UNIVERSITA' DEGLI STUDI DI PALERMO

FACOLTA' DI AGRARIA

AGRO-METEOROLOGICAL CHARACTERISTICS AND SOIL PROPERTIES IN THE RUYIGI AREA, BURUNDI

Technical Report

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Palermo, Italy, October 2007

A special thank to my beloved daughter Sara for her drawings
V.Bagarello

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ABSTRACT

Knowledge of the agro-meteorological characteristics and soil properties of a certain area is important for a variety of reasons, including water resources assessment, land use planning, soil quality evaluation and design of soil conservation practices. The objective of this investigation was to characterize the province of Ruyigi, Burundi, in terms of selected agro-meteorological characteristics and soil properties. The rainfall and air temperature data were collected at the Cankuzo, Kinyinya, Muriza, Musasa and Muyaga stations for a period ranging from 30 to 45 years, depending on the station. For each station, the monthly and annual values of rainfall amount, number of rainy days, minimum, maximum and average temperature were determined. For each considered variable, indices of both central tendency and data variability were calculated using the available data set. Simplified relationships were deduced to estimate monthly rainfall amount on the basis of the measured number of rainy days. The reference evapotranspiration and the associated rainfall deficit were also determined. Surface soil samples were collected at 69 sampling points distributed throughout an area of about 2000 km^2. The particle size distribution (PSD) was determined in the laboratory for each soil sample. The measured PSD was used to evaluate the clay, silt and sand content and the geometric mean particle diameter of each soil sample. Empirical relationships were deduced to compare soil textural data corresponding to different particle size classification schemes. Pedotransfer functions were applied to estimate the plant available water capacity, the saturated and near-saturated soil hydraulic conductivity, the soil erodibility factor and the critical bulk density. Basic statistics of each soil property were calculated. The spatial variability of the considered soil properties was also investigated and maps were developed for the considered area. This report can contribute to the knowledge of the environmental characteristics and the productive potential of the Ruyigi area.

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INTRODUCTION

Knowledge of the agro-meteorological characteristics and soil properties of a certain area is important for a variety of reasons, including water resources assessment, land use planning, soil quality evaluation and design of soil conservation practices.

The province of Ruyigi, in Burundi, is going through a phase of growth thanks to the numerous activities undertaken by the *Maison Shalom* Non Governmental Organization (NGO), led by dr. Marguerite Barankitse. In particular, dr. Barankitse is actively promoting the development of agriculture in the Ruyigi area, with the objective to make local people self-sufficient in terms of availability of foodstuffs and also able to obtain profits improving standard of living. However, little information on the agro-meteorological characteristics and soil properties is available for the Ruyigi area and this hampers planning of sound rural areas development programs.

On March 2006, the Agricultural Faculty of the Palermo's University and the *Maison Shalom* NGO have signed an "Agreement for Practical Training of Agricultural Faculty's Students". According to this agreement, the *Maison Shalom* NGO guesses Italian students in its own structures located in the province of Ruyigi, facilitating them in the practical training.

Following this agreement, the first step of the cooperation between the Agricultural Faculty of Palermo and the *Maison Shalom* was to collect agro-meteorological and soil data usable for a preliminary characterization of the area of Ruyigi. The objective was to prepare a data-base that will be at disposal of agronomists, engineers and zoo-technicians for planning reliable development programs. A professor and a few students stayed in Burundi for a few weeks to retrieve agro-meteorological data and to collect soil samples. The rainfall and temperature data were collected at the Cankuzo, Kinyinya, Muriza, Musasa and Muyaga stations for a period ranging from 30 to 45 years, depending on both the station and the considered variable. For each station, the monthly and annual values of rainfall amount, number of rainy days, minimum, maximum and average temperature, reference evapotranspiration and rainfall deficit were determined and summarized. Surface soil samples were collected at 69 sampling points distributed throughout an area of 2000 km^2. The particle size distribution (PSD) was determined for each soil sample. The measured PSD was used to evaluate the clay, silt and sand content and the geometric mean particle diameter. Pedotransfer functions were applied to estimate the plant available water capacity, the saturated and near-saturated soil hydraulic conductivity, the soil erodibility factor and the critical bulk density. All data were summarized and maps of the considered soil properties were developed for the investigated area.

This preliminary characterization of the Ruyigi area is described in detail in this report.

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THE RUYIGI PROVINCE

The Ruyigi province is located in the central east side of Burundi (Figure 1). On the east, the province boards with Tanzania, from which is separated by the Lugusi and Rumpungu rivers. The area of the province is about 2365 km^2. The province includes seven communes (Ruyigi, Bweru, Gisuru, Butezi, Butaganzwa, Nyabitsinda, Kinyinia). The number of inhabitants living in the province is 366558, the 15% of the Country's total population, with a density of 155 inhabitants per km^2. According to the national trend, population increases yearly at a rate of 3.3%, so that it is estimated to reach 430,000 inhabitants in 2010.

The Ruyigi province is divided into two ecological zones, Buyugoma, covering the extention of 60% of the total surface and Kumoso, covering the remaining 40%. In the former, yearly precipitation varies between 1200 and 1500 mm with average temperatures varying between 17 and 20 °C. Dry season is usually three or four months long. The Buyugoma region is characterized by hills oriented from South-West to North-East, often separated by large flat areas. The average altitude is between 1500 to 1700 m (Cooperation Technique Allemande, 1984). Due to the strong soil erosion and inadequacy of agricultural practices, a high percentage of the soil in the area is characterized by a low fertility. Soils in the valley are usually more fertile but they are poorly drained.

The Kumoso ecological region is a large depression characterized by a precipitation amount varying between 1100 and 1500 mm and a temperature varying between 20 and 23 °C. Dry season is usually four months long. Alluvial sandy deposits characterized by a high fertility are common in the Kumoso area.

Soil agronomic potential is affected by a continuous degradation process due to several factors including high rainfall intensities. These processes determine an acidification of the soil.

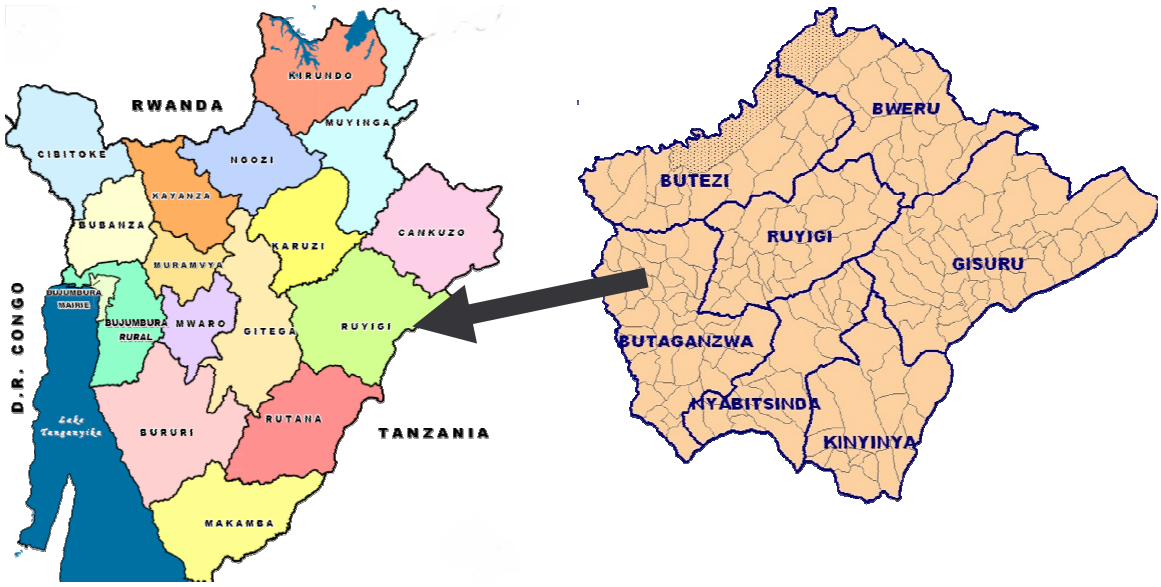

Fig. 1. Maps of Burundi and Ruyigi province

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AGRO-METEOROLOGICAL CHARACTERISTICS

MATERIALS AND METHODS

Daily rainfall and air temperature data were collected for the Cankuzo, Kinyinya, Muriza, Musasa and Muyaga stations. These data were supplied by the Geographic Institute of Burundi (IGEBU). For each station, Table 1 lists the rainfall and the temperature recording periods.

For a given station, the number of missing daily rainfall data, MRD_m (days), was determined for each month of the recording period. The monthly rainfall depth, P_m (mm), and the monthly number of rainy days, NRD_m (days), were determined for each month with a complete record of daily rainfall data. For a given month, P_m was obtained by summing the daily rainfall depth values and NRD_m was obtained by counting the number of days of the month characterized by a daily rainfall depth greater than zero.

The number of missing daily temperature data, MTD_m (days), was also determined for each month of the recording period. The mean of the daily maximum air temperatures, $T_{m,max}$ (°C), the mean of the daily minimum air temperatures, $T_{m,min}$ (°C), and the mean of the daily average air temperatures, $T_{m,ave}$ (°C), were calculated for each month with a complete record of daily temperature data to determine the monthly maximum, minimum and average temperature, respectively.

The historical data set was used to: i) calculate the basic statistics of the monthly rainfall and temperature values for each month of the year; ii) calculate the annual rainfall and temperature values and determine the associated basic statistics; iii) evaluate the relationship between the monthly rainfall depth and the monthly number of rainy days; iv) evaluate the relationship between the relative variability and the associated mean value for both the monthly rainfall depth and the monthly number of rainy days; v) calculate and summarize the monthly values of the reference evapotranspiration and the rainfall deficit; vi) calculate and summarize the annual reference evapotranspiration values. In the following, methodological details are shortly given for each step of the investigation.

For each month of the year, the P_m and NRD_m values were summarized by determining the following statistics: sample size, N (years), minimum, *min*, maximum, *max*, and mean value, M, coefficient of variation, CV. Two different data sets were considered for a given month. The first data set was obtained by selecting all the available data for a given month. The second data set was obtained by considering the years with a complete record of daily rainfall values (i.e., $MRD_m = 0$ for all months of the year). The first approach used all available data, but the sample size changed slightly with the month, precluding a homogeneous comparison among months. By the second approach, less data than the available ones were sometimes considered for a given month. However, a homogeneous comparison among months was possible.

The two approaches (i.e., all available monthly data, years with a complete record of daily values for all months of the year) were also used to summarize the $T_{m,max}$, $T_{m,min}$ and $T_{m,ave}$ measurements for a given month.

The annual values of rainfall depth, P_a (mm), and number of rainy days, NRD_a (days), were determined for each year with a complete record of daily rainfall values by summing the corresponding monthly values.

The annual values of the maximum, $T_{a,max}$, minimum, $T_{a,min}$, and average, $T_{a,ave}$, temperatures were obtained for each year with a continuous record of daily temperatures by averaging the corresponding daily temperature values.

The relationship between the monthly rainfall depth and the monthly number of rainy days was investigated. At first, all individual monthly values with $NRD_m \geq 1$ day were selected. Then, data were grouped according to the number of rainy days and the minimum, maximum and mean value of P_m were determined for each NRD_m value. The relationships between these basic statistics of P_m (i.e., $min(P_m)$, $max(P_m)$ and $M(P_m)$) and NRD_m were then examined.

The relationship between $CV(P_m)$ and $M(P_m)$ was evaluated for the years with a continuous record of daily rainfall values. The CV vs. M relationship was also examined for the NRD_m variable.

The evapotranspiration from the reference surface, ET_0, also called reference crop evapotranspiration or reference evapotranspiration, was calculated. According to FAO (www.fao.org), the reference surface is a hypothetical grass reference crop with an assumed crop height of 0.12 m, a fixed surface resistance of 70 s m^{-1} and an albedo of 0.23. The reference surface closely resembles an extensive surface of green, well-watered grass having a uniform height, actively growing and completely shading the ground. The fixed surface resistance of 70 s m^{-1} implies a moderately dry soil surface resulting from about a weekly irrigation frequency. The equation proposed by Hargreaves and Samani (1982, 1985) was used to calculate the reference evapotranspiration for a particular month, $ET_{0,m}$ (mm day^{-1}):

$$ET_{0,m} = 0.0022\ R_a \left(T_{m,ave} + 17.8\right) \Delta T^{0.5} \tag{1}$$

where R_a (mm day^{-1}) is the extraterrestrial radiation, $T_{m,ave}$ (°C) is the average air temperature of the month, and ΔT (°C), equal to $T_{m,max}–T_{m,min}$, is the difference between the maximum and the minimum temperature for the considered month. Using the Hargreaves and Samani (1982, 1985) equation to estimate ET_0 has been supported by several investigations in different environments (e.g., Bagarello and Crescimanno, 1990; Di Stefano and Ferro, 1997; Verhoef and Feddes, 1991). For each month, a single value of R_a was found to be usable for all stations considered in this investigation (Table 2).

The years with a simultaneous and continuous record of daily rainfall and temperature values were considered to calculate ET_0. By this choice, the mean rainfall amount, $M(P_m)$, and the associated mean reference evapotranspiration, $M(ET_{0,m})$, values were obtained for each month of the year. The monthly values of the rainfall deficit, RD_m, were then determined for each month:

$$RD_m = M\left(ET_{0,m}\right) - M\left(P_m\right) \tag{2}$$

A negative RD_m value ($M(P_m) > (M(ET_{0,m})$) suggests that, in the considered month, water is not a limiting factor for reference crop growth. A positive RD_m value ($M(P_m) < (M(ET_{0,m})$) suggests that water deficiency problems may occur.

The annual values of the reference evapotranspiration, $ET_{0,a}$ (mm), were determined for each year by using the calculated $ET_{0,m}$ values. The basic statistics of $ET_{0,a}$ were determined. A comparison between the $ET_{0,a}$ and the associated P_a data was carried out.

RESULTS AND DISCUSSION

Available monthly data

For the *Cankuzo* station, rainfall data were available for the October 1973 to December 2005 (387 months) period. Daily rainfall data were completely unavailable for one month (missing rainfall data, MRD_m = number of days of the month, *ND*). For another month, MRD_m was equal to 6 days. A single day of record was lacking for three months. Therefore, a complete record of daily rainfall data was available for 382 months. Table 3 lists the individual monthly values of rainfall depth, P_m, and number of rainy days, NRD_m, for each complete month (i.e., a month with $MRD_m = 0$) and also the MRD_m value for each month of the recording period. Air temperature data were available from November 1973 to December 2005 (386 months). Daily temperature data were completely lacking (missing temperature data, $MTD_m = ND$) for eight months of the recording period. The value of MTD_m varied between 2 and 28 days for 15 months. A single day of record was lacking for eight months. Therefore, a continuous record of daily temperature data was available for 355 months. Table 3 also lists the individual monthly values of maximum, $T_{m,max}$, minimum, $T_{m,min}$ and average, $T_{m,ave}$, temperature for each complete month (i.e., a month with $MTD_m = 0$), as well as the MTD_m value for all months of the recording period.

For the *Kinyinia* station, the rainfall data were available from January 1967 to December 2005 (468 months). Daily rainfall data were completely unavailable for six months. For five months, MRD_m varied between 2 and 9 days. Therefore, a complete record of daily rainfall data was available for 457 months. These months were considered to determine P_m and NRD_m (Table 4). Air temperature data were available from January 1972 to December 2005 (408 months). Daily temperature data were completely lacking for 12 months of the recording period. The value of MTD_m varied between 2 and 10 days for 13 months. A single day of record was lacking for eight months. Therefore, a continuous record of daily temperature data was available for 375 months. These months were considered to determine $T_{m,max}$, $T_{m,min}$ and $T_{m,ave}$ (Table 4).

For the *Muriza* station, rainfall data were available for the January 1974 to December 2005 period (384 months). Daily rainfall data were completely unavailable for nine months. For four months, MRD_m varied between 9 and 22 days. A single day of record was lacking for a month. Therefore, the P_m and NRD_m values were determined for 370 months (Table 5). Air temperature data were available for the August 1974 to November 2004 period (364 months). Daily temperature data were completely lacking for 13 months. The value of MTD_m varied between 2 and 27 days for 11 months. A single day of record was lacking for four months. Therefore, the $T_{m,max}$, $T_{m,min}$ and $T_{m,ave}$ data were determined for 336 months (Table 5).

For the *Musasa* station, rainfall data were recorded from January 1961 to November 2005 (539 months). Daily rainfall data were completely unavailable for 24 months. For three months, MRD_m varied between 6 and 11 days. A single day of record was lacking for 12 months. Therefore, P_m and NRD_m were determined for 500 months having a complete record of daily rainfall data (Table 6). Air temperature data were available for the January 1961 to December 2005 period (540 months). Daily temperature data were completely lacking for 85 months of the recording period. The value of MTD_m varied between 3 and 18 days for 11 months. A single day of record was lacking for 16 months. Therefore, a continuous record of daily temperature data was available for 428 months. The $T_{m,max}$, $T_{m,min}$ and $T_{m,ave}$ values were determined for each of these months (Table 6).

For the *Muyaga* station, rainfall data were recorded from January 1960 to December 2005 (552 months). Daily rainfall data were unavailable for 22 months ($MRD_m = ND$). For a month, MRD_m was equal to 9 days. A single day of record was lacking for another month. Therefore, a complete record of daily rainfall data was available for 528 months. Table 7 lists the individual monthly values of P_m and NRD_m for each complete month (i.e., a month with $MRD_m = 0$) and

also the MRD_m value for each month of the recording period. Air temperature data were not available for the Muyaga station.

Monthly rainfall and temperature values

For the *Cankuzo* station, both sets of monthly rainfall values considered in this investigation (all available monthly data for a given month, monthly data for the years with a complete record of daily rainfall values) showed that December was the wettest month ($173 \leq M(P_m) \leq 175$ mm, depending on the considered data set), whereas June was the driest one ($M(P_m)$ close to 4 mm) (Table 8). Approximately 80% of the annual rainfall (1189 – 1215 mm, depending on the data set) occurred from November to April, with $M(NRD_m)$ values varying with the month between 14 and 20 days. The total rainfall of the June to August period was 23.7 mm or 1.9 – 2.0% of the annual rainfall.

For the *Kinyinia* station, April was found to be the wettest month ($M(P_m)$ approximately equal to 198 mm) whereas July was the driest one ($M(P_m)$ close to 2 mm) (Table 9). Approximately 81% of the annual rainfall (1190 – 1194 mm) occurred from November to April, with $M(NRD_m)$ values ranging between 12 and 19 days. Total rainfall for the June, July, and August months was equal to 13.5 – 14.4 mm or 1.1 – 1.2% of annual rainfall.

April was the wettest month ($187 \leq M(P_m) \leq 198$ mm) and July was the driest one ($M(P_m)$ close to 4 mm) at *Muriza* (Table 10). The rainfall occurring from November to April was equal to 82% of the annual rainfall (1133 – 1156 mm). For these months, $M(NRD_m)$ varied between 16 and 21 days. The rainfall occurring from June to August was 20.0 – 20.8 mm, equal to 1.8% of annual rainfall.

For the *Musasa* station, April was found to be the wettest month ($183 \leq M(P_m) \leq 198$ mm) whereas July was the driest one ($2 \leq M(P_m) \leq 3$ mm) (Table 11). The rain falling from November to April was approximately 75% of the annual rainfall (1123 – 1160 mm). The $M(NRD_m)$ values calculated for this period varied with the month from 14 to 22 days. Total rainfall for the June to August months was 34.1 – 34.2 mm or 2.9 – 3.0% of the annual rainfall.

April ($M(P_m)$ equal to 178 – 179 mm) and June ($M(P_m)$ close to 4 mm) were the wettest and the driest months, respectively, at the *Muyaga* station (Table 12). Approximately 79% of the annual rainfall (1180 – 1199 mm) occurred from November to April, with $M(NRD_m)$ values varying between 11 and 15 days. The rainfall occurring from June to August was 22.1 – 24.1 mm or 1.9 – 2.0% of annual rainfall.

This analysis suggested that the considered stations had similar annual rainfall values (1123 – 1215 mm). In all cases, a large percentage (75 – 82%) of annual rainfall occurred during a half-year period. Rainfall was practically negligible for three consecutive months.

The mean values of $T_{m,ave}$ calculated for *Cankuzo* varied with the month from 19.0 to 21.0 °C or 19.1 to 21.2 °C, depending on the considered data set (Table 13). The CV of $T_{m,ave}$ was lower than or equal to 4.0% for each month of the year.

For the *Kinyinia* station, $20.7 \leq M(T_{m,ave}) \leq 23.4$ °C or $20.8 \leq M(T_{m,ave}) \leq 23.2$ °C and $CV(T_{m,ave}) \leq 3.4\%$ was obtained (Table 14).

For *Muriza*, both data sets yielded $17.1 \leq M(T_{m,ave}) \leq 19.7$ °C (Table 15). The value of $CV(T_{m,ave})$ did not exceed 4.8%.

The mean values of $T_{m,ave}$ calculated for the *Musasa* station varied with the month from 20.1 to 23.0 °C or 19.9 to 22.9 °C, depending on the considered data set (Table 16). The maximum $CV(T_{m,ave})$ value was equal to 4.2%.

The maximum difference between the $M(T_{m,ave})$ values determined for each month of the year at a given station was of 3 °C. Therefore, this analysis suggested that the average temperature did not vary appreciably with the month. Moreover, the inter-annual variability of the monthly values of $T_{m,ave}$ was rather low.

Annual rainfall and temperature values

For *Cankuzo*, the mean and the associated coefficient of variation of P_a were equal to 1215 mm and 16.3%, respectively (N = 28 years) (Table 17). For NRD_a, M = 140 days and CV = 10.0% was obtained.

The $M(P_a)$ and the associated $CV(P_a)$ values calculated for the *Kinyinia* station were equal to 1190 mm and 24.6%, respectively (N = 31 years) (Table 18). For NRD_a, M = 126 days and CV = 16.9% was obtained.

For *Muriza*, the mean and the associated coefficient of variation of P_a were equal to 1157 mm and 17.8%, respectively (N = 28 years) (Table 19). For NRD_a, M = 148 days and CV = 11.8% was obtained.

The mean and the associated coefficient of variation of P_a calculated for *Musasa* were equal to 1160 mm and 15.6%, respectively (N = 31 years) (Table 20). For NRD_a, M = 158 days and CV = 8.0% was obtained.

For *Muyaga*, $M(P_a)$ was equal to 1180 mm and $CV(P_a)$ was equal to 16.0% (N = 39 years) (Table 21). For NRD_a, M = 102 days and CV = 22.4% was obtained.

A rough comparison among the selected stations showed that they were characterized by similar values of the mean annual rainfall depth (1157 – 1215 mm). Most of the stations had a similar inter-annual variability of P_a, with CV*s* ranging between from 15.6% and 17.8%. A slightly larger relative variability of P_a was detected at *Kinyinia*. Depending on the station, 28 to 43% of the days of the year were rainy.

For *Cankuzo*, the mean values of $T_{a,max}$, $T_{a,min}$, and $T_{a,ave}$ were equal to 25.1 °C, 14.5 °C and 19.8 °C, respectively, with associated values of $CV \leq 4.2\%$ (N = 18 years) (Table 22).

For *Kinyinia*, the means of $T_{a,max}$, $T_{a,min}$, and $T_{a,ave}$ were equal to 28.1 °C, 15.7 °C and 21.9 °C, respectively, with associated CVs $\leq 3.2\%$ (N = 20 years) (Table 23).

For *Muriza*, the means of $T_{a,max}$, $T_{a,min}$, and $T_{a,ave}$ were equal to 25.0 °C, 12.1 °C and 18.6 °C, respectively, with associated CVs $\leq 4.0\%$ (N = 20 years) (Table 24).

For *Musasa*, the means of $T_{a,max}$, $T_{a,min}$, and $T_{a,ave}$ were equal to 28.3 °C, 14.9 °C and 21.6 °C, respectively, with associated CVs $\leq 2.2\%$ (N = 23 years) (Table 25).

Therefore, slightly higher temperatures were detected for the *Kinyinia* and *Musasa* stations ($M(T_{a,max})$ = 28.1 – 28.3 °C, $M(T_{a,min})$ = 14.9 – 15.7 °C, $M(T_{a,ave})$ = 21.6 – 21.9 °C) than for the *Cankuzo* and *Muriza* ones ($M(T_{a,max})$ = 25.0 – 25.1 °C, $M(T_{a,min})$ = 12.1 – 14.5 °C, $M(T_{a,ave})$ = 18.6 – 19.8 °C).

For all variables (i.e., $T_{a,max}$, $T_{a,min}$, $T_{a,ave}$), the inter-annual variability was rather low given that CV values not larger than 4.2% were obtained.

Monthly rainfall depth versus number of rainy days relationship

The relationship between the monthly rainfall depth, P_m, and the monthly number of rainy days, NRD_m, is plotted for each station in Figure 2. In all cases, the scatter of the data points was noticeable. However, an increasing trend of P_m with NRD_m was detected, as expected.

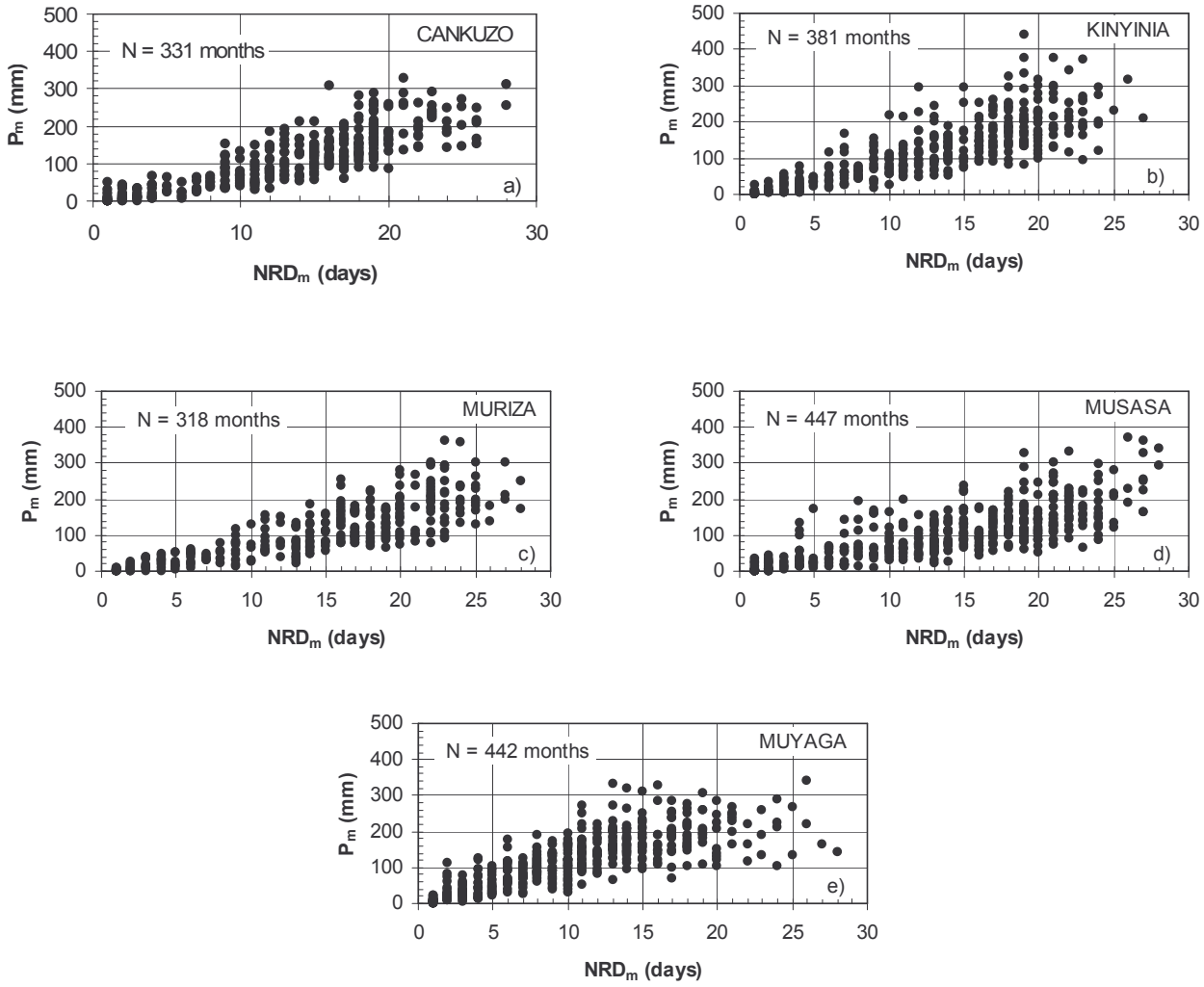

Fig. 2. Monthly rainfall depth, P_m, versus number of rainy days, NRD_m, for the stations of a) CANKUZO, b) KINYINIA, c) MURIZA, d) MUSASA, and e) MUYAGA

For each station, Figure 3 shows the $min(P_m)$ (mm), $max(P_m)$ (mm), and $M(P_m)$ (mm) values plotted against NRD_m (days). In all cases, a power relationship was fitted to the experimental data pairs. In particular, the following relationships and coefficients of determination, R^2, were obtained:

Cankuzo station (Figure 3a)

$$min(P_m) = 0.324\ NRD_m^{1.9674} \qquad R^2 = 0.95 \qquad (3)$$

$$max(P_m) = 22.714\ NRD_m^{0.7878} \qquad R^2 = 0.83 \qquad (4)$$

$$M(P_m) = 5.553\ NRD_m^{1.1430} \qquad R^2 = 0.96 \qquad (5)$$

Kinyinia station (Figure 3b)

$$min(P_m) = 0.563\ NRD_m^{1.7538} \qquad R^2 = 0.92 \qquad (6)$$

$$max(P_m) = 19.823\ NRD_m^{0.9399} \qquad R^2 = 0.91 \qquad (7)$$

$$M(P_m) = 4.721\ NRD_m^{1.2608} \qquad R^2 = 0.99 \qquad (8)$$

Muriza station (Figure 3c)

$$min(P_m) = 0.142\ NRD_m^{2.1636} \qquad R^2 = 0.96 \qquad (9)$$

$$max(P_m) = 10.336\ NRD_m^{1.0432} \qquad R^2 = 0.94 \qquad (10)$$

$$M(P_m) = 3.556\ NRD_m^{1.2660} \qquad R^2 = 0.98 \qquad (11)$$

Musasa station (Figure 3d)

$$min(P_m) = 0.179\ NRD_m^{2.0452} \qquad R^2 = 0.92 \qquad (12)$$

$$max(P_m) = 32.346\ NRD_m^{0.6964} \qquad R^2 = 0.84 \qquad (13)$$

$$M(P_m) = 6.004\ NRD_m^{1.0901} \qquad R^2 = 0.96 \qquad (14)$$

Muyaga station (Figure 3e)

$$min(P_m) = 1.135\ NRD_m^{1.5815} \qquad R^2 = 0.91 \qquad (15)$$

$$max(P_m) = 42.456\ NRD_m^{0.6557} \qquad R^2 = 0.82 \qquad (16)$$

$$M(P_m) = 12.099\ NRD_m^{0.9552} \qquad R^2 = 0.94 \qquad (17)$$

For each variable ($min(P_m)$, $max(P_m)$ and $M(P_m)$), the relationships obtained at the considered five stations are compared in Figure 4. According to the fitted relationships, basic information on the monthly rainfall depth (minimum, maximum, mean) may be deduced using the number of rainy days.

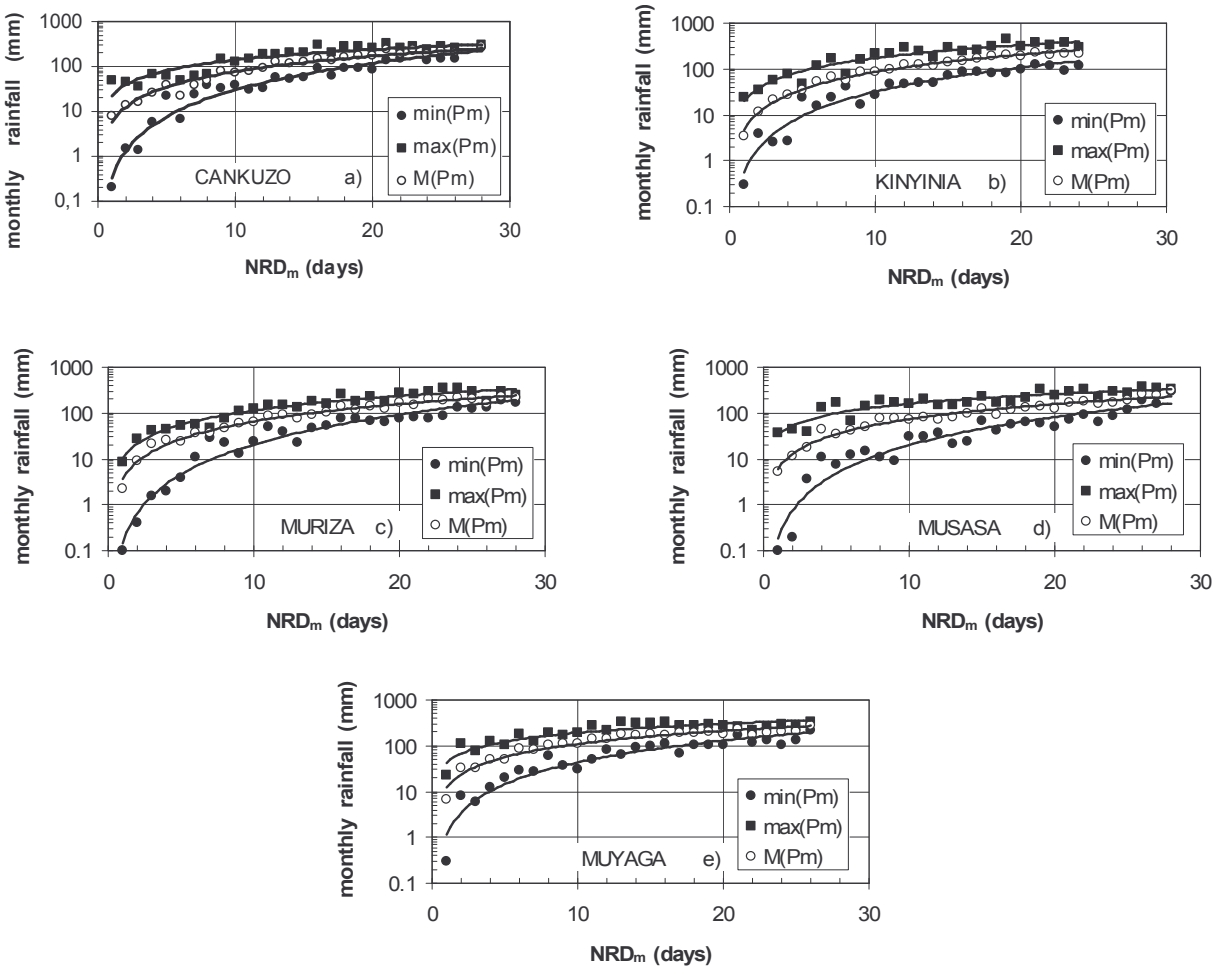

Fig. 3. Relationship between the minimum, *min(P_m)*, maximum, *max(P_m)*, and mean, *M(P_m)*, monthly rainfall depth and the monthly number of rainy days, *NRD_m*, for the stations of a) CANKUZO, b) KINYINIA, c) MURIZA, d) MUSASA, and e) MUYAGA

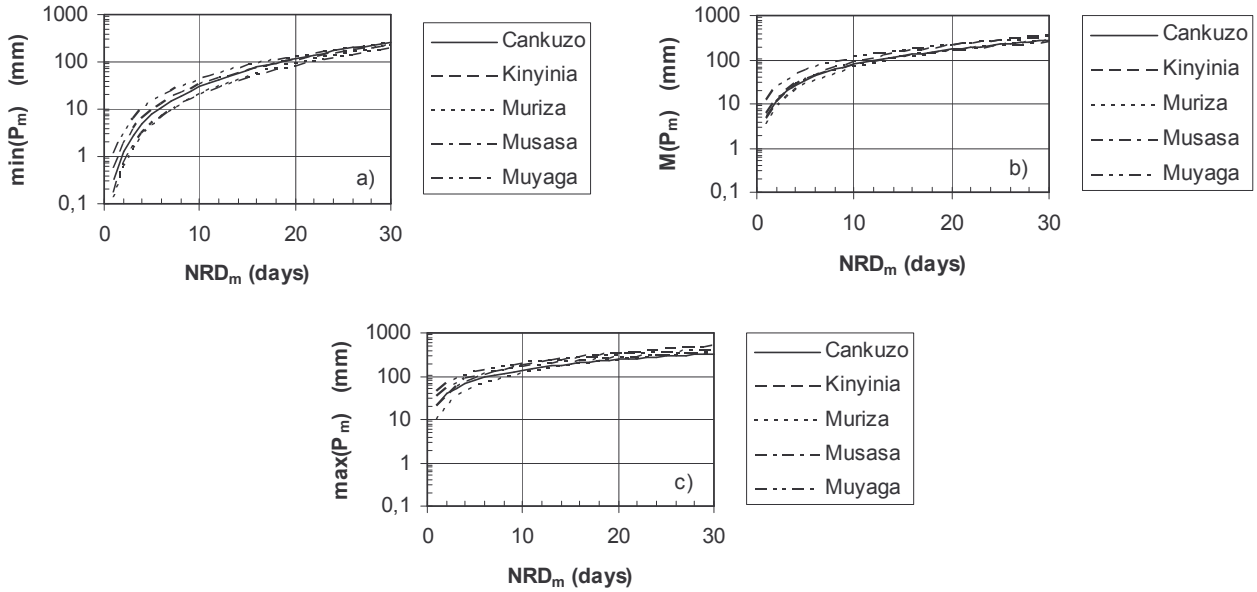

Fig. 4. Comparison among the relationships between a) the minimum monthly rainfall depth, *min(P_m)*, and the number of rainy days, *NRD_m*, b) the mean monthly rainfall depth, *M(P_m)*, and *NRD_m*, and c) the maximum monthly rainfall depth, *max(P_m)*, and *NRD_m* for the CANKUZO, KINYINIA, MURIZA, MUSASA and MUYAGA stations

Relationship between the relative variability and the mean value for monthly rainfall depth and monthly number of rainy days

Using the data set including the complete years, a strong relationship between the monthly *CV* (%) and *M* values was detected for both P_m (mm) (Figure 5) and NRD_m (days) (Figure 6). In particular, the following relationships were obtained:

Cankuzo station (Figures 5a and 6a)

$$CV(P_m) = 446.7\,[M(P_m)]^{-0.4845} \qquad R^2 = 0.93 \qquad (18)$$

$$CV(NRD_m) = 141.8\,[M(NRD_m)]^{-0.6390} \qquad R^2 = 0.96 \qquad (19)$$

Kinyinia station (Figures 5b and 6b)

$$CV(P_m) = 452.1\,[M(P_m)]^{-0.4544} \qquad R^2 = 0.98 \qquad (20)$$

$$CV(NRD_m) = 136.2\,[M(NRD_m)]^{-0.5663} \qquad R^2 = 0.97 \qquad (21)$$

Muriza station (Figures 5c and 6c)

$$CV(P_m) = 593.7\,[M(P_m)]^{-0.5373} \qquad R^2 = 0.98 \qquad (22)$$

$$CV(NRD_m) = 173.9\,[M(NRD_m)]^{-0.6965} \qquad R^2 = 0.96 \qquad (23)$$

Musasa station (Figures 5d and 6d)

$$CV(P_m) = 405.1\,[M(P_m)]^{-0.4424} \qquad R^2 = 0.95 \qquad (24)$$

$$CV(NRD_m) = 183.0\,[M(NRD_m)]^{-0.7341} \qquad R^2 = 0.97 \qquad (25)$$

Muyaga station (Figures 5e and 6e)

$$CV(P_m) = 537.6\,[M(P_m)]^{-0.5217} \qquad R^2 = 0.97 \qquad (26)$$

$$CV(NRD_m) = 135.6\,[M(NRD_m)]^{-0.5072} \qquad R^2 = 0.99 \qquad (27)$$

For both variables, the fitted relationships are compared in Figure 7. These relationship may have some practical interest since they suggest that a knowledge of the mean value of the two variables is enough to predict the variability of the individual values.

