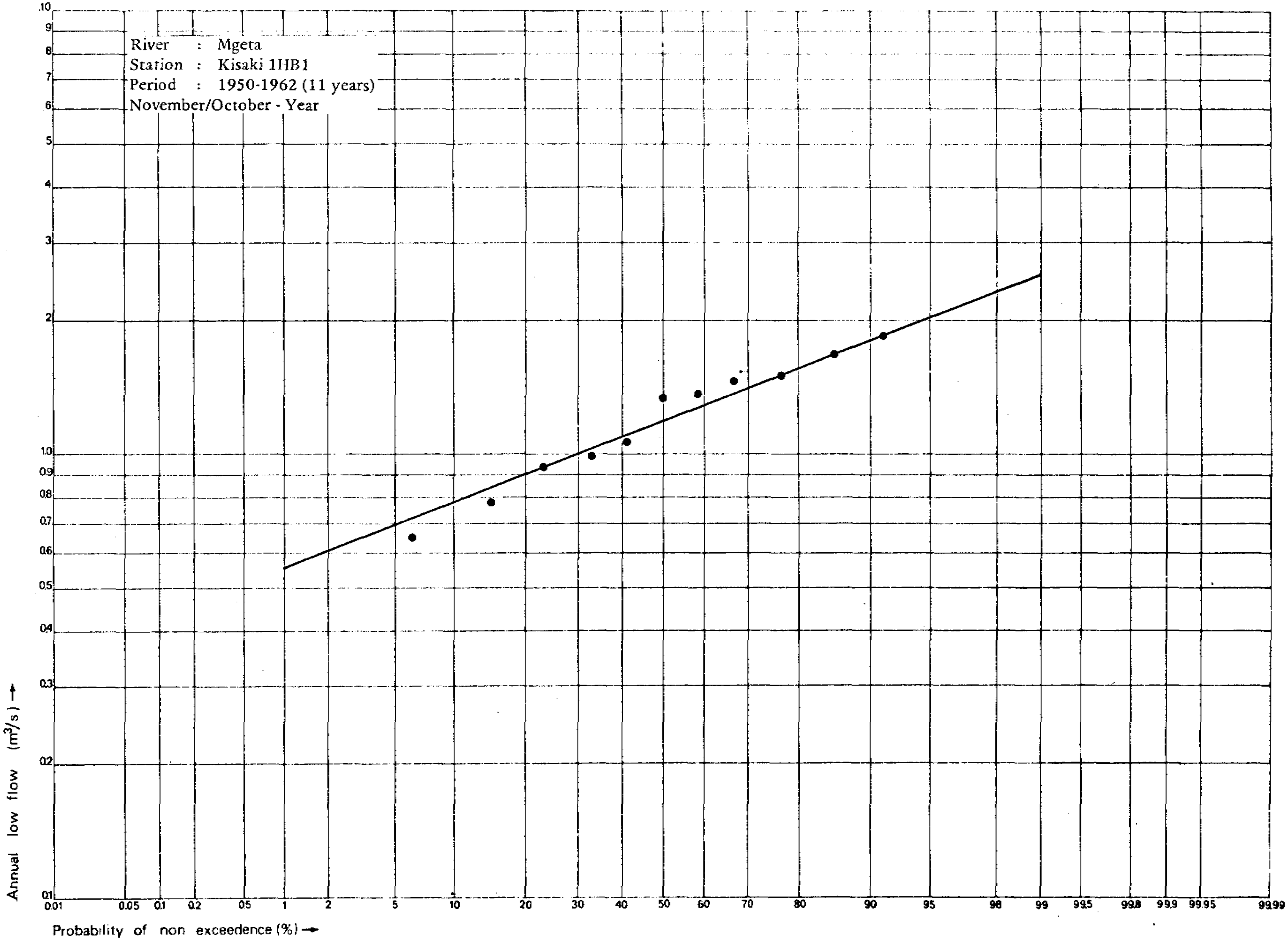

River : Great Ruaha
Station : Kidatu 1KA3
Period : 1954-1959, 1960/1961, 1962/1963, 1964-1967, 1968/1969 (11 years)
November/October - Years
Annual discharge volume (m^3 x 10^6) →
Probability of non exceedence (%) →
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
900
800
700
600
500
400
300
200
100
0.01
0.05
0.1
0.2
0.5
1
2
5
10
20
30
40
50
60
70
80
90
95
98
99
99.5
99.8
99.9
99.95
99.99

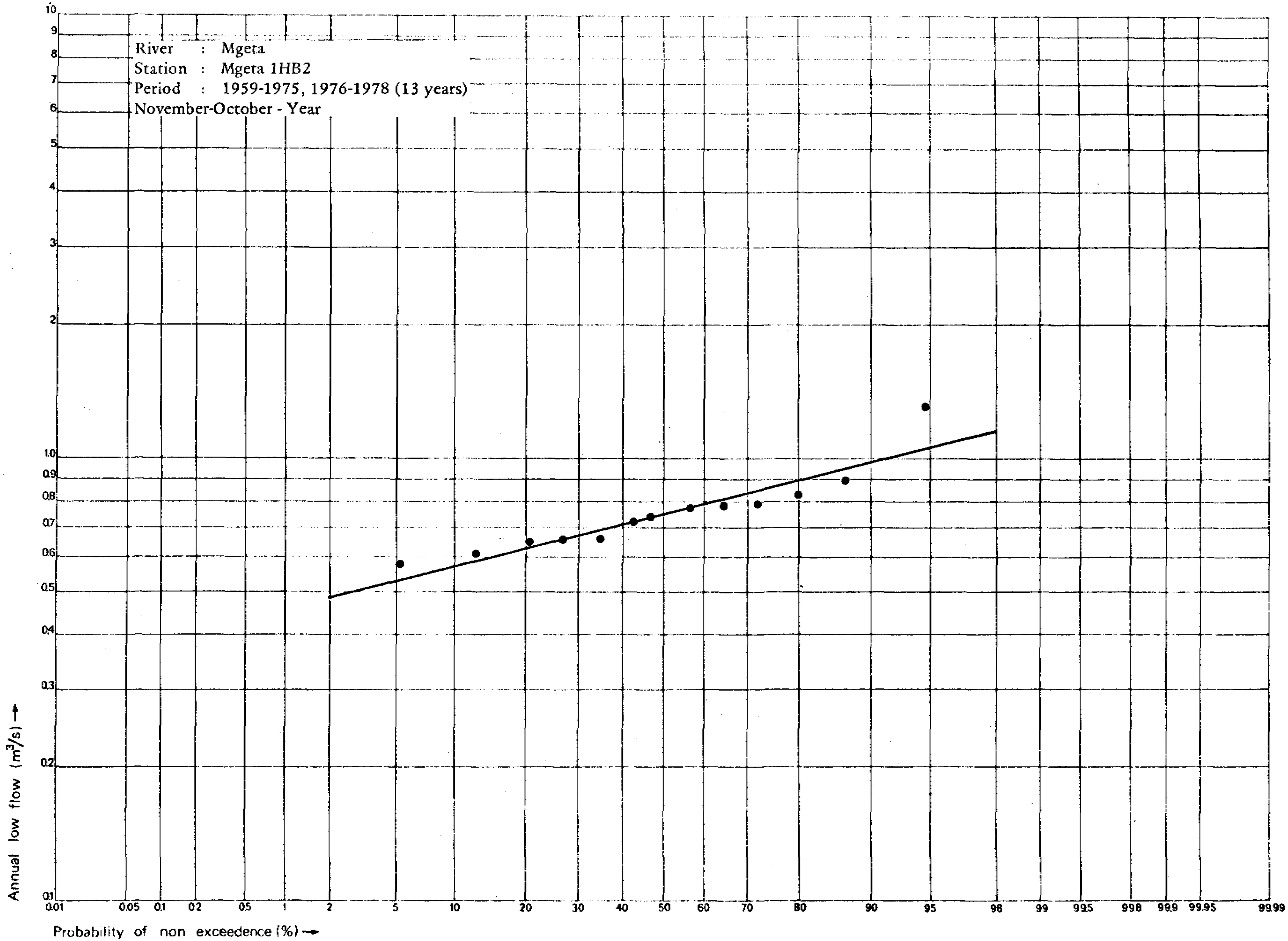

River : Great Ruaha
Station : Yovi 1KA38A
Period : 1958-1963, 1967-1970 (8 years)
November/October - Year
Annual discharge volume (m³ x 10⁶)
Probability of non exceedence (%)
1000
900
800
700
600
500
400
300
200
100
90
80
70
60
50
40
30
20
10
0.01
0.05
0.1
0.2
0.5
1
2
5
10
20
30
40
50
60
70
80
90
95
98
99
99.5
99.8
99.9
99.95
99.99

CD 3.4 Probability distributions of annual low flows

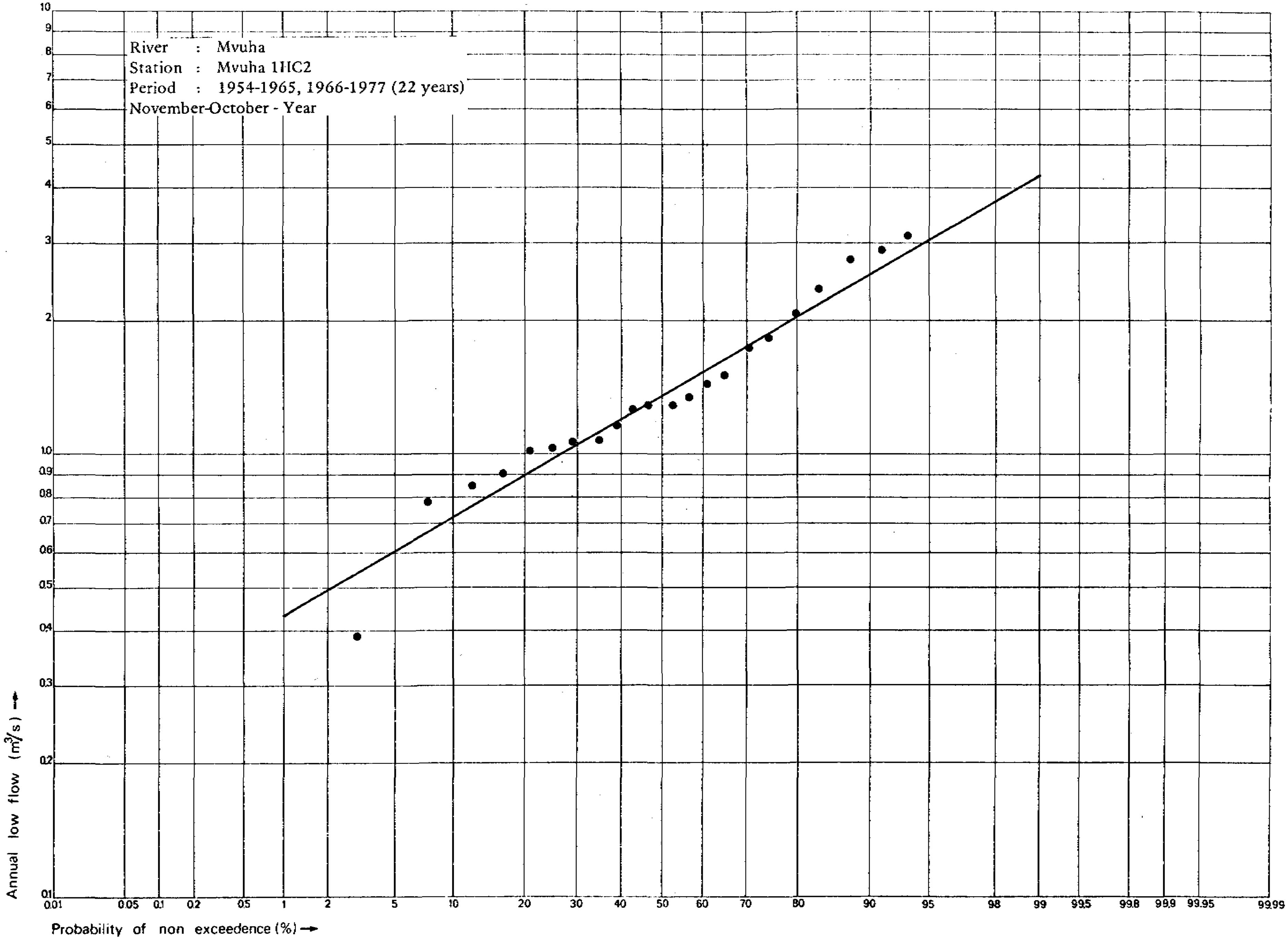

River : Ruvu
Station : Kibungo 1H5
Period : 1953-1975 (22 years)
November/October - Year
Annual low flow (m³/s) →
Probability of non exceedence (%) →
100
90
80
70
60
50
40
30
20
10
9
8
7
6
5
4
3
2
1
0.01
0.05
0.1
0.2
0.5
1
2
5
10
20
30
40
50
60
70
80
90
95
98
99
99.5
99.8
99.9
99.95
99.99