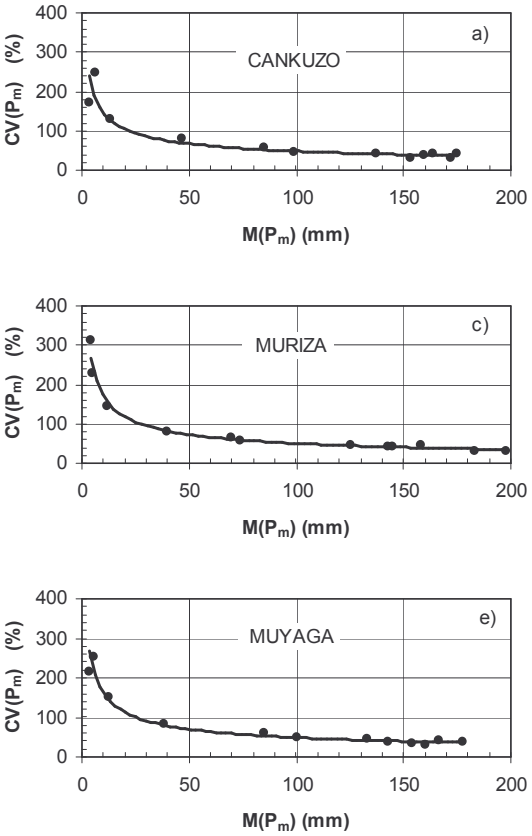

Fig. 5. Relationship between the coefficient of variation, *CV*, and the mean, *M*, of the monthly rainfall depth, P_m, values for the stations of a) CANKUZO, b) KINYINIA, c) MURIZA, d) MUSASA, and e) MUYAGA

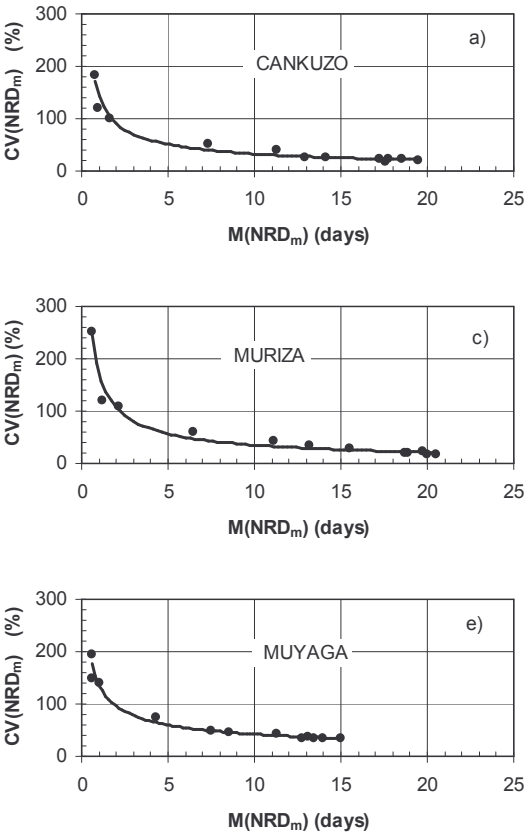

Fig. 6. Relationship between the coefficient of variation, *CV*, and the mean, *M*, of the monthly number of rainy days, NRD_m, values for the stations of a) CANKUZO, b) KINYINIA, c) MURIZA, d) MUSASA, and e) MUYAGA

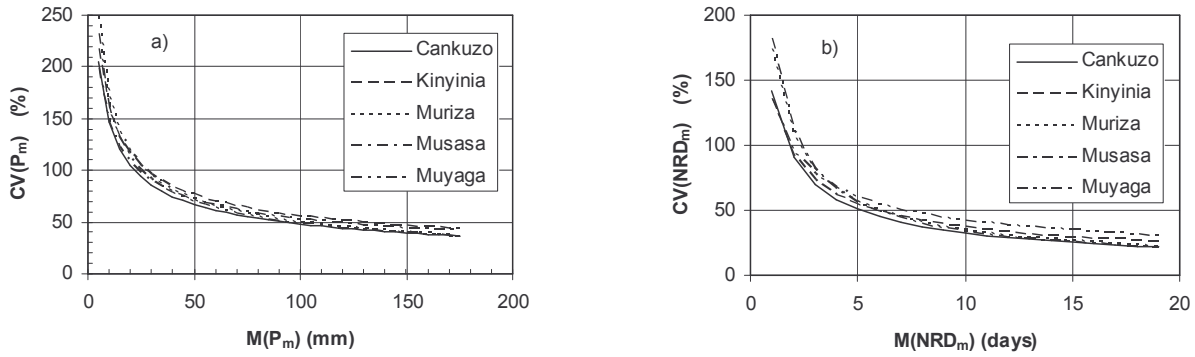

Fig. 7. Comparison among the relationships between the coefficient of variation and the associated mean of the a) monthly rainfall depth, P_m, values and b) monthly number of rainy days, NRD_m, for the stations of CANKUZO, KINYINIA, MURIZA, MUSASA and MUYAGA

Monthly values of reference evapotranspiration and rainfall deficit

For each station, Figure 8 shows the $M(P_m)$ and the associated $M(ET_{0,m})$ values for each month of the year. A total of 17 recording years, listed in Table 26, were used to calculate $M(P_m)$ and $M(ET_{0,m})$ for the *Cankuzo* station (Figure 8a). The monthly rainfall values showed a noticeable variability ($3.3 \leq M(P_m) \leq 185.9$ mm) whereas the corresponding values of the reference evapotranspiration were less variable ($107.6 \leq M(ET_{0,m}) \leq 138.5$ mm). The values of RD_m ranged between –69.4 mm and 115.8 mm. Six months (from November to April) were characterized by a value of $RD_m < 0$ (i.e., monthly rainfall higher than the corresponding monthly reference evapotranspiration) whereas $RD_m > 0$ was obtained for the period from May to October. The maximum value of RD_m, equal to 116 mm, was detected on July.

Figure 8b shows the $M(P_m)$ and the associated $M(ET_{0,m})$ values for each month of the year at the *Kinyinia* station. These data were obtained using 19 recording years, listed in Table 27. The monthly rainfall values varied between 3.4 and 207.9 mm, whereas the corresponding values of the reference evapotranspiration were less variable ($124.0 \leq M(ET_{0,m}) \leq 156.6$ mm). The values of RD_m ranged between –76 mm and 138 mm. Six months (from November to April) were characterized by a value of $RD_m < 0$ whereas $RD_m > 0$ was obtained for the May to October months. The maximum value of RD_m, equal to 138 mm, was detected on both July and August.

For the *Muriza* station, the $M(P_m)$ and the associated $M(ET_{0,m})$ values calculated for each month of the year using a total of 18 recording years (Table 28) were plotted in Figure 8c. The monthly rainfall values varied between 3.6 and 201.9 mm. The reference evapotranspiration values varied between 115.9 and 146.6 mm. The values of RD_m ranged from –81 mm to 128 mm. Six months (from November to April) were characterized by a value of $RD_m < 0$ whereas $RD_m > 0$ was obtained for the May to October months. The maximum value of RD_m, equal to 128 mm, was detected on July.

Figure 8d shows the $M(P_m)$ and the associated $M(ET_{0,m})$ values for each month of the year at the *Musasa* station. A total of 14 recording years (Table 29) were used for these calculations. The monthly rainfall values ranged from 3.0 to 206.0 mm. The corresponding values of the reference evapotranspiration varied between 128.8 and 161.7 mm. The values of RD_m ranged between –72 mm and 146 mm. Two months (April and November) were characterized by a value of $RD_m < 0$ whereas $RD_m > 0$ was obtained for the other months. The maximum value of RD_m, equal to 146 mm, was detected on July.

In general, monthly rainfall was lower than the corresponding monthly reference evapotranspiration for half of the year. For a single station (*Musasa*), the period with a rainfall amount lower than the reference evapotranspiration was appreciably longer, being equal to 10 months.

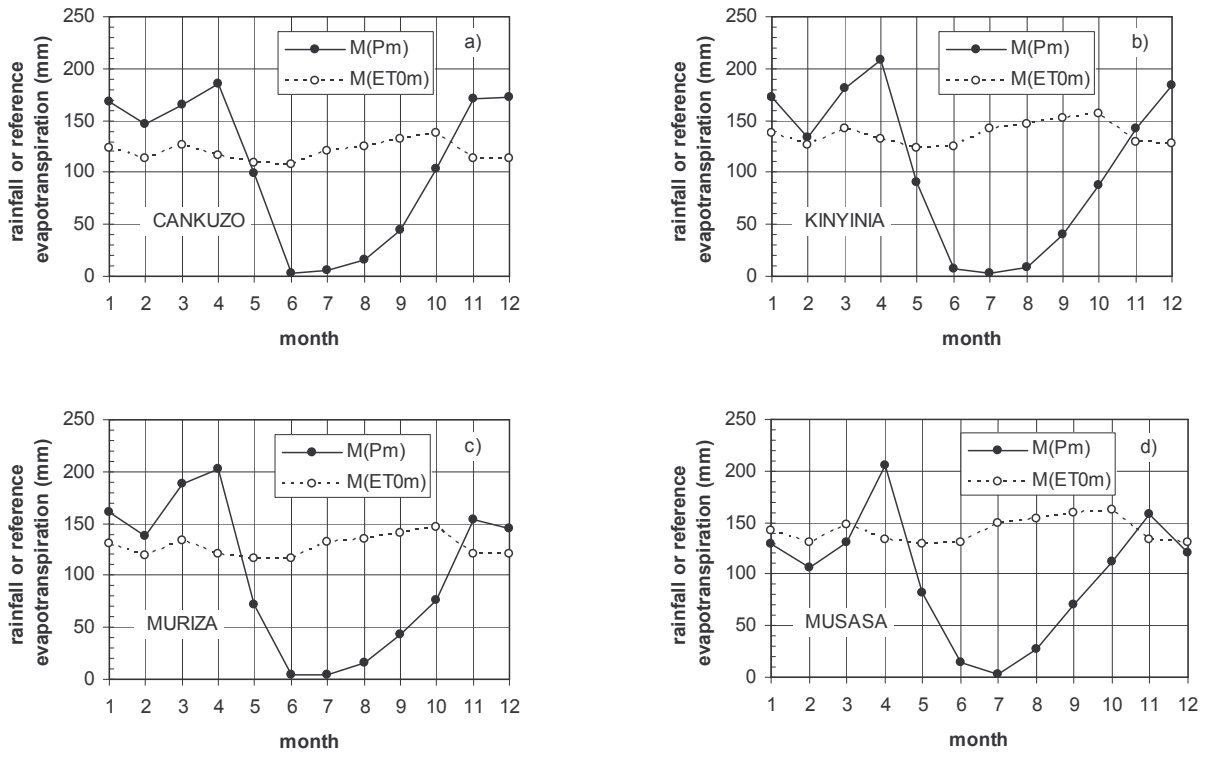

Fig. 8. Mean values of the monthly rainfall depth, $M(P_m)$, and reference evapotranspiration, $M(ET_{0,m})$, for the stations of a) CANKUZO, b) KINYINIA, c) MURIZA, and d) MUSASA

Annual evapotranspiration

For *Cankuzo*, Table 26 lists the annual values of the rainfall depth, P_a, and the associated reference evapotranspiration, $ET_{0,a}$. The ratio between $ET_{0,a}$ and P_a is also reported for each year. The mean value of $ET_{0,a}$ was equal to 1440 mm. The $ET_{0,a}/P_a$ ratio varied from a minimum of 0.86 to a maximum of 1.61. In particular, the reference evapotranspiration was higher than the associated rainfall amount for 12 of the 17 considered years. The mean of $ET_{0,a}/P_a$ was equal to 1.14.

For *Kinyinia*, the mean value of $ET_{0,a}$ was equal to 1644 mm (Table 27). The $ET_{0,a}/P_a$ ratio varied from a minimum of 1.0 to a maximum of 2.1 with a mean value of 1.35. The annual reference evapotranspiration was always higher than the associated rainfall amount.

The mean value of $ET_{0,a}$ determined for the *Muriza* station was equal to 1534 mm (Table 28). The $ET_{0,a}/P_a$ ratio varied from a minimum of 0.91 to a maximum of 1.63 with a mean of 1.31. The reference evapotranspiration was higher than the associated rainfall amount for 16 of the 18 considered years.

For the *Musasa* station, the mean value of $ET_{0,a}$ was equal to 1703 mm (Table 29). The $ET_{0,a}/P_a$ ratio varied from a minimum of 1.14 to a maximum of 1.98. The mean of the $ET_{0,a}/P_a$ ratio was equal to 1.51.

A total of 68 individual years were considered in this investigation. The largest percentage of these years (i.e., 90%) was characterized by a reference evapotranspiration value higher than the associated rainfall amount. This result suggested that problems of water availability to agricultural crops can occur.

Table 1. Rainfall and temperature recording periods for the investigated stations

Station	Recording period	
	Rainfall	**Temperature**
Cankuzo	October 1973 – December 2005	November 1973 – December 2005
Kinyinya	January 1967 – December 2005	January 1972 – December 2005
Muriza	January 1974 – December 2005	August 1974 – November 2004
Musasa	January 1961 – November 2005	January 1961 – December 2005
Muyaga	January 1960 – December 2005	-

Table 2. Monthly values of the extraterrestrial radiation, R_a (mm day^{-1}), used to calculate the reference evapotranspiration at the selected locations by the Hargreaves and Samani (1982, 1985) formula

Month	**R_a**
January	15.20
February	15.02
March	15.55
April	15.33
May	14.03
June	13.44
July	14.17
August	14.13
September	14.96
October	15.68
November	14.66
December	14.21

Table 3. Monthly rainfall and temperature data for the CANKUZO station

YEAR	MONTH	ND	P_m	NRD_m	MRD_m	$T_{m,max}$	$T_{m,min}$	$T_{m,ave}$	MTD_m
1973	oct	31			1				
1973	nov	30	198.3	22	0				7
1973	dec	31	150.8	19	0				12
1974	jan	31	107.2	17	0				31
1974	feb	28	68.6	15	0				28
1974	mar	31	123.1	19	0	24.5	14.6	19.6	0
1974	apr	30	153.3	26	0	23.4	14.4	18.9	0
1974	may	31			31				31
1974	jun	30	34.6	3	0	24.1	13.9	19.0	0
1974	jul	31	6.7	6	0	22.8	13.6	18.2	0
1974	aug	31	39.5	2	0	26.1	14.3	20.2	0
1974	sep	30	33.9	9	0	25.9	15.1	20.5	0
1974	oct	31	70.2	10	0	26.6	14.8	20.7	0
1974	nov	30	142.8	24	0	24.1	14.6	19.3	0
1974	dec	31	82.2	17	0	23.7	14.1	18.9	0
1975	jan	31	92.1	13	0	24.5	14.3	19.4	0
1975	feb	28	96.0	15	0	24.8	14.0	19.4	0
1975	mar	31	214.7	18	0	23.8	14.4	19.1	0
1975	apr	30	259.3	20	0	24.0	14.8	19.4	0
1975	may	31	51.5	14	0	23.6	14.8	19.2	0
1975	jun	30	1.1	1	0	23.7	14.0	18.9	0
1975	jul	31	66.0	4	0	24.1	13.7	18.9	0
1975	aug	31	0.0	0	0	24.9	15.0	20.0	0
1975	sep	30	84.6	14	0	24.4	14.7	19.5	0
1975	oct	31	160.9	19	0	24.2	14.5	19.4	0
1975	nov	30	117.9	15	0	24.7	14.4	19.5	0
1975	dec	31	90.2	18	0	23.9	14.0	18.9	0
1976	jan	31	133.6	15	0	24.6	14.4	19.5	0
1976	feb	29	134.9	15	0	23.3	13.9	18.6	0
1976	mar	31	149.8	20	0	24.5	14.3	19.4	0
1976	apr	30	113.3	15	0	23.9	14.7	19.3	0
1976	may	31	65.4	10	0				4
1976	jun	30	6.0	2	0				2
1976	jul	31	5.4	3	0	24.9	13.8	19.3	0
1976	aug	31	5.9	4	0	25.9	14.9	20.4	0
1976	sep	30	87.0	12	0	26.3	14.9	20.6	0
1976	oct	31	78.9	12	0	26.7	15.1	20.9	0
1976	nov	30	130.9	20	0	24.7	14.4	19.6	0
1976	dec	31	248.8	24	0	24.3	14.5	19.4	0
1977	jan	31	290.9	23	0	23.6	14.5	19.0	0
1977	feb	28	186.8	16	0	24.4	14.5	19.5	0
1977	mar	31	146.5	22	0	24.5	14.9	19.7	0
1977	apr	30	249.9	26	0	23.5	15.0	19.2	0
1977	may	31	210.6	14	0	24.2	14.6	19.4	0
1977	jun	30	0.0	0	0	24.5	14.3	19.4	0
1977	jul	31	0.0	0	0	25.3	14.2	19.8	0
1977	aug	31	33.7	3	0	26.2	14.9	20.5	0
1977	sep	30	39.4	8	0	27.0	15.9	21.4	0
1977	oct	31	121.1	9	0	27.5	16.2	21.8	0
1977	nov	30	192.8	24	0	23.7	14.7	19.2	0
1977	dec	31	160.8	19	0	24.1	14.9	19.5	0
1978	jan	31	125.8	18	0	24.8	14.3	19.6	0
1978	feb	28	193.6	13	0	25.0	14.5	19.7	0
1978	mar	31	215.9	26	0	24.0	14.8	19.4	0
1978	apr	30	173.5	22	0	24.4	15.7	20.0	0

YEAR	MONTH	ND	P_m	NRD_m	MRD_m	$T_{m,max}$	$T_{m,min}$	$T_{m,ave}$	MTD_m
1978	may	31	86.1	9	0	23.8	15.2	19.5	0
1978	jun	30	1.3	1	0	24.3	14.0	19.1	0
1978	jul	31	0.0	0	0	25.1	13.5	19.3	0
1978	aug	31	0.2	1	0	26.4	15.1	20.7	0
1978	sep	30	54.4	7	0	27.4	15.3	21.4	0
1978	oct	31	147.5	11	0	26.0	15.0	20.5	0
1978	nov	30	208.3	26	0	23.2	14.7	19.0	0
1978	dec	31	255.2	28	0	23.2	14.7	19.0	0
1979	jan	31	176.3	22	0	24.2	14.9	19.6	0
1979	feb	28	154.9	19	0	24.2	14.9	19.5	0
1979	mar	31	128.3	18	0	25.0	14.8	19.9	0
1979	apr	30	180.6	24	0	23.8	15.2	19.5	0
1979	may	31	129.1	13	0	23.6	15.4	19.5	0
1979	jun	30	21.1	3	0	23.5	13.6	18.6	0
1979	jul	31	0.0	0	0	24.7	13.6	19.2	0
1979	aug	31	0.0	0	0	26.7	15.6	21.2	0
1979	sep	30	10.7	3	0	28.1	16.1	22.1	0
1979	oct	31	40.3	9	0	27.3	15.9	21.6	0
1979	nov	30	169.3	19	0	24.9	15.4	20.2	0
1979	dec	31	146.2	25	0	23.7	14.7	19.2	0
1980	jan	31	163.6	13	0	24.6	14.9	19.7	0
1980	feb	29	88.3	9	0	24.9	15.2	20.1	0
1980	mar	31	93.0	11	0	24.8	14.4	19.6	0
1980	apr	30	94.1	16	0	24.6	14.3	19.5	0
1980	may	31	47.2	11	0	24.2	14.6	19.4	0
1980	jun	30	3.6	2	0	24.9	13.2	19.1	0
1980	jul	31	0.0	0	0				22
1980	aug	31	0.0	0	0	26.2	15.0	20.6	0
1980	sep	30	64.0	7	0	27.2	16.1	21.6	0
1980	oct	31	33.3	9	0	26.4	15.9	21.2	0
1980	nov	30	177.6	20	0	24.3	14.8	19.5	0
1980	dec	31	125.9	19	0	24.2	15.0	19.6	0
1981	jan	31	193.2	18	0	24.8	14.6	19.7	0
1981	feb	28	149.5	12	0	24.9	15.0	19.9	0
1981	mar	31	192.6	22	0	23.9	15.4	19.7	0
1981	apr	30	203.7	17	0	24.3	15.6	19.9	0
1981	may	31	175.5	15	0	23.5	15.2	19.3	0
1981	jun	30	0.0	0	0	24.5	14.1	19.3	0
1981	jul	31	0.0	0	0	25.2	14.2	19.7	0
1981	aug	31	49.9	6	0	26.2	15.2	20.7	0
1981	sep	30	53.6	9	0	26.4	15.1	20.7	0
1981	oct	31	70.5	9	0	25.9	15.3	20.6	0
1981	nov	30	135.6	12	0	25.5	15.0	20.3	0
1981	dec	31	242.3	23	0	24.8	14.8	19.8	0
1982	jan	31	116.2	19	0	24.4	14.2	19.3	0
1982	feb	28	79.1	12	0	25.0	14.5	19.7	0
1982	mar	31	131.2	10	0	25.2	14.7	19.9	0
1982	apr	30	227.3	23	0	24.1	15.0	19.6	0
1982	may	31	116.3	16	0	23.5	14.9	19.2	0
1982	jun	30	10.5	2	0	24.3	14.5	19.4	0
1982	jul	31	6.8	1	0	24.9	14.2	19.5	0
1982	aug	31	0.0	0	0	26.4	15.4	20.9	0
1982	sep	30	25.9	7	0	27.4	16.0	21.7	0
1982	oct	31	82.8	12	0	25.6	14.9	20.3	0
1982	nov	30	242.6	19	0	23.9	14.5	19.2	0
1982	dec	31	148.3	15	0	24.6	14.8	19.7	0
1983	jan	31	83.5	11	0	24.8	14.9	19.9	0

YEAR	MONTH	ND	P_m	NRD_m	MRD_m	$T_{m,max}$	$T_{m,min}$	$T_{m,ave}$	MTD_m
1983	feb	28	147.3	16	0	26.0	15.3	20.7	0
1983	mar	31	125.4	14	0	25.6	16.0	20.8	0
1983	apr	30	197.0	17	0	24.9	15.5	20.2	0
1983	may	31	48.2	8	0	25.1	15.7	20.4	0
1983	jun	30	0.0	0	0	25.6	15.1	20.3	0
1983	jul	31	0.0	0	0	26.1	15.4	20.7	0
1983	aug	31	34.7	2	0	26.1	15.4	20.8	0
1983	sep	30	26.7	5	0	27.1	15.5	21.3	0
1983	oct	31	117.6	18	0	25.0	15.0	20.0	0
1983	nov	30	162.4	20	0				30
1983	dec	31	119.3	17	0	24.3	14.2	19.3	0
1984	jan	31	255.4	19	0	23.7	13.8	18.8	0
1984	feb	29	69.8	13	0	24.9	13.9	19.4	0
1984	mar	31	166.8	14	0	25.0	14.8	19.9	0
1984	apr	30	186.2	20	0	24.4	15.1	19.8	0
1984	may	31	19.9	1	0	25.0	14.8	19.9	0
1984	jun	30	0.0	0	0	24.8	14.1	19.5	0
1984	jul	31	19.6	4	0	24.8	14.7	19.8	0
1984	aug	31	11.3	3	0	26.2	15.2	20.7	0
1984	sep	30	11.1	4	0	28.0	15.5	21.7	0
1984	oct	31	112.5	12	0	26.0	15.1	20.6	0
1984	nov	30	223.2	23	0	23.6	14.4	19.0	0
1984	dec	31	102.6	15	0	24.1	14.3	19.2	0
1985	jan	31	129.9	17	0	24.8	14.5	19.6	0
1985	feb	28	164.6	19	0	24.2	14.5	19.4	0
1985	mar	31	186.4	12	0				28
1985	apr	30	164.4	26	0	23.9	14.7	19.3	0
1985	may	31	58.9	12	0				31
1985	jun	30	0.0	0	0				30
1985	jul	31	0.0	0	0				21
1985	aug	31	0.5	1	0	25.8	15.2	20.5	0
1985	sep	30	102.8	11	0	26.0	15.8	20.9	0
1985	oct	31	65.3	14	0	26.1	15.7	20.9	0
1985	nov	30	178.2	13	0	24.9	14.9	19.9	0
1985	dec	31	137.2	16	0	24.4	14.2	19.3	0
1986	jan	31	167.6	20	0	24.3	14.3	19.3	0
1986	feb	28	145.9	12	0	24.5	14.1	19.3	0
1986	mar	31	122.5	18	0	24.5	13.9	19.2	0
1986	apr	30	202.0	25	0	23.9	14.9	19.4	0
1986	may	31	88.8	17	0	23.7	14.9	19.3	0
1986	jun	30	1.1	1	0	23.9	12.6	18.2	0
1986	jul	31	0.0	0	0	24.7	13.1	18.9	0
1986	aug	31	1.4	3	0	27.1	15.1	21.1	0
1986	sep	30	24.2	6	0	27.2	15.1	21.2	0
1986	oct	31	122.0	15	0	26.6	14.9	20.7	0
1986	nov	30	251.0	25	0	23.8	14.5	19.1	0
1986	dec	31	181.6	19	0	23.0	14.2	18.6	0
1987	jan	31	178.5	21	0	23.9	14.1	19.0	0
1987	feb	28	68.1	10	0	24.9	14.3	19.6	0
1987	mar	31	148.7	13	0	25.1	15.2	20.2	0
1987	apr	30	170.1	19	0	25.3	15.7	20.5	0
1987	may	31	76.6	12	0	24.5	15.8	20.2	0
1987	jun	30	0.5	1	0	24.4	14.3	19.4	0
1987	jul	31	0.0	0	0	26.4	15.2	20.8	0
1987	aug	31	11.2	1	0	27.0	16.6	21.8	0
1987	sep	30	57.6	12	0	26.9	16.1	21.5	0
1987	oct	31	63.2	14	0	26.5	15.7	21.1	0

YEAR	MONTH	ND	P_m	NRD_m	MRD_m	$T_{m,max}$	$T_{m,min}$	$T_{m,ave}$	MTD_m
1987	nov	30	309.2	16	0	24.7	15.3	20.0	0
1987	dec	31	69.6	11	0	25.9	15.2	20.5	0
1988	jan	31	326.9	21	0	23.7	15.0	19.4	0
1988	feb	29	45.6	10	0	25.7	15.1	20.4	0
1988	mar	31	255.4	21	0	24.5	15.1	19.8	0
1988	apr	30	283.0	18	0	24.6	15.6	20.1	0
1988	may	31	63.1	5	0	24.5	15.4	20.0	0
1988	jun	30	0.0	0	0	25.3	14.9	20.1	0
1988	jul	31	1.5	2	0	25.2	14.8	20.0	0
1988	aug	31	40.3	5	0	25.6	15.5	20.6	0
1988	sep	30	24.5	7	0	26.7	15.6	21.1	0
1988	oct	31	123.0	14	0	25.5	15.1	20.3	0
1988	nov	30	122.0	16	0	24.5	14.6	19.5	0
1988	dec	31	139.3	18	0	23.8	14.5	19.1	0
1989	jan	31	258.7	19	0	23.3	14.3	18.8	0
1989	feb	28	210.5	15	0	23.6	14.1	18.9	0
1989	mar	31	154.7	19	0	24.3	14.1	19.2	0
1989	apr	30	132.8	17	0	23.9	14.8	19.3	0
1989	may	31	77.4	9	0	23.6	14.9	19.2	0
1989	jun	30	6.2	4	0	23.7	13.3	18.5	0
1989	jul	31	0.0	0	0	24.6	13.4	19.0	0
1989	aug	31	29.7	1	0	25.9	14.9	20.4	0
1989	sep	30	79.8	10	0	25.4	15.1	20.3	0
1989	oct	31	87.3	12	0	25.7	14.7	20.2	0
1989	nov	30	157.1	18	0	24.8	15.1	19.9	0
1989	dec	31	242.0	19	0	24.0	14.4	19.2	0
1990	jan	31	38.1	10	0	25.3	14.2	19.8	0
1990	feb	28	261.8	21	0	24.2	14.4	19.3	0
1990	mar	31	288.8	21	0	24.0	14.5	19.3	0
1990	apr	30	126.3	18	0	24.9	15.3	20.1	0
1990	may	31	101.7	9	0	24.6	14.6	19.6	0
1990	jun	30	0.0	0	0	25.1	13.4	19.2	0
1990	jul	31	0.0	0	0	25.3	13.4	19.3	0
1990	aug	31	1.5	2	0	25.9	15.0	20.5	0
1990	sep	30	53.0	10	0	26.8	15.3	21.0	0
1990	oct	31	61.7	12	0	26.8	15.1	20.9	0
1990	nov	30	84.6	15	0	24.5	14.9	19.7	0
1990	dec	31	186.1	20	0	23.7	14.2	19.0	0
1991	jan	31	160.7	19	0	24.1	14.5	19.3	0
1991	feb	28	153.4	15	0	24.7	14.2	19.5	0
1991	mar	31	128.7	14	0	25.4	14.8	20.1	0
1991	apr	30	136.7	21	0	24.4	14.6	19.5	0
1991	may	31	99.7	16	0	24.2	15.1	19.6	0
1991	jun	30	8.3	2	0	24.5	13.9	19.2	0
1991	jul	31	0.0	0	0				1
1991	aug	31	0.0	0	0	26.6	14.6	20.6	0
1991	sep	30	11.9	6	0	27.2	14.9	21.0	0
1991	oct	31	166.7	18	0	24.9	13.8	19.3	0
1991	nov	30	140.4	16	0	24.6	13.7	19.2	0
1991	dec	31	209.7	19	0	23.9	14.4	19.2	0
1992	jan	31	104.7	16	0	24.8	14.4	19.6	0
1992	feb	29	226.6	18	0	24.7	14.2	19.4	0
1992	mar	31	111.7	18	0	25.5	15.3	20.4	0
1992	apr	30	123.9	19	0	24.7	15.0	19.9	0
1992	may	31	147.9	13	0	24.4	14.7	19.6	0
1992	jun	30	0.0	0	0	24.7	14.1	19.4	0
1992	jul	31	0.0	0	0	25.0	13.1	19.0	0

YEAR	MONTH	ND	P_m	NRD_m	MRD_m	$T_{m,max}$	$T_{m,min}$	$T_{m,ave}$	MTD_m
1992	aug	31	0.0	0	0	26.3	14.1	20.2	0
1992	sep	30	43.8	4	0	26.7	15.0	20.9	0
1992	oct	31	147.8	15	0	25.8	14.3	20.0	0
1992	nov	30	130.7	14	0	24.9	14.2	19.5	0
1992	dec	31	272.0	25	0	23.9	13.9	18.9	0
1993	jan	31			6	23.9	14.1	19.0	0
1993	feb	28	124.2	15	0	24.8	13.9	19.4	0
1993	mar	31	164.5	14	0	24.5	13.7	19.1	0
1993	apr	30	159.9	16	0	25.0	14.8	19.9	0
1993	may	31	80.5	13	0	24.4	14.5	19.4	0
1993	jun	30	0.6	1	0	24.6	14.1	19.3	0
1993	jul	31	0.0	0	0	25.2	13.6	19.4	0
1993	aug	31	13.3	2	0	26.3	14.8	20.5	0
1993	sep	30	0.0	0	0	28.3	15.8	22.0	0
1993	oct	31	13.9	4	0	28.8	16.1	22.4	0
1993	nov	30	151.7	15	0	26.3	14.8	20.6	0
1993	dec	31	143.0	22	0	25.4	14.7	20.0	0
1994	jan	31	164.8	17	0	24.2	13.8	19.0	0
1994	feb	28	139.2	15	0	25.5	14.6	20.0	0
1994	mar	31	150.3	18	0	24.9	13.5	19.2	0
1994	apr	30	130.4	15	0	25.1	14.3	19.7	0
1994	may	31	104.9	13	0	24.4	14.6	19.5	0
1994	jun	30	0.0	0	0	25.1	13.5	19.3	0
1994	jul	31	0.4	1	0	25.2	14.1	19.6	0
1994	aug	31	9.6	3	0	26.4	14.4	20.4	0
1994	sep	30	29.5	3	0	28.6	16.2	22.4	0
1994	oct	31	170.4	19	0	26.3	14.2	20.3	0
1994	nov	30	132.0	18	0	23.9	14.0	19.0	0
1994	dec	31	260.1	22	0	24.2	14.1	19.1	0
1995	jan	31	117.5	17	0	25.1	13.9	19.5	0
1995	feb	28	250.9	20	0	24.7	13.4	19.1	0
1995	mar	31	99.7	15	0	25.2	14.0	19.6	0
1995	apr	30	165.3	17	0	24.7	14.5	19.6	0
1995	may	31	143.1	12	0	24.2	14.4	19.3	0
1995	jun	30	14.9	3	0	25.0	13.6	19.3	0
1995	jul	31	0.0	0	0	25.6	13.6	19.6	0
1995	aug	31	0.0	0	0	27.4	15.0	21.2	0
1995	sep	30	4.1	2	0	28.1	15.1	21.6	0
1995	oct	31	169.2	18	0	26.4	14.2	20.3	0
1995	nov	30	201.3	19	0	25.6	13.8	19.7	0
1995	dec	31	61.1	17	0	25.5	13.4	19.4	0
1996	jan	31	148.6	19	0	24.8	13.2	19.0	0
1996	feb	29	152.7	17	0	25.1	13.1	19.1	0
1996	mar	31	124.8	19	0	25.2	13.7	19.4	0
1996	apr	30	165.1	16	0	24.8	14.3	19.6	0
1996	may	31	56.8	13	0	25.1	14.7	19.9	0
1996	jun	30	0.0	0	0	24.8	12.6	18.7	0
1996	jul	31	0.0	0	0	25.6	12.9	19.2	0
1996	aug	31	43.8	2	0	26.9	13.8	20.3	0
1996	sep	30	107.7	12	0	26.9	13.8	20.4	0
1996	oct	31	64.7	13	0	26.8	13.8	20.3	0
1996	nov	30	128.7	15	0	25.1	13.6	19.3	0
1996	dec	31	147.5	14	0	25.6	13.3	19.4	0
1997	jan	31	193.6	19	0	24.9	13.2	19.1	0
1997	feb	28	118.9	9	0	25.1	13.0	19.0	0
1997	mar	31	105.4	18	0	26.1	13.8	20.0	0
1997	apr	30	211.4	24	0	24.2	13.4	18.8	0

YEAR	MONTH	ND	P_m	NRD_m	MRD_m	$T_{m,max}$	$T_{m,min}$	$T_{m,ave}$	MTD_m
1997	may	31	126.3	19	0	24.0	13.4	18.7	0
1997	jun	30	1.4	1	0	24.9	13.0	19.0	0
1997	jul	31	40.4	2	0	25.0	13.3	19.1	0
1997	aug	31	49.2	1	0	27.6	14.0	20.8	0
1997	sep	30	3.8	2	0	29.0	15.8	22.4	0
1997	oct	31	160.2	16	0	26.8	14.7	20.8	0
1997	nov	30	263.3	19	0				30
1997	dec	31	310.7	28	0	23.8	13.3	18.5	0
1998	jan	31	239.5	19	0	24.8	13.6	19.2	0
1998	feb	28	190.6	17	0	26.1	14.0	20.1	0
1998	mar	31	146.0	15	0	26.5	14.1	20.3	0
1998	apr	30	138.2	16	0	25.3	14.4	19.9	0
1998	may	31	70.5	14	0				1
1998	jun	30	20.6	2	0	25.2	12.0	18.6	0
1998	jul	31	0.0	0	0	25.3	12.0	18.7	0
1998	aug	31	0.0	0	0	27.0	13.5	20.2	0
1998	sep	30	5.6	3	0	28.1	14.3	21.2	0
1998	oct	31	127.5	13	0				31
1998	nov	30	37.5	8	0	26.8	13.3	20.0	0
1998	dec	31	106.9	17	0	25.8	12.6	19.2	0
1999	jan	31	90.9	19	0	25.2	12.7	18.9	0
1999	feb	28	61.2	8	0	27.5	12.9	20.2	0
1999	mar	31	152.2	18	0	24.5	12.8	18.7	0
1999	apr	30	180.0	13	0	24.6	13.0	18.8	0
1999	may	31	30.6	7	0	25.3	13.0	19.1	0
1999	jun	30	0.0	0	0	25.2	11.9	18.5	0
1999	jul	31	0.0	0	0	25.4	11.8	18.6	0
1999	aug	31	32.3	4	0	25.7	13.4	19.6	0
1999	sep	30	64.7	8	0	27.0	13.2	20.1	0
1999	oct	31	21.9	5	0	27.4	12.4	19.9	0
1999	nov	30	107.7	19	0	25.0	12.4	18.7	0
1999	dec	31	234.1	23	0	25.0	12.2	18.6	0
2000	jan	31	95.2	17	0	25.4	12.0	18.7	0
2000	feb	29	76.0	15	0	24.8	11.5	18.2	0
2000	mar	31	187.8	19	0	24.8	11.8	18.3	0
2000	apr	30	59.9	10	0	25.6	12.4	19.0	0
2000	may	31	15.1	2	0	26.5	13.0	19.8	0
2000	jun	30	2.1	1	0				1
2000	jul	31	0.0	0	0	26.2	11.9	19.0	0
2000	aug	31	0.0	0	0	27.2	13.2	20.2	0
2000	sep	30	7.6	2	0	28.9	13.4	21.1	0
2000	oct	31	31.8	12	0	28.1	13.3	20.7	0
2000	nov	30			1	25.4	12.3	18.9	0
2000	dec	31	216.1	19	0	24.7	11.9	18.3	0
2001	jan	31	203.5	19	0	23.6	11.4	17.5	0
2001	feb	28	128.9	15	0				6
2001	mar	31	163.0	20	0	25.0	11.5	18.2	0
2001	apr	30	85.4	12	0	25.4	12.6	19.0	0
2001	may	31	37.0	9	0	24.6	12.4	18.5	0
2001	jun	30	0.0	0	0	25.0	11.1	18.0	0
2001	jul	31	43.9	4	0	25.0	11.3	18.1	0
2001	aug	31	12.8	2	0	26.5	12.3	19.4	0
2001	sep	30	155.1	16	0	26.7	11.6	19.2	0
2001	oct	31	99.6	13	0	25.9	12.5	19.2	0
2001	nov	30	139.6	19	0				2
2001	dec	31	86.6	20	0	25.1	11.8	18.5	0
2002	jan	31	179.0	19	0	24.3	11.7	18.0	0

YEAR	MONTH	ND	P_m	NRD_m	MRD_m	$T_{m,max}$	$T_{m,min}$	$T_{m,ave}$	MTD_m
2002	feb	28	72.2	12	0				6
2002	mar	31	111.5	16	0				1
2002	apr	30	256.0	23	0	24.9	12.2	18.5	0
2002	may	31	151.8	9	0				1
2002	jun	30	0.0	0	0	25.8	10.2	18.0	0
2002	jul	31	0.0	0	0	26.7	11.5	19.1	0
2002	aug	31	0.0	0	0				5
2002	sep	30	21.9	6	0				6
2002	oct	31	27.2	7	0				3
2002	nov	30			1				4
2002	dec	31	210.4	22	0				4
2003	jan	31	175.3	17	0	25.9	11.5	18.7	0
2003	feb	28	121.5	11	0	27.2	11.8	19.5	0
2003	mar	31	162.3	17	0	25.7	11.6	18.7	0
2003	apr	30	143.6	15	0	25.1	12.1	18.6	0
2003	may	31	91.1	15	0				1
2003	jun	30	0.0	0	0	24.7	11.3	18.0	0
2003	jul	31	0.0	0	0	25.6	11.2	18.4	0
2003	aug	31	0.0	0	0	27.3	11.4	19.3	0
2003	sep	30	33.7	7	0	27.8	12.8	20.3	0
2003	oct	31	56.2	11	0	27.5	12.6	20.1	0
2003	nov	30	152.4	18	0	25.7	11.8	18.7	0
2003	dec	31	205.5	19	0	25.2	11.3	18.3	0
2004	jan	31	143.0	18	0	25.6	11.5	18.5	0
2004	feb	29	71.9	12	0	25.0	11.2	18.1	0
2004	mar	31	65.4	12	0	25.5	12.0	18.7	0
2004	apr	30	255.6	18	0	24.5	11.5	18.0	0
2004	may	31	0.0	0	0	25.5	11.1	18.3	0
2004	jun	30	0.0	0	0	25.4	10.8	18.1	0
2004	jul	31	0.0	0	0	26.5	10.6	18.5	0
2004	aug	31	4.2	1	0	27.2	12.2	19.7	0
2004	sep	30	48.8	8	0	26.8	11.5	19.1	0
2004	oct	31	29.5	11	0	27.5	12.5	20.0	0
2004	nov	30	115.5	17	0				1
2004	dec	31	288.9	19	0	24.7	10.9	17.8	0
2005	jan	31	120.0	15	0				1
2005	feb	28	39.8	11	0	27.7	11.7	19.7	0
2005	mar	31	153.7	20	0	26.0	10.8	18.4	0
2005	apr	30	113.3	10	0	26.5	11.7	19.1	0
2005	may	31	49.5	11	0	24.8	14.2	19.5	0
2005	jun	30	3.5	2	0	25.6	11.0	18.3	0
2005	jul	31	0.0	0	0	26.2	10.2	18.4	0
2005	aug	31	6.0	2	0	27.4	11.3	19.3	0
2005	sep	30	3.0	2	0	28.7	11.7	20.2	0
2005	oct	31	67.8	10	0	27.5	11.2	19.3	0
2005	nov	30	56.6	15	0	27.3	14.2	20.7	0
2005	dec	31	118.6	17	0	26.7	10.5	18.6	0

ND = number of days of the month; P_m = rainfall depth (mm); NRD_m = number of rainy days (days); MRD_m = missing daily rainfall data (days); $T_{m,max}$ = maximum air temperature (°C); $T_{m,min}$ = minimum air temperature (°C); $T_{m,ave}$ = average air temperature (°C); MTD_m = missing daily temperature data (days). The P_m and NRD_m data are listed for those months with a complete record of daily rainfall values ($MRD_m = 0$). The $T_{m,max}$, $T_{m,min}$ and $T_{m,ave}$ data are listed for those months with a complete record of daily temperature values ($MTD_m = 0$).

Table 4. Monthly rainfall and temperature data for the KINYINIA station

YEAR	MONTH	ND	P_m	NRD_m	MRD_m	$T_{m,max}$	$T_{m,min}$	$T_{m,ave}$	MTD_m
1967	jan	31	116.0	9	0				
1967	feb	28	97.5	10	0				
1967	mar	31	166.6	7	0				
1967	apr	30	176.6	12	0				
1967	may	31	296.0	15	0				
1967	jun	30	0.0	0	0				
1967	jul	31	6.7	1	0				
1967	aug	31	8.2	1	0				
1967	sep	30	115.5	6	0				
1967	oct	31	80.7	11	0				
1967	nov	30	116.7	22	0				
1967	dec	31	197.1	20	0				
1968	jan	31	91.5	13	0				
1968	feb	29	168.3	18	0				
1968	mar	31	140.7	19	0				
1968	apr	30	208.4	20	0				
1968	may	31	122.1	11	0				
1968	jun	30	23.9	3	0				
1968	jul	31	0.0	0	0				
1968	aug	31	0.0	0	0				
1968	sep	30	32.1	5	0				
1968	oct	31	89.9	15	0				
1968	nov	30	316.5	26	0				
1968	dec	31	118.5	15	0				
1969	jan	31	118.4	24	0				
1969	feb	28	225.3	23	0				
1969	mar	31	186.7	21	0				
1969	apr	30	80.6	19	0				
1969	may	31	86.9	12	0				
1969	jun	30	0.0	0	0				
1969	jul	31	0.0	0	0				
1969	aug	31	0.0	0	0				
1969	sep	30	19.2	4	0				
1969	oct	31	108.9	17	0				
1969	nov	30	182.2	22	0				
1969	dec	31	210.3	19	0				
1970	jan	31	202.5	24	0				
1970	feb	28	204.0	16	0				
1970	mar	31	226.8	23	0				
1970	apr	30	268.5	23	0				
1970	may	31	76.3	6	0				
1970	jun	30	3.2	1	0				
1970	jul	31	0.0	0	0				
1970	aug	31	0.0	0	0				
1970	sep	30	30.8	3	0				
1970	oct	31	44.1	8	0				
1970	nov	30	94.4	18	0				
1970	dec	31	154.2	20	0				
1971	jan	31	251.3	15	0				
1971	feb	28	74.2	9	0				
1971	mar	31	146.5	17	0				
1971	apr	30	258.4	23	0				
1971	may	31	96.1	9	0				
1971	jun	30	0.0	0	0				
1971	jul	31	1.2	1	0				

YEAR	MONTH	ND	P_m	NRD_m	MRD_m	$T_{m,max}$	$T_{m,min}$	$T_{m,ave}$	MTD_m
1971	aug	31	2.6	1	0				
1971	sep	30	54.7	10	0				
1971	oct	31	71.7	8	0				
1971	nov	30	181.2	21	0				
1971	dec	31	89.8	16	0				
1972	jan	31	238.2	18	0	26.7	14.9	20.8	0
1972	feb	29	173.8	18	0	26.0	15.2	20.6	0
1972	mar	31	106.8	11	0	27.3	15.0	21.2	0
1972	apr	30	163.0	14	0	27.0	15.4	21.2	0
1972	may	31	114.5	18	0	26.6	15.4	21.0	0
1972	jun	30	44.6	3	0	26.5	14.0	20.2	0
1972	jul	31	0.0	0	0	27.5	12.3	19.9	0
1972	aug	31	23.7	3	0	28.6	13.8	21.2	0
1972	sep	30	46.4	8	0	29.8	15.7	22.7	0
1972	oct	31	127.3	14	0	28.9	16.2	22.6	0
1972	nov	30	185.7	18	0	26.5	15.7	21.1	0
1972	dec	31	225.3	20	0	27.1	15.4	21.3	0
1973	jan	31	145.1	14	0	27.7	15.9	21.8	0
1973	feb	28	93.7	11	0	28.5	16.0	22.3	0
1973	mar	31	47.2	11	0	27.4	15.2	21.3	0
1973	apr	30	262.4	20	0				1
1973	may	31	126.8	7	0	26.9	15.3	21.1	0
1973	jun	30	0.0	0	0	26.8	13.2	20.0	0
1973	jul	31	0.0	0	0	27.7	11.8	19.7	0
1973	aug	31	0.0	0	0	29.1	14.1	21.6	0
1973	sep	30	35.9	5	0	29.8	16.1	23.0	0
1973	oct	31	60.9	14	0				31
1973	nov	30	262.0	21	0	26.3	15.0	20.7	0
1973	dec	31	134.6	14	0	26.2	14.2	20.2	0
1974	jan	31	211.7	13	0	26.5	14.0	20.2	0
1974	feb	28	73.7	10	0	27.5	14.8	21.2	0
1974	mar	31	135.7	11	0	27.0	16.1	21.5	0
1974	apr	30	210.8	18	0	26.1	16.2	21.1	0
1974	may	31	89.9	13	0	26.3	15.4	20.8	0
1974	jun	30	6.8	3	0	26.6	14.2	20.4	0
1974	jul	31	5.6	3	0	25.8	13.2	19.5	0
1974	aug	31	0.0	0	0	28.8	13.1	21.0	0
1974	sep	30			30				30
1974	oct	31			31				31
1974	nov	30	72.5	15	0				30
1974	dec	31	115.8	12	0				31
1975	jan	31	59.9	7	0	27.4	14.8	21.1	0
1975	feb	28	58.1	7	0	28.6	14.4	21.5	0
1975	mar	31	174.1	17	0	26.7	15.1	20.9	0
1975	apr	30	139.6	18	0	26.8	15.8	21.3	0
1975	may	31	64.8	8	0	26.6	15.2	20.9	0
1975	jun	30	0.0	0	0	27.0	13.1	20.0	0
1975	jul	31	22.3	2	0	27.2	12.9	20.1	0
1975	aug	31	0.0	0	0	28.2	13.6	20.9	0
1975	sep	30	63.5	8	0	27.7	15.2	21.5	0
1975	oct	31	66.5	11	0	27.9	15.5	21.7	0
1975	nov	30	78.6	11	0	28.2	14.7	21.5	0
1975	dec	31	138.9	17	0	27.3	14.3	20.8	0
1976	jan	31	65.4	11	0	27.7	14.6	21.1	0
1976	feb	29	108.2	14	0	26.3	13.9	20.1	0
1976	mar	31	62.0	14	0	27.7	15.5	21.6	0
1976	apr	30	185.5	18	0	26.8	15.5	21.2	0

YEAR	MONTH	ND	P_m	NRD_m	MRD_m	$T_{m,max}$	$T_{m,min}$	$T_{m,ave}$	MTD_m
1976	may	31	68.9	10	0	26.4	15.7	21.0	0
1976	jun	30	0.0	0	0	27.4	13.4	20.4	0
1976	jul	31	1.6	1	0	28.3	13.3	20.8	0
1976	aug	31	4.9	2	0	29.4	14.1	21.8	0
1976	sep	30	77.3	4	0	30.1	16.1	23.1	0
1976	oct	31	9.4	2	0	30.4	16.3	23.3	0
1976	nov	30	114.2	17	0	28.0	15.2	21.6	0
1976	dec	31	114.4	16	0	27.6	15.4	21.5	0
1977	jan	31	145.9	16	0	27.0	15.9	21.4	0
1977	feb	28	111.7	12	0	27.2	16.0	21.6	0
1977	mar	31	168.0	22	0	27.3	15.6	21.5	0
1977	apr	30	156.6	18	0	26.5	16.0	21.2	0
1977	may	31	139.2	9	0	27.5	15.1	21.3	0
1977	jun	30	0.0	0	0	27.7	13.4	20.6	0
1977	jul	31	0.0	0	0	28.9	13.2	21.1	0
1977	aug	31	0.5	1	0	29.7	14.2	22.0	0
1977	sep	30	28.2	5	0	30.0	15.4	22.7	0
1977	oct	31	42.2	5	0	31.3	15.7	23.5	0
1977	nov	30			30	26.8	16.0	21.4	0
1977	dec	31	166.0	16	0	27.7	15.7	21.7	0
1978	jan	31	217.6	10	0	27.5	15.9	21.7	0
1978	feb	28	163.4	14	0	27.4	16.3	21.9	0
1978	mar	31	332.5	19	0	26.7	16.5	21.6	0
1978	apr	30	163.6	23	0	27.1	17.1	22.1	0
1978	may	31	39.8	6	0	27.6	15.9	21.7	0
1978	jun	30	0.0	0	0	27.6	14.0	20.8	0
1978	jul	31	0.0	0	0	28.2	12.8	20.5	0
1978	aug	31	1.7	1	0	30.0	14.7	22.3	0
1978	sep	30	46.0	5	0	31.0	16.0	23.5	0
1978	oct	31	77.2	11	0	30.9	17.0	24.0	0
1978	nov	30	207.7	27	0	26.3	16.4	21.4	0
1978	dec	31	179.6	22	0	26.7	16.5	21.6	0
1979	jan	31	173.6	20	0	27.9	16.4	22.1	0
1979	feb	28	186.1	18	0	27.8	16.7	22.3	0
1979	mar	31	179.5	17	0	28.4	16.1	22.3	0
1979	apr	30	294.3	24	0	27.4	16.9	22.2	0
1979	may	31	56.0	10	0	26.8	16.9	21.9	0
1979	jun	30	5.4	3	0	26.7	14.3	20.5	0
1979	jul	31	0.0	0	0	27.8	13.2	20.5	0
1979	aug	31	0.0	0	0	30.3	15.1	22.7	0
1979	sep	30	0.0	0	0	32.0	15.2	23.6	0
1979	oct	31	79.1	13	0	31.1	16.3	23.7	0
1979	nov	30	131.9	18	0	28.3	16.7	22.5	0
1979	dec	31	215.4	22	0	27.2	16.2	21.7	0
1980	jan	31	143.7	16	0	27.8	16.2	22.0	0
1980	feb	29	133.5	14	0	28.1	16.4	22.2	0
1980	mar	31	184.9	16	0	28.1	16.0	22.1	0
1980	apr	30	154.2	14	0	28.1	16.6	22.4	0
1980	may	31	109.1	11	0	27.2	16.4	21.8	0
1980	jun	30	0.0	0	0	28.1	14.0	21.1	0
1980	jul	31	0.0	0	0	28.3	13.8	21.0	0
1980	aug	31	0.0	0	0	30.2	15.8	23.0	0
1980	sep	30	60.1	7	0	31.7	16.9	24.3	0
1980	oct	31	51.9	11	0	29.7	16.8	23.3	0
1980	nov	30	178.7	21	0	27.8	16.2	22.0	0
1980	dec	31	191.3	24	0	27.3	16.5	21.9	0
1981	jan	31	99.3	20	0	27.7	15.9	21.8	0

YEAR	MONTH	ND	P_m	NRD_m	MRD_m	$T_{m,max}$	$T_{m,min}$	$T_{m,ave}$	MTD_m
1981	feb	28	80.0	10	0	28.2	15.6	21.9	0
1981	mar	31	184.6	22	0	27.2	16.5	21.9	0
1981	apr	30	207.6	20	0	27.6	16.6	22.1	0
1981	may	31	78.1	11	0	26.8	16.3	21.6	0
1981	jun	30	0.0	0	0	28.1	13.3	20.7	0
1981	jul	31	0.0	0	0	28.2	13.5	20.8	0
1981	aug	31	28.7	3	0	29.9	16.0	22.9	0
1981	sep	30	27.3	7	0	30.0	15.9	22.9	0
1981	oct	31	75.5	12	0	29.8	16.9	23.4	0
1981	nov	30	103.4	14	0	29.7	16.5	23.1	0
1981	dec	31	181.8	23	0	28.1	16.3	22.2	0
1982	jan	31	148.1	15	0	27.7	15.4	21.5	0
1982	feb	28	95.3	10	0	28.1	15.6	21.8	0
1982	mar	31	88.3	17	0	28.4	15.8	22.1	0
1982	apr	30	251.8	22	0	27.6	16.2	21.9	0
1982	may	31	139.9	19	0	26.5	16.0	21.3	0
1982	jun	30	9.0	2	0	27.4	14.2	20.8	0
1982	jul	31	0.0	0	0	27.9	12.9	20.4	0
1982	aug	31	0.0	0	0	29.6	13.9	21.7	0
1982	sep	30	45.1	5	0	31.0	16.9	24.0	0
1982	oct	31	156.2	16	0	28.3	16.7	22.5	0
1982	nov	30	221.8	20	0	26.8	16.1	21.5	0
1982	dec	31	241.9	17	0	27.7	16.4	22.0	0
1983	jan	31	81.6	7	0	27.3	16.2	21.8	0
1983	feb	28	141.1	12	0	28.8	16.2	22.5	0
1983	mar	31	92.5	14	0	28.3	17.1	22.7	0
1983	apr	30	230.3	17	0	27.3	17.2	22.3	0
1983	may	31	30.2	7	0	27.9	16.7	22.3	0
1983	jun	30	0.0	0	0	28.5	14.9	21.7	0
1983	jul	31	0.0	0	0	28.8	14.2	21.5	0
1983	aug	31	46.6	3	0	29.2	15.8	22.5	0
1983	sep	30	5.3	2	0	30.8	15.9	23.4	0
1983	oct	31	130.6	13	0	28.8	16.4	22.6	0
1983	nov	30	134.3	9	0	27.6	16.5	22.0	0
1983	dec	31	170.0	20	0	27.1	15.7	21.4	0
1984	jan	31	163.0	14	0	26.4	15.6	21.0	0
1984	feb	29	133.5	11	0	28.1	15.3	21.7	0
1984	mar	31	106.2	14	0	28.2	15.8	22.0	0
1984	apr	30	156.8	17	0	27.5	16.3	21.9	0
1984	may	31	57.1	3	0	27.7	15.2	21.4	0
1984	jun	30	0.0	0	0	27.6	13.9	20.7	0
1984	jul	31	2.6	3	0	27.9	15.1	21.5	0
1984	aug	31	36.0	4	0	29.5	15.2	22.3	0
1984	sep	30	9.8	4	0	30.8	15.3	23.1	0
1984	oct	31	79.5	11	0	29.1	16.9	23.0	0
1984	nov	30	133.5	17	0	26.7	16.4	21.5	0
1984	dec	31	132.7	16	0	27.5	16.2	21.9	0
1985	jan	31	99.8	15	0	27.8	16.1	21.9	0
1985	feb	28	173.5	15	0	26.8	16.4	21.6	0
1985	mar	31	227.6	12	0	28.2	16.5	22.3	0
1985	apr	30	371.1	23	0	27.1	16.4	21.7	0
1985	may	31	97.9	10	0	27.1	15.4	21.3	0
1985	jun	30	0.0	0	0	27.2	13.8	20.5	0
1985	jul	31	0.0	0	0	27.8	13.0	20.4	0
1985	aug	31	0.0	0	0	29.1	14.1	21.6	0
1985	sep	30	30.8	9	0	29.8	16.0	22.9	0
1985	oct	31	74.3	10	0	30.5	17.1	23.8	0

YEAR	MONTH	ND	P_m	NRD_m	MRD_m	$T_{m,max}$	$T_{m,min}$	$T_{m,ave}$	MTD_m
1985	nov	30	243.1	13	0	28.4	16.7	22.5	0
1985	dec	31	137.7	18	0	27.5	16.0	21.8	0
1986	jan	31	186.2	14	0	27.6	16.1	21.9	0
1986	feb	28	130.0	13	0	28.2	15.5	21.8	0
1986	mar	31	169.4	19	0	27.0	15.5	21.3	0
1986	apr	30	273.4	24	0	26.7	16.7	21.7	0
1986	may	31	97.3	15	0	26.5	16.4	21.5	0
1986	jun	30	0.7	1	0	26.7	13.1	19.9	0
1986	jul	31	0.0	0	0	27.4	12.4	19.9	0
1986	aug	31	0.0	0	0	30.4	14.3	22.4	0
1986	sep	30	23.5	5	0	30.7	16.7	23.7	0
1986	oct	31	82.7	9	0	30.2	17.0	23.6	0
1986	nov	30	231.7	25	0	26.8	16.7	21.8	0
1986	dec	31	229.9	20	0	26.1	16.6	21.3	0
1987	jan	31	249.5	18	0	27.1	16.2	21.6	0
1987	feb	28	117.1	7	0	28.1	16.8	22.4	0
1987	mar	31	232.7	19	0	28.1	16.7	22.4	0
1987	apr	30	188.3	23	0	28.1	17.2	22.6	0
1987	may	31	51.1	14	0	27.1	16.6	21.9	0
1987	jun	30	0.0	0	0	27.8	14.6	21.2	0
1987	jul	31	0.0	0	0	29.6	14.7	22.1	0
1987	aug	31	1.5	1	0	30.3	16.2	23.3	0
1987	sep	30	113.0	10	0	30.8	17.1	23.9	0
1987	oct	31	69.3	9	0	28.9	17.3	23.1	0
1987	nov	30	173.0	15	0	27.9	17.2	22.6	0
1987	dec	31	80.4	7	0	28.8	16.7	22.8	0
1988	jan	31	131.4	19	0	27.2	16.2	21.7	0
1988	feb	29	102.0	15	0	28.4	16.7	22.6	0
1988	mar	31	203.0	22	0	27.5	16.8	22.1	0
1988	apr	30	261.8	23	0	27.3	17.2	22.3	0
1988	may	31	19.6	3	0	27.6	16.0	21.8	0
1988	jun	30	9.0	1	0	28.1	15.3	21.7	0
1988	jul	31	0.0	0	0	28.3	14.3	21.3	0
1988	aug	31	15.7	2	0	28.8	16.0	22.4	0
1988	sep	30	43.2	8	0	30.0	16.5	23.3	0
1988	oct	31	113.3	16	0	28.8	17.0	22.9	0
1988	nov	30	109.8	14	0	27.1	16.5	21.8	0
1988	dec	31	199.5	19	0	26.2	16.1	21.1	0
1989	jan	31	226.1	20	0	26.6	16.2	21.4	0
1989	feb	28	96.0	12	0	26.7	15.9	21.3	0
1989	mar	31	341.1	22	0	27.2	15.8	21.5	0
1989	apr	30	226.4	22	0	26.2	16.6	21.4	0
1989	may	31	124.4	13	0	25.9	16.1	21.0	0
1989	jun	30	24.2	4	0	26.1	14.2	20.2	0
1989	jul	31	0.0	0	0	27.1	13.8	20.5	0
1989	aug	31	4.2	1	0	29.0	15.4	22.2	0
1989	sep	30	51.0	6	0	29.0	16.4	22.7	0
1989	oct	31	146.5	12	0	29.2	16.8	23.0	0
1989	nov	30	51.9	13	0	28.1	17.3	22.7	0
1989	dec	31	278.8	20	0	27.0	16.5	21.8	0
1990	jan	31	60.7	12	0	28.2	16.4	22.3	0
1990	feb	28	251.5	19	0	27.0	16.3	21.7	0
1990	mar	31	184.1	19	0	26.9	16.9	21.9	0
1990	apr	30	250.4	18	0	27.7	17.1	22.4	0
1990	may	31	98.8	10	0	27.3	15.9	21.6	0
1990	jun	30	0.0	0	0	27.9	14.1	21.0	0
1990	jul	31	0.0	0	0	28.3	12.7	20.5	0

YEAR	MONTH	ND	P_m	NRD_m	MRD_m	$T_{m,max}$	$T_{m,min}$	$T_{m,ave}$	MTD_m
1990	aug	31	0.9	1	0	28.9	15.7	22.3	0
1990	sep	30	25.3	7	0	29.7	16.6	23.1	0
1990	oct	31	78.5	8	0	30.2	16.9	23.6	0
1990	nov	30	146.4	20	0	27.2	17.0	22.1	0
1990	dec	31	134.0	19	0	26.4	16.4	21.4	0
1991	jan	31	252.5	16	0	27.2	16.4	21.8	0
1991	feb	28	143.3	18	0	27.6	16.1	21.9	0
1991	mar	31	125.7	16	0	27.8	16.6	22.2	0
1991	apr	30	164.0	20	0	26.8	16.7	21.7	0
1991	may	31	241.2	17	0	26.1	17.1	21.6	0
1991	jun	30	4.6	1	0	27.4	15.3	21.4	0
1991	jul	31	0.0	0	0	27.3	14.1	20.7	0
1991	aug	31	0.0	0	0	29.9	15.0	22.4	0
1991	sep	30	15.2	4	0	30.4	15.9	23.1	0
1991	oct	31	119.1	20	0	27.6	16.3	22.0	0
1991	nov	30	111.9	20	0	27.0	16.1	21.6	0
1991	dec	31	81.5	18	0	26.9	16.8	21.8	0
1992	jan	31	146.0	16	0	27.6	16.5	22.1	0
1992	feb	29	154.5	13	0	27.4	16.4	21.9	0
1992	mar	31	170.9	19	0	28.1	17.0	22.6	0
1992	apr	30	198.2	20	0				10
1992	may	31	69.6	13	0	26.9	16.5	21.7	0
1992	jun	30	6.5	3	0				1
1992	jul	31	0.0	0	0	27.5	12.6	20.1	0
1992	aug	31	0.0	0	0	29.1	12.6	20.9	0
1992	sep	30	42.4	4	0	30.0	16.4	23.2	0
1992	oct	31	63.7	13	0	29.6	17.2	23.4	0
1992	nov	30	126.9	17	0	28.6	16.6	22.6	0
1992	dec	31	95.3	23	0	27.5	16.3	21.9	0
1993	jan	31	146.8	19	0	27.6	16.7	22.2	0
1993	feb	28	156.3	13	0	28.0	16.1	22.1	0
1993	mar	31	164.1	21	0	27.3	15.6	21.5	0
1993	apr	30	148.4	19	0	27.7	16.7	22.2	0
1993	may	31	90.6	13	0	26.9	16.2	21.5	0
1993	jun	30	0.0	0	0	27.4	14.7	21.0	0
1993	jul	31	0.0	0	0	28.0	12.6	20.3	0
1993	aug	31	6.4	2	0	29.5	15.6	22.6	0
1993	sep	30	0.6	1	0	31.1	16.1	23.6	0
1993	oct	31			9				9
1993	nov	30			30				30
1993	dec	31			31				31
1994	jan	31	96.0	12	0	27.1	16.3	21.7	0
1994	feb	28	169.4	18	0	27.9	16.4	22.1	0
1994	mar	31	127.2	21	0	28.0	16.1	22.0	0
1994	apr	30	111.0	14	0	27.8	16.5	22.2	0
1994	may	31	119.2	12	0				10
1994	jun	30	0.3	1	0	27.9	14.0	21.0	0
1994	jul	31	1.5	1	0	28.3	13.8	21.1	0
1994	aug	31	5.3	4	0	29.5	15.6	22.5	0
1994	sep	30	59.9	4	0	31.7	17.8	24.7	0
1994	oct	31	91.5	16	0	29.1	17.0	23.1	0
1994	nov	30	214.2	16	0	26.9	16.9	21.9	0
1994	dec	31			5				4
1995	jan	31	293.2	12	0				31
1995	feb	28			3				3
1995	mar	31	152.4	14	0	28.3	16.4	22.3	0
1995	apr	30	375.2	21	0	27.3	16.5	21.9	0

YEAR	MONTH	ND	P_m	NRD_m	MRD_m	$T_{m,max}$	$T_{m,min}$	$T_{m,ave}$	MTD_m
1995	may	31	199.2	19	0				1
1995	jun	30	41.8	3	0	27.6	14.5	21.0	0
1995	jul	31	0.0	0	0				31
1995	aug	31	0.0	0	0	30.6	14.6	22.6	0
1995	sep	30	9.0	3	0	31.5	15.5	23.5	0
1995	oct	31	315.4	20	0	29.7	16.7	23.2	0
1995	nov	30	133.9	16	0				30
1995	dec	31	200.4	13	0	28.8	15.8	22.3	0
1996	jan	31	197.5	18	0	27.9	15.4	21.7	0
1996	feb	29	261.5	17	0				2
1996	mar	31	290.5	19	0	27.9	15.5	21.7	0
1996	apr	30	175.6	12	0	27.4	15.8	21.6	0
1996	may	31	9.0	4	0	28.3	16.4	22.3	0
1996	jun	30	2.2	1	0	28.0	13.9	21.0	0
1996	jul	31	0.0	0	0	28.7	13.4	21.1	0
1996	aug	31	7.7	2	0	30.0	13.7	21.9	0
1996	sep	30	74.0	6	0				2
1996	oct	31			4				4
1996	nov	30	52.6	8	0	19.3	25.2	22.2	0
1996	dec	31	133.5	20	0				1
1997	jan	31	99.0	16	0	27.1	16.7	21.9	0
1997	feb	28	106.9	14	0	27.4	16.3	21.8	0
1997	mar	31	132.1	21	0	28.2	17.3	22.7	0
1997	apr	30	296.6	18	0	26.8	16.9	21.8	0
1997	may	31	41.9	7	0	26.7	15.9	21.3	0
1997	jun	30	24.0	1	0	27.4	14.5	21.0	0
1997	jul	31	0.0	0	0	27.5	13.1	20.3	0
1997	aug	31	0.0	0	0	30.4	14.9	22.6	0
1997	sep	30	0.0	0	0	32.9	16.1	24.5	0
1997	oct	31	215.9	17	0	30.0	17.0	23.5	0
1997	nov	30	322.7	18	0				30
1997	dec	31	300.8	21	0	26.8	16.5	21.7	0
1998	jan	31	374.5	19	0	27.3	16.7	22.0	0
1998	feb	28	215.6	11	0	28.8	17.5	23.1	0
1998	mar	31	229.6	18	0	28.6	17.5	23.1	0
1998	apr	30	163.2	20	0	27.9	18.0	22.9	0
1998	may	31	121.2	9	0	28.0	17.1	22.6	0
1998	jun	30	0.9	1	0	28.0	14.6	21.3	0
1998	jul	31	0.0	0	0	28.0	14.0	21.0	0
1998	aug	31	0.0	0	0	29.9	15.5	22.7	0
1998	sep	30	2.7	4	0	31.3	16.9	24.1	0
1998	oct	31	95.3	13	0	31.1	16.4	23.7	0
1998	nov	30	36.3	3	0	29.8	17.3	23.6	0
1998	dec	31	439.4	19	0	28.5	16.2	22.3	0
1999	jan	31	139.3	14	0	27.8	16.1	21.9	0
1999	feb	28	32.5	6	0	30.0	15.7	22.9	0
1999	mar	31	294.9	21	0				5
1999	apr	30	142.1	14	0	27.3	16.7	22.0	0
1999	may	31	49.6	6	0	27.7	15.9	21.8	0
1999	jun	30	0.0	0	0	27.9	14.4	21.1	0
1999	jul	31	0.0	0	0				2
1999	aug	31	5.0	3	0	28.9	16.3	22.6	0
1999	sep	30	26.3	4	0	29.9	16.8	23.3	0
1999	oct	31	16.0	6	0	30.9	16.1	23.5	0
1999	nov	30	212.6	21	0	27.4	16.6	22.0	0
1999	dec	31	240.7	18	0	27.5	16.5	22.0	0
2000	jan	31	145.5	14	0	28.0	16.1	22.1	0

YEAR	MONTH	ND	P_m	NRD_m	MRD_m	$T_{m,max}$	$T_{m,min}$	$T_{m,ave}$	MTD_m
2000	feb	29	127.8	14	0	28.0	15.4	21.7	0
2000	mar	31	194.8	23	0	27.3	16.1	21.7	0
2000	apr	30	99.5	13	0	28.1	16.2	22.2	0
2000	may	31	3.4	1	0	29.0	16.0	22.5	0
2000	jun	30	0.0	0	0				1
2000	jul	31	0.0	0	0	29.5	14.1	21.8	0
2000	aug	31	1.1	1	0	30.5	15.4	23.0	0
2000	sep	30	0.0	0	0	31.9	15.7	23.8	0
2000	oct	31	96.3	9	0	31.4	16.7	24.0	0
2000	nov	30			2	28.3	17.1	22.7	0
2000	dec	31	186.9	17	0	27.7	16.3	22.0	0
2001	jan	31	297.2	20	0	26.3	16.0	21.1	0
2001	feb	28	47.7	12	0	28.2	15.9	22.1	0
2001	mar	31	217.8	19	0	27.5	16.2	21.9	0
2001	apr	30	105.3	10	0	28.0	16.5	22.2	0
2001	may	31	111.2	12	0	27.1	16.3	21.7	0
2001	jun	30	35.8	2	0	27.6	14.1	20.9	0
2001	jul	31	37.4	4	0	27.7	13.5	20.6	0
2001	aug	31	2.4	1	0	29.9	14.6	22.2	0
2001	sep	30	65.4	8	0	30.4	15.9	23.1	0
2001	oct	31	30.5	4	0	29.2	16.6	22.9	0
2001	nov	30	109.8	11	0	28.7	16.9	22.8	0
2001	dec	31	127.6	14	0	28.3	16.2	22.2	0
2002	jan	31	162.9	13	0	27.7	16.2	21.9	0
2002	feb	28	155.7	9	0	28.9	16.0	22.5	0
2002	mar	31	100.3	14	0	27.7	15.3	22.3	0
2002	apr	30	279.3	21	0	27.7	16.8	22.2	0
2002	may	31	21.2	6	0	27.9	15.9	21.9	0
2002	jun	30	0.0	0	0	28.5	13.1	20.8	0
2002	jul	31	0.0	0	0				5
2002	aug	31	1.6	1	0	30.4	15.3	22.8	0
2002	sep	30	18.8	4	0	31.1	17.0	24.1	0
2002	oct	31			31	31.0	17.2	24.1	0
2002	nov	30	77.9	15	0	27.8	15.8	21.8	0
2002	dec	31	199.3	19	0	27.4	16.7	22.0	0
2003	jan	31	94.0	14	0	29.1	16.5	22.8	0
2003	feb	28	53.1	7	0	30.6	16.3	23.4	0
2003	mar	31	89.3	14	0	28.8	15.7	22.3	0
2003	apr	30	117.3	12	0	27.8	16.2	22.0	0
2003	may	31	16.3	9	0	28.4	16.1	22.3	0
2003	jun	30	0.0	0	0	28.4	14.8	21.6	0
2003	jul	31	0.0	0	0				1
2003	aug	31	0.0	0	0	30.9	14.3	22.6	0
2003	sep	30	55.4	6	0	31.5	16.9	24.2	0
2003	oct	31	56.4	8	0	30.7	17.3	24.0	0
2003	nov	30	60.8	11	0	29.2	16.6	22.9	0
2003	dec	31	60.8	10	0				1
2004	jan	31	33.3	5	0	28.2	15.9	22.1	0
2004	feb	29	17.8	4	0	28.9	15.9	22.4	0
2004	mar	31	148.8	16	0	28.5	16.0	22.2	0
2004	apr	30	162.3	19	0	26.9	15.8	21.4	0
2004	may	31	0.0	0	0	29.3	14.7	22.0	0
2004	jun	30	0.0	0	0	29.1	13.3	21.2	0
2004	jul	31	0.0	0	0	29.8	13.4	21.6	0
2004	aug	31	0.0	0	0				1
2004	sep	30	14.6	3	0	31.2	14.9	23.1	0
2004	oct	31	48.5	8	0				2

YEAR	MONTH	ND	P_m	NRD_m	MRD_m	$T_{m,max}$	$T_{m,min}$	$T_{m,ave}$	MTD_m
2004	nov	30	80.4	12	0	28.6	14.9	21.8	0
2004	dec	31	132.8	17	0	27.6	15.4	21.5	0
2005	jan	31	93.6	13	0	28.8	15.3	22.1	0
2005	feb	28	4.0	2	0	31.4	16.4	23.9	0
2005	mar	31	111.7	11	0	29.2	16.0	22.6	0
2005	apr	30	23.9	7	0	30.1	17.0	23.5	0
2005	may	31	9.8	3	0	29.0	15.9	22.5	0
2005	jun	30	0.0	0	0	28.7	14.2	21.4	0
2005	jul	31	0.0	0	0	29.0	12.2	20.6	0
2005	aug	31	0.0	0	0	30.7	14.2	22.5	0
2005	sep	30	6.5	2	0				30
2005	oct	31	27.7	10	0				2
2005	nov	30	39.9	9	0	31.1	16.0	23.6	0
2005	dec	31	39.9	9	0	29.2	15.5	22.4	0

ND = number of days of the month; P_m = rainfall depth (mm); NRD_m = number of rainy days (days); MRD_m = missing daily rainfall data (days); $T_{m,max}$ = maximum air temperature (°C); $T_{m,min}$ = minimum air temperature (°C); $T_{m,ave}$ = average air temperature (°C); MTD_m = missing daily temperature data (days). The P_m and NRD_m data are listed for those months with a complete record of daily rainfall values ($MRD_m = 0$). The $T_{m,max}$, $T_{m,min}$ and $T_{m,ave}$ data are listed for those months with a complete record of daily temperature values ($MTD_m = 0$).

Table 5. Monthly rainfall and temperature data for the MURIZA station

YEAR	MONTH	ND	P_m	NRD_m	MRD_m	$T_{m,max}$	$T_{m,min}$	$T_{m,ave}$	MTD_m
1974	jan	31	22.3	13	0				
1974	feb	28	69.1	14	0				
1974	mar	31	151.4	12	0				
1974	apr	30	125.6	16	0				
1974	may	31	10.7	6	0				
1974	jun	30	4.0	5	0				
1974	jul	31	0.0	0	0				
1974	aug	31	0.3	1	0	26.3	9.4	17.9	0
1974	sep	30	11.5	5	0	26.7	10.9	18.8	0
1974	oct	31	38.4	13	0				1
1974	nov	30	119.9	17	0	24.8	12.8	18.8	0
1974	dec	31	77.1	18	0	24.1	11.4	17.8	0
1975	jan	31	94.4	19	0	24.6	12.1	18.4	0
1975	feb	28	153.3	11	0	25.3	11.4	18.3	0
1975	mar	31	191.1	24	0	24.1	11.9	18.0	0
1975	apr	30	134.3	20	0	24.0	13.3	18.6	0
1975	may	31	56.8	14	0	23.6	11.9	17.8	0
1975	jun	30	1.0	1	0	23.5	9.3	16.4	0
1975	jul	31	45.4	4	0	23.8	9.4	16.6	0
1975	aug	31	0.0	0	0	24.9	10.2	17.5	0
1975	sep	30	92.5	18	0	24.4	11.9	18.1	0
1975	oct	31	70.0	18	0	24.7	12.8	18.8	0
1975	nov	30	98.5	17	0	25.0	11.8	18.4	0
1975	dec	31	122.4	19	0	23.9	11.3	17.6	0
1976	jan	31	155.8	15	0	24.5	12.0	18.2	0
1976	feb	29	127.4	14	0	23.4	11.7	17.5	0
1976	mar	31	170.1	19	0	24.5	12.3	18.4	0
1976	apr	30	162.5	17	0	23.9	12.3	18.1	0
1976	may	31	77.4	17	0	23.6	12.8	18.2	0
1976	jun	30	0.0	0	0	23.7	8.9	16.3	0
1976	jul	31	2.8	2	0	24.6	9.0	16.8	0
1976	aug	31	2.0	4	0	25.9	10.2	18.0	0
1976	sep	30	54.3	9	0	26.5	12.1	19.3	0
1976	oct	31	23.0	8	0	27.3	12.0	19.7	0
1976	nov	30	80.6	15	0	25.7	12.2	18.9	0
1976	dec	31	98.6	21	0	24.8	12.1	18.4	0
1977	jan	31	170.2	25	0	23.7	12.4	18.1	0
1977	feb	28	108.6	17	0	24.7	12.7	18.7	0
1977	mar	31	82.4	21	0	24.5	12.6	18.5	0
1977	apr	30	191.8	22	0	23.5	13.4	18.5	0
1977	may	31	99.4	9	0	24.0	12.1	18.1	0
1977	jun	30	0.0	0	0	23.9	9.7	16.8	0
1977	jul	31	0.0	0	0	24.7	8.9	16.8	0
1977	aug	31	23.4	2	0	25.9	10.8	18.4	0
1977	sep	30	29.2	7	0	27.3	11.8	19.5	0
1977	oct	31	79.6	9	0	27.7	12.9	20.3	0
1977	nov	30	209.7	27	0	24.0	12.9	18.4	0
1977	dec	31	109.9	20	0	23.9	13.0	18.4	0
1978	jan	31	169.7	17	0	24.6	12.7	18.6	0
1978	feb	28	255.0	16	0	24.3	12.3	18.3	0
1978	mar	31	252.0	23	0	24.1	13.7	18.9	0
1978	apr	30	200.3	25	0	24.2	13.9	19.0	0
1978	may	31	55.5	8	0	23.7	11.8	17.7	0
1978	jun	30	2.2	2	0	23.9	10.1	17.0	0
1978	jul	31	0.0	0	0	24.7	8.4	16.6	0

YEAR	MONTH	ND	P_m	NRD_m	MRD_m	$T_{m,max}$	$T_{m,min}$	$T_{m,ave}$	MTD_m
1978	aug	31	8.4	1	0	26.2	9.7	17.9	0
1978	sep	30	39.2	6	0	27.5	11.6	19.5	0
1978	oct	31	135.7	13	0	26.3	12.1	19.2	0
1978	nov	30	216.6	22	0	23.5	12.7	18.1	0
1978	dec	31	269.2	20	0	23.6	13.4	18.5	0
1979	jan	31	238.2	21	0	24.0	12.9	18.4	0
1979	feb	28	170.5	18	0	24.7	13.2	18.9	0
1979	mar	31	133.2	19	0	24.9	12.0	18.5	0
1979	apr	30	293.7	23	0	23.8	14.0	18.9	0
1979	may	31	85.0	17	0	23.2	13.1	18.1	0
1979	jun	30	8.1	2	0	23.0	10.1	16.6	0
1979	jul	31	0.0	0	0	24.3	8.5	16.4	0
1979	aug	31	0.0	0	0	26.3	9.7	18.0	0
1979	sep	30	3.2	1	0	28.1	9.9	19.0	0
1979	oct	31	50.9	11	0	27.5	12.0	19.7	0
1979	nov	30	94.0	17	0	24.9	12.8	18.8	0
1979	dec	31	123.5	18	0	24.2	12.5	18.3	0
1980	jan	31	81.7	12	0	25.1	13.0	19.0	0
1980	feb	29	80.7	14	0	24.9	13.0	18.9	0
1980	mar	31	76.3	12	0	24.9	12.5	18.7	0
1980	apr	30	182.8	17	0	24.7	13.1	18.9	0
1980	may	31	115.4	11	0	23.7	12.7	18.2	0
1980	jun	30	0.0	0	0	24.6	9.7	17.1	0
1980	jul	31			9	24.3	9.6	17.0	0
1980	aug	31			31	26.2	10.9	18.5	0
1980	sep	30			30	27.3	12.0	19.7	0
1980	oct	31			31	26.6	12.5	19.5	0
1980	nov	30			30	24.6	12.6	18.6	0
1980	dec	31			22	24.1	13.1	18.6	0
1981	jan	31	107.7	14	0	24.8	12.2	18.5	0
1981	feb	28	54.2	11	0	25.0	12.1	18.5	0
1981	mar	31	199.4	22	0	24.0	13.3	18.6	0
1981	apr	30	177.8	19	0	24.5	13.6	19.0	0
1981	may	31	29.8	9	0	23.6	12.8	18.2	0
1981	jun	30	0.0	0	0	24.6	8.8	16.7	0
1981	jul	31	0.0	0	0	24.9	13.7	19.3	0
1981	aug	31	48.8	6	0	26.2	16.2	21.2	0
1981	sep	30	49.8	5	0	26.3	16.9	21.6	0
1981	oct	31	24.9	10	0	26.3	14.9	20.6	0
1981	nov	30	116.8	17	0	25.9	12.2	19.1	0
1981	dec	31	234.0	24	0	24.5	13.1	18.8	0
1982	jan	31	87.6	17	0	24.9	13.1	19.0	0
1982	feb	28	77.8	16	0	25.2	13.1	19.1	0
1982	mar	31	143.7	11	0	25.3	11.8	18.6	0
1982	apr	30	225.6	18	0	24.4	13.3	18.8	0
1982	may	31	163.0	16	0	23.5	12.7	18.1	0
1982	jun	30	7.2	3	0	23.9	9.9	16.9	0
1982	jul	31	0.0	0	0	24.6	8.0	16.3	0
1982	aug	31	0.4	1	0	26.2	9.5	17.8	0
1982	sep	30	17.6	5	0	27.6	12.3	19.9	0
1982	oct	31	104.3	22	0	25.1	13.0	19.0	0
1982	nov	30	358.5	24	0	24.1	12.8	18.4	0
1982	dec	31	186.9	20	0	24.9	12.9	18.9	0
1983	jan	31	63.9	19	0	24.9	12.7	18.8	0
1983	feb	28	132.3	12	0	26.1	12.7	19.4	0
1983	mar	31	94.6	17	0	25.5	13.6	19.6	0
1983	apr	30	240.5	22	0	24.6	13.3	19.0	0

YEAR	MONTH	ND	P_m	NRD_m	MRD_m	$T_{m,max}$	$T_{m,min}$	$T_{m,ave}$	MTD_m
1983	may	31	38.7	12	0	24.6	12.4	18.5	0
1983	jun	30	0.0	0	0	25.1	10.2	17.6	0
1983	jul	31	0.0	0	0	25.6	9.9	17.7	0
1983	aug	31	31.4	4	0	26.0	11.1	18.6	0
1983	sep	30	23.6	4	0	27.3	10.7	19.0	0
1983	oct	31	107.4	17	0	25.1	13.0	19.0	0
1983	nov	30	104.2	18	0	24.4	12.6	18.5	0
1983	dec	31	161.1	24	0	24.3	12.1	18.2	0
1984	jan	31	172.5	23	0	23.7	11.9	17.8	0
1984	feb	29	108.9	23	0	24.9	11.3	18.1	0
1984	mar	31	186.0	16	0	25.0	12.1	18.5	0
1984	apr	30	132.4	23	0	24.2	13.3	18.7	0
1984	may	31	16.3	2	0	24.2	10.9	17.6	0
1984	jun	30	0.0	0	0	24.2	9.6	16.9	0
1984	jul	31	16.6	4	0	24.4	10.5	17.4	0
1984	aug	31	36.6	7	0	26.0	10.5	18.3	0
1984	sep	30	17.7	9	0	27.6	10.7	19.2	0
1984	oct	31	76.3	13	0	25.6	13.0	19.3	0
1984	nov	30	174.1	28	0	23.6	13.2	18.4	0
1984	dec	31	91.4	20	0	24.1	12.8	18.4	0
1985	jan	31	202.0	20	0	24.6	12.6	18.6	0
1985	feb	28	214.0	23	0	24.2	13.8	19.0	0
1985	mar	31	235.0	16	0	24.6	13.3	19.0	0
1985	apr	30	262.7	25	0	23.9	14.0	18.9	0
1985	may	31	63.1	13	0	23.5	12.2	17.8	0
1985	jun	30	0.0	0	0	23.9	9.9	16.9	0
1985	jul	31	0.0	0	0	24.6	8.6	16.6	0
1985	aug	31	0.4	1	0	25.7	10.2	17.9	0
1985	sep	30	72.8	9	0	26.0	12.6	19.3	0
1985	oct	31	46.6	14	0	26.2	14.1	20.1	0
1985	nov	30	105.9	19	0	24.7	13.3	19.0	0
1985	dec	31	88.6	23	0	24.3	12.7	18.5	0
1986	jan	31	173.7	20	0	24.7	12.9	18.8	0
1986	feb	28	90.6	16	0	24.7	12.3	18.5	0
1986	mar	31	176.6	22	0	24.4	11.8	18.1	0
1986	apr	30	250.3	28	0	23.7	13.8	18.8	0
1986	may	31	95.1	17	0	23.5	12.9	18.2	0
1986	jun	30	3.7	1	0	23.8	8.5	16.2	0
1986	jul	31	0.0	0	0	24.4	7.7	16.0	0
1986	aug	31	0.9	1	0	27.0	9.1	18.0	0
1986	sep	30	25.3	6	0	27.2	11.1	19.1	0
1986	oct	31	144.8	19	0	26.6	12.9	19.7	0
1986	nov	30	196.3	27	0	23.8	13.6	18.7	0
1986	dec	31	136.9	26	0	23.6	12.7	18.1	0
1987	jan	31	235.8	25	0	24.3	13.6	18.9	0
1987	feb	28	133.9	15	0	25.3	12.7	19.0	0
1987	mar	31	155.2	14	0	25.5	13.6	19.6	0
1987	apr	30	204.8	22	0	25.2	14.3	19.8	0
1987	may	31	82.7	13	0	24.2	13.7	18.9	0
1987	jun	30	0.8	2	0	24.5	11.2	17.8	0
1987	jul	31	0.0	0	0	26.2	10.5	18.3	0
1987	aug	31	0.0	0	0	26.8	12.1	19.4	0
1987	sep	30	144.8	16	0	27.2	13.5	20.3	0
1987	oct	31	29.6	13	0	25.9	13.0	19.4	0
1987	nov	30	195.9	22	0	24.8	14.0	19.4	0
1987	dec	31	82.7	18	0	25.8	12.5	19.2	0
1988	jan	31	189.0	25	0	24.4	13.7	19.0	0