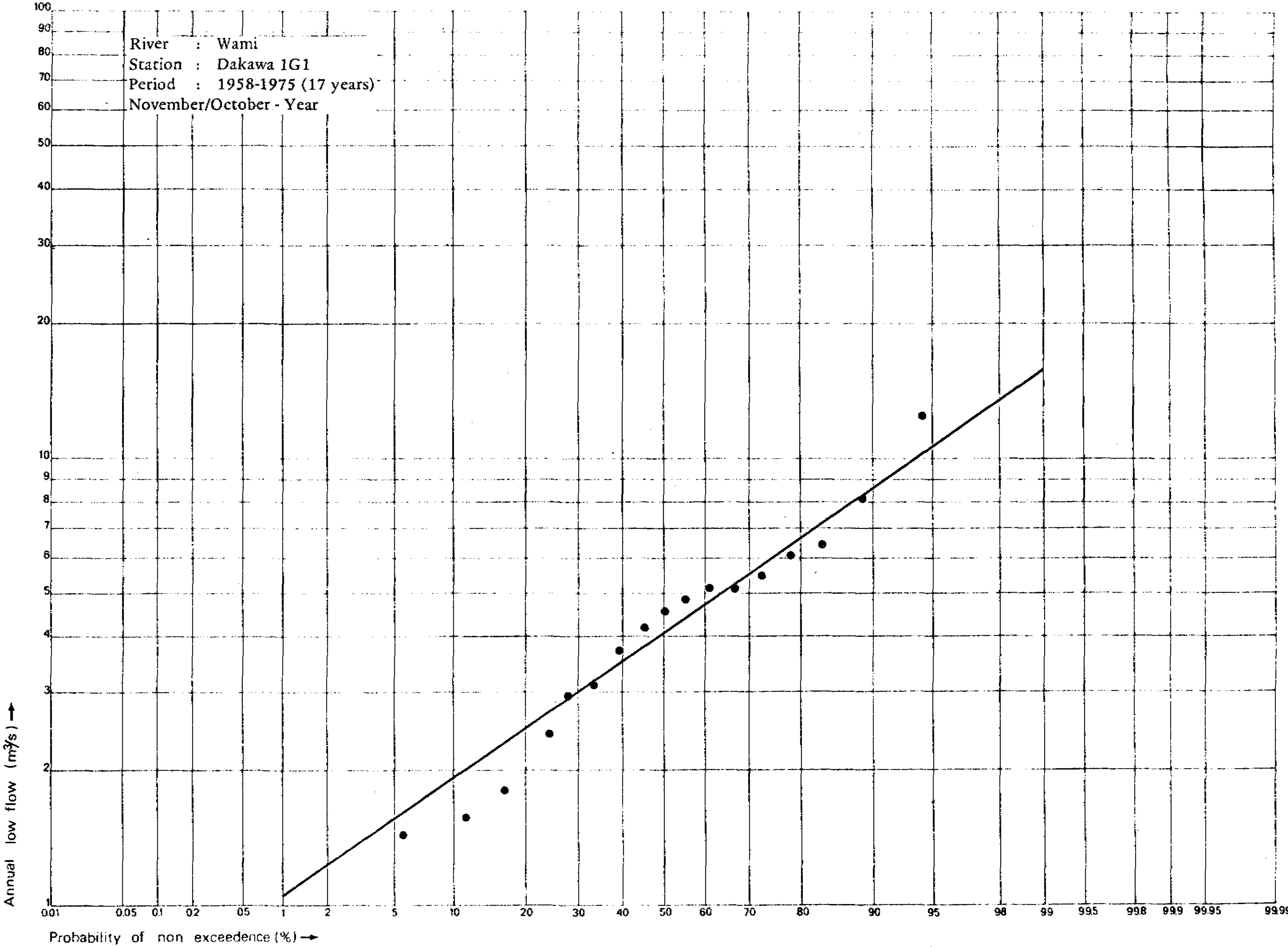

River : Ngerengere
Station : Konga 1HΛ9A
Period : 1962-1978 (16 years)
November/October - Year
Annual low flow (m³/s)
Probability of non exceedence (%)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.01
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.01
0.05
0.1
0.2
0.5
1
2
5
10
20
30
40
50
60
70
80
90
95
98
99
99.5
99.8
99.9
99.95
99.99

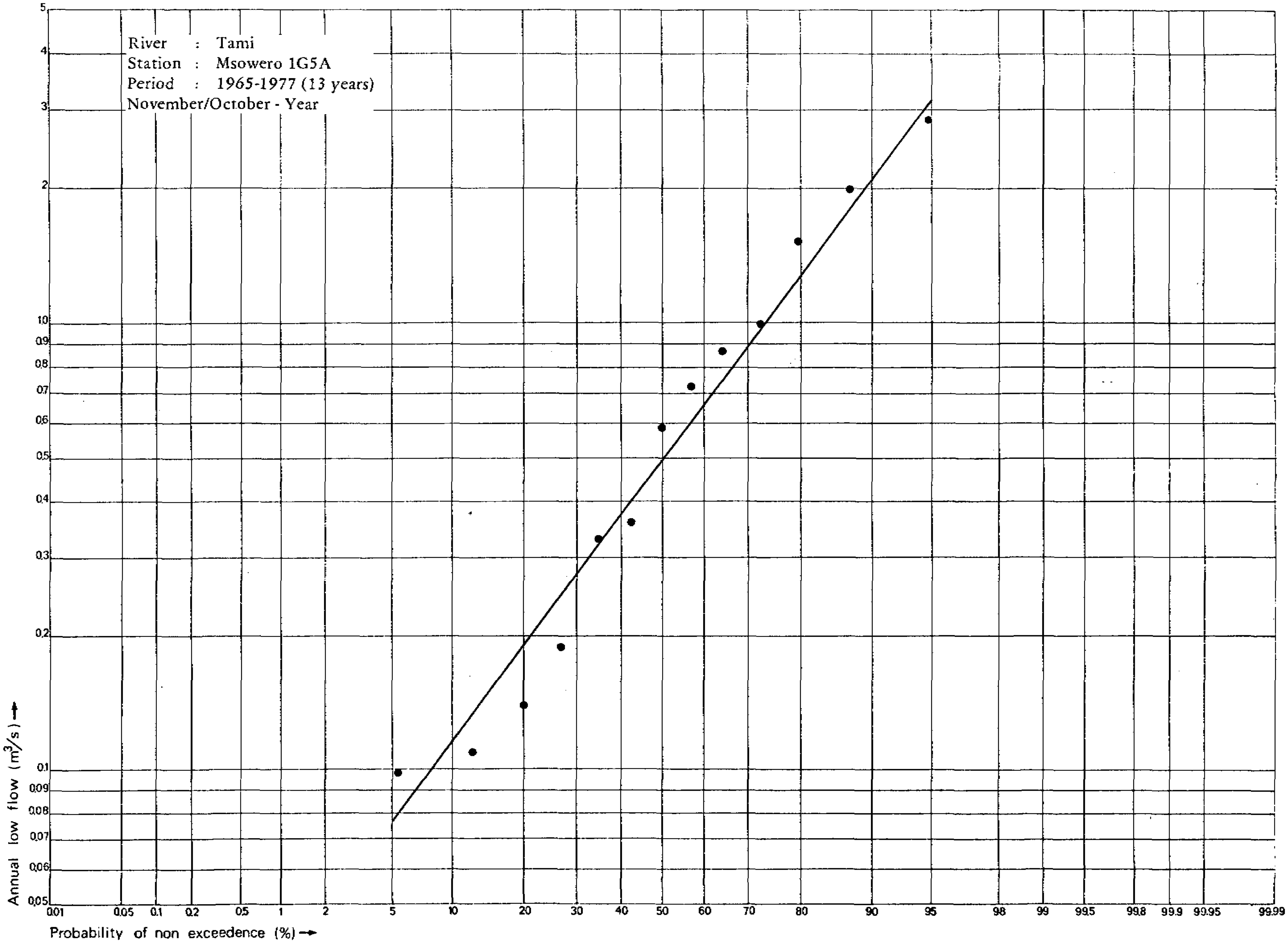

River : Mgeta
Station : Kisaki 1HB1
Period : 1950-1962 (11 years)
November/October - Year
Annual low flow (m^3/s)
Probability of non exceedence (%)
10
9
8
7
6
5
4
3
2
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.01
0.05
0.1
0.2
0.5
1
2
5
10
20
30
40
50
60
70
80
90
95
98
99
99.5
99.8
99.9
99.95
99.99