YEAR	MONTH	ND	P_m	NRD_m	MRD_m	$T_{m,max}$	$T_{m,min}$	$T_{m,ave}$	MTD_m
1988	feb	29	89.7	19	0	25.4	12.8	19.1	0
1988	mar	31	184.4	23	0	24.8	13.7	19.2	0
1988	apr	30	300.4	25	0	24.7	14.2	19.4	0
1988	may	31	8.8	3	0	24.4	12.2	18.3	0
1988	jun	30	0.1	1	0	24.9	10.9	17.9	0
1988	jul	31	0.0	0	0	25.0	10.4	17.7	0
1988	aug	31	49.9	6	0	25.5	11.7	18.6	0
1988	sep	30	33.6	7	0	26.6	12.0	19.3	0
1988	oct	31	61.6	11	0	25.8	12.9	19.4	0
1988	nov	30	173.5	19	0	24.3	13.0	18.6	0
1988	dec	31	237.6	24	0	23.5	13.0	18.2	0
1989	jan	31	362.3	23	0	23.9	13.4	18.7	0
1989	feb	28	125.7	16	0	24.1	12.8	18.5	0
1989	mar	31	292.8	22	0	24.6	12.7	18.6	0
1989	apr	30	206.7	20	0	23.6	13.5	18.5	0
1989	may	31	124.5	13	0	23.1	12.6	17.8	0
1989	jun	30	53.1	5	0	22.9	10.1	16.5	0
1989	jul	31	0.0	0	0	23.9	9.3	16.6	0
1989	aug	31	1.6	3	0	25.6	10.6	18.1	0
1989	sep	30	41.8	4	0	26.0	11.6	18.8	0
1989	oct	31	67.7	15	0	26.0	12.5	19.2	0
1989	nov	30	153.0	20	0	25.1	13.3	19.2	0
1989	dec	31	200.4	24	0	24.1	13.2	18.6	0
1990	jan	31	40.2	13	0	25.2	12.5	18.9	0
1990	feb	28	268.4	21	0	24.0	13.3	18.7	0
1990	mar	31	206.2	22	0	24.0	13.3	18.6	0
1990	apr	30	170.1	19	0	25.0	14.1	19.5	0
1990	may	31	47.3	7	0	24.2	12.0	18.1	0
1990	jun	30	0.0	0	0	24.5	9.8	17.1	0
1990	jul	31	0.0	0	0	24.9	7.7	16.3	0
1990	aug	31	2.8	1	0	25.5	11.5	18.5	0
1990	sep	30	46.3	6	0	26.5	12.2	19.4	0
1990	oct	31	125.2	13	0	26.8	12.4	19.6	0
1990	nov	30	128.8	25	0	24.6	13.7	19.2	0
1990	dec	31	83.5	15	0	24.2	12.4	18.3	0
1991	jan	31	121.6	19	0	24.4	12.6	18.5	0
1991	feb	28	96.2	17	0	25.2	12.6	18.9	0
1991	mar	31	122.2	13	0	25.2	12.7	19.0	0
1991	apr	30	173.8	20	0	24.2	13.6	18.9	0
1991	may	31	195.7	18	0	23.4	13.9	18.7	0
1991	jun	30	26.8	2	0	24.4	11.0	17.7	0
1991	jul	31	0.0	0	0				1
1991	aug	31	0.0	0	0	26.1	9.7	17.9	0
1991	sep	30	27.3	5	0	26.9	10.5	18.7	0
1991	oct	31	97.8	20	0	24.6	12.6	18.6	0
1991	nov	30	171.6	22	0	24.1	12.2	18.1	0
1991	dec	31	149.8	19	0	24.4	13.3	18.9	0
1992	jan	31	156.8	16	0				1
1992	feb	29	165.4	17	0	25.0	13.1	19.0	0
1992	mar	31	198.3	18	0	25.3	13.6	19.5	0
1992	apr	30	202.0	20	0				20
1992	may	31	54.3	15	0	24.1	12.9	18.5	0
1992	jun	30	0.0	0	0	24.3	11.5	17.9	0
1992	jul	31	0.0	0	0	24.7	8.4	16.5	0
1992	aug	31	0.0	0	0	26.1	9.1	17.6	0
1992	sep	30	9.7	4	0	27.2	11.2	19.2	0
1992	oct	31	80.4	13	0	26.4	12.8	19.6	0

YEAR	MONTH	ND	P_m	NRD_m	MRD_m	$T_{m,max}$	$T_{m,min}$	$T_{m,ave}$	MTD_m
1992	nov	30	117.7	19	0	24.9	13.1	19.0	0
1992	dec	31	103.5	19	0	23.9	12.7	18.3	0
1993	jan	31	133.8	24	0	24.2	13.5	18.9	0
1993	feb	28	161.2	20	0	24.8	13.0	18.9	0
1993	mar	31	76.5	22	0	24.3	12.2	18.2	0
1993	apr	30	75.0	20	0	24.7	13.0	18.8	0
1993	may	31	105.9	14	0	23.7	12.8	18.3	0
1993	jun	30	0.0	0	0	23.9	10.3	17.1	0
1993	jul	31	0.0	0	0	24.5	8.0	16.3	0
1993	aug	31	13.1	3	0	25.8	10.8	18.3	0
1993	sep	30			9	27.6	10.5	19.1	0
1993	oct	31			31				31
1993	nov	30			30				30
1993	dec	31			31				31
1994	jan	31			31				31
1994	feb	28			28				28
1994	mar	31			22				31
1994	apr	30	113.5	15	0	25.0	13.2	19.1	0
1994	may	31	94.5	11	0	23.9	13.6	18.8	0
1994	jun	30	0.0	0	0				1
1994	jul	31	0.0	0	0	24.9	9.6	17.2	0
1994	aug	31	31.1	4	0	26.1	11.0	18.6	0
1994	sep	30	36.6	3	0	28.1	13.5	20.8	0
1994	oct	31	99.0	19	0	26.5	13.4	20.0	0
1994	nov	30	131.8	23	0	24.6	13.4	19.0	0
1994	dec	31	230.3	25	0	24.7	13.8	19.2	0
1995	jan	31	169.7	18	0	25.7	13.4	19.5	0
1995	feb	28	169.8	17	0	24.8	13.3	19.1	0
1995	mar	31	144.3	16	0	25.6	13.4	19.5	0
1995	apr	30	219.9	23	0	24.7	13.9	19.3	0
1995	may	31	112.5	15	0	24.3	13.6	19.0	0
1995	jun	30	1.1	2	0	24.7	11.1	17.9	0
1995	jul	31	0.0	0	0	25.3	9.7	17.5	0
1995	aug	31	0.0	0	0	27.5	9.9	18.7	0
1995	sep	30	33.3	7	0	28.1	12.1	20.1	0
1995	oct	31	112.2	21	0	26.8	14.1	20.4	0
1995	nov	30	78.8	15	0	25.9	13.8	19.9	0
1995	dec	31	76.5	17	0	25.8	12.1	19.0	0
1996	jan	31	94.2	23	0	25.0	12.6	18.8	0
1996	feb	29	147.3	23	0	25.2	13.0	19.1	0
1996	mar	31	231.4	22	0	25.1	13.7	19.4	0
1996	apr	30	128.5	19	0	24.4	14.6	19.5	0
1996	may	31	68.1	12	0	24.3	14.0	19.2	0
1996	jun	30	8.0	2	0	24.4	11.2	17.8	0
1996	jul	31	0.0	0	0	25.3	10.4	17.8	0
1996	aug	31	36.8	3	0	26.8	9.5	18.2	0
1996	sep	30	40.9	3	0	27.1	12.0	19.6	0
1996	oct	31	76.1	9	0	26.9	13.4	20.2	0
1996	nov	30	106.5	18	0	25.9	13.8	19.8	0
1996	dec	31	80.8	16	0	25.6	13.2	19.4	0
1997	jan	31	87.7	19	0	25.2	13.5	19.4	0
1997	feb	28	66.9	11	0				2
1997	mar	31	138.9	22	0	26.0	14.2	20.1	0
1997	apr	30	302.6	27	0	24.7	14.2	19.4	0
1997	may	31	127.2	14	0	24.5	12.9	18.7	0
1997	jun	30	11.7	2	0	24.7	10.9	17.8	0
1997	jul	31	1.3	1	0	24.8	9.9	17.4	0

YEAR	MONTH	ND	P_m	NRD_m	MRD_m	$T_{m,max}$	$T_{m,min}$	$T_{m,ave}$	MTD_m
1997	aug	31	0.0	0	0	27.7	10.5	19.1	0
1997	sep	30	20.7	5	0	29.7	13.0	21.3	0
1997	oct	31	181.7	20	0	27.1	14.4	20.7	0
1997	nov	30	235.8	24	0				30
1997	dec	31	171.0	24	0	24.3	14.5	19.4	0
1998	jan	31	292.9	23	0	25.5	14.5	20.0	0
1998	feb	28	176.8	21	0	26.8	15.1	21.0	0
1998	mar	31	283.0	23	0	26.9	14.8	20.8	0
1998	apr	30	129.7	19	0	26.0	16.0	21.0	0
1998	may	31	87.1	13	0	25.8	14.1	19.9	0
1998	jun	30	0.7	1	0	25.5	10.6	18.0	0
1998	jul	31	0.0	0	0	25.1	10.2	17.7	0
1998	aug	31	0.3	1	0	26.6	10.9	18.8	0
1998	sep	30	13.8	5	0				10
1998	oct	31	54.3	11	0				31
1998	nov	30	64.0	14	0	26.9	13.2	20.1	0
1998	dec	31	77.1	14	0	25.9	13.2	19.5	0
1999	jan	31	158.9	15	0	25.6	13.1	19.4	0
1999	feb	28	67.7	13	0	27.3	12.4	19.8	0
1999	mar	31	298.3	22	0	24.9	12.7	18.8	0
1999	apr	30	132.3	16	0	24.5	13.8	19.2	0
1999	may	31	79.8	9	0	24.6	12.5	18.5	0
1999	jun	30	0.0	0	0	24.6	10.6	17.6	0
1999	jul	31	0.0	0	0	25.0	9.8	17.4	0
1999	aug	31	33.8	8	0	25.3	13.3	19.3	0
1999	sep	30	16.6	6	0	26.9	12.2	19.6	0
1999	oct	31	30.3	7	0	27.7	11.7	19.7	0
1999	nov	30	181.2	26	0	24.8	13.3	19.0	0
1999	dec	31	223.1	22	0	24.9	13.9	19.4	0
2000	jan	31	82.5	14	0	25.6	12.9	19.2	0
2000	feb	29	155.0	18	0	25.3	12.5	18.9	0
2000	mar	31	105.8	22	0	25.2	12.9	19.1	0
2000	apr	30	61.8	13	0	25.4	13.1	19.3	0
2000	may	31	0.0	0	0	26.2	12.2	19.2	0
2000	jun	30	0.0	0	0	25.5	10.0	17.8	0
2000	jul	31	0.0	0	0	25.9	9.6	17.8	0
2000	aug	31	0.0	0	0	27.0	10.0	18.5	0
2000	sep	30	7.8	1	0	28.7	12.6	20.7	0
2000	oct	31	47.0	13	0	27.9	13.8	20.9	0
2000	nov	30			1	25.8	13.9	19.9	0
2000	dec	31	146.0	20	0	25.0	13.7	19.4	0
2001	jan	31	164.4	22	0	24.4	13.6	19.0	0
2001	feb	28	103.5	17	0	25.6	11.7	18.7	0
2001	mar	31	237.0	20	0				2
2001	apr	30	151.4	18	0	24.7	13.6	19.2	0
2001	may	31	32.2	10	0	24.2	12.5	18.3	0
2001	jun	30	0.1	1	0	24.3	9.6	16.9	0
2001	jul	31	58.5	6	0	24.5	9.6	17.1	0
2001	aug	31	15.4	3	0	26.2	9.5	17.8	0
2001	sep	30	93.8	14	0	26.5	12.1	19.3	0
2001	oct	31	64.7	14	0	26.0	13.3	19.7	0
2001	nov	30	127.2	10	0	25.3	13.5	19.4	0
2001	dec	31	169.4	16	0	25.2	13.4	19.3	0
2002	jan	31	161.5	17	0				21
2002	feb	28	114.5	9	0				11
2002	mar	31	120.3	18	0	26.0	13.6	19.8	0
2002	apr	30	302.5	22	0	25.0	14.5	19.8	0

YEAR	MONTH	ND	P_m	NRD_m	MRD_m	$T_{m,max}$	$T_{m,min}$	$T_{m,ave}$	MTD_m
2002	may	31	54.3	6	0	25.1	13.3	19.2	0
2002	jun	30	0.0	0	0	25.5	9.3	17.4	0
2002	jul	31	0.0	0	0	26.4	9.9	18.2	0
2002	aug	31	0.0	0	0	26.7	11.8	19.3	0
2002	sep	30	1.3	1	0	28.4	13.1	20.8	0
2002	oct	31	13.3	9	0	28.4	13.4	20.9	0
2002	nov	30	134.7	19	0	25.5	14.2	19.8	0
2002	dec	31	181.5	25	0				16
2003	jan	31	134.9	15	0				31
2003	feb	28	124.0	13	0				21
2003	mar	31	133.2	14	0	26.7	13.2	20.0	0
2003	apr	30	172.4	17	0	25.6	14.0	19.8	0
2003	may	31	46.3	14	0	25.1	14.5	19.8	0
2003	jun	30	0.0	0	0	24.9	10.9	17.9	0
2003	jul	31	0.0	0	0	25.8	9.3	17.5	0
2003	aug	31	0.4	2	0	28.1	10.3	19.2	0
2003	sep	30	36.4	4	0	28.6	13.5	21.1	0
2003	oct	31	80.6	11	0				27
2003	nov	30	108.2	15	0				30
2003	dec	31	138.6	16	0				31
2004	jan	31	183.4	14	0				31
2004	feb	29	41.9	7	0				29
2004	mar	31	177.2	16	0				14
2004	apr	30	280.9	20	0	25.1	11.7	18.4	0
2004	may	31	2.0	1	0	25.9	9.1	17.5	0
2004	jun	30	0.0	0	0	25.9	7.1	16.5	0
2004	jul	31	0.0	0	0	26.8	6.0	16.4	0
2004	aug	31	2.5	1	0	28.2	8.6	18.4	0
2004	sep	30	77.0	8	0	28.3	10.5	19.4	0
2004	oct	31	65.2	10	0	27.8	11.5	19.6	0
2004	nov	30	103.4	21	0				4
2004	dec	31	248.7	22	0				
2005	jan	31	219.5	18	0				
2005	feb	28	52.3	8	0				
2005	mar	31	193.1	16	0				
2005	apr	30	71.3	10	0				
2005	may	31	45.6	9	0				
2005	jun	30	5.6	1	0				
2005	jul	31	0.0	0	0				
2005	aug	31	26.3	4	0				
2005	sep	30	34.1	3	0				
2005	oct	31	19.7	6	0				
2005	nov	30	98.4	16	0				
2005	dec	31	78.2	16	0				

ND = number of days of the month; P_m = rainfall depth (mm); NRD_m = number of rainy days (days); MRD_m = missing daily rainfall data (days); $T_{m,max}$ = maximum air temperature (°C); $T_{m,min}$ = minimum air temperature (°C); $T_{m,ave}$ = average air temperature (°C); MTD_m = missing daily temperature data (days). The P_m and NRD_m data are listed for those months with a complete record of daily rainfall values ($MRD_m = 0$). The $T_{m,max}$, $T_{m,min}$ and $T_{m,ave}$ data are listed for those months with a complete record of daily temperature values ($MTD_m = 0$).

Table 6. Monthly rainfall and temperature data for the MUSASA station

YEAR	MONTH	ND	P_m	NRD_m	MRD_m	$T_{m,max}$	$T_{m,min}$	$T_{m,ave}$	MTD_m
1961	jan	31	68.6	13	0	28.1	15.8	22.0	0
1961	feb	28	210.9	21	0	26.6	15.0	20.8	0
1961	mar	31	126.3	24	0	27.1	15.5	21.3	0
1961	apr	30	212.3	22	0	27.4	15.7	21.5	0
1961	may	31	59.7	10	0	27.8	14.5	21.2	0
1961	jun	30	0.0	0	0				1
1961	jul	31	2.3	2	0	28.1	13.1	20.6	0
1961	aug	31	1.2	1	0	29.4	13.5	21.4	0
1961	sep	30	56.1	10	0	30.9	16.3	23.6	0
1961	oct	31	208.1	22	0	29.6	16.2	22.9	0
1961	nov	30	370.2	26	0	25.9	16.0	21.0	0
1961	dec	31	187.9	26	0				1
1962	jan	31	127.2	13	0				31
1962	feb	28	104.0	10	0	29.5	15.6	22.6	0
1962	mar	31	140.9	17	0	28.2	15.2	21.7	0
1962	apr	30	102.8	15	0	28.2	15.9	22.0	0
1962	may	31	125.8	13	0				3
1962	jun	30			6	28.1	12.8	20.4	0
1962	jul	31	0.0	0	0	28.6	11.0	19.8	0
1962	aug	31	135.5	4	0	29.4	14.5	22.0	0
1962	sep	30	14.3	3	0	30.0	14.9	22.5	0
1962	oct	31	200.2	11	0	29.4	16.2	22.8	0
1962	nov	30	143.8	8	0	28.8	15.5	22.2	0
1962	dec	31	157.6	9	0				1
1963	jan	31	141.8	7	0				5
1963	feb	28	99.7	4	0	29.1	15.0	22.0	0
1963	mar	31	173.0	5	0	28.7	15.2	21.9	0
1963	apr	30	195.5	8	0	26.9	15.7	21.3	0
1963	may	31	161.5	9	0	26.4	16.4	21.4	0
1963	jun	30	36.0	1	0	26.8	13.3	20.1	0
1963	jul	31	0.0	0	0	27.8	12.1	19.9	0
1963	aug	31	0.0	0	0	29.2	12.0	20.6	0
1963	sep	30	24.5	1	0	30.8	15.4	23.1	0
1963	oct	31	113.2	4	0	31.4	15.7	23.5	0
1963	nov	30			11	26.4	16.4	21.4	0
1963	dec	31	152.6	18	0	26.7	16.5	21.6	0
1964	jan	31			31	27.5	16.4	21.9	0
1964	feb	29			29	27.4	16.0	21.7	0
1964	mar	31			31	28.1	16.1	22.1	0
1964	apr	30			30	26.0	16.8	21.4	0
1964	may	31			31	26.6	14.7	20.7	0
1964	jun	30			30	27.2	12.9	20.0	0
1964	jul	31			31	26.3	10.8	18.6	0
1964	aug	31			31	28.6	13.3	21.0	0
1964	sep	30			30	29.5	14.8	22.2	0
1964	oct	31			31	29.4	15.7	22.6	0
1964	nov	30			30	27.5	16.2	21.9	0
1964	dec	31			31	26.8	15.2	21.0	0
1965	jan	31			31	27.7	15.2	21.4	0
1965	feb	28			28	27.5	15.0	21.3	0
1965	mar	31			31	27.0	15.9	21.5	0
1965	apr	30			30	27.1	16.6	21.9	0
1965	may	31			31	26.7	15.5	21.1	0
1965	jun	30			30	27.8	11.8	19.8	0
1965	jul	31			31	28.4	10.9	19.6	0

YEAR	MONTH	ND	P_m	NRD_m	MRD_m	$T_{m,max}$	$T_{m,min}$	$T_{m,ave}$	MTD_m
1965	aug	31			31	29.4	12.9	21.1	0
1965	sep	30			30	30.1	15.5	22.8	0
1965	oct	31			31	29.3	16.4	22.9	0
1965	nov	30			30	27.2	16.2	21.7	0
1965	dec	31			31	27.4	16.1	21.7	0
1966	jan	31	163.8	10	0				31
1966	feb	28	172.2	15	0				28
1966	mar	31	224.3	15	0				31
1966	apr	30	133.6	19	0				30
1966	may	31			1				31
1966	jun	30	0.0	0	0				30
1966	jul	31	0.9	1	0				31
1966	aug	31	10.8	4	0				31
1966	sep	30	50.2	12	0				30
1966	oct	31	108.9	21	0				31
1966	nov	30	110.0	20	0				30
1966	dec	31	92.4	16	0				31
1967	jan	31	51.6	10	0				31
1967	feb	28	46.5	12	0				28
1967	mar	31	82.6	19	0				31
1967	apr	30	118.9	25	0				30
1967	may	31	137.8	17	0				31
1967	jun	30	21.1	5	0				30
1967	jul	31	0.0	0	0				31
1967	aug	31	24.6	2	0				31
1967	sep	30	77.8	13	0				30
1967	oct	31	129.9	24	0				31
1967	nov	30	163.3	27	0				30
1967	dec	31	102.9	15	0				31
1968	jan	31	55.2	14	0				31
1968	feb	29	174.6	21	0				29
1968	mar	31	254.5	27	0				31
1968	apr	30	266.6	24	0				30
1968	may	31	97.1	17	0				31
1968	jun	30	18.4	7	0				30
1968	jul	31	0.0	0	0				31
1968	aug	31	0.0	0	0				31
1968	sep	30	24.9	7	0				30
1968	oct	31	132.3	14	0				31
1968	nov	30	228.2	26	0				30
1968	dec	31	107.4	19	0				31
1969	jan	31	212.6	20	0				6
1969	feb	28	140.7	19	0				8
1969	mar	31	159.8	19	0	27.5	16.5	22.0	0
1969	apr	30	165.4	19	0				1
1969	may	31	132.1	17	0	27.4	16.0	21.7	0
1969	jun	30	0.0	0	0	27.8	13.4	20.6	0
1969	jul	31	0.0	0	0	28.3	12.3	20.3	0
1969	aug	31	0.2	1	0	29.8	13.1	21.4	0
1969	sep	30	12.2	6	0				30
1969	oct	31	64.6	18	0	30.6	16.0	23.3	0
1969	nov	30	136.2	23	0				10
1969	dec	31	78.9	14	0				31
1970	jan	31	104.1	19	0				31
1970	feb	28	206.3	18	0				28
1970	mar	31	176.7	22	0	27.4	15.6	21.5	0
1970	apr	30	214.4	25	0	26.9	16.3	21.6	0

YEAR	MONTH	ND	P_m	NRD_m	MRD_m	$T_{m,max}$	$T_{m,min}$	$T_{m,ave}$	MTD_m
1970	may	31	65.7	13	0	26.9	14.8	20.9	0
1970	jun	30	4.1	1	0	27.4	11.8	19.6	0
1970	jul	31	10.7	2	0	28.1	11.9	20.0	0
1970	aug	31	22.3	3	0	29.2	13.6	21.4	0
1970	sep	30	18.0	7	0	30.9	13.8	22.4	0
1970	oct	31	62.5	6	0	30.1	15.0	22.6	0
1970	nov	30	96.9	19	0	28.2	15.9	22.0	0
1970	dec	31	211.8	21	0	26.8	15.7	21.2	0
1971	jan	31	174.9	16	0				31
1971	feb	28	104.3	15	0	27.0	14.4	20.7	0
1971	mar	31	120.2	9	0	27.9	14.7	21.3	0
1971	apr	30	207.1	22	0	27.1	16.0	21.5	0
1971	may	31	76.4	13	0	27.0	15.1	21.1	0
1971	jun	30	0.0	0	0	26.8	11.3	19.0	0
1971	jul	31	1.8	2	0	27.1	12.5	19.8	0
1971	aug	31	62.7	6	0	29.3	11.6	20.4	0
1971	sep	30	50.7	11	0	30.5	14.1	22.3	0
1971	oct	31	68.0	14	0	29.9	15.3	22.6	0
1971	nov	30	91.5	22	0	28.3	14.8	21.5	0
1971	dec	31	96.3	17	0	26.5	14.8	20.6	0
1972	jan	31	154.5	21	0				1
1972	feb	29	213.8	22	0	26.7	15.2	21.0	0
1972	mar	31	94.6	19	0				31
1972	apr	30	119.8	17	0				30
1972	may	31	88.0	15	0				31
1972	jun	30	14.5	7	0				30
1972	jul	31	0.0	0	0				31
1972	aug	31	34.7	6	0				31
1972	sep	30	61.2	11	0				30
1972	oct	31	162.7	19	0				31
1972	nov	30	150.9	24	0				30
1972	dec	31	126.9	21	0				31
1973	jan	31	89.1	16	0	28.3	16.0	22.2	0
1973	feb	28	155.0	13	0	29.2	16.6	22.9	0
1973	mar	31	104.6	20	0	28.2	15.5	21.9	0
1973	apr	30	198.7	22	0				30
1973	may	31	245.8	19	0				31
1973	jun	30	0.5	1	0				16
1973	jul	31	0.0	0	0	28.2	10.0	19.1	0
1973	aug	31	0.0	0	0	29.4	12.2	20.8	0
1973	sep	30	69.7	12	0	30.3	15.5	22.9	0
1973	oct	31	88.7	15	0	28.7	15.1	21.9	0
1973	nov	30	112.8	19	0	27.1	15.2	21.1	0
1973	dec	31	42.2	8	0	26.9	14.8	20.8	0
1974	jan	31	100.3	18	0				31
1974	feb	28	103.2	12	0	27.4	14.7	21.0	0
1974	mar	31	290.3	19	0				31
1974	apr	30	243.7	21	0				30
1974	may	31	114.1	14	0				31
1974	jun	30	25.9	5	0				30
1974	jul	31	28.1	6	0				31
1974	aug	31	1.1	2	0	29.6	11.3	20.4	0
1974	sep	30	19.9	5	0				30
1974	oct	31	35.7	9	0				31
1974	nov	30	86.1	24	0				30
1974	dec	31	59.6	16	0				31
1975	jan	31	119.5	18	0	27.8	15.3	21.5	0

YEAR	MONTH	ND	P_m	NRD_m	MRD_m	$T_{m,max}$	$T_{m,min}$	$T_{m,ave}$	MTD_m
1975	feb	28	89.4	12	0	28.6	14.4	21.5	0
1975	mar	31	121.1	18	0	27.6	15.0	21.3	0
1975	apr	30	174.3	24	0	27.2	15.9	21.6	0
1975	may	31	74.9	12	0	27.0	14.8	20.9	0
1975	jun	30	0.0	0	0	26.9	12.0	19.4	0
1975	jul	31	13.1	4	0	27.6	11.8	19.7	0
1975	aug	31	1.3	1	0	28.7	12.3	20.5	0
1975	sep	30	162.7	22	0	28.3	15.1	21.7	0
1975	oct	31	123.0	21	0	27.8	15.9	21.8	0
1975	nov	30	73.4	18	0	28.2	15.3	21.8	0
1975	dec	31	143.8	19	0	27.3	14.8	21.1	0
1976	jan	31	54.2	16	0	27.9	14.9	21.4	0
1976	feb	29	87.1	15	0	26.9	14.4	20.7	0
1976	mar	31	92.8	16	0	27.3	15.2	21.2	0
1976	apr	30	145.7	18	0	27.0	15.3	21.1	0
1976	may	31	47.8	13	0	26.4	15.1	20.8	0
1976	jun	30	0.2	2	0	27.2	11.8	19.5	0
1976	jul	31	11.6	4	0	28.3	10.9	19.6	0
1976	aug	31	21.0	5	0	29.5	13.0	21.2	0
1976	sep	30	52.7	13	0	30.5	15.2	22.9	0
1976	oct	31	66.4	10	0	30.3	15.4	22.8	0
1976	nov	30	133.3	21	0	28.3	14.9	21.6	0
1976	dec	31	152.6	22	0	28.1	14.8	21.5	0
1977	jan	31	182.1	23	0	27.2	15.1	21.1	0
1977	feb	28	75.4	17	0	27.9	15.3	21.6	0
1977	mar	31	146.9	24	0	27.7	15.2	21.5	0
1977	apr	30	328.7	27	0	26.7	15.6	21.1	0
1977	may	31	125.7	11	0	27.2	14.2	20.7	0
1977	jun	30	2.0	1	0	27.5	11.5	19.5	0
1977	jul	31	0.0	0	0	28.4	10.2	19.3	0
1977	aug	31	36.3	5	0	29.7	13.7	21.7	0
1977	sep	30	61.4	8	0	31.3	15.8	23.6	0
1977	oct	31	46.4	9	0	31.6	16.8	24.2	0
1977	nov	30	173.4	23	0	27.6	16.4	22.0	0
1977	dec	31	110.5	22	0	27.0	15.9	21.5	0
1978	jan	31			1	27.3	15.9	21.6	0
1978	feb	28	99.4	13	0	27.6	15.8	21.7	0
1978	mar	31	250.4	24	0	27.2	16.3	21.7	0
1978	apr	30	193.8	24	0	27.4	16.7	22.1	0
1978	may	31	64.0	7	0	27.4	15.1	21.2	0
1978	jun	30	2.6	2	0	27.5	12.8	20.2	0
1978	jul	31	0.0	0	0	27.9	10.2	19.0	0
1978	aug	31	24.5	5	0	29.6	11.6	20.6	0
1978	sep	30	48.6	9	0	31.1	13.7	22.4	0
1978	oct	31	117.4	18	0	30.4	15.3	22.9	0
1978	nov	30	74.5	21	0	26.4	15.4	20.9	0
1978	dec	31			1	26.3	15.3	20.8	0
1979	jan	31	262.6	21	0	27.4	15.2	21.3	0
1979	feb	28	144.0	19	0	27.7	14.8	21.3	0
1979	mar	31	105.8	17	0	28.1	15.7	21.9	0
1979	apr	30	205.4	25	0	27.0	16.5	21.7	0
1979	may	31	75.1	12	0	26.7	15.2	21.0	0
1979	jun	30	23.6	6	0	28.9	12.2	20.5	0
1979	jul	31	0.0	0	0	28.1	10.5	19.3	0
1979	aug	31	0.0	0	0	30.0	12.0	21.0	0
1979	sep	30	28.2	2	0	32.0	12.9	22.5	0
1979	oct	31	63.8	11	0	30.9	15.4	23.1	0

YEAR	MONTH	ND	P_m	NRD_m	MRD_m	$T_{m,max}$	$T_{m,min}$	$T_{m,ave}$	MTD_m
1979	nov	30	135.1	19	0	28.7	16.0	22.3	0
1979	dec	31	142.8	20	0	27.7	15.4	21.5	0
1980	jan	31	82.6	13	0	28.3	15.7	22.0	0
1980	feb	29	78.7	14	0	28.1	15.4	21.8	0
1980	mar	31	114.1	14	0	28.4	14.4	21.4	0
1980	apr	30	114.7	19	0	28.0	15.7	21.9	0
1980	may	31	70.5	18	0	27.2	16.1	21.7	0
1980	jun	30	22.2	2	0	28.2	13.0	20.6	0
1980	jul	31	0.0	0	0	28.2	12.0	20.1	0
1980	aug	31	12.5	1	0	30.3	13.5	21.9	0
1980	sep	30	58.0	13	0	31.2	16.0	23.6	0
1980	oct	31	108.8	14	0	30.4	16.4	23.4	0
1980	nov	30	153.1	23	0	28.2	16.1	22.2	0
1980	dec	31	136.2	19	0	27.8	16.4	22.1	0
1981	jan	31	78.8	17	0	28.2	15.8	22.0	0
1981	feb	28	72.4	11	0	28.6	15.7	22.1	0
1981	mar	31	156.6	21	0	27.4	16.5	22.0	0
1981	apr	30	127.7	17	0	27.2	17.1	22.2	0
1981	may	31	82.0	19	0	27.1	15.9	21.5	0
1981	jun	30	0.0	0	0	28.0	12.1	20.0	0
1981	jul	31	0.0	0	0	28.2	11.4	19.8	0
1981	aug	31	101.3	7	0	29.8	14.0	21.9	0
1981	sep	30	62.6	10	0	30.0	15.0	22.5	0
1981	oct	31	88.2	20	0	29.5	16.0	22.7	0
1981	nov	30	92.0	15	0	29.5	15.4	22.5	0
1981	dec	31	59.4	19	0	28.2	16.2	22.2	0
1982	jan	31	117.5	21	0	27.9	15.1	21.5	0
1982	feb	28	24.5	14	0	28.0	15.1	21.5	0
1982	mar	31	114.2	12	0	28.3	14.9	21.6	0
1982	apr	30	215.2	23	0	27.4	16.0	21.7	0
1982	may	31	121.0	18	0	26.8	15.7	21.3	0
1982	jun	30	11.8	4	0	27.5	12.9	20.2	0
1982	jul	31	3.2	2	0	28.2	11.0	19.6	0
1982	aug	31	0.1	1	0	29.8	12.1	20.9	0
1982	sep	30	62.3	13	0	31.5	15.2	23.3	0
1982	oct	31	84.3	20	0	28.9	16.0	22.4	0
1982	nov	30	225.5	27	0	27.4	15.6	21.5	0
1982	dec	31	148.9	18	0	27.7	15.9	21.8	0
1983	jan	31	40.5	11	0	27.6	15.7	21.7	0
1983	feb	28	167.1	17	0	28.2	16.6	22.4	0
1983	mar	31	148.1	18	0	27.8	17.4	22.6	0
1983	apr	30	228.8	22	0	27.8	17.3	22.5	0
1983	may	31	68.2	13	0	28.2	14.4	21.3	0
1983	jun	30	0.1	1	0	28.6	14.2	21.4	0
1983	jul	31	0.0	0	0	29.1	13.0	21.0	0
1983	aug	31			1	27.2	14.7	21.0	0
1983	sep	30	74.8	8	0	30.7	15.2	22.9	0
1983	oct	31	101.7	20	0	28.8	16.6	22.7	0
1983	nov	30	97.7	24	0	28.0	16.0	22.0	0
1983	dec	31	81.4	19	0	28.0	15.8	21.9	0
1984	jan	31	72.1	15	0	27.3	15.7	21.5	0
1984	feb	29	67.1	15	0	28.2	15.3	21.8	0
1984	mar	31	121.9	15	0	28.5	15.7	22.1	0
1984	apr	30	70.6	20	0	27.6	16.7	22.1	0
1984	may	31	9.4	9	0	28.0	14.5	21.3	0
1984	jun	30	0.0	0	0	27.9	12.0	20.0	0
1984	jul	31	14.4	5	0	28.2	13.9	21.0	0

YEAR	MONTH	ND	P_m	NRD_m	MRD_m	$T_{m,max}$	$T_{m,min}$	$T_{m,ave}$	MTD_m
1984	aug	31	112.4	8	0	29.8	13.8	21.8	0
1984	sep	30	65.7	9	0	31.2	14.1	22.6	0
1984	oct	31	171.6	16	0	29.0	16.0	22.5	0
1984	nov	30	291.9	28	0	27.2	16.1	21.6	0
1984	dec	31	66.6	15	0	27.3	15.7	21.5	0
1985	jan	31	113.5	21	0	27.8	15.5	21.6	0
1985	feb	28	209.0	22	0	26.7	15.9	21.3	0
1985	mar	31	77.4	14	0	27.9	15.6	21.8	0
1985	apr	30	248.5	27	0	27.1	16.3	21.7	0
1985	may	31	78.6	12	0	27.4	14.7	21.0	0
1985	jun	30	0.0	0	0	27.6	12.6	20.1	0
1985	jul	31	0.0	0	0	28.0	11.0	19.5	0
1985	aug	31	5.6	2	0	29.2	12.4	20.8	0
1985	sep	30	103.0	16	0	30.3	15.5	22.9	0
1985	oct	31	127.6	15	0	30.2	16.7	23.5	0
1985	nov	30	196.7	18	0	27.6	16.2	21.9	0
1985	dec	31	147.0	22	0	27.2	15.8	21.5	0
1986	jan	31	116.3	20	0	27.2	15.8	21.5	0
1986	feb	28	100.1	17	0	27.6	14.9	21.2	0
1986	mar	31	159.1	20	0	27.6	15.1	21.4	0
1986	apr	30	341.7	28	0	27.0	16.6	21.8	0
1986	may	31	57.5	17	0	26.8	15.8	21.3	0
1986	jun	30	43.7	2	0	27.0	11.7	19.4	0
1986	jul	31	0.0	0	0	27.7	10.4	19.0	0
1986	aug	31	1.4	2	0	30.5	11.8	21.2	0
1986	sep	30	30.1	10	0	30.8	14.8	22.8	0
1986	oct	31	182.4	19	0	30.0	16.3	23.2	0
1986	nov	30	164.0	27	0	27.3	16.1	21.7	0
1986	dec	31	51.8	20	0	26.7	16.1	21.4	0
1987	jan	31	145.3	14	0	27.5	15.9	21.7	0
1987	feb	28	63.3	11	0	28.3	15.8	22.0	0
1987	mar	31	236.6	15	0	28.5	15.9	22.2	0
1987	apr	30	211.0	21	0	28.1	16.3	22.2	0
1987	may	31	184.0	18	0	27.3	15.6	21.4	0
1987	jun	30	26.8	3	0	27.5	13.3	20.4	0
1987	jul	31	0.0	0	0	29.3	11.5	20.4	0
1987	aug	31	1.6	2	0	30.4	13.0	21.7	0
1987	sep	30	141.9	15	0	31.1	16.0	23.5	0
1987	oct	31	97.9	15	0	29.1	16.1	22.6	0
1987	nov	30	332.0	22	0	28.3	16.2	22.2	0
1987	dec	31	64.9	12	0	29.0	15.7	22.4	0
1988	jan	31	325.5	19	0	27.6	15.8	21.7	0
1988	feb	29	167.0	14	0	28.7	15.6	22.2	0
1988	mar	31	169.7	20	0	27.9	16.0	21.9	0
1988	apr	30	281.6	25	0	28.0	16.4	22.2	0
1988	may	31	36.8	8	0	28.0	14.6	21.3	0
1988	jun	30	6.2	1	0	28.7	13.0	20.9	0
1988	jul	31	0.1	1	0	28.8	12.5	20.7	0
1988	aug	31	63.8	7	0	29.2	14.2	21.7	0
1988	sep	30	30.0	11	0	30.5	14.6	22.5	0
1988	oct	31	187.3	19	0	29.5	15.8	22.6	0
1988	nov	30	80.2	19	0	27.7	16.4	22.1	0
1988	dec	31	125.6	22	0	26.8	16.1	21.4	0
1989	jan	31	31.6	13	0	26.9	16.2	21.6	0
1989	feb	28	170.4	15	0	27.3	16.0	21.7	0
1989	mar	31	119.6	20	0	27.9	15.5	21.7	0
1989	apr	30	115.2	19	0	27.1	16.3	21.7	0

YEAR	MONTH	ND	P_m	NRD_m	MRD_m	$T_{m,max}$	$T_{m,min}$	$T_{m,ave}$	MTD_m
1989	may	31	143.2	13	0	26.8	15.3	21.0	0
1989	jun	30	57.5	4	0	26.8	12.8	19.8	0
1989	jul	31	0.0	0	0	27.7	11.9	19.8	0
1989	aug	31	26.4	2	0	29.6	13.4	21.5	0
1989	sep	30	62.3	11	0	30.4	14.9	22.6	0
1989	oct	31	94.4	20	0	30.0	16.2	23.1	0
1989	nov	30	87.9	21	0	28.3	16.5	22.4	0
1989	dec	31	195.8	22	0	27.4	16.1	21.7	0
1990	jan	31	72.6	14	0	28.5	15.8	22.2	0
1990	feb	28			1	27.2	15.9	21.5	0
1990	mar	31	147.0	18	0	27.4	16.3	21.8	0
1990	apr	30	111.4	22	0	28.4	16.5	22.4	0
1990	may	31	64.6	10	0	28.0	14.9	21.4	0
1990	jun	30			1	28.6	12.1	20.4	0
1990	jul	31	0.0	0	0	28.9	10.5	19.7	0
1990	aug	31	17.8	4	0	29.6	13.4	21.5	0
1990	sep	30	79.7	11	0	30.3	15.1	22.7	0
1990	oct	31	105.0	16	0	30.3	14.8	22.6	0
1990	nov	30	110.9	20	0	28.0	15.8	21.9	0
1990	dec	31	152.5	22	0	27.0	15.3	21.2	0
1991	jan	31			1	27.7	15.7	21.7	0
1991	feb	28	86.7	13	0	28.5	15.8	22.2	0
1991	mar	31			10	28.4	16.0	22.2	0
1991	apr	30	148.2	20	0	27.7	16.5	22.1	0
1991	may	31	162.5	19	0	26.8	16.8	21.8	0
1991	jun	30	39.2	3	0	28.0	14.0	21.0	0
1991	jul	31	0.4	1	0	27.4	12.2	19.8	0
1991	aug	31	23.3	1	0	30.0	12.5	21.3	0
1991	sep	30	15.7	7	0	30.7	14.3	22.5	0
1991	oct	31	141.3	23	0	27.8	16.1	22.0	0
1991	nov	30	106.3	21	0	27.5	15.7	21.6	0
1991	dec	31	44.7	12	0	27.5	16.3	21.9	0
1992	jan	31	108.4	15	0	27.7	15.7	21.7	0
1992	feb	29	132.4	14	0	28.4	16.1	22.2	0
1992	mar	31	103.1	18	0	28.7	16.2	22.5	0
1992	apr	30	303.5	21	0	27.8	17.0	22.4	0
1992	may	31	42.7	16	0	27.5	15.7	21.6	0
1992	jun	30	7.6	5	0	27.6	14.6	21.1	0
1992	jul	31	0.0	0	0	28.1	11.4	19.7	0
1992	aug	31	0.5	1	0	29.5	11.8	20.7	0
1992	sep	30	56.8	7	0	31.3	15.4	23.4	0
1992	oct	31	117.2	19	0	30.5	15.7	23.1	0
1992	nov	30	65.7	23	0	28.3	15.9	22.1	0
1992	dec	31	143.9	22	0	27.0	15.6	21.3	0
1993	jan	31	221.1	22	0	27.2	15.6	21.4	0
1993	feb	28	50.4	13	0	27.7	15.5	21.6	0
1993	mar	31	150.5	17	0	27.5	15.0	21.2	0
1993	apr	30	270.0	21	0	28.0	16.0	22.0	0
1993	may	31	78.8	11	0	27.1	15.2	21.2	0
1993	jun	30	0.3	1	0	27.5	13.0	20.2	0
1993	jul	31	0.0	0	0	28.2	10.4	19.3	0
1993	aug	31	56.0	4	0	29.5	13.7	21.6	0
1993	sep	30	0.3	1	0	31.6	13.5	22.5	0
1993	oct	31	88.5	10	0	32.5	15.7	24.1	0
1993	nov	30	84.9	20	0	29.2	16.3	22.8	0
1993	dec	31	144.6	21	0				9
1994	jan	31	108.2	14	0	27.3	15.4	21.3	0

YEAR	MONTH	ND	P_m	NRD_m	MRD_m	$T_{m,max}$	$T_{m,min}$	$T_{m,ave}$	MTD_m
1994	feb	28	83.0	15	0	28.0	15.7	21.8	0
1994	mar	31	160.8	17	0	28.0	15.2	21.6	0
1994	apr	30	103.7	17	0	28.0	15.3	21.6	0
1994	may	31	85.8	15	0	27.3	15.6	21.4	0
1994	jun	30	0.0	0	0	28.0	12.4	20.2	0
1994	jul	31	0.0	0	0	28.6	12.2	20.4	0
1994	aug	31			1	30.1	13.1	21.6	0
1994	sep	30	1.6	1	0	31.8	16.0	23.9	0
1994	oct	31	107.8	20	0	29.3	16.3	22.8	0
1994	nov	30	218.9	15	0	27.6	16.2	21.9	0
1994	dec	31	132.1	25	0	27.4	16.6	22.0	0
1995	jan	31	80.6	10	0	27.9	16.2	22.0	0
1995	feb	28			1	27.5	15.7	21.6	0
1995	mar	31	67.4	16	0	28.3	16.0	22.2	0
1995	apr	30	163.1	19	0	27.4	16.5	22.0	0
1995	may	31	108.2	16	0	27.2	16.3	21.7	0
1995	jun	30	37.2	4	0	27.8	13.7	20.7	0
1995	jul	31	0.0	0	0	28.7	12.5	20.6	0
1995	aug	31	0.0	0	0	30.9	12.2	21.6	0
1995	sep	30	52.2	7	0	32.0	15.0	23.5	0
1995	oct	31	74.8	17	0	30.3	16.9	23.6	0
1995	nov	30	141.1	21	0	28.9	16.7	22.8	0
1995	dec	31	113.3	16	0	29.1	15.4	22.3	0
1996	jan	31	85.4	16	0	27.6	15.7	21.6	0
1996	feb	29	131.1	21	0	28.2	15.8	22.0	0
1996	mar	31	168.4	17	0	28.1	16.7	22.4	0
1996	apr	30	89.2	17	0	27.1	16.6	21.9	0
1996	may	31	21.8	13	0	28.2	16.1	22.2	0
1996	jun	30	0.0	0	0	28.2	13.2	20.7	0
1996	jul	31	2.3	2	0	28.6	12.5	20.6	0
1996	aug	31	35.0	4	0				1
1996	sep	30	88.9	12	0	29.7	15.7	22.7	0
1996	oct	31	111.2	14	0	30.7	16.6	23.7	0
1996	nov	30	103.0	18	0	28.5	16.3	22.4	0
1996	dec	31	154.2	12	0	28.0	16.0	22.0	0
1997	jan	31	136.4	14	0	27.6	16.0	21.8	0
1997	feb	28	58.5	9	0	27.8	15.6	21.7	0
1997	mar	31	199.9	22	0	28.8	16.5	22.6	0
1997	apr	30	297.6	24	0	27.1	16.1	21.6	0
1997	may	31	93.7	16	0	27.1	15.2	21.2	0
1997	jun	30	3.7	3	0	27.6	13.5	20.5	0
1997	jul	31	0.0	0	0	28.0	12.5	20.3	0
1997	aug	31	24.0	4	0	30.7	12.6	21.7	0
1997	sep	30	14.8	2	0	33.1	15.2	24.1	0
1997	oct	31	174.7	19	0	30.0	16.7	23.3	0
1997	nov	30	215.8	24	0				30
1997	dec	31	361.8	27	0	26.9	17.5	22.2	0
1998	jan	31	188.3	22	0	27.8	17.3	22.6	0
1998	feb	28	137.8	18	0	29.0	17.6	23.3	0
1998	mar	31	228.7	22	0	29.3	17.6	23.4	0
1998	apr	30	125.5	23	0	28.5	18.4	23.4	0
1998	may	31	46.8	12	0	28.1	17.0	22.6	0
1998	jun	30	7.4	3	0	28.4	13.6	21.0	0
1998	jul	31	0.0	0	0				1
1998	aug	31	0.2	1	0	30.0	13.5	21.8	0
1998	sep	30	42.4	9	0	31.8	15.5	23.7	0
1998	oct	31	70.1	13	0				31

YEAR	MONTH	ND	P_m	NRD_m	MRD_m	$T_{m,max}$	$T_{m,min}$	$T_{m,ave}$	MTD_m
1998	nov	30	59.3	13	0	29.7	16.0	22.8	0
1998	dec	31	57.4	16	0	28.1	15.9	22.0	0
1999	jan	31			1	28.3	15.6	22.0	0
1999	feb	28	15.5	5	0	30.4	15.5	23.0	0
1999	mar	31	247.1	20	0	27.7	15.4	21.6	0
1999	apr	30			1	27.6	16.2	21.9	0
1999	may	31	41.5	9	0	28.1	14.9	21.5	0
1999	jun	30	0.0	0	0	28.4	12.8	20.6	0
1999	jul	31	0.0	0	0	28.8	11.6	20.2	0
1999	aug	31	17.7	7	0	29.1	15.4	22.3	0
1999	sep	30	42.2	12	0	30.3	15.2	22.8	0
1999	oct	31	49.2	10	0	31.3	15.4	23.4	0
1999	nov	30	122.1	24	0	27.9	16.1	22.0	0
1999	dec	31	133.0	20	0	27.9	16.4	22.2	0
2000	jan	31	86.0	13	0	28.3	15.7	22.0	0
2000	feb	29	36.5	12	0	28.3	15.1	21.7	0
2000	mar	31	221.3	18	0	27.9	15.8	21.9	0
2000	apr	30	87.0	13	0	28.3	15.8	22.1	0
2000	may	31	21.7	2	0	29.4	15.0	22.2	0
2000	jun	30	2.2	2	0	29.1	13.3	21.2	0
2000	jul	31	0.0	0	0	29.7	11.8	20.7	0
2000	aug	31	0.0	0	0	31.2	13.8	22.5	0
2000	sep	30	10.8	8	0				1
2000	oct	31	85.8	14	0	31.8	16.5	24.2	0
2000	nov	30			1	28.6	17.1	22.8	0
2000	dec	31	169.2	19	0				1
2001	jan	31	125.1	21	0	26.6	16.5	21.5	0
2001	feb	28	134.3	15	0	28.7	15.9	22.3	0
2001	mar	31	141.0	22	0	28.6	16.1	22.3	0
2001	apr	30	139.3	13	0				1
2001	may	31	54.5	14	0	27.3	16.2	21.7	0
2001	jun	30	1.8	1	0	27.9	13.3	20.6	0
2001	jul	31	0.0	0	0	28.2	12.4	20.3	0
2001	aug	31	2.5	2	0	30.2	12.9	21.5	0
2001	sep	30	162.0	15	0	30.5	15.4	22.9	0
2001	oct	31	165.8	18	0				1
2001	nov	30	222.6	23	0				1
2001	dec	31	70.6	16	0				10
2002	jan	31	142.8	20	0				31
2002	feb	28	40.9	10	0				28
2002	mar	31	158.8	24	0				31
2002	apr	30	166.8	22	0				30
2002	may	31	166.0	9	0				31
2002	jun	30	0.0	0	0				30
2002	jul	31	0.0	0	0				31
2002	aug	31	0.0	0	0				31
2002	sep	30	15.0	3	0				30
2002	oct	31	49.6	13	0				31
2002	nov	30	142.4	20	0				30
2002	dec	31	160.4	23	0				31
2003	jan	31	119.7	11	0				18
2003	feb	28	62.8	8	0	30.7	16.4	23.6	0
2003	mar	31	77.8	16	0				1
2003	apr	30	199.3	21	0	28.2	16.5	22.3	0
2003	may	31	135.3	13	0				1
2003	jun	30	0.0	0	0	28.3	15.6	21.9	0
2003	jul	31	0.0	0	0	29.1	12.4	20.8	0

YEAR	MONTH	ND	P_m	NRD_m	MRD_m	$T_{m,max}$	$T_{m,min}$	$T_{m,ave}$	MTD_m
2003	aug	31	18.0	4	0	31.4	12.7	22.0	0
2003	sep	30	62.5	11	0				1
2003	oct	31	112.3	13	0	31.1	14.9	23.0	0
2003	nov	30	113.7	18	0				1
2003	dec	31	128.1	15	0	28.6	16.1	22.3	0
2004	jan	31	138.9	19	0				7
2004	feb	29	166.6	18	0				7
2004	mar	31	244.9	21	0	28.7	15.7	22.2	0
2004	apr	30	224.0	19	0	27.5	15.5	21.5	0
2004	may	31	36.0	2	0	29.3	16.2	22.7	0
2004	jun	30	0.0	0	0	29.5	16.4	22.9	0
2004	jul	31	0.0	0	0	30.3	13.8	22.1	0
2004	aug	31	2.9	2	0				31
2004	sep	30	47.9	11	0	31.8	12.2	22.0	0
2004	oct	31	88.1	19	0				31
2004	nov	30	131.5	21	0				30
2004	dec	31	76.8	13	0				31
2005	jan	31	121.5	10	0				31
2005	feb	28	50.5	6	0				28
2005	mar	31	133.2	11	0				31
2005	apr	30	69.0	6	0	29.8	12.2	21.0	0
2005	may	31	52.1	8	0	28.6	15.6	22.1	0
2005	jun	30	0.5	1	0	29.1	17.0	23.0	0
2005	jul	31	0.0	0	0	29.3	17.0	23.2	0
2005	aug	31	0.0	0	0	31.0	16.2	23.6	0
2005	sep	30	26.5	4	0	31.7	16.1	23.9	0
2005	oct	31	30.7	4	0	31.4	17.3	24.3	0
2005	nov	30	54.2	7	0	28.5	17.4	23.0	0
2005	dec	31				28.1	17.1	22.6	0

ND = number of days of the month; P_m = rainfall depth (mm); NRD_m = number of rainy days (days); MRD_m = missing daily rainfall data (days); $T_{m,max}$ = maximum air temperature (°C); $T_{m,min}$ = minimum air temperature (°C); $T_{m,ave}$ = average air temperature (°C); MTD_m = missing daily temperature data (days). The P_m and NRD_m data are listed for those months with a complete record of daily rainfall values ($MRD_m = 0$). The $T_{m,max}$, $T_{m,min}$ and $T_{m,ave}$ data are listed for those months with a complete record of daily temperature values ($MTD_m = 0$).

Table 7. Monthly rainfall data for the MUYAGA station

YEAR	MONTH	ND	P_m	NRD_m	MRD_m
1960	jan	31	119.8	20	0
1960	feb	29	112.2	16	0
1960	mar	31	209.2	18	0
1960	apr	30	196.2	21	0
1960	may	31	14.1	4	0
1960	jun	30	0.4	1	0
1960	jul	31	0.0	0	0
1960	aug	31	0.0	0	0
1960	sep	30	32.3	7	0
1960	oct	31	56.7	6	0
1960	nov	30	116.0	22	0
1960	dec	31	31.3	10	0
1961	jan	31	68.9	17	0
1961	feb	28	201.7	17	0
1961	mar	31	134.1	25	0
1961	apr	30	246.0	21	0
1961	may	31	47.5	10	0
1961	jun	30	0.0	0	0
1961	jul	31	4.6	1	0
1961	aug	31			31
1961	sep	30			30
1961	oct	31	176.0	14	0
1961	nov	30	266.0	21	0
1961	dec	31			31
1962	jan	31	138.0	20	0
1962	feb	28	88.0	11	0
1962	mar	31	105.0	18	0
1962	apr	30	238.0	17	0
1962	may	31	206.0	12	0
1962	jun	30	12.0	2	0
1962	jul	31	21.0	2	0
1962	aug	31	41.0	5	0
1962	sep	30	12.0	2	0
1962	oct	31	190.0	16	0
1962	nov	30	181.1	17	0
1962	dec	31	145.0	18	0
1963	jan	31			31
1963	feb	28	162.0	15	0
1963	mar	31	166.0	18	0
1963	apr	30	225.0	20	0
1963	may	31	141.0	17	0
1963	jun	30	20.0	1	0
1963	jul	31	0.0	0	0
1963	aug	31	10.4	2	0
1963	sep	30	11.5	3	0
1963	oct	31	12.5	4	0
1963	nov	30	260.0	19	0
1963	dec	31	304.0	19	0
1964	jan	31	122.6	14	0
1964	feb	29	208.1	14	0
1964	mar	31	143.5	14	0
1964	apr	30	339.0	26	0
1964	may	31	47.0	3	0
1964	jun	30	32.7	3	0
1964	jul	31	26.0	3	0
1964	aug	31	0.0	0	0
1964	sep	30	16.4	3	0
1964	oct	31	142.4	14	0
1964	nov	30	105.0	20	0
1964	dec	31	135.7	23	0
1965	jan	31	114.2	14	0
1965	feb	28	106.5	19	0
1965	mar	31	188.8	23	0
1965	apr	30	165.4	27	0
1965	may	31	38.2	9	0
1965	jun	30	0.0	0	0
1965	jul	31	0.0	0	0
1965	aug	31	2.5	1	0
1965	sep	30	123.5	13	0
1965	oct	31	108.4	16	0
1965	nov	30	222.2	24	0
1965	dec	31	104.2	24	0
1966	jan	31	97.4	17	0
1966	feb	28	267.5	25	0
1966	mar	31	141.3	28	0
1966	apr	30	258.2	23	0
1966	may	31	26.7	7	0
1966	jun	30	0.0	0	0
1966	jul	31	0.0	0	0
1966	aug	31	0.0	0	0
1966	sep	30	55.7	6	0
1966	oct	31	188.0	15	0
1966	nov	30	179.4	19	0
1966	dec	31	152.9	20	0
1967	jan	31	153.1	11	0
1967	feb	28	139.5	9	0
1967	mar	31	138.1	10	0
1967	apr	30	282.8	20	0
1967	may	31	122.7	16	0
1967	jun	30	0.0	0	0
1967	jul	31			31
1967	aug	31			31
1967	sep	30			30
1967	oct	31			31
1967	nov	30			30
1967	dec	31			31
1968	jan	31			31
1968	feb	29			29
1968	mar	31			31
1968	apr	30			30
1968	may	31	148.3	13	0
1968	jun	30	5.8	3	0
1968	jul	31	0.0	0	0
1968	aug	31	0.0	0	0
1968	sep	30			30
1968	oct	31			9
1968	nov	30	218.3	26	0
1968	dec	31	162.3	18	0
1969	jan	31	166.3	19	0
1969	feb	28	161.4	18	0

YEAR	MONTH	ND	P_m	NRD_m	MRD_m
1969	mar	31	130.9	20	0
1969	apr	30	106.0	11	0
1969	may	31	81.3	9	0
1969	jun	30	0.0	0	0
1969	jul	31	0.3	1	0
1969	aug	31	0.0	0	0
1969	sep	30	37.3	3	0
1969	oct	31	114.5	12	0
1969	nov	30	153.4	18	0
1969	dec	31	164.0	22	0
1970	jan	31	177.2	18	0
1970	feb	28	250.3	21	0
1970	mar	31	227.7	21	0
1970	apr	30	190.0	17	0
1970	may	31	64.5	5	0
1970	jun	30	3.0	1	0
1970	jul	31	0.0	0	0
1970	aug	31	6.0	1	0
1970	sep	30	49.2	5	0
1970	oct	31	37.2	3	0
1970	nov	30	78.1	7	0
1970	dec	31	108.3	11	0
1971	jan	31	193.9	10	0
1971	feb	28	55.4	5	0
1971	mar	31	104.9	8	0
1971	apr	30	217.8	12	0
1971	may	31	69.5	7	0
1971	jun	30	0.0	0	0
1971	jul	31	0.6	1	0
1971	aug	31	72.0	2	0
1971	sep	30	31.2	5	0
1971	oct	31	30.1	5	0
1971	nov	30	93.7	4	0
1971	dec	31	147.4	15	0
1972	jan	31	88.6	11	0
1972	feb	29	175.3	14	0
1972	mar	31	164.3	13	0
1972	apr	30	118.9	10	0
1972	may	31	101.8	7	0
1972	jun	30	26.0	2	0
1972	jul	31			31
1972	aug	31	38.7	2	0
1972	sep	30	143.1	8	0
1972	oct	31	67.0	8	0
1972	nov	30	184.0	17	0
1972	dec	31	181.0	13	0
1973	jan	31	106.3	7	0
1973	feb	28	165.7	9	0
1973	mar	31	177.6	11	0
1973	apr	30	149.7	13	0
1973	may	31	107.3	8	0
1973	jun	30	0.0	0	0
1973	jul	31	0.0	0	0
1973	aug	31	0.0	0	0
1973	sep	30	26.2	5	0
1973	oct	31	70.3	7	0
1973	nov	30	147.2	11	0

YEAR	MONTH	ND	P_m	NRD_m	MRD_m
1973	dec	31	109.9	10	0
1974	jan	31	46.1	5	0
1974	feb	28	70.5	10	0
1974	mar	31	154.6	11	0
1974	apr	30	103.0	15	0
1974	may	31	37.6	10	0
1974	jun	30	3.2	1	0
1974	jul	31	7.5	3	0
1974	aug	31	22.8	3	0
1974	sep	30	14.0	4	0
1974	oct	31	83.7	7	0
1974	nov	30	159.4	13	0
1974	dec	31	87.6	12	0
1975	jan	31	107.2	7	0
1975	feb	28	115.0	10	0
1975	mar	31	282.5	17	0
1975	apr	30	208.7	17	0
1975	may	31	51.9	10	0
1975	jun	30	0.3	1	0
1975	jul	31	60.7	3	0
1975	aug	31	0.0	0	0
1975	sep	30	43.0	7	0
1975	oct	31	200.4	13	0
1975	nov	30	122.6	11	0
1975	dec	31	109.8	12	0
1976	jan	31	52.0	7	0
1976	feb	29	93.6	4	0
1976	mar	31	175.5	10	0
1976	apr	30	165.9	16	0
1976	may	31	60.3	6	0
1976	jun	30	0.0	0	0
1976	jul	31	20.0	2	0
1976	aug	31	25.7	4	0
1976	sep	30	59.1	8	0
1976	oct	31	72.3	7	0
1976	nov	30	163.3	15	0
1976	dec	31	236.1	21	0
1977	jan	31	193.6	12	0
1977	feb	28	183.0	12	0
1977	mar	31	97.0	8	0
1977	apr	30	187.8	18	0
1977	may	31	142.6	9	0
1977	jun	30	0.0	0	0
1977	jul	31	0.0	0	0
1977	aug	31	42.1	4	0
1977	sep	30	28.7	6	0
1977	oct	31	119.3	4	0
1977	nov	30	254.5	17	0
1977	dec	31	172.1	13	0
1978	jan	31	115.0	9	0
1978	feb	28	270.6	11	0
1978	mar	31	200.7	17	0
1978	apr	30	156.2	18	0
1978	may	31	67.5	6	0
1978	jun	30			30
1978	jul	31			31
1978	aug	31			31

YEAR	MONTH	ND	P_m	NRD_m	MRD_m
1978	sep	30			30
1978	oct	31			31
1978	nov	30			30
1978	dec	31	288.7	24	0
1979	jan	31	164.5	14	0
1979	feb	28	146.9	10	0
1979	mar	31	167.8	12	0
1979	apr	30	217.9	18	0
1979	may	31	114.1	7	0
1979	jun	30	29.4	3	0
1979	jul	31	0.0	0	0
1979	aug	31	0.0	0	0
1979	sep	30	9.0	2	0
1979	oct	31	64.9	6	0
1979	nov	30	163.4	14	0
1979	dec	31	180.3	15	0
1980	jan	31	151.5	13	0
1980	feb	29	90.6	7	0
1980	mar	31	130.0	11	0
1980	apr	30	80.8	12	0
1980	may	31	98.9	11	0
1980	jun	30	1.5	1	0
1980	jul	31	0.0	0	0
1980	aug	31	0.0	0	0
1980	sep	30	72.4	4	0
1980	oct	31	58.3	6	0
1980	nov	30	114.1	6	0
1980	dec	31	125.4	4	0
1981	jan	31	173.5	9	0
1981	feb	28	143.9	11	0
1981	mar	31	202.7	17	0
1981	apr	30	183.8	14	0
1981	may	31	211.0	13	0
1981	jun	30	0.0	0	0
1981	jul	31	0.0	0	0
1981	aug	31	51.7	3	0
1981	sep	30	56.4	7	0
1981	oct	31	122.4	10	0
1981	nov	30	132.3	8	0
1981	dec	31	158.1	14	0
1982	jan	31	90.4	11	0
1982	feb	28	66.0	9	0
1982	mar	31	100.6	6	0
1982	apr	30	223.4	15	0
1982	may	31	160.3	17	0
1982	jun	30	8.3	1	0
1982	jul	31	4.2	1	0
1982	aug	31	0.0	0	0
1982	sep	30	42.9	5	0
1982	oct	31	92.4	6	0
1982	nov	30	309.9	15	0
1982	dec	31	184.3	13	0
1983	jan	31	96.7	6	0
1983	feb	28	165.7	10	0
1983	mar	31	123.1	8	0
1983	apr	30	270.2	13	0
1983	may	31	67.5	6	0

YEAR	MONTH	ND	P_m	NRD_m	MRD_m
1983	jun	30	0.0	0	0
1983	jul	31	0.0	0	0
1983	aug	31	44.9	2	0
1983	sep	30	19.6	3	0
1983	oct	31	133.0	12	0
1983	nov	30	191.2	19	0
1983	dec	31	146.0	14	0
1984	jan	31	244.8	20	0
1984	feb	29	50.1	11	0
1984	mar	31	136.3	11	0
1984	apr	30	148.7	17	0
1984	may	31	29.7	2	0
1984	jun	30	0.0	0	0
1984	jul	31	23.2	4	0
1984	aug	31	14.3	1	0
1984	sep	30	21.7	2	0
1984	oct	31	113.6	8	0
1984	nov	30	186.3	17	0
1984	dec	31	122.4	10	0
1985	jan	31	155.8	10	0
1985	feb	28	183.7	18	0
1985	mar	31	104.7	11	0
1985	apr	30	209.5	24	0
1985	may	31	64.9	5	0
1985	jun	30	0.0	0	0
1985	jul	31	0.0	0	0
1985	aug	31	0.0	0	0
1985	sep	30	98.0	9	0
1985	oct	31	121.5	8	0
1985	nov	30	177.7	6	0
1985	dec	31	89.0	6	0
1986	jan	31	128.8	12	0
1986	feb	28	201.8	13	0
1986	mar	31	138.2	11	0
1986	apr	30	218.4	22	0
1986	may	31	63.0	10	0
1986	jun	30	0.0	0	0
1986	jul	31	0.0	0	0
1986	aug	31	3.4	1	0
1986	sep	30	3.5	1	0
1986	oct	31	101.1	9	0
1986	nov	30	250.6	18	0
1986	dec	31	165.6	21	0
1987	jan	31	206.5	19	0
1987	feb	28	68.2	7	0
1987	mar	31	101.4	11	0
1987	apr	30	143.1	15	0
1987	may	31	73.1	7	0
1987	jun	30	0.0	0	0
1987	jul	31	0.0	0	0
1987	aug	31	12.2	1	0
1987	sep	30	85.1	10	0
1987	oct	31	90.2	8	0
1987	nov	30	332.2	13	0
1987	dec	31	114.7	9	0
1988	jan	31	261.0	18	0
1988	feb	29	95.4	5	0

YEAR	MONTH	ND	P_m	NRD_m	MRD_m
1988	mar	31	237.4	17	0
1988	apr	30	325.7	16	0
1988	may	31	59.0	2	0
1988	jun	30	0.0	0	0
1988	jul	31	0.0	0	0
1988	aug	31	54.3	4	0
1988	sep	30	49.7	5	0
1988	oct	31	155.3	6	0
1988	nov	30	173.2	11	0
1988	dec	31	180.9	15	0
1989	jan	31	202.4	19	0
1989	feb	28	203.8	13	0
1989	mar	31	205.7	20	0
1989	apr	30	125.1	13	0
1989	may	31	51.8	9	0
1989	jun	30	3.5	1	0
1989	jul	31	0.0	0	0
1989	aug	31	22.3	1	0
1989	sep	30	74.7	7	0
1989	oct	31	55.3	9	0
1989	nov	30	216.7	14	0
1989	dec	31	248.9	15	0
1990	jan	31	24.4	5	0
1990	feb	28	248.5	17	0
1990	mar	31	277.4	18	0
1990	apr	30	94.2	14	0
1990	may	31	114.4	6	0
1990	jun	30	0.0	0	0
1990	jul	31	0.0	0	0
1990	aug	31	0.0	0	0
1990	sep	30	106.3	7	0
1990	oct	31	65.4	13	0
1990	nov	30	160.4	14	0
1990	dec	31	157.6	15	0
1991	jan	31	95.7	12	0
1991	feb	28	196.8	13	0
1991	mar	31	167.1	10	0
1991	apr	30	137.1	13	0
1991	may	31	157.0	15	0
1991	jun	30	7.9	2	0
1991	jul	31	0.0	0	0
1991	aug	31	0.0	0	0
1991	sep	30	0.0	0	0
1991	oct	31	176.4	12	0
1991	nov	30	190.2	16	0
1991	dec	31	204.8	14	0
1992	jan	31	148.3	16	0
1992	feb	29	176.4	11	0
1992	mar	31	159.5	16	0
1992	apr	30	148.0	12	0
1992	may	31	135.8	9	0
1992	jun	30	2.5	1	0
1992	jul	31	0.0	0	0
1992	aug	31	0.0	0	0
1992	sep	30	26.8	4	0
1992	oct	31	130.7	9	0
1992	nov	30	226.3	15	0

YEAR	MONTH	ND	P_m	NRD_m	MRD_m
1992	dec	31	192.0	19	0
1993	jan	31	138.3	11	0
1993	feb	28	132.7	12	0
1993	mar	31	133.9	14	0
1993	apr	30	198.8	14	0
1993	may	31	119.7	10	0
1993	jun	30	0.0	0	0
1993	jul	31	0.0	0	0
1993	aug	31	24.8	2	0
1993	sep	30	0.0	0	0
1993	oct	31	18.8	4	0
1993	nov	30	138.0	9	0
1993	dec	31	161.2	13	0
1994	jan	31	205.4	13	0
1994	feb	28	159.4	13	0
1994	mar	31	122.2	11	0
1994	apr	30	156.7	11	0
1994	may	31	93.2	5	0
1994	jun	30	0.0	0	0
1994	jul	31	0.0	0	0
1994	aug	31	0.0	0	0
1994	sep	30	10.1	1	0
1994	oct	31	91.9	9	0
1994	nov	30	143.6	12	0
1994	dec	31	83.5	7	0
1995	jan	31	145.6	13	0
1995	feb	28	165.6	10	0
1995	mar	31	159.7	10	0
1995	apr	30	180.5	14	0
1995	may	31	136.5	9	0
1995	jun	30	24.4	2	0
1995	jul	31	0.0	0	0
1995	aug	31	0.0	0	0
1995	sep	30	10.1	1	0
1995	oct	31	91.9	9	0
1995	nov	30	143.6	12	0
1995	dec	31	83.5	7	0
1996	jan	31	118.7	9	0
1996	feb	29	193.6	17	0
1996	mar	31	161.1	13	0
1996	apr	30	126.3	15	0
1996	may	31	72.1	9	0
1996	jun	30	0.0	0	0
1996	jul	31	0.0	0	0
1996	aug	31	0.0	0	0
1996	sep	30	10.0	1	0
1996	oct	31	205.6	15	0
1996	nov	30	319.9	14	0
1996	dec	31	257.6	19	0
1997	jan	31	151.2	14	0
1997	feb	28	84.1	8	0
1997	mar	31	121.2	15	0
1997	apr	30	263.5	14	0
1997	may	31	153.8	8	0
1997	jun	30	0.0	0	0
1997	jul	31	0.0	0	0
1997	aug	31	0.0	0	0

YEAR	MONTH	ND	P_m	NRD_m	MRD_m
1997	sep	30	0.0	0	0
1997	oct	31	102.6	10	0
1997	nov	30	32.4	5	0
1997	dec	31	132.5	9	0
1998	jan	31	146.8	16	0
1998	feb	28	100.5	8	0
1998	mar	31	208.2	11	0
1998	apr	30	107.7	13	0
1998	may	31	44.8	9	0
1998	jun	30	15.3	2	0
1998	jul	31	0.0	0	0
1998	aug	31	0.0	0	0
1998	sep	30	0.0	0	0
1998	oct	31	102.6	10	0
1998	nov	30	32.4	5	0
1998	dec	31	132.5	9	0
1999	jan	31	113.2	11	0
1999	feb	28	86.9	5	0
1999	mar	31	156.5	15	0
1999	apr	30	115.9	6	0
1999	may	31	24.4	5	0
1999	jun	30	0.0	0	0
1999	jul	31	0.0	0	0
1999	aug	31	80.4	2	0
1999	sep	30	20.6	5	0
1999	oct	31	19.1	4	0
1999	nov	30	183.1	14	0
1999	dec	31			1
2000	jan	31	96.6	15	0
2000	feb	29	86.7	8	0
2000	mar	31	200.1	13	0
2000	apr	30	43.5	4	0
2000	may	31	20.5	2	0
2000	jun	30	0.0	0	0
2000	jul	31	0.0	0	0
2000	aug	31	0.0	0	0
2000	sep	30	10.1	2	0
2000	oct	31	42.7	4	0
2000	nov	30	192.2	15	0
2000	dec	31	229.7	13	0
2001	jan	31	218.0	11	0
2001	feb	28	99.5	7	0
2001	mar	31	208.0	14	0
2001	apr	30	78.4	5	0
2001	may	31	55.6	4	0
2001	jun	30	0.0	0	0
2001	jul	31	57.9	3	0
2001	aug	31	29.8	3	0
2001	sep	30	58.4	10	0
2001	oct	31	117.5	6	0
2001	nov	30	106.9	6	0
2001	dec	31	138.9	14	0
2002	jan	31	190.6	8	0
2002	feb	28	37.2	6	0
2002	mar	31	129.7	9	0
2002	apr	30	224.9	18	0
2002	may	31	110.5	2	0
2002	jun	30	0.0	0	0
2002	jul	31	0.0	0	0
2002	aug	31	0.0	0	0
2002	sep	30	78.6	4	0
2002	oct	31	10.5	1	0
2002	nov	30	234.1	15	0
2002	dec	31	216.5	18	0
2003	jan	31	112.8	10	0
2003	feb	28	90.4	9	0
2003	mar	31	165.7	9	0
2003	apr	30	126.2	7	0
2003	may	31	95.7	7	0
2003	jun	30	0.0	0	0
2003	jul	31	0.0	0	0
2003	aug	31	0.0	0	0
2003	sep	30	77.1	3	0
2003	oct	31	103.4	5	0
2003	nov	30	156.7	14	0
2003	dec	31	213.2	15	0
2004	jan	31	139.6	16	0
2004	feb	29	81.6	8	0
2004	mar	31	75.8	10	0
2004	apr	30	251.4	11	0
2004	may	31	0.0	0	0
2004	jun	30	0.0	0	0
2004	jul	31	0.0	0	0
2004	aug	31	4.8	1	0
2004	sep	30	52.8	6	0
2004	oct	31	38.9	4	0
2004	nov	30	131.9	12	0
2004	dec	31	284.0	16	0
2005	jan	31	116.7	9	0
2005	feb	28	38.6	5	0
2005	mar	31	162.7	11	0
2005	apr	30	115.6	8	0
2005	may	31	76.5	8	0
2005	jun	30	3.4	1	0
2005	jul	31	0.0	0	0
2005	aug	31	17.2	1	0
2005	sep	30	1.9	1	0
2005	oct	31	100.6	10	0
2005	nov	30	69.3	9	0
2005	dec	31	95.3	10	0

ND = number of days of the month; P_m = rainfall depth (mm); NRD_m = number of rainy days (days); *MRD* = missing daily rainfall data (days). The P_m and NRD_m data are listed for those months with a complete record of daily rainfall values ($MRD_m = 0$).

Table 8. Summary of the monthly rainfall, P_m (mm), and number of rainy days, NRD_m (days), data for the CANKUZO station

MONTH	VARIABLE	ALL COMPLETE MONTHS					ONLY COMPLETE YEARS				
		N	min	max	M	CV	N	min	max	M	CV
jan	P_m	31	38.1	326.9	160.4	40.1	28	38.1	326.9	164.0	40.0
	NRD_m	31	10.0	23.0	17.6	16.7	28	10.0	23.0	17.6	17.5
feb	P_m	32	39.8	261.8	131.0	45.3	28	39.8	261.8	137.6	43.7
	NRD_m	32	8.0	21.0	14.1	23.6	28	8.0	21.0	14.1	25.0
mar	P_m	32	65.4	288.8	152.2	30.3	28	65.4	288.8	153.0	31.4
	NRD_m	32	10.0	26.0	17.2	21.1	28	10.0	26.0	17.3	22.0
apr	P_m	32	59.9	283.0	170.0	32.0	28	85.4	283.0	171.9	30.0
	NRD_m	32	10.0	26.0	18.6	24.2	28	10.0	26.0	18.5	22.5
may	P_m	31	0.0	210.6	84.6	57.5	28	0.0	210.6	84.8	56.3
	NRD_m	31	0.0	19.0	11.0	41.2	28	0.0	19.0	11.3	38.9
jun	P_m	32	0.0	34.6	4.3	186.5	28	0.0	21.1	3.6	171.8
	NRD_m	32	0.0	4.0	1.0	116.4	28	0.0	4.0	1.0	121.3
jul	P_m	32	0.0	66.0	6.0	257.3	28	0.0	66.0	6.6	247.9
	NRD_m	32	0.0	6.0	0.8	190.7	28	0.0	4.0	0.8	183.7
aug	P_m	32	0.0	49.9	13.5	128.3	28	0.0	49.9	13.5	129.1
	NRD_m	32	0.0	6.0	1.6	101.9	28	0.0	6.0	1.7	100.0
sep	P_m	32	0.0	155.1	43.0	84.8	28	3.0	155.1	46.8	79.1
	NRD_m	32	0.0	16.0	6.9	56.2	28	2.0	16.0	7.3	51.9
oct	P_m	32	13.9	170.4	91.0	53.5	28	21.9	170.4	98.9	46.8
	NRD_m	32	4.0	19.0	12.4	30.3	28	5.0	19.0	13.0	26.6
nov	P_m	31	37.5	309.2	160.0	36.8	28	37.5	309.2	159.6	38.5
	NRD_m	31	8.0	26.0	18.0	22.2	28	8.0	26.0	17.8	22.1
dec	P_m	33	61.1	310.7	172.7	39.7	28	61.1	310.7	174.9	40.8
	NRD_m	33	11.0	28.0	19.5	19.4	28	11.0	28.0	19.5	20.8

N=sample size (years); *min* =minimum value; *max* = maximum value; *M* = mean; *CV* = coefficient of variation (%).

Table 9. Summary of the monthly rainfall, P_m (mm), and number of rainy days, NRD_m (days), data for the KINYINIA station

MONTH	VARIABLE	ALL COMPLETE MONTHS					ONLY COMPLETE YEARS				
		N	min	max	M	CV	N	min	max	M	CV
jan	P_m	39	33.3	374.5	158.9	47.2	31	33.3	374.5	154.8	51.0
	NRD_m	39	5.0	24.0	15.0	28.5	31	5.0	24.0	15.1	30.7
feb	P_m	38	4.0	261.5	127.3	48.1	31	4.0	251.5	122.0	50.4
	NRD_m	38	2.0	23.0	12.5	35.5	31	2.0	23.0	12.4	38.0
mar	P_m	39	47.2	341.1	170.2	40.0	31	47.2	341.1	171.1	41.6
	NRD_m	39	7.0	23.0	17.2	23.2	31	7.0	23.0	17.0	23.0
apr	P_m	39	23.9	375.2	197.5	38.1	31	23.9	371.1	198.3	36.3
	NRD_m	39	7.0	24.0	18.3	23.1	31	7.0	24.0	18.6	23.5
may	P_m	39	0.0	296.0	86.8	71.9	31	0.0	296.0	87.5	70.6
	NRD_m	39	0.0	19.0	9.8	48.5	31	0.0	19.0	9.8	46.2
jun	P_m	39	0.0	44.6	6.2	194.1	31	0.0	44.6	6.2	188.6
	NRD_m	39	0.0	4.0	0.9	139.7	31	0.0	4.0	0.8	144.7
jul	P_m	39	0.0	37.4	2.0	342.6	31	0.0	37.4	2.3	333.1
	NRD_m	39	0.0	4.0	0.4	235.4	31	0.0	4.0	0.4	246.7
aug	P_m	39	0.0	46.6	5.2	202.9	31	0.0	46.6	5.9	201.0
	NRD_m	39	0.0	4.0	1.0	125.7	31	0.0	4.0	0.9	138.2
sep	P_m	38	0.0	115.5	36.2	80.0	31	0.0	115.5	38.2	75.9
	NRD_m	38	0.0	10.0	4.9	52.8	31	0.0	10.0	5.3	48.9
oct	P_m	35	9.4	315.4	88.4	64.7	31	9.4	215.9	82.2	52.6
	NRD_m	35	2.0	20.0	11.4	36.9	31	2.0	20.0	11.3	34.8
nov	P_m	36	36.3	322.7	145.9	50.9	31	36.3	322.7	151.6	49.5
	NRD_m	36	3.0	27.0	16.5	32.1	31	3.0	27.0	16.9	32.4
dec	P_m	37	39.9	439.4	169.6	44.2	31	39.9	439.4	170.2	47.5
	NRD_m	37	7.0	24.0	17.6	22.1	31	7.0	24.0	17.8	22.3

N=sample size (years); *min*= minimum value; *max* = maximum value; *M* = mean; *CV* = coefficient of variation (%).

Table 10. Summary of the monthly rainfall, P_m (mm), and number of rainy days, NRD_m (days), data for the MURIZA station

MONTH	VARIABLE	ALL COMPLETE MONTHS					ONLY COMPLETE YEARS				
		N	min	max	M	CV	N	min	max	M	CV
jan	P_m	31	22.3	362.3	152.5	47.2	28	22.3	362.3	158.2	46.2
	NRD_m	31	12.0	25.0	18.6	21.3	28	13.0	25.0	18.9	19.9
feb	P_m	31	41.9	268.4	125.9	44.2	28	41.9	268.4	125.2	45.8
	NRD_m	31	7.0	23.0	15.7	27.2	28	7.0	23.0	15.5	28.3
mar	P_m	31	76.3	298.3	173.9	35.3	28	82.4	298.3	183.3	30.9
	NRD_m	31	11.0	24.0	18.7	20.8	28	11.0	24.0	18.7	20.3
apr	P_m	32	61.8	302.6	186.9	36.6	28	71.3	302.6	198.1	31.9
	NRD_m	32	10.0	28.0	20.0	19.6	28	10.0	28.0	20.5	18.4
may	P_m	32	0.0	195.7	71.1	64.4	28	2.0	195.7	70.0	65.2
	NRD_m	32	0.0	18.0	10.9	44.5	28	1.0	18.0	11.1	42.1
jun	P_m	32	0.0	53.1	4.2	248.3	28	0.0	53.1	4.8	230.0
	NRD_m	32	0.0	5.0	1.0	133.7	28	0.0	5.0	1.2	120.1
jul	P_m	31	0.0	58.5	4.0	329.7	28	0.0	58.5	4.5	312.3
	NRD_m	31	0.0	6.0	0.5	265.7	28	0.0	6.0	0.6	250.9
aug	P_m	31	0.0	49.9	11.8	138.7	28	0.0	49.9	11.5	145.2
	NRD_m	31	0.0	8.0	2.2	105.6	28	0.0	8.0	2.1	109.0
sep	P_m	30	1.3	144.8	38.4	81.6	28	1.3	144.8	39.6	80.6
	NRD_m	30	1.0	18.0	6.2	64.6	28	1.0	18.0	6.5	61.0
oct	P_m	30	13.3	181.7	73.6	54.9	28	13.3	181.7	73.7	56.1
	NRD_m	30	6.0	22.0	13.4	32.5	28	6.0	22.0	13.2	33.1
nov	P_m	29	64.0	358.5	144.3	42.4	28	64.0	358.5	144.8	43.0
	NRD_m	29	10.0	28.0	19.9	22.3	28	10.0	28.0	19.8	22.7
dec	P_m	30	76.5	269.2	145.9	41.5	28	76.5	269.2	142.9	42.3
	NRD_m	30	14.0	26.0	20.2	16.8	28	14.0	26.0	20.0	16.9

N=sample size (years); *min*= minimum value; *max* = maximum value; *M* = mean; *CV* = coefficient of variation (%).