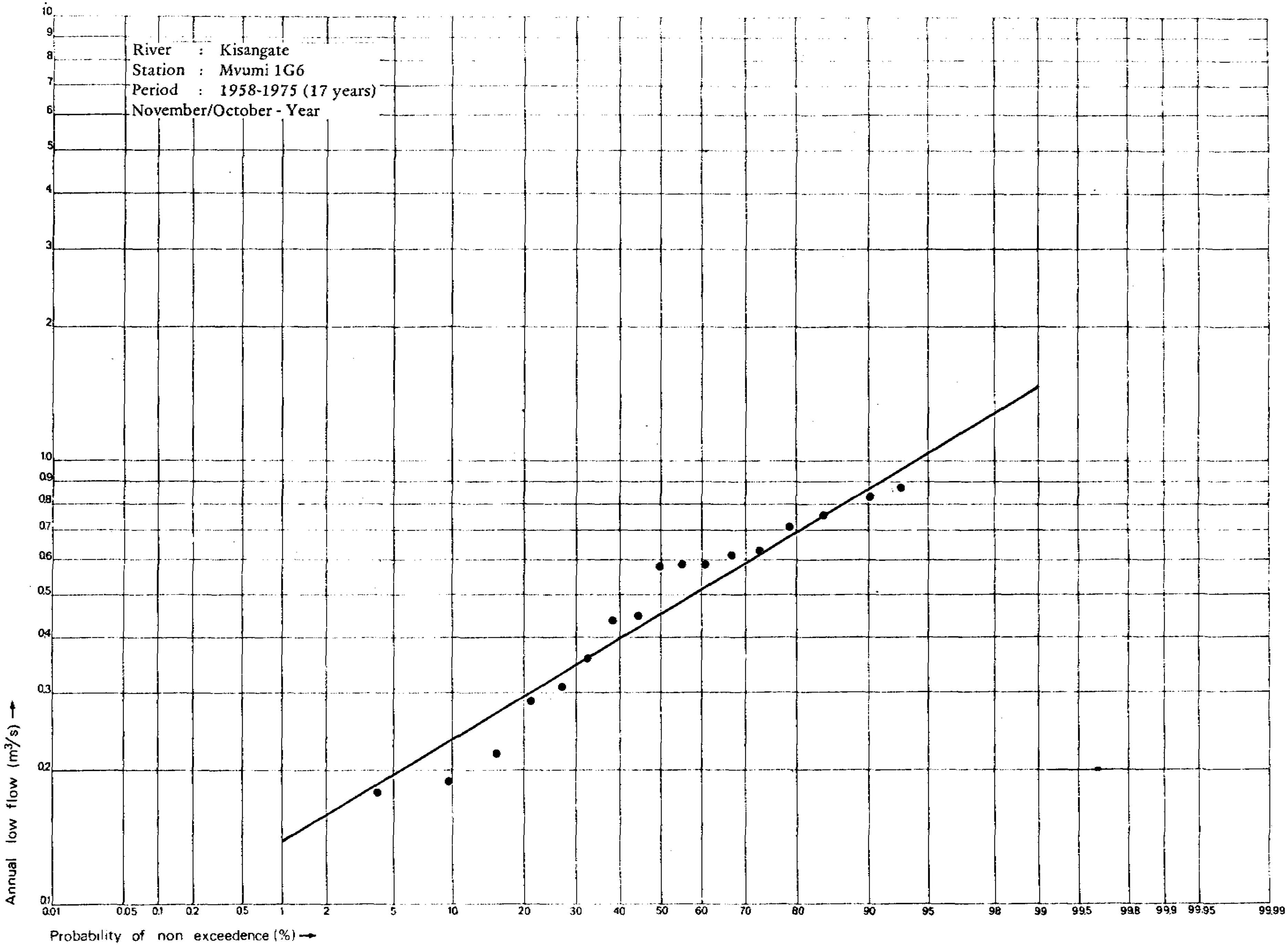


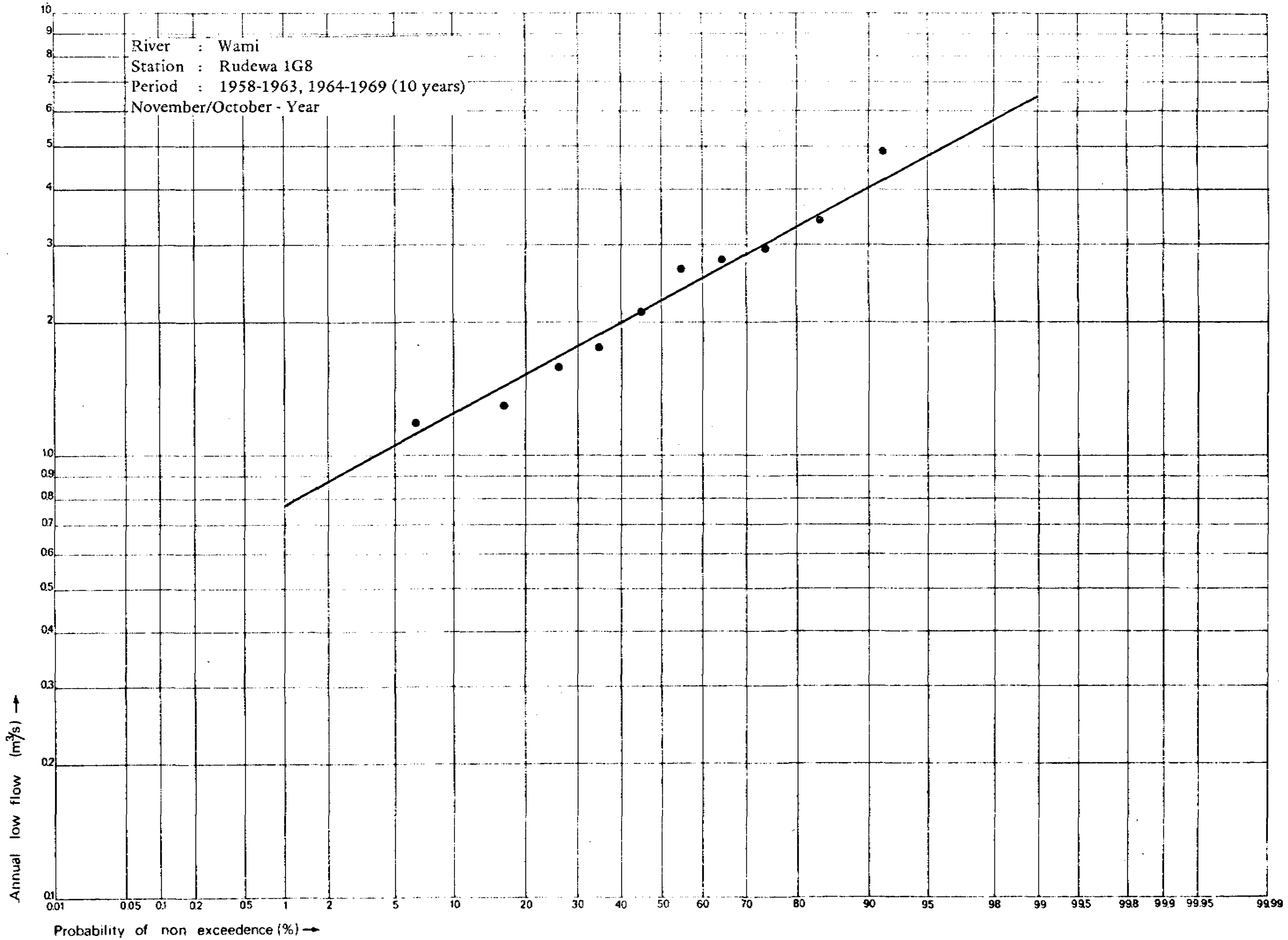
River : Mgeta
Station : Mgeta 1HB2
Period : 1959-1975, 1976-1978 (13 years)
November-October - Year
Annual low flow (m³/s)
Probability of non exceedence (%)
10
9
8
7
6
5
4
3
2
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.01
0.05
0.1
0.2
0.5
1
2
5
10
20
30
40
50
60
70
80
90
95
98
99
99.5
99.8
99.9
99.95
99.99


River : Mvuha
Station : Mvuha 1HC2
Period : 1954-1965, 1966-1977 (22 years)
November-October - Year
Annual low flow (m^3/s) →
Probability of non exceedence (%) →
10
9
8
7
6
5
4
3
2
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.01 0.05 0.1 0.2 0.5 1 2 5 10 20 30 40 50 60 70 80 90 95 98 99 99.5 99.8 99.9 99.95 99.99

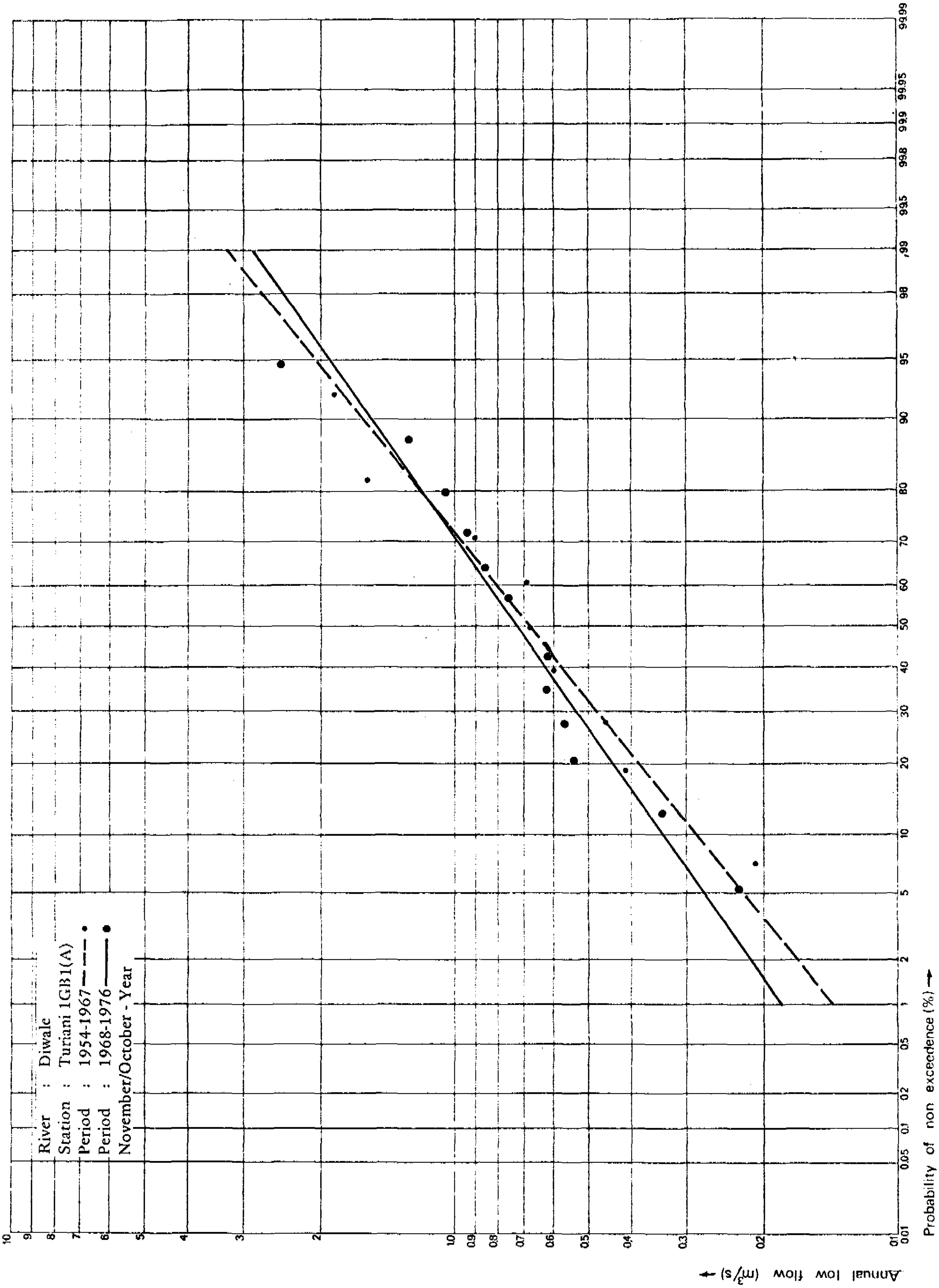

River : Wami
Station : Dakawa 1G1
Period : 1958-1975 (17 years)
November/October - Year
Annual low flow (m³/s)
Probability of non exceedence (%)
100
90
80
70
60
50
40
30
20
10
9
8
7
6
5
4
3
2
1
0.01
0.05
0.1
0.2
0.5
1
2
5
10
20
30
40
50
60
70
80
90
95
98
99
99.5
99.8
99.9
99.95
99.99