Table 11. Summary of the monthly rainfall, P_m (mm), and number of rainy days, NRD_m (days), data for the MUSASA station

MONTH	VARIABLE	ALL COMPLETE MONTHS					ONLY COMPLETE YEARS				
		N	min	max	M	CV	N	min	max	M	CV
jan	P_m	40	31.6	325.5	123.0	49.0	31	31.6	325.5	128.3	50.5
	NRD_m	40	7.0	23.0	16.0	25.9	31	10.0	23.0	17.4	20.4
feb	P_m	41	15.5	213.8	110.6	49.7	31	24.5	213.8	116.7	47.6
	NRD_m	41	4.0	22.0	14.3	30.9	31	8.0	22.0	15.3	25.3
mar	P_m	42	67.4	290.3	155.5	36.0	31	77.4	290.3	149.0	37.1
	NRD_m	42	5.0	27.0	18.1	23.4	31	9.0	27.0	18.8	20.6
apr	P_m	42	69.0	341.7	182.8	39.0	31	70.6	341.7	198.1	36.3
	NRD_m	42	6.0	28.0	20.4	22.7	31	13.0	28.0	21.6	15.8
may	P_m	42	9.4	245.8	89.4	55.5	31	9.4	245.8	90.3	56.7
	NRD_m	42	2.0	19.0	12.9	32.1	31	2.0	19.0	13.6	27.7
jun	P_m	41	0.0	57.5	10.2	147.1	31	0.0	57.5	9.7	147.5
	NRD_m	41	0.0	7.0	1.9	109.5	31	0.0	7.0	2.1	109.7
jul	P_m	43	0.0	28.1	2.1	264.8	31	0.0	28.1	2.8	223.3
	NRD_m	43	0.0	6.0	0.7	199.1	31	0.0	6.0	1.0	173.9
aug	P_m	41	0.0	135.5	21.9	147.2	31	0.0	112.4	21.6	138.0
	NRD_m	41	0.0	8.0	2.7	86.3	31	0.0	8.0	2.8	82.6
sep	P_m	43	0.3	162.7	52.2	72.2	31	0.3	162.7	58.1	69.3
	NRD_m	43	1.0	22.0	9.0	49.9	31	1.0	22.0	9.9	45.7
oct	P_m	43	30.7	208.1	107.2	41.9	31	35.7	208.1	108.8	42.4
	NRD_m	43	4.0	24.0	15.5	32.0	31	6.0	24.0	15.7	27.8
nov	P_m	41	54.2	370.2	143.7	50.0	31	59.3	370.2	152.0	50.9
	NRD_m	41	7.0	28.0	20.8	21.9	31	13.0	28.0	21.6	16.8
dec	P_m	41	42.2	361.8	124.1	46.6	31	42.2	361.8	124.4	50.8
	NRD_m	41	8.0	27.0	18.3	23.7	31	8.0	27.0	18.5	23.1

N=sample size (years); *min* =minimum value; *max* = maximum value; *M* = mean; *CV* = coefficient of variation (%).

Table 12. Summary of the monthly rainfall, P_m (mm), and number of rainy days, NRD_m (days), data for the MUYAGA station

MONTH	VARIABLE	ALL COMPLETE MONTHS					ONLY COMPLETE YEARS				
		N	min	max	M	CV	N	min	max	M	CV
jan	P_m	44	24.4	261.0	138.6	36.8	39	24.4	261.0	142.5	36.4
	NRD_m	44	5.0	20.0	12.7	33.9	39	5.0	20.0	12.8	34.8
feb	P_m	45	37.2	270.6	138.2	45.0	39	37.2	267.5	132.9	46.2
	NRD_m	45	4.0	25.0	11.4	41.1	39	4.0	25.0	11.3	42.2
mar	P_m	45	75.8	282.5	160.0	28.7	39	75.8	282.5	160.0	30.4
	NRD_m	45	6.0	28.0	13.9	34.8	39	6.0	28.0	13.5	35.1
apr	P_m	45	43.5	339.0	179.3	37.1	39	43.5	339.0	177.6	37.6
	NRD_m	45	4.0	27.0	15.1	34.2	39	4.0	27.0	15.0	33.8
may	P_m	46	0.0	211.0	86.5	57.2	39	0.0	211.0	85.3	58.9
	NRD_m	46	0.0	17.0	7.9	49.7	39	0.0	17.0	7.5	48.7
jun	P_m	45	0.0	32.7	4.4	195.7	39	0.0	32.7	3.8	215.3
	NRD_m	45	0.0	3.0	0.6	144.8	39	0.0	3.0	0.6	149.2
jul	P_m	43	0.0	60.7	5.3	262.6	39	0.0	60.7	5.7	254.1
	NRD_m	43	0.0	4.0	0.6	196.7	39	0.0	4.0	0.6	193.4
aug	P_m	43	0.0	80.4	14.4	148.3	39	0.0	72.0	12.6	152.1
	NRD_m	43	0.0	5.0	1.1	131.2	39	0.0	5.0	1.0	140.6
sep	P_m	42	0.0	143.1	40.0	89.4	39	0.0	123.5	38.6	84.7
	NRD_m	42	0.0	13.0	4.4	70.6	39	0.0	13.0	4.3	73.0
oct	P_m	43	10.5	205.6	97.6	53.3	39	10.5	205.6	100.5	49.1
	NRD_m	43	1.0	16.0	8.5	45.5	39	1.0	16.0	8.6	44.5
nov	P_m	44	32.4	332.2	173.0	39.5	39	32.4	332.2	166.7	41.4
	NRD_m	44	4.0	26.0	13.8	37.7	39	4.0	24.0	13.1	37.4
dec	P_m	43	31.3	304.0	161.4	37.4	39	31.3	284.0	153.9	35.6
	NRD_m	43	4.0	24.0	14.4	34.4	39	4.0	24.0	14.0	34.7

N=sample size (years); *min*= minimum value; *max* = maximum value; *M* = mean; *CV* = coefficient of variation (%).

Table 13. Summary of the monthly maximum, $T_{m,max}$ (°C), minimum, $T_{m,min}$ (°C), and average, $T_{m,ave}$ (°C), air temperature data for the CANKUZO station

MONTH	VARIABLE	ALL COMPLETE MONTHS					ONLY COMPLETE YEARS				
		N	min	max	M	CV	N	min	max	M	CV
jan	$T_{m,max}$	30	23.3	25.9	24.5	2.6	18	23.3	25.3	24.4	2.4
	$T_{m,min}$	30	11.4	15.0	13.8	8.1	18	12.7	15.0	14.1	3.9
	$T_{m,ave}$	30	17.5	19.9	19.1	2.8	18	18.8	19.8	19.3	1.7
feb	$T_{m,max}$	29	23.3	27.7	25.1	4.0	18	23.6	27.5	24.9	3.2
	$T_{m,min}$	29	11.2	15.3	13.8	8.1	18	12.9	15.1	14.2	4.3
	$T_{m,ave}$	29	18.1	20.7	19.5	3.0	18	18.9	20.4	19.5	2.1
mar	$T_{m,max}$	30	23.8	26.5	24.9	2.7	18	23.8	25.5	24.6	2.1
	$T_{m,min}$	30	10.8	16.0	14.0	9.2	18	12.8	15.4	14.4	4.9
	$T_{m,ave}$	30	18.2	20.8	19.4	3.3	18	18.7	20.4	19.5	2.2
apr	$T_{m,max}$	32	23.4	26.5	24.6	2.7	18	23.5	25.3	24.4	2.1
	$T_{m,min}$	32	11.5	15.7	14.3	8.7	18	13.0	15.7	14.9	4.3
	$T_{m,ave}$	32	18.0	20.5	19.4	2.8	18	18.8	20.5	19.7	2.0
may	$T_{m,max}$	26	23.5	26.5	24.4	2.9	18	23.5	25.3	24.2	2.4
	$T_{m,min}$	26	11.1	15.8	14.5	7.4	18	13.0	15.8	14.8	4.0
	$T_{m,ave}$	26	18.3	20.4	19.4	2.4	18	19.1	20.2	19.5	1.5
jun	$T_{m,max}$	29	23.5	25.8	24.7	2.4	18	23.5	25.3	24.5	2.2
	$T_{m,min}$	29	10.2	15.1	13.2	9.9	18	11.9	14.9	13.7	5.5
	$T_{m,ave}$	29	18.0	20.3	19.0	3.2	18	18.2	20.1	19.1	2.4
jul	$T_{m,max}$	29	22.8	26.7	25.3	3.0	18	24.1	26.4	25.1	1.9
	$T_{m,min}$	29	10.2	15.4	13.2	10.2	18	11.8	15.2	13.7	5.8
	$T_{m,ave}$	29	18.1	20.8	19.2	3.4	18	18.6	20.8	19.4	2.6
aug	$T_{m,max}$	31	24.9	27.6	26.5	2.4	18	24.9	27.4	26.3	2.3
	$T_{m,min}$	31	11.3	16.6	14.4	8.8	18	13.4	16.6	15.0	4.8
	$T_{m,ave}$	31	19.3	21.8	20.4	2.8	18	19.6	21.8	20.6	2.4
sep	$T_{m,max}$	31	24.4	29.0	27.2	3.8	18	24.4	28.6	27.1	3.8
	$T_{m,min}$	31	11.5	16.2	14.8	9.2	18	13.2	16.2	15.3	5.1
	$T_{m,ave}$	31	19.1	22.4	21.0	4.0	18	19.5	22.4	21.2	3.6
oct	$T_{m,max}$	30	24.2	28.8	26.5	3.7	18	24.2	28.8	26.4	3.7
	$T_{m,min}$	30	11.2	16.2	14.5	8.6	18	12.4	16.2	14.9	6.0
	$T_{m,ave}$	30	19.2	22.4	20.5	3.6	18	19.4	22.4	20.6	3.6
nov	$T_{m,max}$	27	23.2	27.3	24.8	3.9	18	23.2	26.3	24.6	3.3
	$T_{m,min}$	27	11.8	15.4	14.2	6.3	18	12.4	15.4	14.5	4.9
	$T_{m,ave}$	27	18.7	20.7	19.5	2.8	18	18.7	20.6	19.5	2.7
dec	$T_{m,max}$	31	23.0	26.7	24.5	3.5	18	23.0	25.9	24.3	3.4
	$T_{m,min}$	31	10.5	15.2	13.7	9.4	18	12.2	15.2	14.2	5.0
	$T_{m,ave}$	31	17.8	20.5	19.1	2.9	18	18.6	20.5	19.3	2.6

N=sample size (years); *min*= minimum value; *max* = maximum value; *M* = mean; *CV* = coefficient of variation (%).

Table 14. Summary of the monthly maximum, $T_{m,max}$ (°C), minimum, $T_{m,min}$ (°C), and average, $T_{m,ave}$ (°C), air temperature data for the KINYINIA station

MONTH	VARIABLE	ALL COMPLETE MONTHS					ONLY COMPLETE YEARS				
		N	min	max	M	CV	N	min	max	M	CV
jan	$T_{m,max}$	33	26.3	29.1	27.5	2.3	20	26.3	28.2	27.3	1.9
	$T_{m,min}$	33	14.0	16.7	15.9	4.0	20	14.6	16.7	15.9	3.6
	$T_{m,ave}$	33	20.2	22.8	21.7	2.3	20	20.8	22.3	21.6	1.9
feb	$T_{m,max}$	32	26.0	31.4	28.1	4.0	20	26.0	28.8	27.7	2.9
	$T_{m,min}$	32	13.9	17.5	15.9	4.5	20	13.9	17.5	15.9	5.2
	$T_{m,ave}$	32	20.1	23.9	22.0	3.4	20	20.1	23.1	21.8	3.1
mar	$T_{m,max}$	33	26.7	29.2	27.8	2.3	20	26.7	28.6	27.7	2.2
	$T_{m,min}$	33	15.0	17.5	16.1	4.0	20	15.0	17.5	16.2	4.2
	$T_{m,ave}$	33	20.9	23.1	22.0	2.3	20	20.9	23.1	21.9	2.4
apr	$T_{m,max}$	32	26.1	30.1	27.4	2.6	20	26.2	28.1	27.3	2.0
	$T_{m,min}$	32	15.4	18.0	16.5	3.3	20	15.4	18.0	16.6	3.8
	$T_{m,ave}$	32	21.1	23.5	22.0	2.4	20	21.2	22.9	21.9	2.3
may	$T_{m,max}$	32	25.9	29.3	27.3	3.1	20	25.9	28.0	27.0	2.2
	$T_{m,min}$	32	14.7	17.1	16.0	3.6	20	15.1	17.1	16.1	3.9
	$T_{m,ave}$	32	20.8	22.6	21.7	2.2	20	20.9	22.6	21.6	2.0
jun	$T_{m,max}$	32	26.1	29.1	27.6	2.5	20	26.1	28.5	27.5	2.2
	$T_{m,min}$	32	13.1	15.3	14.1	4.4	20	13.1	15.3	14.1	4.6
	$T_{m,ave}$	32	19.9	21.7	20.8	2.3	20	19.9	21.7	20.8	2.5
jul	$T_{m,max}$	30	25.8	29.8	28.1	2.9	20	27.1	29.6	28.0	2.2
	$T_{m,min}$	30	11.8	15.1	13.3	5.7	20	12.3	15.1	13.5	5.6
	$T_{m,ave}$	30	19.5	22.1	20.7	3.1	20	19.9	22.1	20.8	2.7
aug	$T_{m,max}$	33	28.2	30.9	29.7	2.3	20	28.2	30.4	29.5	2.1
	$T_{m,min}$	33	12.6	16.3	14.8	6.3	20	13.6	16.2	15.0	5.6
	$T_{m,ave}$	33	20.9	23.3	22.2	2.8	20	20.9	23.3	22.2	2.6
sep	$T_{m,max}$	31	27.7	32.9	30.6	3.3	20	27.7	32.0	30.4	3.2
	$T_{m,min}$	31	14.9	17.8	16.2	4.2	20	15.2	17.1	16.1	3.8
	$T_{m,ave}$	31	21.5	24.7	23.4	2.8	20	21.5	24.3	23.2	2.7
oct	$T_{m,max}$	28	27.6	31.4	29.8	3.5	20	27.6	31.3	29.6	3.7
	$T_{m,min}$	28	15.5	17.3	16.7	2.7	20	15.5	17.3	16.6	2.8
	$T_{m,ave}$	28	21.7	24.1	23.2	2.6	20	21.7	24.0	23.1	2.6
nov	$T_{m,max}$	30	19.3	31.1	27.6	7.0	20	26.3	29.8	27.7	3.6
	$T_{m,min}$	30	14.7	25.2	16.6	10.6	20	14.7	17.3	16.4	4.0
	$T_{m,ave}$	30	20.7	23.6	22.1	3.2	20	21.1	23.6	22.0	3.0
dec	$T_{m,max}$	29	26.1	29.2	27.4	2.8	20	26.1	28.8	27.4	2.6
	$T_{m,min}$	29	14.2	16.8	16.0	4.0	20	14.3	16.8	16.1	3.5
	$T_{m,ave}$	29	20.2	22.8	21.7	2.4	20	20.8	22.8	21.7	2.1

N=sample size (years); *min*= minimum value; *max* = maximum value; *M* = mean; *CV* = coefficient of variation (%).

Table 15. Summary of the monthly maximum, $T_{m,max}$ (°C), minimum, $T_{m,min}$ (°C), and average, $T_{m,ave}$ (°C), air temperature data for the MURIZA station

MONTH	VARIABLE	ALL COMPLETE MONTHS					ONLY COMPLETE YEARS				
		N	min	max	M	CV	N	min	max	M	CV
jan	$T_{m,max}$	25	23.7	25.7	24.7	2.4	20	23.7	25.7	24.7	2.4
	$T_{m,min}$	25	11.9	14.5	12.9	4.8	20	11.9	13.7	12.8	4.0
	$T_{m,ave}$	25	17.8	20.0	18.8	2.5	20	17.8	19.5	18.7	2.3
feb	$T_{m,max}$	25	23.4	27.3	25.0	3.3	20	23.4	27.3	24.9	3.2
	$T_{m,min}$	25	11.3	15.1	12.7	6.3	20	11.3	13.8	12.6	5.1
	$T_{m,ave}$	25	17.5	21.0	18.9	3.3	20	17.5	19.8	18.8	2.6
mar	$T_{m,max}$	27	24.0	26.9	25.0	3.0	20	24.0	25.6	24.8	2.1
	$T_{m,min}$	27	11.8	14.8	13.0	5.9	20	11.8	13.7	12.8	5.4
	$T_{m,ave}$	27	18.0	20.8	19.0	3.5	20	18.0	19.6	18.8	2.4
apr	$T_{m,max}$	29	23.5	26.0	24.5	2.5	20	23.5	25.4	24.3	2.2
	$T_{m,min}$	29	11.7	16.0	13.7	5.6	20	12.3	14.6	13.6	3.8
	$T_{m,ave}$	29	18.1	21.0	19.1	2.9	20	18.1	19.8	19.0	2.1
may	$T_{m,max}$	30	23.1	26.2	24.2	3.2	20	23.1	26.2	24.0	2.9
	$T_{m,min}$	30	9.1	14.5	12.7	8.2	20	10.9	14.0	12.6	5.7
	$T_{m,ave}$	30	17.5	19.9	18.4	3.3	20	17.6	19.2	18.3	2.6
jun	$T_{m,max}$	29	22.9	25.9	24.4	2.9	20	22.9	25.5	24.2	2.7
	$T_{m,min}$	29	7.1	11.5	10.0	9.6	20	8.5	11.2	10.0	7.7
	$T_{m,ave}$	29	16.2	18.0	17.2	3.4	20	16.2	17.9	17.1	3.4
jul	$T_{m,max}$	29	23.8	26.8	25.0	2.9	20	23.8	26.2	24.8	2.5
	$T_{m,min}$	29	6.0	13.7	9.3	14.2	20	7.7	13.7	9.5	14.0
	$T_{m,ave}$	29	16.0	19.3	17.1	4.4	20	16.0	19.3	17.1	4.8
aug	$T_{m,max}$	31	24.9	28.2	26.3	2.9	20	24.9	27.5	26.1	2.4
	$T_{m,min}$	31	8.6	16.2	10.6	13.6	20	9.1	16.2	10.8	15.0
	$T_{m,ave}$	31	17.5	21.2	18.5	3.9	20	17.5	21.2	18.5	4.3
sep	$T_{m,max}$	30	24.4	29.7	27.3	3.7	20	24.4	28.7	27.0	3.5
	$T_{m,min}$	30	9.9	16.9	12.0	11.1	20	9.9	16.9	12.1	11.4
	$T_{m,ave}$	30	18.1	21.6	19.6	4.3	20	18.1	21.6	19.5	3.8
oct	$T_{m,max}$	27	24.6	28.4	26.5	3.8	20	24.7	27.9	26.4	3.5
	$T_{m,min}$	27	11.5	14.9	13.0	6.3	20	11.7	14.9	12.9	6.3
	$T_{m,ave}$	27	18.6	20.9	19.7	3.1	20	18.8	20.9	19.7	2.9
nov	$T_{m,max}$	27	23.5	26.9	24.9	3.3	20	23.5	25.9	24.8	3.1
	$T_{m,min}$	27	11.8	14.2	13.1	4.8	20	11.8	14.0	13.1	4.8
	$T_{m,ave}$	27	18.1	20.1	19.0	3.0	20	18.1	19.9	18.9	2.8
dec	$T_{m,max}$	27	23.5	25.9	24.5	2.8	20	23.5	25.8	24.5	2.9
	$T_{m,min}$	27	11.3	14.5	12.9	5.6	20	11.3	13.9	12.8	4.7
	$T_{m,ave}$	27	17.6	19.5	18.7	2.8	20	17.6	19.4	18.6	2.5

N=sample size (years); *min*= minimum value; *max* = maximum value; *M* = mean; *CV* = coefficient of variation (%).

Table 16. Summary of the monthly maximum, $T_{m,max}$ (°C), minimum, $T_{m,min}$ (°C), and average, $T_{m,ave}$ (°C), air temperature data for the MUSASA station

MONTH	VARIABLE	ALL COMPLETE MONTHS					ONLY COMPLETE YEARS				
		N	min	max	M	CV	N	min	max	M	CV
jan	$T_{m,max}$	31	26.6	28.5	27.7	1.6	23	26.9	28.5	27.7	1.5
	$T_{m,min}$	31	14.9	17.3	15.7	3.0	23	14.9	16.4	15.6	2.4
	$T_{m,ave}$	31	21.1	22.6	21.7	1.4	23	21.1	22.2	21.6	1.2
feb	$T_{m,max}$	37	26.6	30.7	28.1	3.4	23	26.7	30.4	28.0	2.8
	$T_{m,min}$	37	14.4	17.6	15.5	4.3	23	14.4	16.6	15.5	3.4
	$T_{m,ave}$	37	20.7	23.6	21.8	3.1	23	20.7	23.0	21.7	2.2
mar	$T_{m,max}$	37	27.0	29.3	28.0	1.9	23	27.0	28.7	27.9	1.7
	$T_{m,min}$	37	14.4	17.6	15.8	4.4	23	14.4	17.4	15.7	4.0
	$T_{m,ave}$	37	21.2	23.4	21.9	2.1	23	21.2	22.6	21.8	1.7
apr	$T_{m,max}$	36	26.0	29.8	27.5	2.4	23	26.0	28.4	27.4	1.9
	$T_{m,min}$	36	12.2	18.4	16.2	5.7	23	15.3	17.3	16.3	3.3
	$T_{m,ave}$	36	21.0	23.4	21.9	2.1	23	21.1	22.5	21.9	1.7
may	$T_{m,max}$	36	26.4	29.4	27.4	2.7	23	26.4	28.2	27.2	1.9
	$T_{m,min}$	36	14.2	17.0	15.4	4.6	23	14.2	16.8	15.3	4.3
	$T_{m,ave}$	36	20.7	22.7	21.4	2.3	23	20.7	21.8	21.3	1.5
jun	$T_{m,max}$	37	26.8	29.5	27.9	2.5	23	26.8	28.9	27.8	2.1
	$T_{m,min}$	37	11.3	17.0	13.1	9.6	23	11.5	14.6	12.7	6.6
	$T_{m,ave}$	37	19.0	23.0	20.5	4.2	23	19.4	21.4	20.2	2.8
jul	$T_{m,max}$	38	26.3	30.3	28.3	2.5	23	26.3	29.3	28.2	2.3
	$T_{m,min}$	38	10.0	17.0	11.8	11.0	23	10.2	13.9	11.5	8.3
	$T_{m,ave}$	38	18.6	23.2	20.1	4.2	23	18.6	21.0	19.9	3.2
aug	$T_{m,max}$	38	27.2	31.4	29.7	2.6	23	27.2	30.9	29.6	2.5
	$T_{m,min}$	38	11.3	16.2	13.1	8.2	23	11.6	15.4	13.0	7.5
	$T_{m,ave}$	38	20.4	23.6	21.4	3.0	23	20.5	22.3	21.3	2.2
sep	$T_{m,max}$	36	28.3	33.1	30.8	2.8	23	28.3	32.0	30.7	2.7
	$T_{m,min}$	36	12.2	16.3	15.0	6.0	23	12.9	16.0	15.0	4.9
	$T_{m,ave}$	36	21.7	24.1	22.9	2.5	23	21.7	23.9	22.9	2.3
oct	$T_{m,max}$	36	27.8	32.5	30.0	3.5	23	27.8	31.6	29.8	3.3
	$T_{m,min}$	36	14.8	17.3	16.0	3.7	23	14.8	16.9	16.0	3.2
	$T_{m,ave}$	36	21.8	24.3	23.0	2.7	23	21.8	24.2	22.9	2.3
nov	$T_{m,max}$	34	25.9	29.7	28.0	3.0	23	26.4	29.5	27.9	2.4
	$T_{m,min}$	34	14.8	17.4	16.0	3.4	23	14.9	16.7	16.0	2.6
	$T_{m,ave}$	34	20.9	23.0	22.0	2.4	23	20.9	22.8	21.9	1.8
dec	$T_{m,max}$	32	26.3	29.1	27.5	2.6	23	26.3	29.1	27.5	2.5
	$T_{m,min}$	32	14.8	17.5	15.9	3.9	23	14.8	16.6	15.8	3.0
	$T_{m,ave}$	32	20.6	22.6	21.7	2.3	23	20.8	22.4	21.6	1.9

N=sample size (years); *min*= minimum value; *max* = maximum value; *M* = mean; *CV* = coefficient of variation (%).

Table 17. Annual values of rainfall depth, P_a (mm), and number of rainy days, NRD_a (days), for the CANKUZO station

Year	P_a	NRD_a
1975	1234.3	151
1976	1159.9	152
1977	1632.5	164
1978	1461.8	162
1979	1156.8	155
1980	890.6	117
1981	1466.4	143
1982	1187.0	136
1983	1062.1	128
1984	1178.4	128
1985	1188.2	141
1986	1308.1	161
1987	1153.3	130
1988	1424.6	137
1989	1436.2	143
1990	1203.6	138
1991	1216.2	146
1992	1309.1	142
1994	1291.6	144
1995	1227.1	140
1996	1140.4	140
1997	1584.6	158
1998	1082.9	124
1999	975.6	124
2001	1155.4	149
2003	1141.6	130
2004	1022.8	116
2005	731.8	115
N	***28***	***28***
min	***731.8***	***115***
max	***1632.5***	***164***
M	***1215.1***	***139.8***
CV	***16.3***	***10.0***

Table 18. Annual values of rainfall depth, P_a (mm), and number of rainy days, NRD_a (days), for the KINYINIA station

Year	P_a	NRD_a
1967	1377.6	114
1968	1311.9	145
1969	1218.5	161
1970	1304.8	142
1971	1227.7	130
1972	1449.3	145
1973	1168.6	117
1975	866.3	106
1976	811.8	109
1978	1429.1	138
1979	1321.3	145
1980	1207.4	134
1981	1066.3	142
1982	1397.4	143
1983	1062.5	104
1984	1010.7	114
1985	1455.8	125
1986	1424.8	145
1987	1275.9	123
1988	1208.3	142
1989	1570.6	145
1990	1230.6	133
1991	1259.0	150
1992	1074.0	141
1997	1539.9	133
1998	1678.7	117
1999	1159.0	113
2001	1188.1	117
2003	603.4	91
2004	638.5	84
2005	357.0	66
N	***31***	***31***
min	***357.0***	***66***
max	***1678.7***	***161***
M	***1190.2***	***126.3***
CV	***24.6***	***16.9***

Table 19. Annual values of rainfall depth, P_a (mm), and number of rainy days, NRD_a (days), for the MURIZA station

Year	P_a	NRD_a
1974	630.3	120
1975	1059.7	165
1976	954.5	141
1977	1104.2	159
1978	1603.8	153
1979	1200.3	147
1981	1043.2	137
1982	1372.6	153
1983	997.7	149
1984	1028.8	168
1985	1291.1	163
1986	1294.2	183
1987	1266.2	160
1988	1328.6	163
1989	1629.6	165
1990	1118.8	142
1991	1182.8	155
1992	1088.1	141
1995	1118.1	151
1996	1018.6	150
1997	1345.5	169
1998	1179.7	145
1999	1222.0	144
2001	1217.6	151
2002	1083.9	126
2003	975.0	121
2004	1182.2	120
2005	844.1	107
N	***28***	***28***
min	***630.3***	***107***
max	***1629.6***	***183***
M	***1156.5***	***148.1***
CV	***17.8***	***11.8***

N=sample size (years); *min*=minimum value; *max*= maximum value; *M* = mean; *CV* = coefficient of variation (%).

Table 20. Annual values of rainfall depth, P_a (mm), and number of rainy days, NRD_a (days), for the MUSASA station

Year	P_a	NRD_a
1961	1503.6	177
1967	957.0	169
1968	1359.2	176
1969	1102.7	156
1970	1193.5	156
1971	1053.9	147
1972	1221.6	182
1973	1107.1	145
1974	1108.0	151
1975	1096.5	169
1976	865.4	155
1977	1288.8	170
1979	1186.4	152
1980	951.4	150
1981	921.0	156
1982	1128.5	173
1984	1063.7	155
1985	1306.9	169
1986	1248.1	182
1987	1505.3	148
1988	1473.8	166
1989	1104.3	160
1992	1081.8	161
1993	1145.4	141
1996	990.5	146
1997	1580.9	164
1998	963.9	152
2001	1219.5	160
2002	1042.7	144
2003	1029.5	130
2004	1157.6	145
N	***31***	***31***
min	***865.4***	***130.0***
max	***1580.9***	***182.0***
M	***1160.0***	***158.3***
CV	***15.6***	***8.0***

Table 21. Annual values of rainfall depth, P_a (mm), and number of rainy days, NRD_a (days), for the MUYAGA station

Year	P_a	NRD_a
1960	888.2	125
1962	1377.1	140
1964	1318.4	137
1965	1173.9	170
1966	1367.1	160
1969	1115.4	133
1970	1191.5	110
1971	1016.5	74
1973	1060.2	81
1974	790	94
1975	1302.1	108
1976	1123.8	100
1977	1420.7	103
1979	1258.2	101
1980	923.5	75
1981	1435.8	106
1982	1282.7	99
1983	1257.9	93
1984	1091.1	103
1985	1204.8	97
1986	1274.4	118
1987	1226.7	100
1988	1591.9	99
1989	1410.2	121
1990	1248.6	109
1991	1333	107
1992	1346.3	112
1993	1066.2	89
1994	1066	82
1995	1141.4	87
1996	1464.9	112
1997	1041.3	83
1998	890.8	83
2000	922.1	76
2001	1168.9	83
2002	1232.6	81
2003	1141.2	79
2004	1060.8	84
2005	797.8	73
N	***39***	***39***
min	***790.0***	***73.0***
max	***1591.9***	***170.0***
M	***1180.1***	***102.2***
CV	***16.0***	***22.4***

N=sample size (years); *min*=minimum value; *max*= maximum value; *M* = mean; *CV* = coefficient of variation (%).

Table 22. Annual values of maximum, $T_{a,max}$ (°C), minimum, $T_{a,min}$ (°C), and average, $T_{a,ave}$ (°C), temperature for the CANKUZO station

Year	$T_{a,max}$	$T_{a,min}$	$T_{a,ave}$
1975	24.2	14.4	19.3
1977	24.9	14.9	19.9
1978	24.8	14.7	19.8
1979	25.0	15.0	20.0
1981	25.0	15.0	20.0
1982	24.9	14.8	19.9
1984	25.0	14.6	19.8
1986	24.8	14.3	19.5
1987	25.5	15.3	20.4
1988	25.0	15.1	20.0
1989	24.4	14.4	19.4
1990	25.1	14.5	19.8
1992	25.1	14.4	19.7
1993	25.6	14.6	20.1
1994	25.3	14.3	19.8
1995	25.6	14.1	19.9
1996	25.6	13.6	19.6
1999	25.6	12.6	19.1
N	***18***	***18***	***18***
min	***24.2***	***12.6***	***19.1***
max	***25.6***	***15.3***	***20.4***
M	***25.1***	***14.5***	***19.8***
CV	***1.6***	***4.2***	***1.5***

Table 23. Annual values of maximum, $T_{a,max}$ (°C), minimum, $T_{a,min}$ (°C), and average, $T_{a,ave}$ (°C), temperature for the KINYINIA station

Year	$T_{a,max}$	$T_{a,min}$	$T_{a,ave}$
1972	27.4	14.9	21.1
1975	27.5	14.6	21.0
1976	28.0	14.9	21.5
1977	28.1	15.2	21.7
1978	28.1	15.8	21.9
1979	28.5	15.8	22.2
1980	28.5	16.0	22.3
1981	28.4	15.8	22.1
1982	28.1	15.5	21.8
1983	28.4	16.1	22.2
1984	28.1	15.6	21.8
1985	28.1	15.6	21.9
1986	27.9	15.6	21.7
1987	28.6	16.4	22.5
1988	27.9	16.2	22.1
1989	27.4	15.9	21.6
1990	28.0	16.0	22.0
1991	27.7	16.0	21.9
1998	28.9	16.5	22.7
2001	28.2	15.7	22.0
N	***20***	***20***	***20***
min	***27.4***	***14.6***	***21.0***
max	***28.9***	***16.5***	***22.7***
M	***28.1***	***15.7***	***21.9***
CV	***1.5***	***3.2***	***1.8***

N=sample size (years); *min*=minimum value; *max*=maximum value; *M*=mean; *CV*=coefficient of variation (%).

Table 24. Annual values of maximum, $T_{a,max}$ (°C), minimum, $T_{a,min}$ (°C), and average, $T_{a,ave}$ (°C), temperature for the MURIZA station

Year	$T_{a,max}$	$T_{a,min}$	$T_{a,ave}$
1975	24.3	11.4	17.9
1976	24.9	11.4	18.2
1977	24.8	11.9	18.4
1978	24.7	11.8	18.3
1979	24.9	11.7	18.3
1980	25.1	12.0	18.6
1981	25.0	13.3	19.2
1982	25.0	11.9	18.4
1983	25.3	12.0	18.7
1984	24.8	11.6	18.2
1985	24.7	12.2	18.5
1986	24.8	11.6	18.2
1987	25.5	12.9	19.2
1988	24.9	12.5	18.7
1989	24.4	12.1	18.3
1990	25.0	12.1	18.5
1995	25.8	12.5	19.2
1996	25.5	12.6	19.1
1999	25.5	12.4	19.0
2000	26.1	12.3	19.2
N	***20***	***20***	***20***
min	***24.3***	***11.4***	***17.9***
max	***26.1***	***13.3***	***19.2***
M	***25.0***	***12.1***	***18.6***
CV	***1.8***	***4.0***	***2.2***

Table 25. Annual values of maximum, $T_{a,max}$ (°C), minimum, $T_{a,min}$ (°C), and average, $T_{a,ave}$ (°C), temperature for the MUSASA station

Year	$T_{a,max}$	$T_{a,min}$	$T_{a,ave}$
1964	27.6	14.9	21.2
1965	28.0	14.8	21.4
1975	27.7	14.4	21.1
1976	28.1	14.2	21.2
1977	28.3	14.6	21.5
1978	28.0	14.5	21.2
1979	28.6	14.3	21.4
1980	28.7	15.1	21.9
1981	28.5	15.1	21.8
1982	28.3	14.6	21.5
1983	28.3	15.6	22.0
1984	28.3	14.9	21.6
1985	28.1	14.8	21.5
1986	28.0	14.6	21.3
1987	28.7	15.1	21.9
1988	28.5	15.1	21.8
1989	28.0	15.1	21.6
1990	28.5	14.7	21.6
1991	28.2	15.2	21.7
1992	28.5	15.1	21.8
1994	28.4	15.0	21.7
1995	28.8	15.3	22.1
1999	28.8	15.0	21.9
N	***23***	***23***	***23***
min	***27.6***	***14.2***	***21.1***
max	***28.8***	***15.6***	***22.1***
M	***28.3***	***14.9***	***21.6***
CV	***1.2***	***2.2***	***1.3***

N = sample size (years); *min* = minimum value; *max* = maximum value; *M* = mean; *CV* = coefficient of variation (%).

Table 26. Annual values of rainfall depth, P_a (mm), reference evapotranspiration, $ET_{0,a}$ (mm), and ratio between $ET_{0,a}$ and P_a for the CANKUZO station

Year	P_a	ET_{0a}	ET_{0a}/P_a
1975	1234.3	1372.1	1.11
1977	1632.5	1404.3	0.86
1978	1461.8	1404.7	0.96
1979	1156.8	1407.9	1.22
1981	1466.4	1409.9	0.96
1982	1187.0	1417.7	1.19
1984	1178.4	1436.1	1.22
1986	1308.1	1423.9	1.09
1987	1153.3	1436.5	1.25
1988	1424.6	1405.0	0.99
1989	1436.2	1386.0	0.97
1990	1203.6	1441.2	1.20
1992	1309.1	1455.3	1.11
1994	1291.6	1474.5	1.14
1995	1227.1	1509.7	1.23
1996	1140.4	1529.6	1.34
1999	975.6	1571.6	1.61
N	***17***	***17***	***17***
min	***975.6***	***1372.1***	***0.86***
max	***1632.5***	***1571.6***	***1.61***
M	***1281.6***	***1440.3***	***1.14***
CV	***12.5***	***3.7***	***15.5***

Table 27. Annual values of rainfall depth, P_a (mm), reference evapotranspiration, $ET_{0,a}$ (mm), and ratio between $ET_{0,a}$ and P_a for the KINYINIA station

Year	P_a	ET_{0a}	ET_{0a}/P_a
1972	1449.3	1624.7	1.12
1975	866.3	1642.3	1.90
1976	811.8	1679.8	2.07
1978	1429.1	1640.2	1.15
1979	1321.3	1673.8	1.27
1980	1207.4	1678.7	1.39
1981	1066.3	1671.3	1.57
1982	1397.4	1654.8	1.18
1983	1062.5	1651.2	1.55
1984	1010.7	1654.8	1.64
1985	1455.8	1653.6	1.14
1986	1424.8	1628.5	1.14
1987	1275.9	1651.2	1.29
1988	1208.3	1613.1	1.33
1989	1570.6	1572.4	1.00
1990	1230.6	1619.9	1.32
1991	1259.0	1592.6	1.26
1998	1678.7	1684.1	1.00
2001	1188.1	1656.2	1.39
N	***19***	***19***	***19***
min	***811.8***	***1572.4***	***1.00***
max	***1678.7***	***1684.1***	***2.07***
M	***1258.6***	***1644.4***	***1.35***
CV	***18.1***	***1.8***	***21.0***

N=sample size (years); *min*= minimum value; *max* = maximum value; *M* = mean; *CV* = coefficient of variation (%).

Table 28. Annual values of rainfall depth, P_a (mm), reference evapotranspiration, $ET_{0,a}$ (mm), and ratio between $ET_{0,a}$ and P_a for the MURIZA station

Year	P_a	ET_{0a}	ET_{0a}/P_a
1975	1059.7	1506.9	1.42
1976	954.5	1557.5	1.63
1977	1104.2	1528.1	1.38
1978	1603.8	1520.6	0.95
1979	1200.3	1541.5	1.28
1981	1043.2	1486.7	1.43
1982	1372.6	1540.8	1.12
1983	997.7	1561.2	1.56
1984	1028.8	1540.0	1.50
1985	1291.1	1501.7	1.16
1986	1294.2	1532.5	1.18
1987	1266.2	1543.9	1.22
1988	1328.6	1518.5	1.14
1989	1629.6	1487.5	0.91
1990	1118.8	1531.7	1.37
1995	1118.1	1581.2	1.41
1996	1018.6	1560.0	1.53
1999	1222.0	1566.8	1.28
N	***18***	***18***	***18***
min	***954.5***	***1486.7***	***0.91***
max	***1629.6***	***1581.2***	***1.63***
M	***1202.9***	***1533.7***	***1.31***
CV	***16.2***	***1.7***	***15.5***

Table 29. Annual values of rainfall depth, P_a (mm), reference evapotranspiration, $ET_{0,a}$ (mm), and ratio between $ET_{0,a}$ and P_a for the MUSASA station

Year	P_a	ET_{0a}	ET_{0a}/P_a
1975	1096.5	1670.6	1.52
1976	865.4	1715.5	1.98
1977	1288.8	1707.9	1.33
1979	1186.4	1741.2	1.47
1980	951.4	1730.2	1.82
1981	921.0	1700.2	1.85
1982	1128.5	1706.0	1.51
1984	1063.7	1703.0	1.60
1985	1306.9	1679.5	1.29
1986	1248.1	1679.2	1.35
1987	1505.3	1720.5	1.14
1988	1473.8	1705.7	1.16
1989	1104.3	1664.0	1.51
1992	1081.8	1713.4	1.58
N	***14***	***14***	***14***
min	***865.4***	***1664.0***	***1.14***
max	***1505.3***	***1741.2***	***1.98***
M	***1158.7***	***1702.6***	***1.51***
CV	***16.5***	***1.3***	***16.6***

N=sample size (years); *min*= minimum value; *max* = maximum value; *M* = mean; *CV* = coefficient of variation (%).

4

SOIL PHYSICAL AND HYDRAULIC PROPERTIES

MATERIALS AND METHODS

A total of 69 soil samples were collected from the surface layer. The geographical coordinates of each soil sampling location were determined by a Global Position System (Table 30).

For each sampling point, the particle size distribution, PSD, of the soil material (i.e., particles smaller than 2 mm in diameter) was determined. The PSD indicates the percentage of soil particles with diameters smaller than pre-established values. The information obtainable from a PSD curve includes the diameter of the largest grains in the assemblage, and the grading pattern, i.e. whether the soil is composed of distinct groups of particles each of uniform size or whether it consists of a more or less continuous array of particle sizes (Hillel, 1998). The PSD was determined by conventional methods, following H_2O_2 pre-treatment in order to eliminate organic matter and clay deflocculation by sodium hexametaphospate and mechanical agitation (Hillel, 1998). Fine size fractions were determined by the hydrometer method, whereas the coarse fractions were obtained by mechanical sieving. In particular, sieving analysis was carried out using six sieves with mesh sizes of 2.0, 0.850, 0.425, 0.250, 0.106 and 0.074 mm.