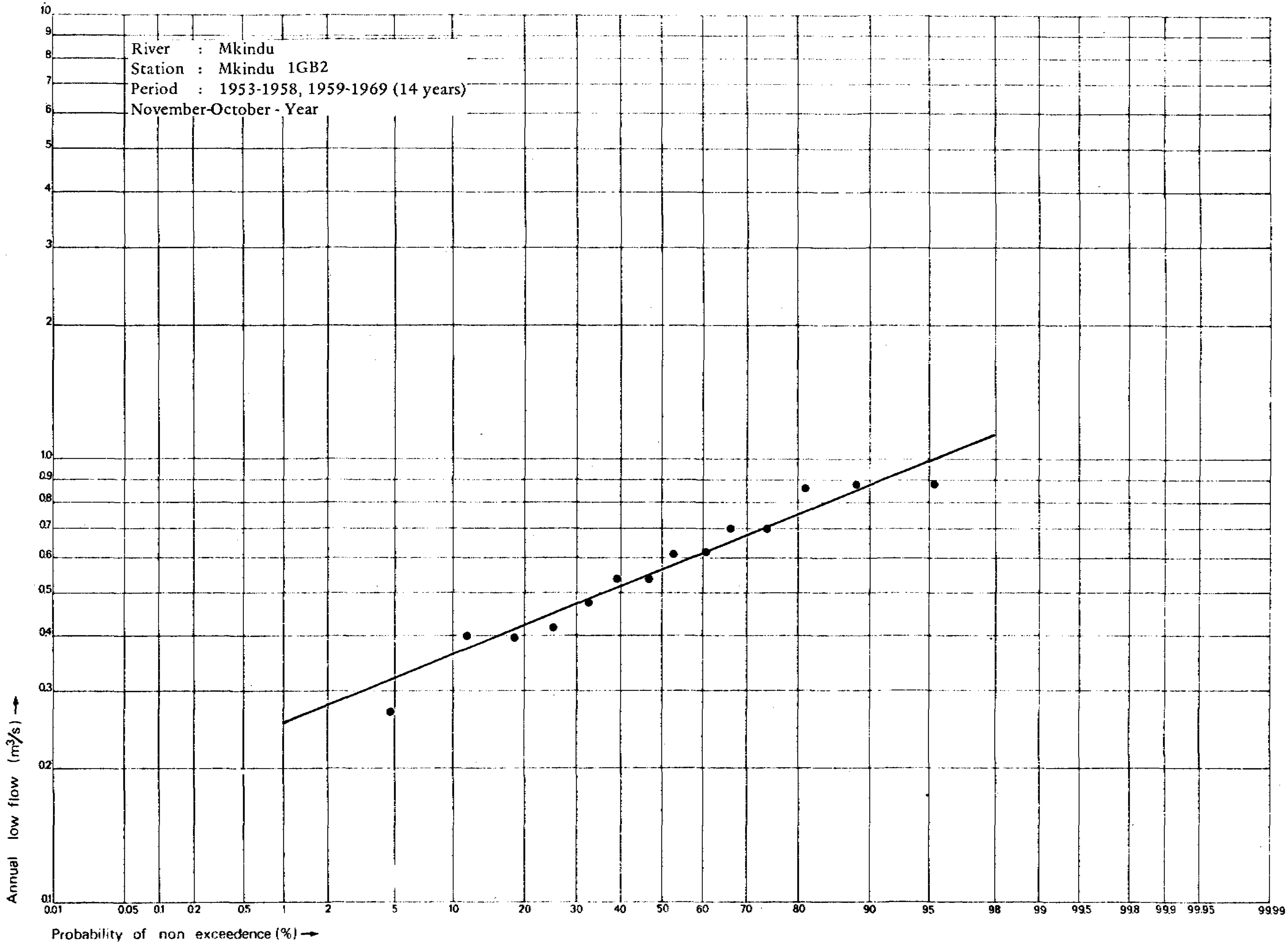

River : Tami
Station : Msowero 1G5A
Period : 1965-1977 (13 years)
November/October - Year
Annual low flow (m3/s)
Probability of non exceedence (%)


River : Kisangate
Station : Mvumi 1G6
Period : 1958-1975 (17 years)
November/October - Year
Annual low flow (m³/s)
Probability of non exceedence (%)
0.01 0.05 0.1 0.2 0.5 1 2 5 10 20 30 40 50 60 70 80 90 95 98 99 99.5 99.8 99.9 99.95 99.99
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 2 3 4 5 6 7 8 9 10



River : Wami
Station : Rudewa 1G8
Period : 1958-1963, 1964-1969 (10 years)
November/October - Year
Annual low flow (m³/s) →
Probability of non exceedence (%) →


River : Diwale
Station : Turiani 1GB1(A)
Period : 1954-1967
Period : 1968-1976
November/October - Year
Annual low flow (m³/s)
Probability of non exceedence (%)
10 9 8 7 6 5 4 3 2 1.0 0.9 0.8 0.7 0.6 0.5 0.4 0.3 0.2 0.1
0.01 0.05 0.1 0.2 0.5 1 2 5 10 20 30 40 50 60 70 80 90 95 98 99 99.5 99.8 99.9 99.95 99.99


River : Mkindu
Station : Mkindu 1GB2
Period : 1953-1958, 1959-1969 (14 years)
November-October - Year
Annual low flow (m^3/s) →
Probability of non exceedence (%) →
10
9
8
7
6
5
4
3
2
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.01 0.05 0.1 0.2 0.5 1 2 5 10 20 30 40 50 60 70 80 90 95 98 99 99.5 99.8 99.9 99.95 99.99

CD 3.5 1978/79 Field data

<u>Legend</u> (Field data)

m a.MSL	=	meters above mean sea level
km^2	=	square kilometers
m	=	meter
l/s	=	liter/second
mS/m	=	micro Siemens/meter
EC	=	electrical conductivity
~	=	estimated value
-	=	not measured or not estimated or no remarks

Field data 1978/79 of Rivers

Site number	Rivers	Area	Site	Altitude (m.a.MSL)	Catchment (km^2)	Remarks	Date	Water level (m)	Discharge (l/s)	EC (mS/m)	Remarks
1.	Ikonde	Kaguru	near	980		Perennial	5/7/78	-	3.4	8.0	-
	spring	Mountains	Mamboya			spring	22/8/78	-	1.6	10.5	-
							18/9/78	-	0.7	11.5	-
							-	-	almost dry	-	lowest flow 1978
						non perennial	5/7/78	-	0.3	8.0	-
						spring	22/8/78	-	0.2	-	-
							18/9/78	-	0.05	-	-
							19/10/78	-	no flow	-	-
							-	-	0	-	lowest flow 1978
2.	Kitange	Kaguru	near Kitange	1000		non perennial	27/6/78	-	181.0	34.0	Tami dry
		Mountains	at confluence			according to	22/8/78	-	87.3	33.0	upstream confluence
			with Tami			local infor-				40.0	downstream confluence
						mation	18/9/78	-	59.3	36.0	upstream confluence
										44.0	downstream confluence
							19/10/78	-	18.9	-	-
							-	-	~ 6	-	lowest flow 1978
3.	Mahero	Kaguru	near Masenge	1920	1.04	tapped for	26/7/78	0.10	5.0	4.5	V-notch measurement
		Mountains	at existing			Gairo gravity	23/8/78	0.08	2.5	4.5	B.M.= 0 corresponds
			intake			scheme	19/9/78	0.12	6.9	5.4	with lowest point
							19/10/78	0.11	5.6	-	of notch.
											25% leakage
							-	-	~ 5.5	-	lowest flow 1978
			near Masenge	1920	0.36	tributary	26/7/78	-	2.5	4.5	-
			at existing			tapped for	23/8/78	-	2.4	4.8	-
			intake			Gairo gravity	19/9/78	-	2.2	4.7	-
						scheme	19/10/78	-	1.6	-	-
							-	-	~ 1.5	-	lowest flow 1978
4.	Mnibule	Kaguru	near Masenge	1700	-	-	25/8/78	-	26.0	4.0	-
		Mountains	at culvert				23/8/78	-	17.0	5.2	-
			on road to				19/9/78	-	14.3	5.4	-
			Mvumi				19/10/78	-	11.8	-	-
							-	-	~ 9.5	-	lowest flow 1978
5.	Mnyera	Kaguru	near Masenge	1700	-	source for	25/7/78	-	3.3	-	-
		Mountains	at road to			gravity supply	23/8/78	-	4.1	12.0	-
			Mvumi			to Gairo area	19/9/78	-	2.9	12.0	-
						proposed by	20/10/78	-	6.2	-	-
						Water Dept.	-	-	~ 2.5	-	lowest flow 1978
6.	Maboto	Kaguru	near Masenge	1750	-	source for	25/7/78	-	4.5	6.0	-
		Mountains	at road to			gravity supply	23/8/78	-	3.2	8.0	-
			Mvumi			to Gairo area	19/9/78	-	3.5	7.4	-
						proposed by	20/10/78	-	4.5	-	-
						Water Dept.	-	-	~ 3.5	-	lowest flow 1978

Field data 1978/79 of Rivers (continued)

Site number	Rivers	Area	Site	Altitude (m.a.MSL)	Catchment (km^2)	Remarks	Date	Water level (m)	Discharge (l/s)	EC (mS/m)	Remarks
7.	Masonbowe	Kaguru	near Masenge	1500	7.3	-	26/7/8	-	61.0	5.0	-
		Mountains	200 m below				23/8/78		51.0	5.6	-
			road to				19/9/78	-	38.5	5.6	-
			Mvumi				20/10/78	-	42.5	-	-
							-	-	~ 20	-	lowest flow 1978
8.	Manga	Kaguru	near Masenge	1730	-	-	25/7/78	-	~ 8	-	-
		Mountains	at culvert				23/8/78	-	6.4	8.8	-
			on road to				19/9/78	-	5.3	9.0	-
			Mvumi				19/10/78	-	2.4	-	-
							-	-	~ 1.5	-	lowest flow 1978
9.	Milindo	Kaguru	near Mandege	1410	10.8		21/9/78	-	106.1	4.0	-
		Mountains	Forest Station				20/10/78	-	85.9	-	-
			at bridge in				-	-	~ 65	-	lowest flow 1978
			road to Mvumi								
10.	Milindo	Kaguru	near Mandege	1270	-		21/9/78	-	201.0	4.0	-
		Mountains	Forest Station				-	-	-	-	lowest flow 1978
			at bridge in								
			road to Mvumi								
10a.	Milindo	Kaguru	near Mandege	1525	0.6		21/9/78	-	5.8	3.6	-
	tributary	Mountains	Forest Station				20/10/78	-	4.2	-	-
			at bridge in				-	-	-	-	lowest flow 1978
			road to station								
10b.	Milindo	Kaguru	near Mandege	1550	1.6	upstream	21/9/78	-	16.9	3.8	-
	tributary	Mountains	Forest Station			exists a small	20/10/78	-	18.3	-	-
			at road to			reservoir from	-	-	-	-	lowest flow 1978
			Forest Station			which water is					
						tapped for					
						supply to					
						Forest Station					
10c.	Milindo	Kaguru	"	1525	2.1	-	21/9/78	-	29.4	4.8	-
	tributary	Mountains					20/10/78	-	23.9	-	-
							-	-	-	-	lowest flow 1978
10d.	Milindo	Kaguru	"	1525	0.4	-	21/9/78	-	5.0	-	-
	tributary	Mountains					20/10/78	-	no flow	-	-
							-	-	0	-	lowest flow 1978

Field data 1978/79 of Rivers (continued)

Site number	Rivers	Area	Site	Altitude (m.a.MSL)	Catchment (km^2)	Remarks	Date	Water level (m)	Discharge (l/s)	EC (mS/m)	Remarks
10e.	Milindo tributary	Kaguru Mountains	"	1490	3.7	-	21/9/78	-	32.0	4.2	-
							20/10/78	-	34.0	-	-
							-	-	-	-	lowest flow 1978
10f.	Milindo tributary	Kaguru Mountains	"	1480	1.3	-	20/9/78	-	13.5	4.4	-
							20/10/78	-	12.1	-	-
							-	-	-	-	lowest flow 1978
10g.	Milindo tributary	Kaguru Mountains	"	1460	0.9	-	20/9/78	-	7.9	3.5	-
							20/10/78	-	8.8	-	-
							-	-	-	-	lowest flow 1978
10h.	Milindo tributary	Kaguru Mountains	"	1450	0.9	-	20/9/78	-	13.0	3.3	-
							20/10/78	-	6.4	-	-
							-	-	-	-	lowest flow 1978
21.	Mvomero	Nguru Mountains	Mvomero at road to Turiani	410	84.5	2 km upstream intake for gravity supply to village	8/6/78	-	~ 350	7.0	-
							12/7/78	-	~ 250	7.0	-
							16/8/78	-	~ 60	8.0	-
							12/8/78	-	~ 40	8.2	-
							10/10/78	-	30	9.0	-
							13/11/78	-	no flow	-	-
							-	-	0	-	lowest flow 1978
22.	Madenho	Nguru Mountains	Msufini at road to Turiani	390	19.5	-	8/6/78	-	~ 150	-	-
							12/7/78	-	~ 150	6.0	-
							15/8/78	-	30	6.0	-
							12/9/78	-	~ 25	7.2	-
							10/10/78	-	~ 20	6.5	-
							13/11/78	-	~ 3	8.0	-
							-	-	-	-	lowest flow 1978
23.	Dihombo	Nguru Mountains	Dihombo 100 m down-stream bridge in road to Turiani	350		-	12/7/78	0.195	277	6.0	at weir
							15/8/78	0.135	161	3.5	"
							24/8/78	0.135	161	-	"
							12/9/78	0.100	103	4.3	"
							10/10/78	0.80	74	4.5	"
							13/11/78	0.65	65	6.0	"
							-	-	~ 40	-	lowest flow 1978
24.	Mkindu	Nguru Mountains	Mkindu at road to Turiani	350	25.3	-	12/7/78	1.33	~3000	2.5	-
							16/8/78	1.27	1525	3.2	-
							12/9/78	1.23	1160	3.2	-
							10/10/78	1.21	940	3.0	-
							13/11/78	1.20	798	3.5	-
							-	-	~ 750	-	lowest flow 1978

Field data 1978/79 of Rivers (continued)

Site number	Rivers	Area	Site	Altitude (m.a.MSL)	Catchment (km^2)	Remarks	Date	Water level (m)	Discharge (l/s)	EC (mS/m)	Remarks
25.	Kigugu	Nguru Mountains	Kigugu at road to Turiani	370		-	12/7/78	-	~ 40	4.0	-
							15/8/78	-	~ 12	8.0	-
							12/9/78	-	~ 5	7.8	-
							10/10/78	-	10	6.5	-
							13/11/78	-	4	6.0	-
							-	-	-	-	lowest flow 1978
26.	Chazi	Nguru Mountains	Kigugu at road to Turiani	370		upstream from road weir of closed hydro-metric station 1GB3	14/7/78	-	71.2	4.0	at road
							14/7/78	-	68.0	4.0	at weir
							15/8/78	-	39.1	4.0	at road
							12/9/78	-	38.9	5.4	at road
							10/10/78	-	18.3	5.0	at road
							13/11/78	-	10.2	6.5	at road
							-	-	~ 9.5	-	lowest flow 1978
27.	Kikwane	Nguru Mountains	Mbogo at road to Turiani	360		-	12/7/78	-	~ 35	6.5	-
							15/8/78	-	~ 10	9.2	-
							12/9/78	-	~ 10	9.2	-
							12/10/78	-	~ 10	8.5	-
							13/11/78	-	~ 3	8.5	-
							-	-	-	-	lowest flow 1978
28.	Mahuvuge	Nguru Mountains	Mbogo at road to Turiani	370		-	12/7/78	-	~ 30	8.0	-
							15/8/78	-	~ 10	-	-
							10/10/78	-	~ 3	-	-
							13/11/78	-	no flow	-	-
							-	-	0	-	lowest flow 1978
29.	Divue	Nguru Mountains	Kwamtonga 250 m upstream bridge in road to Turiani	350		River flows over 30 m high water falls	12/7/78	-	~1000	5.0	at bridge
							15/8/78	-	581	2.6	at bridge
							12/9/78	-	405	2.8	at bridge
							10/10/78	-	359	2.5	-
							13/11/78	-	381	8.0	-
							-	-	~ 330	-	lowest flow 1978
30.	Msengele	Nguru Mountains	Kwamtonga at road to Turiani	350			12/7/78	-	~ 150	5.0	-
							15/8/78	-	112	6.1	-
							12/9/78	-	66	5.8	
							10/10/78	-	36	6.0	-
							13/11/78	-	33	7.0	-
							-	-	~ 15	-	lowest flow 1978
31.	Mvaji	Nguru Mountains	Kwamtonga at road to Turiani	350			12/7/78	-	~ 150	5.0	-
							15/8/78	-	~ 60	4.0	-
							12/9/78	-	~ 50	5.4	-
							10/10/78	-	~ 40	5.0	-
							13/11/78	-	~ 15	6.0	-
								-	-	-	lowest flow 1978

Field data 1978/79 of Rivers (continued)

Site number	Rivers	Area	Site	Altitude (m.a.MSL)	Catchment (km²)	Remarks	Date	Water level (m)	Discharge (l/s)	EC (mS/m)	Remarks
32.	Diwale	Nguru	gauging site	370		gauging	8/6/78	-	-	7.5	-
		Mountains	1 km upstream			station 1GB1A	12/7/78	1.32	-	7.0	-
		and part of	road			in good condi-	15/8/78	1.23	2288	6.4	at gauge site below
		Masai plain				tion					bridge
							11/10/78	1.10	1049	4.5	
							13/11/78	1.08	-	5.0	-
							-	-	~ 650	-	lowest flow 1978
33.	Mjonga	Nguru	just before	390		hardly any	13/7/78	-	825	11.0	(1)
		Mountains	entering			flow in old	16/8/78	-	407	16.2	(1)
		and part of	Diwale (1)			river bed	2/9/78	-	452	5.4	(2)
		Masai plain	near Kwadole	410		(see (34))	11/10/78	-	191	12.0	(2)
			(2)				13/11/78	-	137	8.0	(2)
							-	-	~ 120	-	lowest flow 1978
34.	Mjonga	"	near Rusanga	390	-	-	13/7/78	-	~ 15	-	-
	old river bed		at road to				16/8/78	-	~ 8	-	-
			Mziha				12/9/78	-	~ 1	-	-
							10/10/78	-	no flow	-	-
							-	-	0	-	lowest flow 1978
35.	Lusonge	Nguru	near Dihinda			once out of	13/7/78	-	~ 100	8.0	(1)
		Mountains	at road to			5 years dry	16/8/78	-	~ 60	10.0	(1)
			Mziha (1)	370		according to	11/10/78	-	no flow	-	(1)
			at road to			local infor-	-	-	0	-	lowest flow 1978
			Difinga (2)	390		mation	24/8/78	-	89	7.5	(2)
							13/9/78	-	56	8.5	(2)
							10/10/78	-	45	8.0	(2)
							13/11/78	-	27	7.0	(2)
							-	-	~ 25	-	lowest flow 1978
36.	Creek	Nguru	Kanga	390		-	13/7/78	-	~ 35	5.0	-
		Mountains	at road to				16/8/78	-	~ 6	-	-
			Mziha				13/9/78	-	no flow	-	-
							-	-	0	-	lowest flow 1978
37.	Mziha	Nguru	Mziha	-		gauging	14/7/78	0.23	-	15.0	gauge
		Mountains	gauging			site 1GA2	16/8/78	0.19	53.7	15.0	"
			station				11/10/78	0.12	15.0	13.5	"
40.	Mkundi	Nguru	Dumila	410		-	17/8/78	-	~1000	12.0	-
		Mountains	at road to				13/9/78	-	~ 150	13.0	-
			Kilosa				12/10/78	-	~ 1	17.0	-
							14/11/78	-	no flow	-	-
							-	-	0	-	lowest flow 1978

Field data 1978/79 of Rivers (continued)

Site number	Rivers	Area	Site	Altitude (m.a.MSL)	Catchment (km^2)	Remarks	Date	Water level (m)	Discharge (l/s)	EC (mS/m)	Remarks
41.	Chogowale	Nguru	at confluence	570	1762	-	11/8/78	-	519	5.0	Berega river dug
		Mountains	with Berega				-	-	-	-	lowest flow 1978
	Ndole	"	river near	710		Tributary of	11/8/78	-	~ 75	4.0	-
			Ndole at road			Chogowale	-	-	-	-	lowest flow 1978
			to Chogowale								
	Lubata	"	near Digoboke	750			11/8/78	-	~ 150	3.5	-
			at road to				-	-	-	-	lowest flow 1978
			Chogowale								
	Mgunga	"	near Digoboke	750		"	11/8/78	-	~ 75	6.0	-
			at road to				-	-	-	-	lowest flow 1978
			Chogowale								
42.	Kitete	Nguru	Kitete	450		-	7/6/78	-	~ 60	-	-
		Mountains	at road to				18/8/78	-	no flow	-	-
			Kilosa				-	-	0	-	lowest flow 1978
43.	Tami	Kaguru	Msowero	430		gauge site	7/6/78	-	~10000	9.5	-
		Mountains	at road to			1G5A	17/8/78	-	2166	9.0	-
			Kilosa				13/9/78	-	1124	8.6	-
							12/10/78	0.64	871	5.5	gauge water
							14/11/78	0.60	646	7.0	level
							-	-	~ 580	-	lowest flow 1978
44.	Kisangate	Rubeho	Mvumi	430		gauge site	17/8/78	0.46	1563	6.4	gauge water
		Mountains	at road to			1G6	13/9/78	0.38	-	6.5	level
			Kilosa				12/10/78	0.32	796	5.0	"
							14/11/78	0.31	770	7.0	"
							-	-	~ 450	-	lowest flow 1978
45.	Wami	Rubeho	Rudewa	430		gauge site	18/7/78	1.10	4648	-	water level
		Mountains	at road to			1G8 (closed)	17/8/78	1.12	3908	12.0	from bench
			Kilosa				13/9/78	0.90	3371	13.0	mark on
							12/10/78	0.80	2613	12.0	bridge
							14/11/78	0.73	2441	15.0	"
							-	-	~2000	-	lowest flow 1978
46.	Kisungusi	Rubeho	Rudewa	450		at 560 m a.MSL	18/7/78	0.94	638	15.0	water level
		Mountains	at road to			intake for					below weir
			Kilosa			gravity system	17/8/78	-	640	17.0	-
						(Capacity	13/9/78	-	467	18.5	-
						1 l/s)	12/10/78	-	369	12.0	-
							14/11/78	-	318	20.0	-
							-	-	~ 300	-	lowest flow 1978
47.	Ilonga	Rubeho	Ilonga	490		-	14/11/78	-	154	17.5	-
		Mountains	at road to				-	-	-	-	lowest flow 1978
			Kilosa								