The measured PSD was used to determine or estimate the following soil physical and hydraulic properties: clay, silt and sand content; geometric mean particle diameter; plant available water capacity; saturated and near-saturated soil hydraulic conductivity; soil erodibility factor; critical bulk density. The clay, silt and sand content and the geometric mean particle diameter were determined using the measured PSD. Pedotransfer functions (PTFs) were applied to estimate the other soil properties. A PTF may be used to estimate a soil physical or hydraulic property from other, more easily determined, soil properties such as textural fractions. In particular, continuous PTFs provide continuously varying estimates of soil properties across the textural triangle through linear or nonlinear regression models. Model performance can be improved with additional information such as bulk density, porosity and organic matter content (e.g., Sobieraj et al., 2001) although other authors have concluded that PTFs based on PSD and represented by a simple regression equation may lead to similar results as compared to more complex models (Tietje and Hennings, 1996). A description of the procedure used to determine each variable is given below.

The traditional method to characterize particle sizes in soils is to divide the array of possible particle diameters into three conveniently separable size ranges known as *textural fractions*, namely *clay*, *silt* and *sand* (Hillel, 1998). Unfortunately, there is as yet no universally accepted scheme for classifying particle sizes. However, the two most commonly used schemes are the classification standardized by the U.S. Department of Agriculture (USDA) and that of the International Soil Science Society (ISSS) (Hillel, 1998). Both classification schemes define clay as particles of less than 0.002 mm in diameter. According to the USDA scheme, the silt fraction includes the particles ranging in diameter from 0.002 mm to 0.05 mm, whereas the sand includes the particles with a diameter varying between 0.05 mm and 2 mm. The ISSS classification establishes that silt particles have a diameter varying from 0.002 mm to 0.02 mm, whereas the sand particles have a diameter ranging from 0.02 mm to 2 mm (Hillel, 1998). Therefore, a soil

sample classified according to the USDA scheme has in general a higher silt content and a lower sand content than the same soil sample classified according to the ISSS scheme. In several cases, only a given classification scheme is used and this complicates comparison among data from different sources. In this investigation, both the USDA and the ISSS classification schemes were used to determine the textural fractions for each soil sample. For a given classification scheme, the clay, *cl*, silt, *si*, and sand, *sa*, textural fractions were expressed in percent by weight. The available data were analyzed to deduce an empirical conversion model between the ISSS and USDA classification schemes.

The *geometric mean particle diameter*, d_g (L), is given by (Shirazi and Boersma, 1984):

$$d_g = exp\{\sum[m_i \; ln(d_i)]\} \tag{28}$$

where m_i (-) and d_i (L) are the mass fraction and the arithmetic mean diameter of particle class *i*, respectively. The geometric mean particle diameter yields a synthetic information on the primary particle sizes in a given soil sample. Moreover, this variable has been used to estimate other soil physical and hydraulic properties (e.g., Renard et al., 1997; Jarvis et al., 2002). In this investigation, three estimates of d_g were obtained for each soil sample. In particular, an estimation of d_g was carried out using the measured PSD (d_{gPSD}), including 14 particle size classes. Following Shirazi and Boersma (1984) and Jarvis et al. (2002), another estimation of d_g was deduced using the textural fractions (*cl*, *si* and *sa*) defined according to the USDA classification scheme (d_{gUSDA}). As an example, in this case values for d_i are 0.001, 0.026 and 1.025 mm for clay, silt and sand, respectively. The last estimation of d_g was carried out using the *cl*, *si* and *sa* fractions defined according to the ISSS classification scheme (d_{gISSS}). A comparison between d_{gPSD}, d_{gUSDA} and d_{gISSS} was carried out to establish the relationships between the three estimates of d_g.

The *plant available water capacity*, *PAWC* (m^3m^{-3}), which is a measure of the soil water that is readily available for crop growth, is given by (e.g., Topp et al., 1997; van den Berg et al., 1997; Reynolds et al., 2002):

$$PAWC = \theta_{10kPa} - \theta_{1500kPa} \tag{29}$$

where θ_{10kPa} (m^3m^{-3}) is the volumetric soil water content corresponding to a suction of 10 kPa (i.e., the so-called *field capacity, FC,* water content) and $\theta_{1500kPa}$ (m^3m^{-3}) is the volumetric soil water content corresponding to a suction of 1500 kPa (i.e., the so-called *permanent wilting point, PWP,* water content). The *PAWC* concept represents a crude measure for water supply to crops because both field capacity and wilting point, when expressed in terms of pressures, vary widely among soils. However, models based on the concept of available water capacity are still important tools to assess water-limited crop yield potentials and irrigation needs (van den Berg et al., 1997). The PTFs developed by Saxton et al. (1986), based on a large data-base, and van den Berg et al. (1997), based on soil samples collected in South America, Africa and South East Asia, were applied in this investigation. According to Saxton et al. (1986), the following relationship may be applied to obtain an estimate of the soil water content, θ (m^3m^{-3}), corresponding to a given soil water potential, ψ (kPa):

$$\theta = \left(\frac{\psi}{A}\right)^{1/B} \tag{30}$$

where the *A* and *B* parameters may be estimated by the following PTFs, that were deduced on the basis of the 2500 samples considered by Rawls et al. (1982):

$$A = exp\left[-4.396 - 0.0715(cl) - 4.88x10^{-4}(sa)^2 - 4.285x10^{-5}(sa)^2(cl)\right]100 \quad (31)$$

$$B = -3.140 - 2.22x10^{-3}(cl)^2 - 3.484x10^{-5}(sa)^2(cl) \quad (32)$$

where *cl* (%) is percent clay and *sa* (%) is percent sand (USDA classification scheme). Eq.(30) can be applied in the tension range 10 to 1500 kPa and greater. At some low and high clay contents, the equations produce low potential moisture contents that exceed the saturation moisture content. The region of the USDA texture triangle for which the PTF appear quite valid is approximately defined as 5% $\leq$ *sa* $\leq$ 30% with 8% $\leq$ *cl* $\leq$ 58%, and 30% $\leq$ *sa* $\leq$ 95% with 5% $\leq$ *cl* $\leq$ 60% (Saxton et al., 1986). Therefore, soil samples falling within this region of the texture triangle were considered for estimating θ_{10kPa} and θ_{1500} kPa by eqs.(30), (31) and (32). For each soil sample, eq.(29) was then applied to estimate *PAWC*. van den Berg et al. (1997) developed PTFs to estimate the moisture retention characteristics of Ferralsols and related soils using 91 soil samples from ten countries, including five African countries (Gabon, Ivory Coast, Kenya, Mozambique, Zambia). In particular, the following relationships were suggested to estimate θ_{10kPa} (m^3m^{-3}) and θ_{1500} kPa (m^3m^{-3}) on the basis of the clay, *cl* (%), and silt, *si* (%) (USDA scheme), content:

$$\theta_{10kPa} = 0.1127 + 3.67 \cdot 10^{-3} cl + 2.26 \cdot 10^{-3} si \quad (33)$$

$$\theta_{1500kPa} = 0.0383 + 2.72 \cdot 10^{-3} cl + 2.12 \cdot 10^{-3} si \quad (34)$$

van den Berg et al. (1997) also suggested that the moisture retained between 10 and 1500 kPa should be estimated by equations that are based on direct regression between *PAWC* and easily measured soil properties, rather than on subtracting a regression equation for *PWP* from an equation for *FC*. According to van den Berg et al. (1997), *PAWC* (m^3m^{-3}) may be estimated by the following relationship:

$$PAWC = 0.07676 + 9.30 \cdot 10^{-4} cl \quad (35)$$

Eq.(35) is characterized by a rather low coefficient of determination (R^2 = 0.21). Prediction of *PAWC* may be improved using bulk density (R^2 = 0.38) or clay content, specific surface area and bulk density (R^2 = 0.48) (van den Berg et al., 1997). However, these data were not available for the sampled soils in the Ruyigi area. The data set considered by van den Berg et al. (1997) to develop and test the predictive equations included soils with a clay content ranging from 2 to 95%. The soils considered in this investigation had a clay content varying between 12 and 71% (Table 31). Therefore, eqs.(33), (34) and (35) were applied to predict θ_{10kPa}, θ_{1500} and *PAWC* at each sampling point.

The *hydraulic conductivity of saturated soil*, K_s, is one of the most important soil properties controlling water infiltration and surface runoff, leaching of pesticides from agricultural lands, and migration of pollutants from contaminated sites to the groundwater. The saturated soil hydraulic conductivity depends strongly on soil texture and structure, and therefore it can vary widely both in space and time. In this investigation, the following PTF was applied to calculate K_s ($mm\ h^{-1}$) at each sampling location (Saxton et al., 1986):

$$K_S = 10\ exp\left[12.012 - 0.0755sa + \frac{-3.895 + 0.03671sa - 0.1103cl + 8.7546 \cdot 10^{-4} cl^2}{0.332 - 7.251 \cdot 10^{-4} sa + 0.1276\ log_{10}\ cl}\right] \quad (36)$$

where *sa* (%) is the sand content (0.05-2 mm) and *cl* (%) is the clay content. Eq.(36) was chosen for the following reasons: i) the PTF may be applied using the available data for the soils of Burundi; ii) the PTF yields an estimate of the mean saturated hydraulic conductivity within a textural class (Tietje and Hennings, 1996). Estimating a mean value of K_s should yield a more representative result than estimating a local value of K_s; and iii) other investigations have suggested that the selected PTF yields reasonable estimates of K_s (Ferrer Julià et al., 2004). Eq.(36) was found to provide quite reasonable values over the same textural region detected for the water retention results (Saxton et al., 1986). Therefore, soil samples falling within this region of the texture triangle (i.e., 5% ≤ *sa* ≤ 30% with 8% ≤ *cl* ≤ 58%, and 30% ≤ *sa* ≤ 95% with 5% ≤ *cl* ≤ 60%) were considered to estimate K_s.

Jarvis et al. (2002) developed an indirect method for estimating the *near-saturated soil hydraulic conductivity*, corresponding to a pressure head of -10 cm, K_{10} (mm h^{-1}), that may be considered as the saturated conductivity of the soil matrix. The suggested relationship is:

$$K_{10} = 25.2\, d_{g,USDA} \tag{37}$$

where d_{gUSDA} is expressed in mm. According to Jarvis et al. (2002), this relationship could prove useful in large-scale (regional) modeling applications where direct measurements are not practical, and where it is sufficient to distinguish broad differences in hydraulic behavior between soil types.

The *soil erodibility factor*, *K* (t ha h ha^{-1} MJ^{-1} mm^{-1}), of the Universal Soil Loss Equation (USLE) is the rate of soil loss per rainfall erosion index unit as measured on a unit plot, i.e. a plot 22.1-m-long, with a slope of 9%, continuously in a clean-tilled fallow condition with tillage performed upslope and downslope (Wischmeier and Smith, 1978). The soil erodibility factor is a measure of the susceptibility of the soil to be eroded by rainfall and runoff. The following relationship was developed to predict *K* values of soils for which data are limited (Renard et al., 1997):

$$K = 0.0034 + 0.0405\, exp\left[-\frac{1}{2}\left(\frac{log\left(d_g\right) + 1.659}{0.7101} \right)^2 \right] \tag{38}$$

where d_g (mm) is the geometric mean particle diameter. Eq.(38) was deduced using measured *K* values for 225 soils (Renard et al., 1997). These data were pooled and grouped into textural classes. The mean values of the soil erodibility factor for soils within each size class were then related to the geometric mean particle diameter of the class. The fact that the USDA textural classes were reported in the Agriculture Handbook no.703 (Renard et al., 1997) suggested to use d_{gUSDA} as the estimate of d_g to be used with eq.(38). This estimate of *K* was denoted by the symbol K_{USDA}. However, d_{gISSS} and d_{gPSD} were also used with eq.(38) to detect a possible effect of the calculation procedure of d_g on the estimate of *K*. These last estimates of the soil erodibility factor were denoted by the symbols K_{ISSS} and K_{PSD}, respectively.

Using published and unpublished data from 10 studies, Jones (1983) developed empirical regression relationships to distinguish for various textures a *"lower" critical bulk density*, $\rho_{b,L}$ (g cm^{-3}), below which root growth is effectively unimpeded, and an *"upper" critical bulk density*, $\rho_{b,U}$ (g cm^{-3}), above which root growth is severely impeded (Reynolds et al., 2002). The upper critical bulk density is defined as ≤ 20% of the root growth at the lower critical bulk density. The two critical values vary with the clay, *cl* (%), + silt, *si* (%), content (i.e., particles of less than 0.05 mm) according to the following relationships (Jones, 1983):

$$\rho_{b,L} = 1.60 - 0.00468(cl + si) \quad (39)$$

$$\rho_{b,U} = 1.83 - 0.00429(cl + si) \quad (40)$$

Crop root growth becomes progressively more impeded as bulk density increases above $\rho_{b,L}$ due to increasing soil strength. However, bulk densities below $\rho_{b,L}$ may not provide sufficient root-soil contact and soil water retention for adequate seed germination and seedling growth, nor adequate anchoring to maintain field crops upright when subjected to wind and rain (Reynolds et al., 2003).

The spatial variability of selected soil properties was studied. In particular, the considered variables were: (i) clay, silt and sand content (USDA classification scheme), because they were directly measured in this investigation; (ii) plant available water capacity estimated according to Saxton et al. (1986), as an example for the considered variable; and (iii) soil erodibility factor, because areas with the highest *K* values could be selected to further investigate the erosion phenomenon in the Ruyigi area. The geographical coordinates of the collected soil samples were used to realize a topographic input layer by the software ArcGis 9.1. The input topographic layer was used with the other covers to determine the spatial distribution of a considered variable. The interpolation procedure was developed by the TOPOGRID section of the ARC/INFO software using a mesh size equal to 100 m. TOPOGRID is a specific algorithm developed by ESRI and it is based on polynomial surfaces. TOPOGRID was specifically developed to realize 3D-elevation model of a basin using a small number of data points and the blue-lines. TOPOGRID is based upon the ANUDEM program developed by Hutchinson (1988, 1989). This method uses an iterative finite difference interpolation technique. It is optimized to have the computational efficiency of "local" interpolation methods, such as inverse distance weighted interpolation, without loosing the surface continuity of "global" interpolation methods such as kriging and splines. It is essentially a discretised thin plate spline technique where the roughness penalty has been modified to allow the fitted DEM to follow abrupt changes in terrain, such as streams and ridges. The quantity of input data can be up to an order of magnitude less than normally required to adequately describe a surface with digitized contours.

RESULTS AND DISCUSSION

Clay, silt and sand content

Table 31 lists the individual values of the *clay*, *cl* (%), *silt*, *si* (%), and *sand*, *sa* (%), content for each soil sample. The basic statistics (sample size, *N*; minimum value, *min*; maximum value, *max*; mean value, *M*; and coefficient of variation, *CV*) were calculated for each soil textural fraction and they were included in Table 31. The textural composition of each soil sample was also summarized in the USDA textural triangle shown in Figure 9.

The spatial distribution of the clay, silt and sand content (USDA classification scheme) was reported in Figures 10, 11 and 12, respectively. A large variability was detected for each textural fraction. In particular, the *max*/*min* ratio was equal to 5.7 for *cl*, 13.6 – 33.3 for *si*, depending on the classification scheme, and 8.0 – 17.2 for *sa*. However, most sampled soils were fine textured.

Figure 13 shows the comparison between the silt percentages determined according to the USDA (si_{USDA}) and ISSS (si_{ISSS}) classification schemes, respectively. The ratio between si_{USDA} and si_{ISSS} ranged from 1.0 to 3.3, depending on the soil sample. However, the two variables were linearly related according to the following relationship:

$$si_{USDA} = 3.46 + 1.228\ si_{ISSS} \qquad R^2 = 0.90 \quad (41)$$

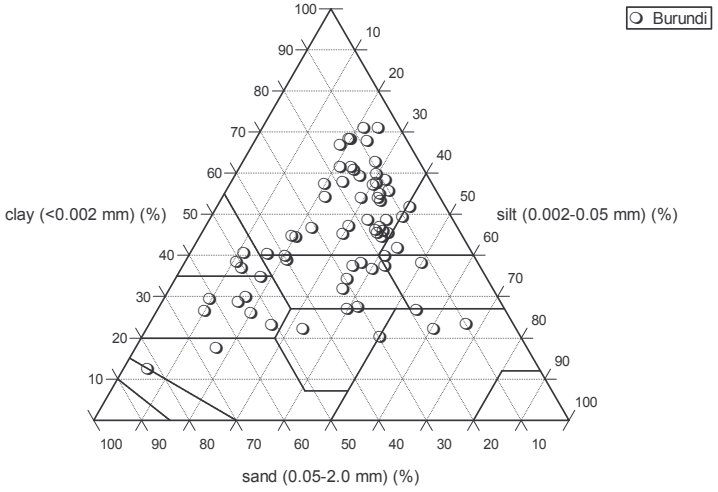

Figure 9. Textural composition of the soil data set for the USDA classification scheme

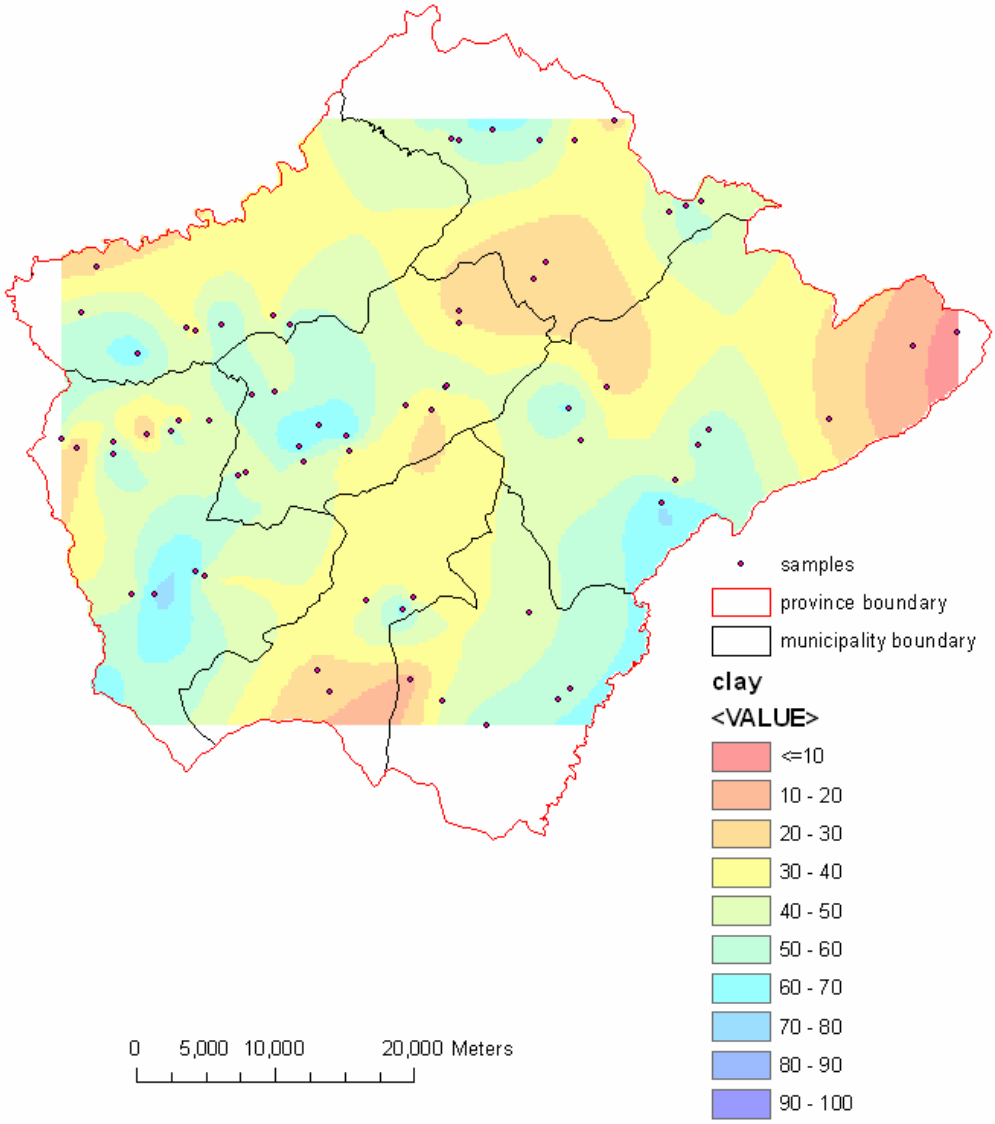

Figure 10. Spatial distribution of the clay content, in percent by weight, throughout the Ruyigi area

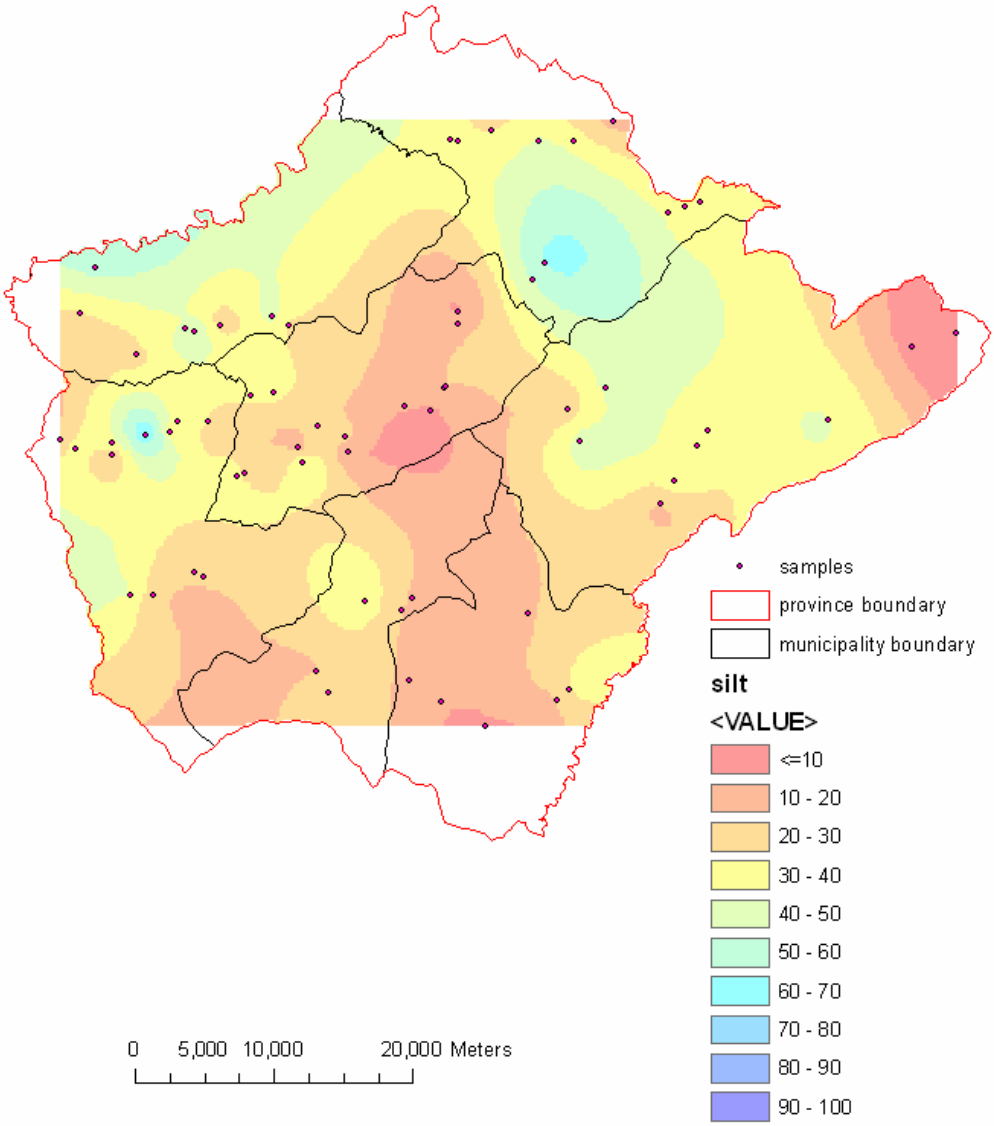

Figure 11. Spatial distribution of the silt content, in percent by weight (USDA classification scheme), throughout the Ruyigi area

Eq.(41) can be applied to deduce si_{USDA} when si_{ISSS} is known. Therefore, the sand percentage according to the USDA scheme, sa_{USDA} (%), can be estimated by the following relationship:

$$sa_{USDA} = 100 - cl - \left(3.46 + 1.228\ si_{ISSS}\right) \tag{42}$$

where the clay content, cl (%), does not depend on the adopted classification scheme. In other words, eqs.(41) and (42) may be applied to estimate silt and sand content according to the USDA scheme when the data are summarized according to the ISSS scheme. Figure 14 shows the comparison between the measured and the predicted sand content.

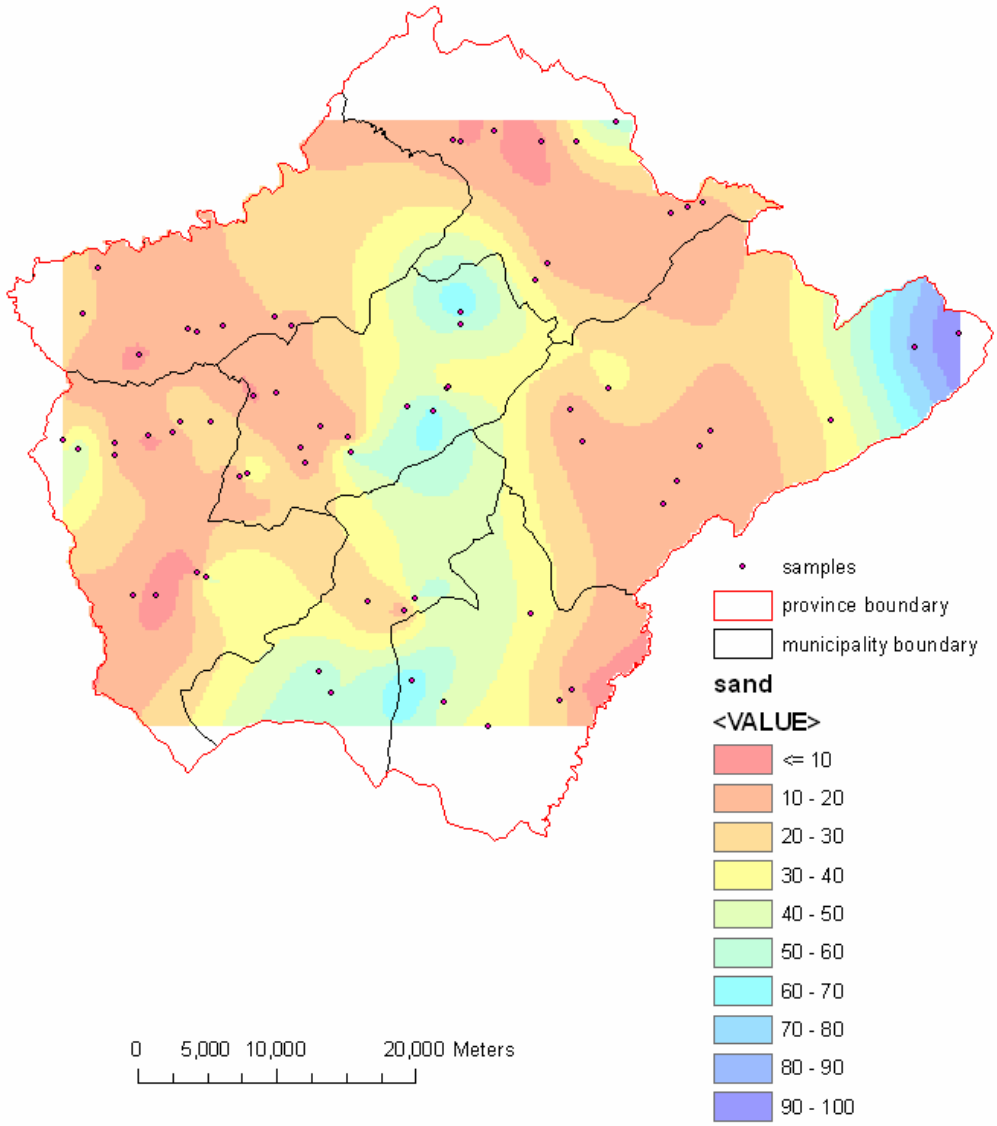

Figure 12. Spatial distribution of the sand content, in percent by weight (USDA classification scheme), throughout the Ruyigi area

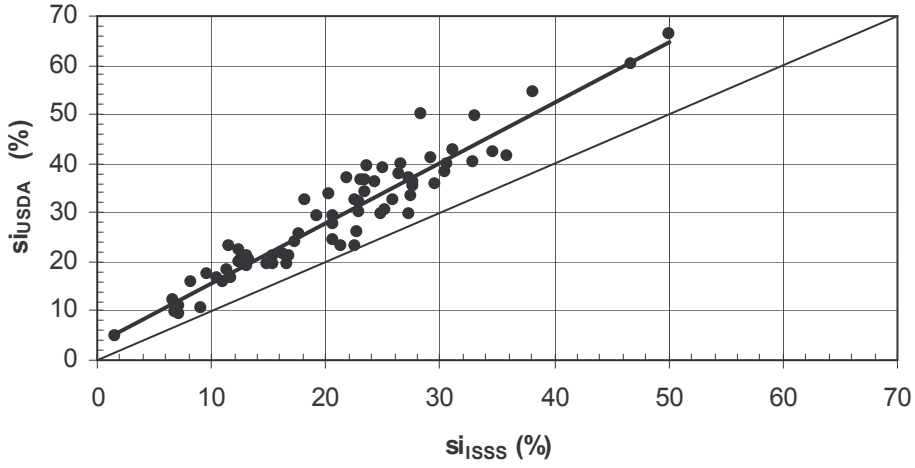

Figure 13. Comparison between the silt percentages determined according to the USDA (si_{USDA}, 0.002-0.05 mm) and ISSS (si_{ISSS}, 0.002-0.02 mm) classification schemes

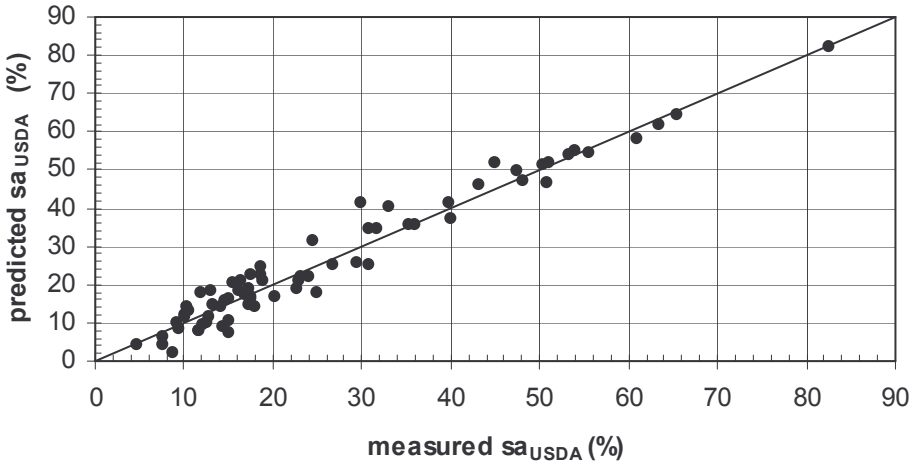

Figure 14. Comparison between the measured and the predicted (eq.42) sand content (USDA scheme, sa_{USDA}) for the considered soil samples

Geometric mean particle diameter

The values of the *geometric mean particle diameter*, d_g (mm), calculated for each soil sample by using the three different representations of the soil textural characteristics (PSD, USDA scheme, ISSS scheme) were listed in Table 32. The basic statistics of $d_{g,PSD}$, $d_{g,USDA}$ and $d_{g,ISSS}$ were also included in Table 32. The investigated area showed a noticeable variability in terms of d_g results given that values varying approximately by two orders of magnitude were obtained (i.e., $0.0012 \leq d_{g,PSD} \leq 0.1058$ mm; $0.0030 \leq d_{g,USDA} \leq 0.3609$ mm; and $0.0034 \leq d_{g,ISSS} \leq 0.3983$ mm). The geometric mean particle diameter values obtained by using the ISSS classification scheme, $d_{g,ISSS}$, differed by the corresponding values obtained with the USDA scheme, $d_{g,USDA}$, by a factor ranging from 0.84 to 1.72 (Figure 15). On average, the $d_{g,ISSS}/d_{g,USDA}$ ratio was equal to 1.14.

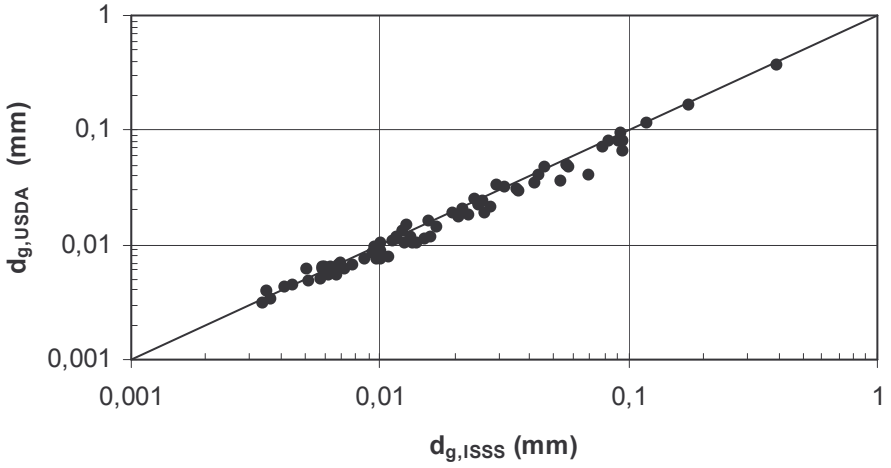

Figure 15. Comparison between the geometric mean particle diameter values obtained by using the ISSS ($d_{g,ISSS}$) and USDA ($d_{g,USDA}$) classification schemes

Both $d_{g,ISSS}$ and $d_{g,USDA}$ were higher than $d_{g,PSD}$. In particular, $1.81 \leq d_{g,ISSS}/d_{g,PSD} \leq 4.59$ (mean 2.96) and $1.97 \leq d_{g,USDA}/d_{g,PSD} \leq 3.41$ (mean 2.60) was obtained. However, $d_{g,PSD}$ (mm) was related to both $d_{g,ISSS}$ (mm) (Figure 16) and $d_{g,USDA}$ (mm) (Figure 17) according to the following relationships:

$$d_{g,PSD} = 0.218\ d_{g,ISSS}^{0.887} \qquad R^2 = 0.98 \qquad (43)$$

$$d_{g,PSD} = 0.275\ d_{g,USDA}^{0.918} \qquad R^2 = 0.99 \qquad (44)$$

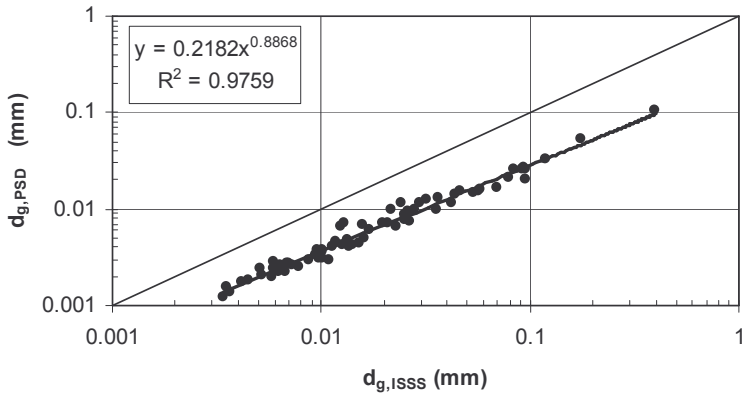

Figure 16. Comparison between the geometric mean particle diameter values obtained by using the measured particle size distribution ($d_{g,PSD}$) and the corresponding ones determined on the basis of the ISSS classification scheme ($d_{g,ISSS}$)

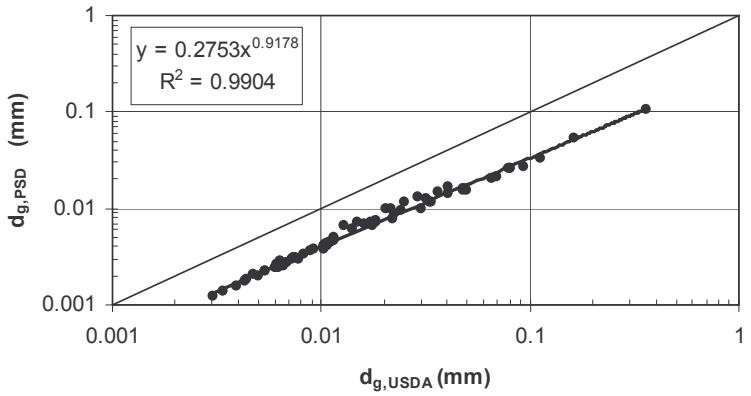

Figure 17. Comparison between the geometric mean particle diameter values obtained by using the particle size distribution ($d_{g,PSD}$) and the corresponding ones determined on the basis of the USDA classification scheme ($d_{g,USDA}$)

Assuming reasonably that an estimate of the geometric mean particle diameter obtained by using the PSD is more reliable than an estimate based on three textural fractions, it may be concluded that eqs.(43) and (44) could be of practical interest to improve the reliability of the d_g prediction when a limited textural information is available.

Plant available water capacity

Table 33 lists the individual *field capacity*, *FC*, *permanent wilting point*, *PWP*, and *plant available water capacity*, *PAWC*, values obtained with both the Saxton et al. (1986) and van den Berg et al. (1997) PTFs. The basic statistics of each variable were also included in Table 33. A total of 56 soil samples were selected for estimating *FC*, *PWP* and *PAWC* according to Saxton et al. (1986). The other 13 samples were excluded because they did not fall within the region of the USDA texture triangle for which the selected PTF appears valid (Saxton et al., 1986). The spatial distribution of the *PAWC* values obtained with eqs.(29), (30), (31) and (32) is shown in Figure 18. The

comparison between the Saxton et al. (1986) and van den Berg et al. (1997) PTFs yielded different results, depending on the considered variable. In particular, eqs.(30), (31) and (32) yielded higher *FC* estimates as compared to eq.(33) by a factor varying from 1.19 to 1.39, depending on the soil sample. However, the two sets of data were highly correlated (R^2 = 0.97, N = 56). An appreciably lower correlation (R^2 = 0.55) was detected for *PWP*. In this case, the ratio between the two estimated values varied between 0.55 and 1.40. Finally, the two estimates of PAWC were not correlated (R^2 = 0.04). The Saxton et al. (1986) PTF yielded *PAWC* values that were 1.23 to 2.83 times higher than those calculated according to van den Berg et al. (1997). Reynolds et al. (2002) have recently reported that plant available water capacity should be > 0.20 m^3m^{-3} or within the range 0.15 – 0.25 m^3m^{-3}. According to Saxton et al. (1986), the investigated area is characterized by a near-optimal *PAWC* but individual locations may exhibit problems in crop water availability considered that *PAWC* < 0.20 m^3m^{-3} was obtained for 41% of the sampling points. Following van den Berg et al. (1997), a lower *PAWC* than the optimal one is a common occurrence in the Ruyigi area, suggesting that crop water availability is an important factor limiting crop growth. Direct measurement of moisture retention characteristics, yielding more reliable *FC*, *PWP* and *PAWC* results, is necessary since soil water availability to crops is a key factor to improve yields in an area of interest.

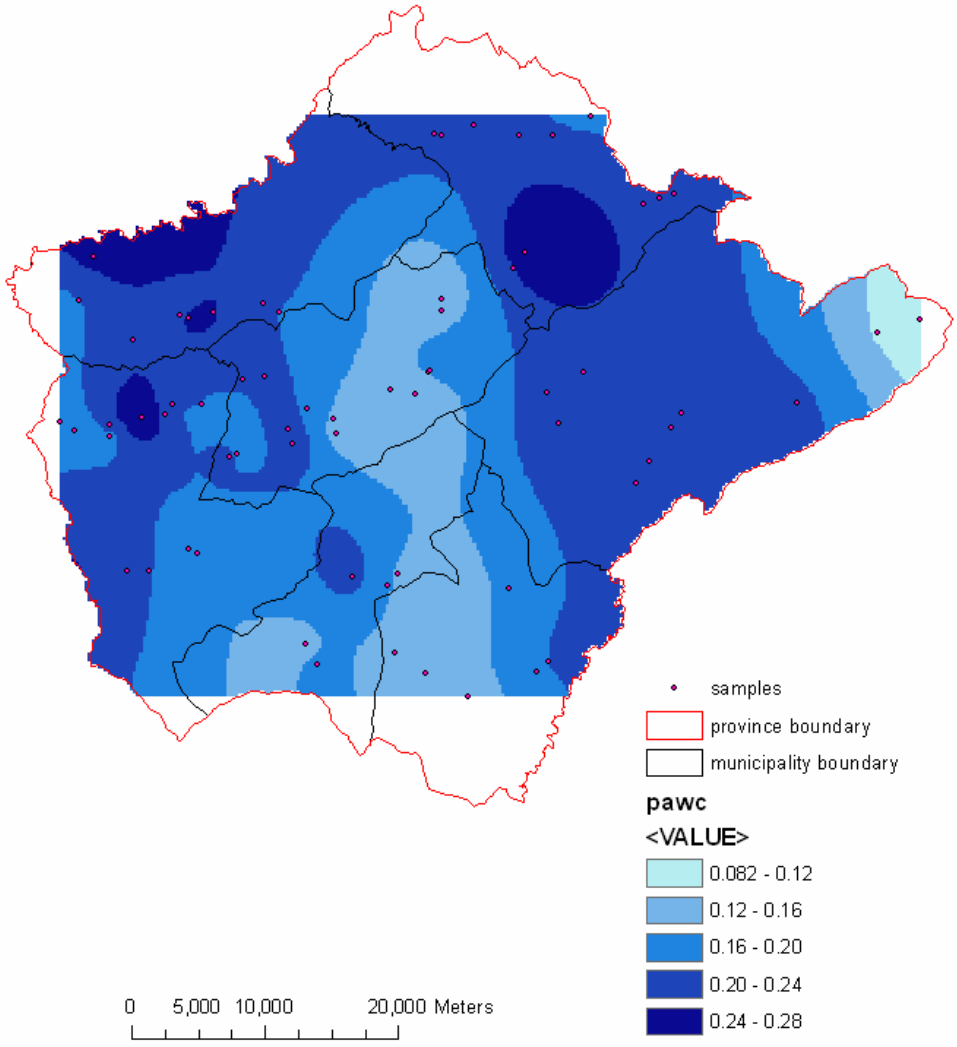

Figure 18. Spatial distribution of the plant available water capacity, *PAWC* (m^3m^{-3}), estimated according to Saxton et al. (1986)

Soil hydraulic conductivity

Table 34 lists the individual estimated values of both the *saturated*, K_s (mm h^{-1}), and *near-saturated*, K_{10} (mm h^{-1}), *soil hydraulic conductivity*. The basic statistics of K_s and K_{10} were also included in Table 34. Following Saxton et al. (1986), a total of 56 soil samples were selected for estimating K_s. The complete data set (N = 69) was considered to estimate K_{10}. On average, K_s was equal to 3.4 mm h^{-1} with an associated CV = 88.4%. For K_{10}, M = 0.7 mm h^{-1} and CV = 167.8% was obtained. The predicted K_s values varied by a factor of 13 ($1.5 \leq K_s \leq 19.7$ mm h^{-1}). The observed range was rather narrow as compared to the range of possible K_s values (several orders of magnitude). Tietje and Hennings (1996) also noted that the range of hydraulic conductivities predicted by eq.(36) tends to be rather small and they attributed this result to the fact that the relationship estimates a mean saturated conductivity. According to these authors, the calculated values of K_s have to be considered as an order of magnitude of this variable, and must be used with a particular caution, due to the low accuracy characterizing the prediction of K_s using a PTF. A wider range was detected for K_{10} (approximately, two orders of magnitude, $0.1 \leq K_{10} \leq 9.1$ mm h^{-1}). In all cases, the comparison between K_s and K_{10} yielded physically reasonable results, given that $K_s > K_{10}$ was obtained for all soil samples (N = 56). In particular, the ratio between K_s and K_{10} varied from 1.1 to 22.1. with a mean value of 7.0.