Field data 1978/79 of Rivers (continued)

Site number	Rivers	Area	Site	Altitude (m.a.MSL)	Catchment (km^2)	Remarks	Date	Water level (m)	Discharge (l/s)	EC (mS/m)	Remarks
48.	Mkondoa	Rubeho Mountains	Kilosa at gauge	490		gauge site 1GD2	14/9/78	0.415	-	21.0	gauge
							12/10/78	0.380	-	17.5	water level
							15/11/78	0.365	2680	19.0	"
							-	-	-	-	lowest flow 1978
49.	Miyombo	Rubeho Mountains	Ulaya-Kibaoni	540		-	18/8/78	-	2324	7.0	-
							14/9/78	-	1840	9.2	-
							13/10/78	-	1266	7.5	-
							15/11/78	-	1093	9.5	-
							-	-	~1000	-	lowest flow 1978
	Southern tributary	"	along road from Ulaya to Kisanga	600		-	15/11/78	-	174	9.0	-
							-	-	-	-	lowest flow 1978
50.	Mgeta	Uluguru Mountains	Mgeta at gauge	975	85.2	gauge site 1HB2	1/8/78	0.390	1289	4.5	gauge
							1/9/78	0.350	920	4.0	water level
							25/9/78	0.315	904	6.5	"
							26/10/78	0.305	754	-	"
							-	-	~ 750	-	lowest flow 1978
51.	Mlali	Uluguru Mountains	Mzumbe at road to Mzumbe	518	18.1	gauge site 1HA7	14/12/78	0.55	3948	-	gauge
							23/1/79	-	1280	-	water level
							-	-	-	-	lowest flow 1978
52.	Ngerengere	Uluguru Mountains	Konga at gauge	530	20.5	gauge site 1HA9A at 550 and 640 m a.MSL intakes for gravity system (capacity 1.6 l/s)	25/5/78	0.25	-	4.0	gauge
							1/8/78	0.09	234	5.5	water level
							25/9/78	0.04	143	6.2	"
							26/10/78	0.01	114	-	"
							23/11/78	0.44	2833	-	"
							14/12/78	0.40	2320	-	"
							23/1/79	0.26	721	-	"
							-	-	~ 110	-	lowest flow 1978
53.	Morogoro	Uluguru Mountains	Morogoro at gauge	543	23.3	gauge site 1HA8 below intake of gravity system of Morogoro town (capacity about 40 l/s)	21/6/78	0.110	~ 400	-	-
							2/8/78	0.050	-	6.0	-
							4/8/78	0.050	154	-	-
							1/9/78	0.020	46	7.7	-
							27/9/78	0.000	27	8.0	-
							23/10/78	-0.030	~ 10	-	-
							20/12/78	0.335	2092	-	-
							8/1/79	0.145	607	-	-
							15/1/79	0.190	1011	-	-
							19/1/79	0.160	793	-	-
							-	-	0	-	lowest flow 1978
54.	Ngerengere	Uluguru Mountains	Mindu at dam-site	490		location of planned Mindu dam	1/9/78	-	405	12.0	-
							25/9/78	-	292	14.5	-
							26/10/78	-	172	-	-
							-	-	~ 170	-	lowest flow 1978

Field data 1978/79 of Rivers (continued)

Site number	Rivers	Area	Site	Altitude (m.a.MSL)	Catchment (km^2)	Remarks	Date	Water level (m)	Discharge (l/s)	EC (mS/m)	Remarks
55.	Ngerengere	Uluguru Mountains	Kihonda at gauge	466	461	gauge site 1HA6	20/6/78	1.12	1657	-	-
							12/7/78	0.81	-	18.0	-
							2/8/78	0.76	649	22.0	-
							28/8/78	0.68	371	34.0	-
							26/9/78	0.60	262	36.0	-
							23/10/78	0.58	149	-	-
							-	-	~ 140	-	lowest flow 1978
							21/11/78	3.44	19350	-	-
							23/11/78	3.36	11030	-	-
							24/11/78	3.14	7279	-	-
							27/11/78	2.55	5394	-	-
							1/12/78	2.39	4595	-	-
							13/12/78	2.84	6245	-	-
							8/1/79	1.435	2304	-	-
							2/3/79	1.80	3241	-	-
							10/3/79	1.505	2445	-	-
56.	Ngerengere	Ngerengere valley	Ngerengere at road to Dar es Salaam	270			20/6/78	0.80	2486	21.0	-
							2/8/78	0.47	817	40.0	-
							24/8/78	0.30	399	60.0	-
							26/9/78	0.25	136	64.0	-
							23/10/78	-	14	-	-
							-	-	0	-	lowest flow 1978
57.	Mgolole	Uluguru Mountains	Mgolole at road to Kisaki	490		at 580 and 600 m a.MSL intakes for gravity system	7/9/78	-	~ 30	-	-
							26/9/78	-	20	23.0	-
							23/10/78	-	14	-	-
							-	-	~ 12	-	lowest flow 1978
58.	Mgolole	Uluguru Mountains	at road to Dar es Salaam	450		-	20/6/78	0.03	209	-	-
							2/8/78	0.02	56	48.0	-
							30/8/78	0.01	6	70.0	-
							26/9/78	0.00	no flow	-	-
							-	-	0	-	lowest flow 1978
60.	Kiroka	Uluguru Mountains	upstream of Kiroka	430		-	7/8/78	-	65	19.0	-
							7/9/78	-	39	22.0	-
							5/10/78	-	50	18.0	-
							2/11/78	-	22	-	-
							-	-	~ 19	-	lowest flow 1978

Field data 1978/79 of Rivers (continued)

Site number	Rivers	Area	Site	Altitude (m.a.MSL)	Catchment (km^2)	Remarks	Date	Water level (m)	Discharge (l/s)	EC (mS/m)	Remarks
61.	Kiroka	Uluguru Mountains	Kiroka at confluence with Mahembe	380		-	5/6/78	-	-	22.0	-
							7/8/78	-	57	24.0	-
							7/9/78	-	26	28.0	-
							5/10/78	-	28	28.0	-
							2/11/78	-	no flow	-	-
							-	-	0	-	lowest flow 1978
62.	Mahembe	Uluguru Mountains	Kiroka at confluence with Kiroka	390		-	5/6/78	-	-	11.0	-
							7/8/78	-	49	16.0	-
							7/9/78	-	28	18.0	-
							5/10/78	-	29	15.0	-
							2/11/78	-	9	-	-
							-	-	~ 6	-	lowest flow 1978
63.	Mahembe	Uluguru Mountains	near confluence with Ndege	420		-	2/11/78	-	~ 20	-	-
							-	-	-	-	lowest flow 1978
64.	Ndege	Uluguru Mountains	near confluence with Mahembe	400		-	2/11/78	-	~ 10	-	-
							-	-	-	-	lowest flow 1978
65.	Kiroka	Uluguru Mountains	Msumbisi at road to Kisaki	370			5/6/78	-	448	23.5	-
							7/8/78	-	113	24.0	-
							7/9/78	-	48	33.0	-
							5/10/78	-	49	32.0	-
							2/11/78	-	no flow	-	-
							-	-	0	-	lowest flow 1978
66.	Msumbisi	Uluguru Mountains	Kibwaya at road to Kisaki	370			7/8/78	-	~ 50	-	-
							7/9/78	-	~ 40	19.5	-
							5/10/78	-	~ 40	20.0	-
							2/11/78	-	no flow	-	-
							-	-	0	-	lowest flow 1978
67.	Madumu	Uluguru Mountains	Kibwaya at road to Kisaki	370			7/8/78	-	~ 25	-	-
							7/9/78	-	~ 22	18.0	-
							5/10/78	-	~ 25	16.0	-
							2/11/78	-	~ 3	-	-
							-	-	0	-	lowest flow 1978
68.	Mkalazi	Uluguru Mountains	Kilundwa at road to Tandai	410	5.6	perennial according to local information	7/8/78	-	~ 25	-	-
							7/9/78	-	~ 20	7.2	-
							5/10/78	-	~ 30	8.0	-
							2/11/78	-	29	-	-
							-	-	~ 25	-	lowest flow 1978

Field data 1978/79 of Rivers (continued)

Site number	Rivers	Area	Site	Altitude (m.a.MSL)	Catchment (km²)	Remarks	Date	Water level (m)	Discharge (l/s)	EC (mS/m)	Remarks
69.	Msuazi	Uluguru Mountains	Kalundwa at road to Tandai	430	9.7	-	7/8/78	-	133	5.0	-
							7/9/78	-	~ 60	5.6	-
							5/10/78	-	82	6.0	-
							2/11/78	-	76	-	-
							-	-	~ 58	-	lowest flow 1978
70.	Mkungazi	Uluguru Mountains	Tandai at road	450		-	7/8/78	-	244	5.5	-
							-	-	-	-	lowest flow 1978
71.	Mkuyuni spring	Uluguru Mountains	Mkuyuni 100 m east of road	410		Lime stown outcrop	10/8/78	-	9.0	50.0	-
							7/9/78	-	4.8	62.0	-
							5/10/78	-	3.7	65.0	-
							2/11/78	-	2.9	-	-
							-	-	~ 2.2	-	lowest flow 1978
72.	Ruvu	Uluguru Mountains	Kibungo at gauge	473	420	gauge site 1H5	23/5/78	-	-	6.0	-
							20/7/78	0.70	-	7.5	-
							10/8/78	0.72	5800	9.4	-
							7/9/78	0.62	-	8.8	-
							5/10/78	0.69	-	6.0	-
							-	-	~4100	-	lowest flow 1978
73.	Kisemu	Uluguru Mountains	Kibangile at road to Kisaki	-			21/7/78	-	64	48.0	-
							7/9/78	-	60	46.0	-
							5/10/78	-	47	41.0	-
							2/11/78	-	~ 30	-	-
							-	-	~ 25	-	lowest flow 1978
74.	Mtamba springs	Uluguru Mountains	Mtamba at intakes	-	-	three springs are tapped	21/7/78	-	1.1	-	southern spring
							21/7/78	-	0.2	43.0	middle spring
							10/8/78	-	1.0	46.0	northern spring
							7/9/78	-	0.8	47.0	"
							5/10/78	-	0.8	45.0	"
							2/11/78	-	0.5	-	"
							-	-	~ 0.4	-	lowest flow 1978
75.	Tambuu springs	Uluguru Mountains	Tambuu	-	-	many small springs	21/7/78		10.4	48.0	-
							-	-	-	-	lowest flow 1978
76.	Msonge springs	Uluguru Mountains	Msonge	-	-	eastern and western springs and perennial according to local information	2/11/78	-	5 l/min	-	eastern spring
							2/11/78	-	~ 1 l/min	-	middle spring
							2/11/78	-	~ 10 l/min	-	western spring
							-	-	-	-	lowest flow 1978

Field data 1978/79 of Rivers (continued)

Site number	Rivers	Area	Site	Altitude (m.a.MSL)	Catchment (km^2)	Remarks	Date	Water level (m)	Discharge (l/s)	EC (mS/m)	Remarks
77.	Msonge	Uluguru	Msonge	-	-	perennial	20/7/78	-	157	39.0	-
		Mountains	at road to			river accord-	7/9/78	-	94	41.0	-
			Ngerengere			ing to local	5/10/78	-	95	35.0	-
						information	2/11/78	-	39	-	-
							-	-	~ 30	-	lowest flow 1978
78.	Mvuha	Uluguru	Mvuha	274	251	gauge site	20/7/78	0.90	2640	8.0	-
		Mountains	at gauge			1HC2	8/9/78	0.86	-	7.8	-
			1HC2				6/10/78	0.89	-	6.0	-
							-	-	~1700	-	lowest flow 1978
79.	Ditumi	Uluguru	Bonye-	-		-	8/8/78	-	467	-	-
		Mountains	Mbwade				8/9/78	-	274	13.0	-
			at road to				6/10/78	-	222	9.0	-
			Kisaki				3/11/78	-	59	-	-
							-	-	~ 38	-	lowest flow 1978
80.	Bwakira	Uluguru	Bwakira	-		-	9/8/78	-	~ 50	18.0	-
		Mountains	Chini				8/9/78	-	21	22.0	-
			at road to				6/10/78	-	~ 30	22.0	-
			Kisaki				3/11/78	-	no flow	-	-
							-	-	0	-	lowest flow 1978
81.	Mngazi	Uluguru	Mngazi	-		-	9/8/78	-	1250	6.0	-
		Mountains	at road to				8/9/78	-	1007	6.6	-
			Kisaki				6/10/78	-	741	6.5	-
							3/11/78	-	515	-	-
							-	-	~ 420	-	lowest flow 1978
			at road to			upper	9/8/78	-	646	4.0	-
			Singisa			tributary	-	-	-	-	lowest flow 1978
82.	Mgeta	Uluguru	Gomero	-	963	new-course	9/8/78	-	2607	13.0	-
		Mountains	at road to			since 1968	8/9/78	-	2192	15.5	-
			Kisaki				6/10/78	-	1727	12.5	-
							3/11/78	-	1860	-	-
							-	-	~1250	-	lowest flow 1978
90.	Ruembe	Migomberame	Mikumi	500		-	31/8/78	-	~ 30	-	-
		Mountains	at road to				29/9/78	-	~ 25	-	-
			Kidatu				27/10/78	-	no flow	-	-
							-	-	0	-	lowest flow 1978
91.	Ruembe	"	at last bridge	350		-	31/8/78	-	129	13.5	-
			from road to				29/9/78	-	71	14.0	-
			Kidatu				27/10/78	-	55	-	-
							-	-	~ 45	-	lowest flow 1978

Field data 1978/79 of Rivers (continued)

Site number	Rivers	Area	Site	Altitude (m.a.MSL)	Catchment (km^2)	Remarks	Date	Water level (m)	Discharge (l/s)	EC (mS/m)	Remarks
92.	Ruembe	"	at road to Kidogobasi	-		-	31/8/78	-	1024	7.5	-
							29/9/78	-	823	7.5	-
							27/10/78	-	740	-	-
							-	-	~ 650	-	lowest flow 1978
93.	Msowero	Migomberame Mountains	Msowero at road to Kidatu	-		-	31/8/78	-	531	4.5	-
							29/9/78		457	4.8	-
							27/10/78	-	381	-	-
							-	-	~ 350	-	lowest flow 1978
94.	Tundu	Migomberame Mountains	Tundu at road to Kidatu	-		small intake for gravity supply (capa- city ~0.5 l/s)	31/8/78	-	~ 250	6.8	-
							29/9/78	-	145	6.0	-
							27/10/78	-	136	6.8	-
							-	-	~ 120	-	lowest flow 1978
95.	Tundu creek	Migomberame Mountains	Tundu at road to Kidatu	-		-	31/8/78	-	~ 10	-	-
							29/9/78	-	no flow	-	-
							-	-	0	-	lowest flow 1978
96.	Iwemba creek	Migomberame Mountains	Iwemba at road to Kidatu	-		-	31/8/78	-	~ 20	-	-
							29/9/78	-	17	-	-
							-	-	-	-	lowest flow 1978
97.	Kidodi	Migomberame Mountains	Kidodi at road to Kidatu	-		small intake for gravity supply to hospital	31/8/78	-	~ 100	6.5	-
							29/9/78	-	45	-	-
							-	-	-	-	lowest flow 1978
98.	Kifinga	Migomberame Mountains	Kifinga at road to Kidatu	-		perennial river accord- ing to local information	31/8/78	-	~ 10	19.5	-
							29/9/78	-	~ 5	-	-
							-	-	-	-	lowest flow 1978
99.	Nyambisi	Migomberame Mountains	near Ruaha at road to Kidatu	-		perennial river accord- ing to local information	31/8/78	-	~ 30	20.5	-
							29/9/78	-	~ 20	-	-
							-	-	-	-	lowest flow 1978
100.	Wami	Wami valley	Dakawa at gauge	380	28500	Gauge site 1G1	12/6/78	2.06	-	12.0	-
							12/7/78	1.54	-	13.0	-
							27/7/78	1.44	-	15.0	-
							11/8/78	1.34	-	16.0	-
							15/8/78	1.275	-	14.0	-
							30/8/78	1.11	7399	18.0	-
							10/10/78	0.88	5023	17.5	-
							-	-	~ 3800	-	lowest flow 1978

Field data 1978/79 of Rivers *(continued)*

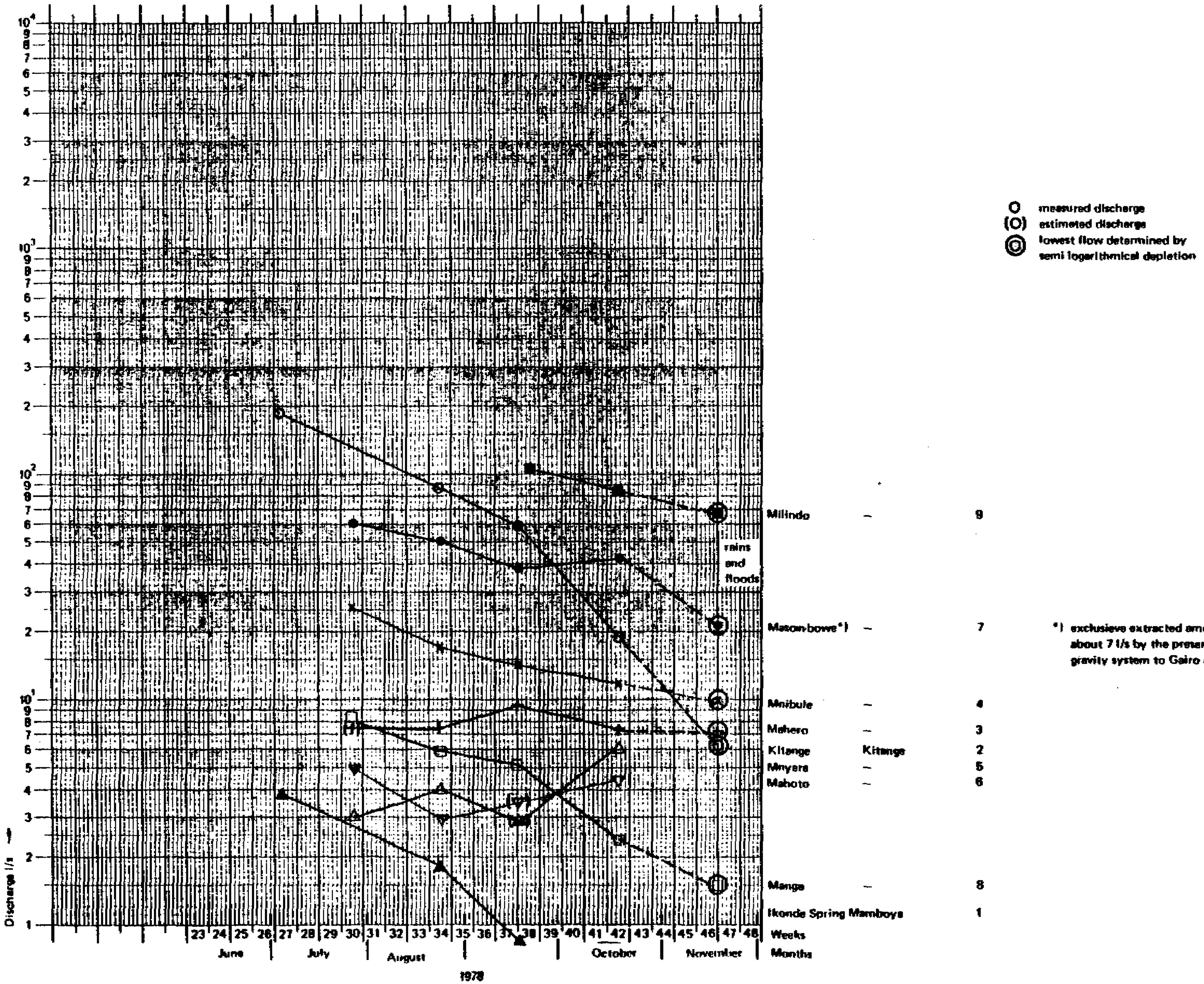
Site number	Rivers	Area	Site	Altitude (m.a.MSL)	Catchment (km^2)	Remarks	Date	Water level (m)	Discharge (l/s)	EC (mS/m)	Remarks
101.	Mkata	Mkata valley	Mkata Range at gauge	-	-	Gauge site IGD 36	14/6/78	1.77	-	19.0	-
							18/8/78	1.39	4681	22.0	-
							14/9/78	1.20	2540	24.0	-
							13/10/78	1.15	1874	16.0	-
							15/11/78	1.14	-	17.5	-
							-	-	~1100	-	lowest flow 1978

Field data 1978 of Reservoirs

Site number	Rivers	Area	Site	Altitude (m.a.MSL)	Catchment (km^2)	Remarks	Date	Water level (m)	EC (mS/m)	Remarks
110.	Fulwe	Ngerengere catchment	near Fulwe 37° 50' 20" E 6° 40' 40" S	510		reservoir not in use anymore	20/6/78 29/8/78 26/9/78	0.55 1.50 1.70	9.5 12.0 -	water levels below crest
111.	Ubena	Ngerengere catchment	at Ubena prison 38° 00' 30" E 6° 35' 45" S	290		reservoir used for irrigation level recorder and gauge plates installed on 15/9/78	20/6/78 29/8/78 15/9/78 20/9/78 26/9/78	4.14 - 3.67 3.64 3.95	90.0 96.0 - - 130.0	spillway level = 4.14 m
112.	Kingolwira	Ngerengere catchment	at Kingolwira prison 37° 45' 40" E 6° 40' 50" S	450		reservoir used for irrigation	16/8/78 29/8/78	~4 -	100.0 105.0	water level below crest

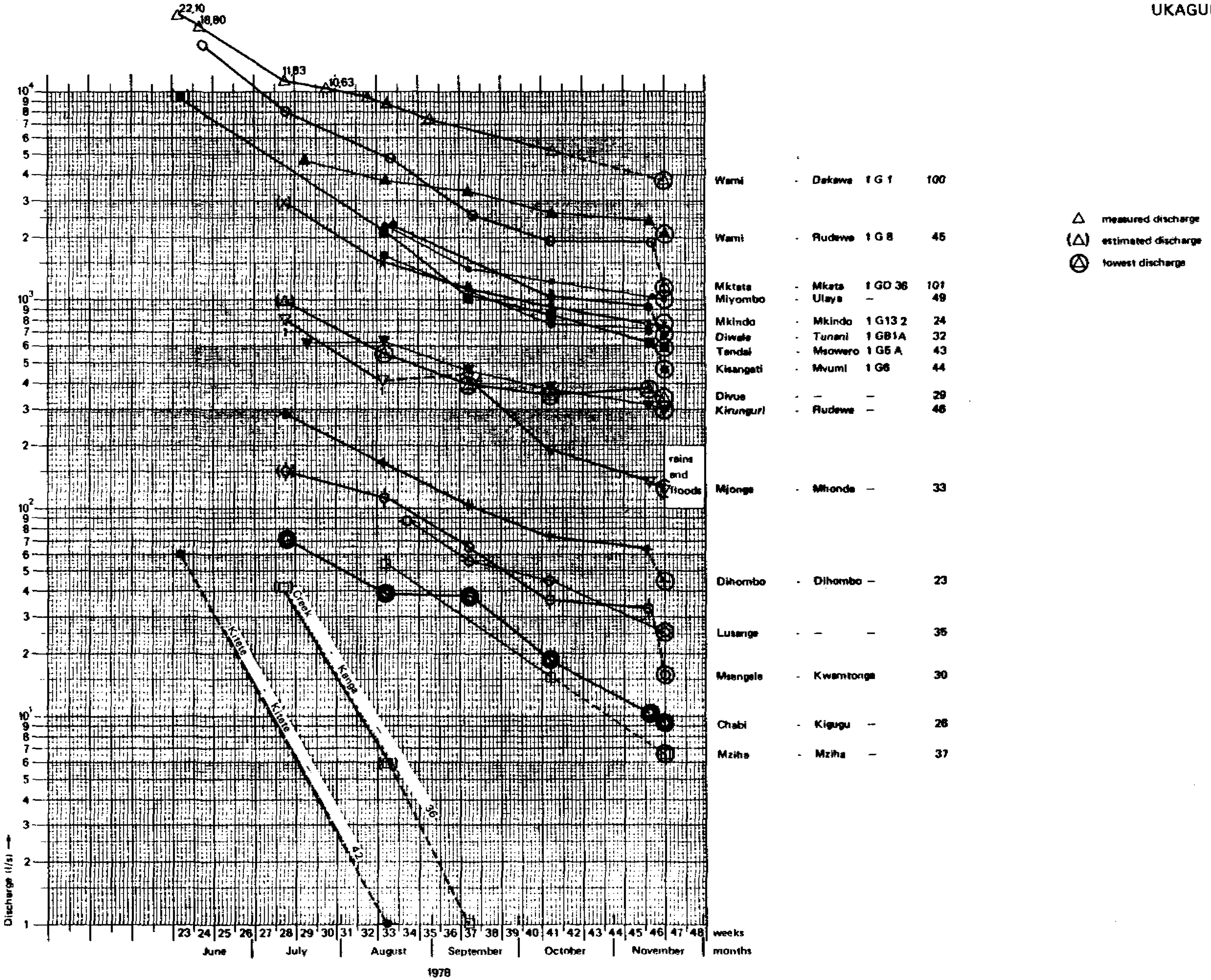
CD 3.6 Depletion curves

DEPLETION CURVES 1978
UKAGURU MOUNTAINS

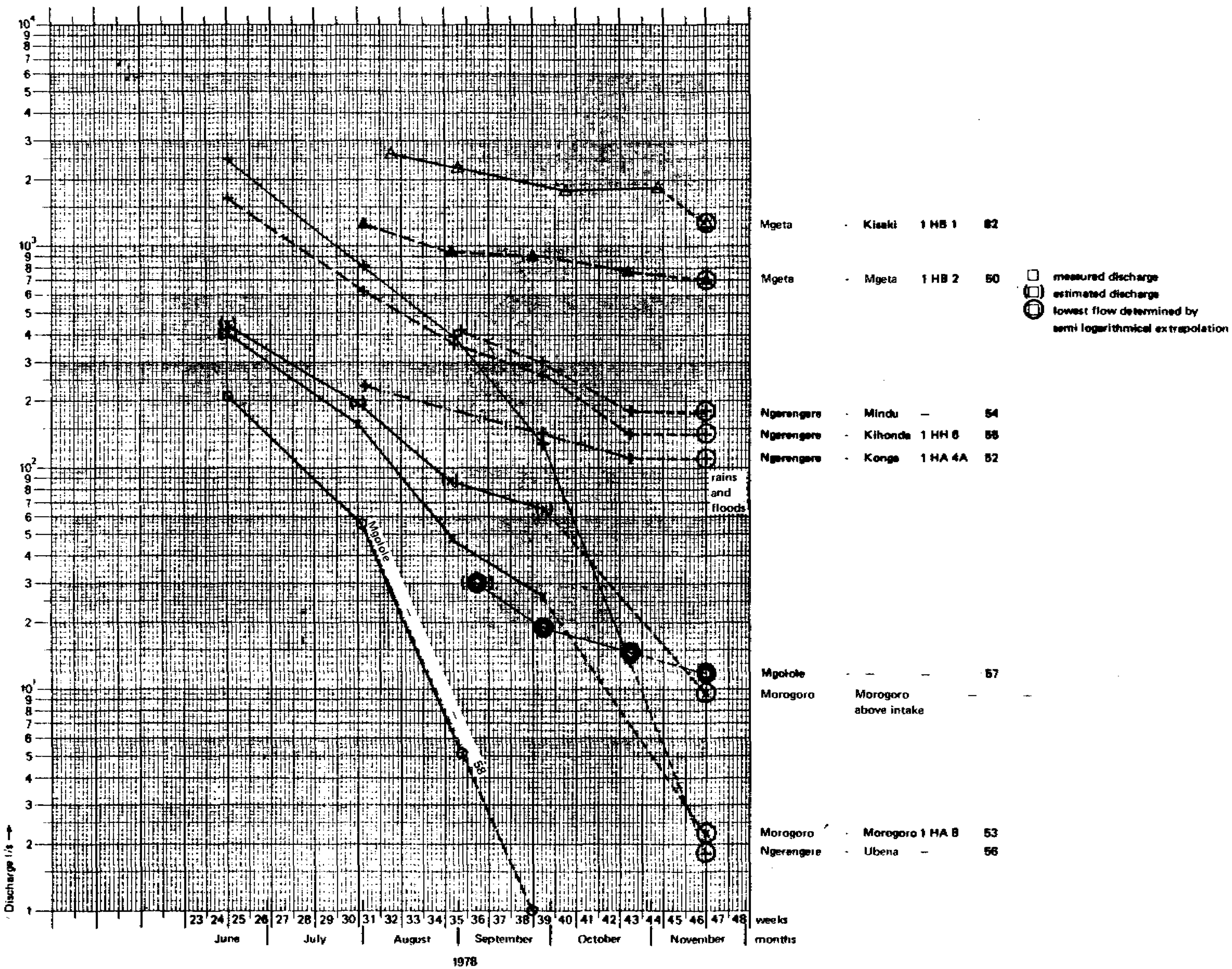


*) exclusieve extracted amount of about 7 l/s by the present gravity system to Gairo area

DEPLETION CURVES 1978
UKAGURU AND NGUMI MOUNTAINS



DEPLETION CURVES 1978
NORTH - WEST ULUGURU MOUNTAINS



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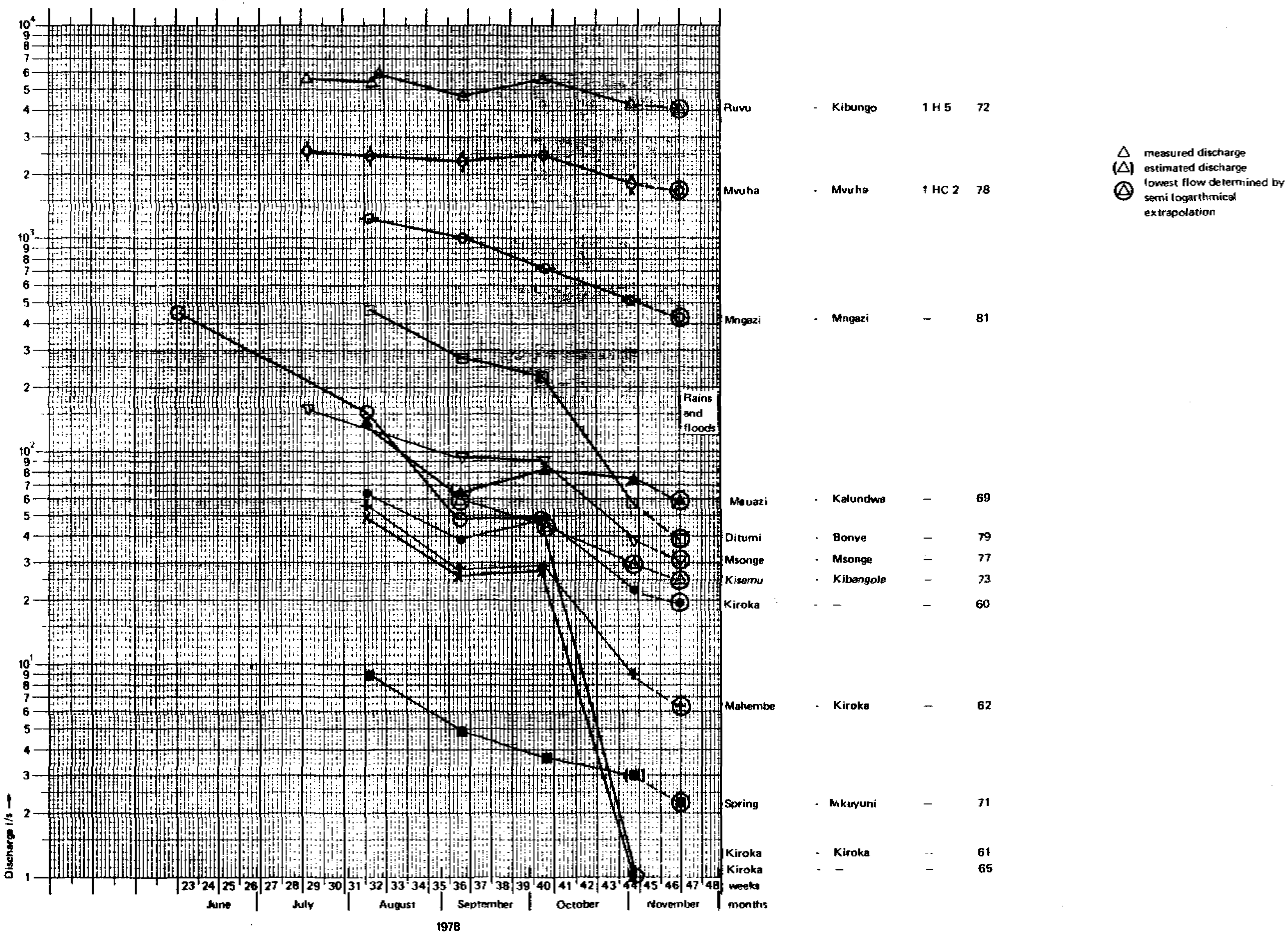
DEPLETION CURVES 1978 SOUTH - EAST ULUGURU MOUNTAINS



DEPLETION CURVES 1978 MIGOM BERAME MOUNTAINS