Soil erodibility factor

Table 35 lists the individual estimates of the *soil erodibility factor* (K_{USDA}, K_{ISSS}, and K_{PSD}) obtained by eq.(38) with different estimates of the geometric mean particle diameter ($d_{g,USDA}$, $d_{g,ISSS}$, and $d_{g,PSD}$, respectively). The basic statistics of each variable were also included in Table 35. Figure 19 shows the spatial distribution of K_{USDA}. The K_{USDA} results varied between 0.013 and 0.044 t ha h ha^{-1} MJ^{-1} mm^{-1}. According to Wischmeier and Smith (1978), individual values of the soil erodibility factor may vary approximately between zero (non-erodible soil) and 0.09 t ha h ha^{-1} MJ^{-1} mm^{-1} (maximum erodibility). The relationship proposed by Renard et al. (1997) predicts a maximum erodibility value of 0.044 t ha h ha^{-1} MJ^{-1} mm^{-1} for d_g = 0.022 mm. Lower erodibilities are predicted for both d_g < 0.022 mm and d_g > 0.022 mm. Therefore, the soil erodibility values calculated in this investigation included the maximum predictable one. In other words, the investigated area includes zones with an appreciable susceptibility to rainfall erosion according to the relationship by Renard et al. (1997). Figure 20 shows the cumulative empirical frequency distribution of K_{USDA}, K_{ISSS}, and K_{PSD}. The three sets of data were characterized by a similar range (i.e., minimum value = 0.012-0.013 t ha h ha^{-1} MJ^{-1} mm^{-1}, depending on the considered data set; maximum value = 0.044 t ha h ha^{-1} MJ^{-1} mm^{-1} for all data sets). However, K_{USDA} and K_{ISSS} also yielded similar mean (M = 0.037 t ha h ha^{-1} MJ^{-1} mm^{-1}) and CV (17.4 – 17.8%) results, whereas K_{PSD} was lower (M = 0.031 t ha h ha^{-1} MJ^{-1} mm^{-1}) and more variable (CV = 31.9%). The ratio between K_{USDA} and K_{PSD} varied from a minimum of 0.44 to a maximum of 1.93. Moreover, both $K_{PSD} < K_{USDA}$ and $K_{PSD} > K_{USDA}$ were obtained for a given value of K_{USDA}. This result occurred because d_g varied appreciably with the considered representation of the soil textural characteristics for a given soil sample and the relationship developed by Renard et al. (1997) is bell-shaped, i.e. it predicts the maximum erodibility at an intermediate value of the range of possible d_g values and similar erodibilities for very different d_g values.

Critical bulk density

The individual *critical bulk density* results and the associated basic statistics are shown in Table 36. A noticeable range of the critical bulk density values was detected ($1.15 \leq \rho_{b,L} \leq 1.52$ g cm^{-3} and $1.42 \leq \rho_{b,U} \leq 1.76$ g cm^{-3}). This occurred because both $\rho_{b,L}$ and $\rho_{b,U}$ were calculated on the basis of the clay plus silt content, that varied widely in the investigated area (i.e., from 17.4% to 95.3%).

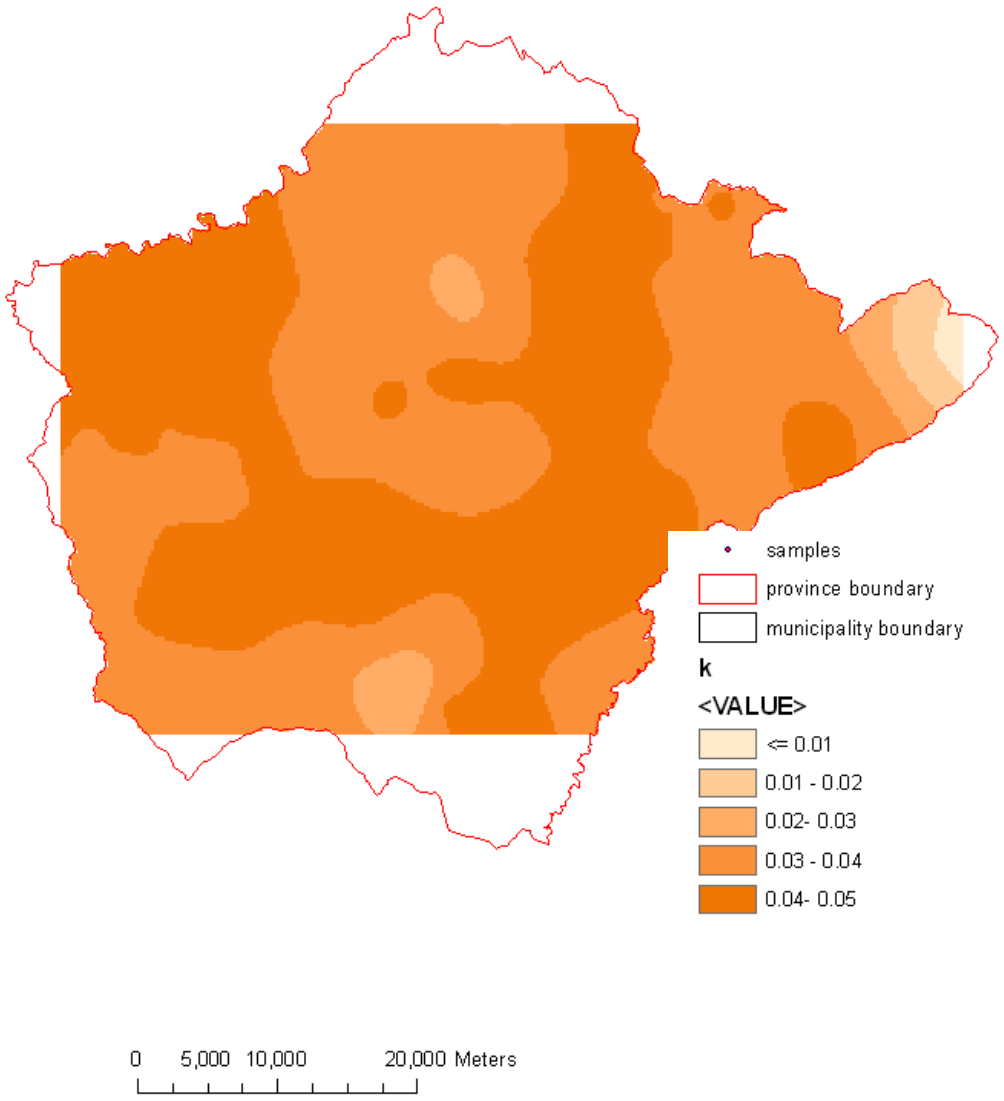

Figure 19. Spatial distribution of the soil erodibility factor, *K* (t ha h ha^{-1} MJ^{-1} mm^{-1}), estimated according to Renard et al. (1997)

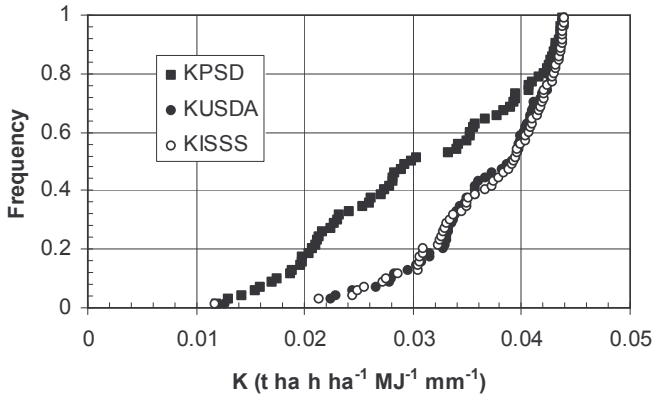

Figure 20. Cumulative empirical frequency distribution of the soil erodibility factors deduced with different representations of the soil textural characteristics

Table 30. Geographic coordinates of the selected soil sampling locations (sample size, *N* = 69)

Code	Name	Latitude	Longitude	Altitude (m)
1	NYAMUTOBO1	S3°28.027'	E30°15.699'	1809
2	NYAMUTOBO2	S3°28.574'	E30°15.808'	1605
3	MUREHE1	S3°29.002'	E30°14.036'	1599
4	MUREHE2	S3°28.426'	E30°13.868'	1581
5	GISORO1	S3°26.125'	E30°19.519'	1604
6	GISORO2	S3°26.062'	E30°19.570'	1605
7	DUTWE1	S3°26.971'	E30°19.008'	1651
8	DUTWE2	S3°26.811'	E30°18.025'	1596
9	MIGEGE1	S3°23.629'	E30°20.041'	1611
10	MIGEGE2	S3°23.154'	E30°20.067'	1657
11	NYABURONDWE1	S3°33.243'	E30°09.816'	1621
12	NYABURONDWE2	S3°33.451'	E30°10.170'	1643
13	MURIZA1	S3°34.148'	E30°08.219'	1640
14	MURIZA2	S3°34.127'	E30°07.359'	1649
15	BISINDE1	S3°29.528'	E30°11.464'	1631
16	BISINDE2	S3°29.448'	E30°11.777'	1630
17	BIYORWA1	S3°28.258'	E30°06.633'	1544
18	BIYORWA2	S3°28.726'	E30°06.656'	1539
19	MPAME1	S3°28.119'	E30°04.643'	1584
20	MPAME2	S3°28.472'	E30°05.210'	1475
21	NYAMUGARI1	S3°27.948'	E30°07.949'	1517
22	NYAMUGARI2	S3°27.799'	E30°08.897'	1542
23	RUCONGO1	S3°27.429'	E30°10.378'	1692
24	MASAKE	S3°27.433'	E30°09.195'	1683
25	NTUNDA1	S3°21.934'	E30°22.989'	1658
26	NTUNDA2	S3°21.258'	E30°23.415'	1644
27	GATWARO1	S3°18.897'	E30°29.455'	1577
28	KIRAMBI1	S3°19.069'	E30°28.855'	1571
29	KIRAMBI2	S3°19.282'	E30°28.224'	1593
30	SENGA1	S3°23.682'	E30°13.483'	1579
31	SENGA2	S3°23.342'	E30°12.858'	1626
32	KIRASYRA1	S3°23.924'	E30°09.847'	1538
33	KIRASYRA2	S3°23.788'	E30°09.464'	1549
34	RUGOTI1	S3°24.801'	E30°07.618'	1639
35	RUGOTI2	S3°24.600'	E30°07.420'	1730
36	GITWA1	S3°23.206'	E30°05.426'	1632
37	GITWA2	S3°21.442'	E30°05.993'	1579
38	NYABIGUGO1	S3°26.406'	E30°12.023'	1580
39	NYABIGUGO2	S3°26.292'	E30°12.933'	1533
40	TITI1	S3°23.691'	E30°10.827'	1533
42	MUHWAZI1	S3°59.187'	E29°55.631'	1314
43	MUHWAZI2	S3°37.947'	E30°15.058'	1253
44	NYAKIBINGO1	S3°37.128'	E30°14.584'	1268
45	VUMWE1	S3°37.469'	E30°18.186'	1265
46	KINYINIA1	S3°38.312'	E30°19.443'	1194
47	KINYINIA2	S3°39.233'	E30°21.124'	1252
48	KABANGA1	S3°38.216'	E30°23.907'	1180
49	KABANGA2	S3°37.831'	E30°24.395'	1198
51	NYAMIGINA2	S3°34.881'	E30°22.815'	1247
52	NYABITSINDA1	S3°34.724'	E30°17.851'	1251
53	NYABITSINDA2	S3°34.292'	E30°18.297'	1245
54	NYABITSINDA3	S3°34.378'	E30°16.448'	1267
55	KABUYENGE1	S3°24.008'	E30°39.420'	1441
56	KABUYENGE2	S3°24.525'	E30°37.677'	1463

Code	Name	Latitude	Longitude	Altitude (m)
58	KAVUMWE2	S3°27.331'	E30°34.434'	1535
59	BUSORO1	S3°15.741'	E30°26.126'	1626
60	BUSORO2	S3°16.548'	E30°24.576'	1624
61	GASENYI1	S3°16.554'	E30°23.173'	1561
62	CAGA1	S3°16.143'	E30°21.369'	1517
63	CAGA2	S3°16.510'	E30°20.062'	1488
64	KANISHA	S3°16.499'	E30°19.761'	1503
66	BWAGIRIZA2	S3°27.594'	E30°14.613'	1575
67	MUNYINYA1	S3°29.690'	E30°28.440'	1571
68	MUNYINYA2	S3°30.600'	E30°27.912'	1467
69	KINAMA1	S3°28.377'	E30°29.363'	1369
70	KINAMA2	S3°27.744'	E30°29.787'	1347
72	NYABIGOZI2	S3°26.085'	E30°25.810'	1256
73	RUHUNI1	S3°28.161'	E30°24.825'	1253
74	RUHUNI2	S3°26.915'	E30°24.319'	1310

Table 31. Clay, silt and sand content (% by weight) of the soil samples collected in the Ruyigi area

Code	NAME	Clay	Silt	Sand	Silt	Sand
			USDA classification		ISSS classification	
1	NYAMUTOBO1	67.9	23.4	8.7	21.4	10.7
2	NYAMUTOBO2	37.2	12.3	50.5	6.6	56.2
3	MUREHE1	47.1	36.5	16.4	23.4	29.5
4	MUREHE2	67.1	18.2	14.7	11.4	21.5
5	GISORO1	40.7	16.0	43.3	8.2	51.2
6	GISORO2	44.6	20.2	35.2	13.4	42.0
7	DUTWE1	29.6	9.4	61.0	7.2	63.2
8	DUTWE2	38.7	10.5	50.9	9.1	52.3
9	MIGEGE1	29.9	16.8	53.3	10.5	59.6
10	MIGEGE2	26.6	9.9	63.5	6.8	66.6
11	NYABURONDWE1	71.2	21.2	7.6	15.5	13.4
12	NYABURONDWE2	38.9	21.0	40.0	16.8	44.3
13	MURIZA1	71.2	24.1	4.8	17.2	11.6
14	MURIZA2	45.5	39.1	15.4	25.0	29.5
15	BISINDE1	49.6	40.0	10.4	26.6	23.7
16	BISINDE2	40	20.2	39.8	12.5	47.4
17	BIYORWA1	45.6	36.8	17.6	23.1	31.3
18	BIYORWA2	57.9	23.4	18.7	11.5	30.6
19	MPAME1	46.7	22.4	30.9	12.4	40.9
20	MPAME2	22.3	32.7	45.0	18.3	59.5
21	NYAMUGARI1	23.5	66.4	10.0	50.0	26.4
22	NYAMUGARI2	53.4	33.7	13.0	20.3	26.4
23	RUCONGO1	45.3	29.7	25.0	27.3	27.4
24	MASAKE	37.5	35.6	26.9	27.7	34.8
25	NTUNDA1	20.2	49.9	29.9	28.3	51.5
26	NTUNDA2	22.2	60.2	17.5	46.8	31.0
27	GATWARO1	46.4	36.0	17.6	27.6	26.0
28	KIRAMBI1	57.7	30.5	11.8	25.2	17.1
29	KIRAMBI2	46.1	37.8	16.1	26.4	27.5
30	SENGA1	54.1	29.1	16.8	20.7	25.2
31	SENGA2	37.5	42.3	20.2	34.6	27.9
32	KIRASYRA1	38.3	49.7	12.0	33.0	28.7
33	KIRASYRA2	39.9	41.2	18.8	29.2	30.9

Code	NAME	Clay	Silt	Sand	Silt	Sand
			USDA classification		ISSS classification	
34	RUGOTI1	62.7	27.8	9.4	20.6	16.7
35	RUGOTI2	32	36.3	31.7	24.4	43.6
36	GITWA1	47.4	29.9	22.8	24.8	27.8
37	GITWA2	27.0	54.4	18.6	38.1	34.9
38	NYABIGUGO1	58.6	32.1	9.3	23	18.5
39	NYABIGUGO2	48.8	33.3	18.0	27.4	23.8
40	TITI1	59.5	26.1	14.4	22.8	17.7
42	MUHWAZI1	54.3	21.5	24.2	16.3	29.4
43	MUHWAZI2	23.2	25.7	51.2	17.6	59.2
44	NYAKIBINGO1	26.1	19.8	54.1	12.4	61.5
45	VUMWE1	17.6	16.9	65.5	11.7	70.7
46	KINYINIA1	40.8	11.1	48.1	7.1	52.1
47	KINYINIA2	68.3	19.4	12.2	15.4	16.2
48	KABANGA1	57.4	19.6	22.9	15	27.6
49	KABANGA2	57.1	30.0	12.8	22.8	20.0
51	NYAMIGINA2	44.9	19.1	35.9	13.2	41.9
52	NYABITSINDA1	61.6	21.0	17.3	13.1	25.3
53	NYABITSINDA2	34.9	17.6	47.5	9.7	55.4
54	NYABITSINDA3	38.3	37.1	24.6	21.9	39.8
55	KABUYENGE1	36.8	40.0	23.2	30.7	32.5
56	KABUYENGE2	12.5	4.9	82.6	1.5	86.0
58	KAVUMWE2	27.2	39.6	33.2	23.6	49.3
59	BUSORO1	28.7	15.8	55.5	11.1	60.2
60	BUSORO2	34.5	36	29.5	29.6	35.9
61	GASENYI1	51.8	40.5	7.7	33	15.2
62	CAGA1	60	29.5	10.6	19.3	20.8
63	CAGA2	55.9	34.0	10.1	23.5	20.6
64	KANISHA	48.8	37.2	14.1	27.3	24
66	BWAGIRIZA2	61.7	23.3	15.0	22.6	15.7
67	MUNYINYA1	44.6	38.1	17.3	30.5	24.9
68	MUNYINYA2	68.6	19.6	11.8	16.6	14.8
69	KINAMA1	55	32.5	12.5	25.8	19.2
70	KINAMA2	54	32.7	13.3	22.5	23.5
72	NYABIGOZI2	27.5	41.7	30.8	35.8	36.7
73	RUHUNI1	42	42.8	15.1	31.2	26.8
74	RUHUNI2	60.7	24.2	15.1	20.6	18.7

Statistic	Clay	Silt	Sand	Silt	Sand
		USDA classification		ISSS classification	
Sample Size, N	69	69	69	69	69
Minimum, min	12.5	4.9	4.8	1.5	10.7
Maximum, max	71.2	66.4	82.6	50.0	86.0
Mean, M	44.5	29.4	26.1	21.1	34.4
Coefficient of variation, CV (%)	32.4	41.4	66.1	44.7	48.2

Clay: particles of less than 0.002 mm in diameter; *Silt*: particles with a diameter ranging between 0.002 and 0.05 mm (U.S. Department of Agriculture, USDA classification scheme) or between 0.002 and 0.02 mm (International Soil Science Society, ISSS classification scheme); *Sand*: particles with a diameter ranging between 0.05 and 2.0 mm (USDA classification scheme) or between 0.02 and 2.0 mm (ISSS classification scheme).

Table 32. Geometric mean particle diameter of the sampled soils obtained by using the measured particle size distribution, $d_{g,PSD}$ (mm), the clay, silt and sand fractions defined according to the USDA classification scheme, $d_{g,USDA}$ (mm), and the clay, silt and sand fractions defined according to the ISSS classification scheme, $d_{g,ISSS}$ (mm)

Code	Name	$d_{g,PSD}$	$d_{g,USDA}$	$d_{g,ISSS}$
1	NYAMUTOBO1	0.0015	0.0039	0.0035
2	NYAMUTOBO2	0.0151	0.0494	0.0571
3	MUREHE1	0.0041	0.0102	0.0135
4	MUREHE2	0.0020	0.0050	0.0058
5	GISORO1	0.0114	0.0339	0.0419
6	GISORO2	0.0078	0.0222	0.0252
7	DUTWE1	0.0274	0.0932	0.0942
8	DUTWE2	0.0156	0.0478	0.0462
9	MIGEGE1	0.0209	0.0696	0.0794
10	MIGEGE2	0.0330	0.1127	0.1181
11	NYABURONDWE1	0.0014	0.0034	0.0036
12	NYABURONDWE2	0.0125	0.0318	0.0320
13	MURIZA1	0.0012	0.0030	0.0034
14	MURIZA2	0.0043	0.0104	0.0140
15	BISINDE1	0.0031	0.0075	0.0098
16	BISINDE2	0.0100	0.0304	0.0359
17	BIYORWA1	0.0044	0.0112	0.0151
18	BIYORWA2	0.0029	0.0078	0.0109
19	MPAME1	0.0065	0.0177	0.0227
20	MPAME2	0.0206	0.0657	0.0947
21	NYAMUGARI1	0.0071	0.0175	0.0207
22	NYAMUGARI2	0.0031	0.0074	0.0101
23	RUCONGO1	0.0071	0.0149	0.0128
24	MASAKE	0.0098	0.0205	0.0215
25	NTUNDA1	0.0163	0.0403	0.0694
26	NTUNDA2	0.0096	0.0240	0.0262
27	GATWARO1	0.0043	0.0109	0.0117
28	KIRAMBI1	0.0024	0.0061	0.0060
29	KIRAMBI2	0.0042	0.0105	0.0126
30	SENGA1	0.0033	0.0083	0.0094
31	SENGA2	0.0069	0.0161	0.0158
32	KIRASYRA1	0.0050	0.0116	0.0161
33	KIRASYRA2	0.0061	0.0141	0.0171
34	RUGOTI1	0.0020	0.0048	0.0052
35	RUGOTI2	0.0133	0.0293	0.0366
36	GITWA1	0.0065	0.0128	0.0124
37	GITWA2	0.0100	0.0214	0.0279
38	NYABIGUGO1	0.0023	0.0054	0.0062
39	NYABIGUGO2	0.0038	0.0103	0.0100
40	TITI1	0.0028	0.0064	0.0059
42	MUHWAZI1	0.0040	0.0107	0.0113
43	MUHWAZI2	0.0255	0.0801	0.0917
44	NYAKIBINGO1	0.0261	0.0811	0.0947
45	VUMWE1	0.0530	0.1627	0.1761
46	KINYINIA1	0.0141	0.0403	0.0437
47	KINYINIA2	0.0018	0.0044	0.0044
48	KABANGA1	0.0037	0.0093	0.0097
49	KABANGA2	0.0027	0.0065	0.0069

Code	Name	$d_{g,PSD}$	$d_{g,USDA}$	$d_{g,ISSS}$
51	NYAMIGINA2	0.0086	0.0225	0.0249
52	NYABITSINDA1	0.0026	0.0066	0.0079
53	NYABITSINDA2	0.0160	0.0477	0.0581
54	NYABITSINDA3	0.0073	0.0184	0.0265
55	KABUYENGE1	0.0073	0.0184	0.0198
56	KABUYENGE2	0.1058	0.3609	0.3983
58	KAVUMWE2	0.0148	0.0363	0.0531
59	BUSORO1	0.0257	0.0785	0.0840
60	BUSORO2	0.0117	0.0250	0.0243
61	GASENYI1	0.0026	0.0064	0.0063
62	CAGA1	0.0023	0.0054	0.0067
63	CAGA2	0.0027	0.0061	0.0073
64	KANISHA	0.0036	0.0089	0.0101
66	BWAGIRIZA2	0.0024	0.0060	0.0051
67	MUNYINYA1	0.0047	0.0115	0.0116
68	MUNYINYA2	0.0017	0.0043	0.0041
69	KINAMA1	0.0027	0.0069	0.0070
70	KINAMA2	0.0030	0.0073	0.0087
72	NYABIGOZI2	0.0114	0.0329	0.0298
73	RUHUNI1	0.0048	0.0115	0.0135
74	RUHUNI2	0.0024	0.0063	0.0060

Statistic	$d_{g,PSD}$	$d_{g,USDA}$	$d_{g,ISSS}$
Sample Size, N	69	69	69
Minimum, min	0.0012	0.0030	0.0034
Maximum, max	0.1058	0.3609	0.3983
Mean, M	0.0102	0.0297	0.0338
Coefficient of variation, CV (%)	144.2	167.8	163.5

Table 33. Field capacity, *FC* (m^3m^{-3}), permanent wilting point, *PWP* (m^3m^{-3}), and plant available water capacity, *PAWC* (m^3m^{-3}) estimated for the sampled soils with the Saxton et al. (1986) and the van den Berg et al (1997) pedotransfer functions

Code	Name	Saxton et al. (1986)			van den Berg et al. (1997)		
		FC	PWP	PAWC	FC	PWP	PAWC
1	NYAMUTOBO1				0.415	0.273	0.140
2	NYAMUTOBO2	0.348	0.205	0.142	0.277	0.166	0.111
3	MUREHE1	0.486	0.270	0.216	0.368	0.244	0.121
4	MUREHE2				0.400	0.259	0.139
5	GISORO1	0.379	0.223	0.156	0.298	0.183	0.115
6	GISORO2	0.419	0.247	0.172	0.322	0.202	0.118
7	DUTWE1	0.300	0.171	0.129	0.243	0.139	0.104
8	DUTWE2	0.351	0.212	0.139	0.278	0.166	0.113
9	MIGEGE1	0.318	0.171	0.147	0.260	0.155	0.105
10	MIGEGE2	0.286	0.158	0.128	0.233	0.132	0.101
11	NYABURONDWE1				0.422	0.277	0.143
12	NYABURONDWE2	0.383	0.215	0.168	0.303	0.189	0.113
13	MURIZA1				0.428	0.283	0.143
14	MURIZA2	0.482	0.260	0.222	0.368	0.245	0.119
15	BISINDE1	0.510	0.289	0.221	0.385	0.258	0.123
16	BISINDE2	0.388	0.221	0.167	0.305	0.190	0.114
17	BIYORWA1	0.477	0.260	0.217	0.363	0.240	0.119
18	BIYORWA2	0.525	0.337	0.188	0.378	0.245	0.131
19	MPAME1	0.441	0.261	0.180	0.335	0.213	0.120
20	MPAME2	0.321	0.136	0.185	0.268	0.168	0.097
21	NYAMUGARI1	0.414	0.134	0.280	0.349	0.243	0.099
22	NYAMUGARI2	0.521	0.312	0.209	0.385	0.255	0.126
23	RUCONGO1	0.454	0.255	0.199	0.346	0.224	0.119
24	MASAKE	0.418	0.209	0.209	0.331	0.216	0.112
25	NTUNDA1	0.362	0.124	0.238	0.300	0.199	0.096
26	NTUNDA2	0.398	0.130	0.268	0.331	0.227	0.097
27	GATWARO1	0.480	0.265	0.215	0.364	0.241	0.120
28	KIRAMBI1	0.542	0.341	0.201	0.393	0.260	0.130
29	KIRAMBI2	0.483	0.263	0.219	0.367	0.244	0.120
30	SENGA1	0.515	0.314	0.200	0.377	0.247	0.127
31	SENGA2	0.437	0.209	0.228	0.346	0.230	0.112
32	KIRASYRA1	0.458	0.214	0.244	0.366	0.248	0.112
33	KIRASYRA2	0.450	0.224	0.226	0.352	0.234	0.114
34	RUGOTI1				0.406	0.268	0.135
35	RUGOTI2	0.384	0.179	0.206	0.312	0.202	0.107
36	GITWA1	0.470	0.269	0.201	0.354	0.230	0.121
37	GITWA2	0.405	0.151	0.254	0.335	0.227	0.102
38	NYABIGUGO1				0.400	0.266	0.131
39	NYABIGUGO2	0.489	0.280	0.209	0.367	0.241	0.122
40	TITI1				0.390	0.255	0.132
42	MUHWAZI1	0.494	0.310	0.183	0.361	0.232	0.127
43	MUHWAZI2	0.306	0.141	0.165	0.256	0.156	0.098
44	NYAKIBINGO1	0.306	0.154	0.152	0.253	0.151	0.101
45	VUMWE1	0.261	0.120	0.141	0.215	0.122	0.093
46	KINYINIA1	0.366	0.223	0.143	0.287	0.173	0.115
47	KINYINIA2				0.407	0.265	0.140
48	KABANGA1	0.510	0.330	0.180	0.368	0.236	0.130
49	KABANGA2	0.537	0.336	0.201	0.390	0.257	0.130

Code	Name	Saxton et al. (1986)			van den Berg et al. (1997)		
		FC	PWP	PAWC	FC	PWP	PAWC
51	NYAMIGINA2	0.418	0.248	0.169	0.321	0.201	0.119
52	NYABITSINDA1				0.386	0.251	0.134
53	NYABITSINDA2	0.348	0.194	0.154	0.281	0.171	0.109
54	NYABITSINDA3	0.428	0.213	0.214	0.337	0.221	0.112
55	KABUYENGE1	0.426	0.205	0.221	0.338	0.223	0.111
56	KABUYENGE2	0.213	0.098	0.115	0.170	0.083	0.088
58	KAVUMWE2	0.366	0.155	0.211	0.302	0.196	0.102
59	BUSORO1	0.310	0.166	0.143	0.254	0.150	0.103
60	BUSORO2	0.399	0.192	0.208	0.321	0.208	0.109
61	GASENYI1	0.524	0.304	0.220	0.394	0.265	0.125
62	CAGA1				0.399	0.264	0.133
63	CAGA2	0.537	0.330	0.207	0.395	0.263	0.129
64	KANISHA	0.499	0.281	0.217	0.376	0.250	0.122
66	BWAGIRIZA2				0.392	0.255	0.134
67	MUNYINYA1	0.473	0.253	0.220	0.363	0.240	0.118
68	MUNYINYA2				0.409	0.266	0.141
69	KINAMA1	0.529	0.323	0.206	0.388	0.257	0.128
70	KINAMA2	0.523	0.316	0.207	0.385	0.254	0.127
72	NYABIGOZI2	0.374	0.156	0.218	0.308	0.201	0.102
73	RUHUNI1	0.468	0.238	0.230	0.364	0.243	0.116
74	RUHUNI2				0.390	0.255	0.133

Statistic	Saxton et al. (1986)			van den Berg et al. (1997)		
	FC	PWP	PAWC	FC	PWP	PAWC
Sample Size, N	56	56	56	69	69	69
Minimum, min	0.213	0.098	0.115	0.170	0.083	0.088
Maximum, max	0.542	0.341	0.280	0.428	0.283	0.143
Mean, M	0.423	0.228	0.195	0.342	0.222	0.118
Coefficient of variation, CV (%)	19.1	28.9	18.7	16.2	19.5	11.3

Table 34. Saturated soil hydraulic conductivity, K_s (mm h^{-1}) estimated for the sampled soils with the Saxton et al. (1986) pedotransfer function, PTF, and associated near-saturated soil hydraulic conductivity, K_{10} (mm h^{-1}), estimated with the Jarvis et al. (2002) PTF

Code	Name	K_s	K_{10}
1	NYAMUTOBO1		0.1
2	NYAMUTOBO2	1.7	1.2
3	MUREHE1	2.2	0.3
4	MUREHE2		0.1
5	GISORO1	1.6	0.9
6	GISORO2	1.6	0.6
7	DUTWE1	2.6	2.3
8	DUTWE2	1.6	1.2
9	MIGEGE1	2.8	1.8
10	MIGEGE2	3.4	2.8
11	NYABURONDWE1		0.1
12	NYABURONDWE2	1.9	0.8
13	MURIZA1		0.1
14	MURIZA2	2.4	0.3
15	BISINDE1	2.5	0.2
16	BISINDE2	1.8	0.8
17	BIYORWA1	2.3	0.3
18	BIYORWA2	1.9	0.2
19	MPAME1	1.6	0.4
20	MPAME2	6.5	1.7
21	NYAMUGARI1	9.7	0.4
22	NYAMUGARI2	2.2	0.2
23	RUCONGO1	1.9	0.4
24	MASAKE	2.6	0.5
25	NTUNDA1	9.6	1.0
26	NTUNDA2	9.6	0.6
27	GATWARO1	2.2	0.3
28	KIRAMBI1	2.3	0.2
29	KIRAMBI2	2.3	0.3
30	SENGA1	2.0	0.2
31	SENGA2	3.0	0.4
32	KIRASYRA1	3.4	0.3
33	KIRASYRA2	2.7	0.4
34	RUGOTI1		0.1
35	RUGOTI2	3.4	0.7
36	GITWA1	1.9	0.3
37	GITWA2	6.3	0.5
38	NYABIGUGO1		0.1
39	NYABIGUGO2	2.1	0.3
40	TITI1		0.2
42	MUHWAZI1	1.7	0.3
43	MUHWAZI2	5.5	2.0
44	NYAKIBINGO1	4.0	2.0
45	VUMWE1	9.4	4.1
46	KINYINIA1	1.5	1.0
47	KINYINIA2		0.1
48	KABANGA1	1.7	0.2
49	KABANGA2	2.2	0.2
51	NYAMIGINA2	1.6	0.6
52	NYABITSINDA1		0.2
53	NYABITSINDA2	2.1	1.2
54	NYABITSINDA3	2.6	0.5
55	KABUYENGE1	2.9	0.5
56	KABUYENGE2	19.7	9.1
58	KAVUMWE2	4.8	0.9
59	BUSORO1	3.1	2.0
60	BUSORO2	3.0	0.6
61	GASENYI1	2.5	0.2
62	CAGA1		0.1
63	CAGA2	2.4	0.2
64	KANISHA	2.3	0.2
66	BWAGIRIZA2		0.2
67	MUNYINYA1	2.4	0.3
68	MUNYINYA2		0.1
69	KINAMA1	2.2	0.2
70	KINAMA2	2.2	0.2
72	NYABIGOZI2	4.9	0.8
73	RUHUNI1	2.7	0.3
74	RUHUNI2		0.2

Statistic	K_s	K_{10}
Sample Size, N	56	69
Minimum, min	1.5	0.1
Maximum, max	19.7	9.1
Mean, M	3.4	0.7
Coefficient of variation, CV (%)	88.4	167.8

Table 35. Soil erodibility factor of the Universal Soil Loss Equation, K_{USDA}, K_{ISSS}, and K_{PSD} (t ha h ha^{-1} MJ^{-1} mm^{-1}), obtained with different estimates of the geometric mean particle diameter, d_g ($d_{g,USDA}$, $d_{g,ISSS}$, and $d_{g,PSD}$, respectively)

Code	Name	K_{USDA}	K_{ISSS}	K_{PSD}
1	NYAMUTOBO1	0.0266	0.0250	0.0142
2	NYAMUTOBO2	0.0392	0.0375	0.0429
3	MUREHE1	0.0397	0.0422	0.0274
4	MUREHE2	0.0304	0.0325	0.0171
5	GISORO1	0.0425	0.0409	0.0408
6	GISORO2	0.0439	0.0438	0.0366
7	DUTWE1	0.0308	0.0306	0.0435
8	DUTWE2	0.0396	0.0399	0.0430
9	MIGEGE1	0.0350	0.0331	0.0439
10	MIGEGE2	0.0279	0.0272	0.0426
11	NYABURONDWE1	0.0245	0.0256	0.0130
12	NYABURONDWE2	0.0429	0.0428	0.0416
13	MURIZA1	0.0229	0.0244	0.0119
14	MURIZA2	0.0399	0.0424	0.0281
15	BISINDE1	0.0361	0.0392	0.0233
16	BISINDE2	0.0431	0.0421	0.0395
17	BIYORWA1	0.0406	0.0429	0.0283
18	BIYORWA2	0.0366	0.0404	0.0225
19	MPAME1	0.0436	0.0439	0.0342
20	MPAME2	0.0357	0.0305	0.0439
21	NYAMUGARI1	0.0435	0.0439	0.0353
22	NYAMUGARI2	0.0358	0.0396	0.0231
23	RUCONGO1	0.0428	0.0418	0.0353
24	MASAKE	0.0439	0.0439	0.0393
25	NTUNDA1	0.0412	0.0350	0.0432
26	NTUNDA2	0.0438	0.0437	0.0391
27	GATWARO1	0.0404	0.0410	0.0282
28	KIRAMBI1	0.0333	0.0329	0.0198
29	KIRAMBI2	0.0400	0.0417	0.0278
30	SENGA1	0.0373	0.0388	0.0242
31	SENGA2	0.0432	0.0431	0.0350
32	KIRASYRA1	0.0409	0.0432	0.0304
33	KIRASYRA2	0.0425	0.0434	0.0333
34	RUGOTI1	0.0296	0.0309	0.0175
35	RUGOTI2	0.0433	0.0420	0.0420
36	GITWA1	0.0418	0.0415	0.0341
37	GITWA2	0.0439	0.0435	0.0395
38	NYABIGUGO1	0.0315	0.0335	0.0188
39	NYABIGUGO2	0.0398	0.0395	0.0261
40	TITI1	0.0338	0.0327	0.0217
42	MUHWAZI1	0.0402	0.0407	0.0271
43	MUHWAZI2	0.0330	0.0310	0.0437
44	NYAKIBINGO1	0.0328	0.0305	0.0437
45	VUMWE1	0.0225	0.0214	0.0384
46	KINYINIA1	0.0412	0.0405	0.0424
47	KINYINIA2	0.0284	0.0286	0.0160
48	KABANGA1	0.0387	0.0391	0.0260
49	KABANGA2	0.0341	0.0350	0.0212
51	NYAMIGINA2	0.0439	0.0438	0.0377
52	NYABITSINDA1	0.0343	0.0367	0.0205
53	NYABITSINDA2	0.0396	0.0373	0.0432
54	NYABITSINDA3	0.0437	0.0436	0.0357
55	KABUYENGE1	0.0437	0.0438	0.0357
56	KABUYENGE2	0.0127	0.0118	0.0289
58	KAVUMWE2	0.0420	0.0384	0.0427
59	BUSORO1	0.0333	0.0323	0.0437
60	BUSORO2	0.0438	0.0438	0.0410
61	GASENYI1	0.0339	0.0337	0.0207
62	CAGA1	0.0316	0.0345	0.0188
63	CAGA2	0.0332	0.0357	0.0210
64	KANISHA	0.0382	0.0396	0.0253
66	BWAGIRIZA2	0.0331	0.0306	0.0196
67	MUNYINYA1	0.0408	0.0410	0.0293
68	MUNYINYA2	0.0280	0.0275	0.0155
69	KINAMA1	0.0349	0.0351	0.0214
70	KINAMA2	0.0357	0.0379	0.0227
72	NYABIGOZI2	0.0427	0.0432	0.0408
73	RUHUNI1	0.0409	0.0421	0.0299
74	RUHUNI2	0.0336	0.0329	0.0198

Statistic	K_{USDA}	K_{ISSS}	K_{PSD}
Sample Size, N	69	69	69
Minimum, min	0.0127	0.0118	0.0119
Maximum, max	0.0439	0.0439	0.0439
Mean, M	0.0369	0.0370	0.0308
Coefficient of variation, CV (%)	17.4	17.8	31.9

Table 36. Values of the lower, $\rho_{b,L}$ (g cm^{-3}), and the upper, $\rho_{b,U}$ (g cm^{-3}), critical bulk density for the sampled soils

Code	Name	$\rho_{b,L}$	$\rho_{b,U}$
1	NYAMUTOBO1	1.17	1.44
2	NYAMUTOBO2	1.37	1.62
3	MUREHE1	1.21	1.47
4	MUREHE2	1.20	1.46
5	GISORO1	1.33	1.59
6	GISORO2	1.30	1.55
7	DUTWE1	1.42	1.66
8	DUTWE2	1.37	1.62
9	MIGEGE1	1.38	1.63
10	MIGEGE2	1.43	1.67
11	NYABURONDWE1	1.17	1.43
12	NYABURONDWE2	1.32	1.57
13	MURIZA1	1.15	1.42
14	MURIZA2	1.20	1.47
15	BISINDE1	1.18	1.45
16	BISINDE2	1.32	1.57
17	BIYORWA1	1.21	1.48
18	BIYORWA2	1.22	1.48
19	MPAME1	1.28	1.53
20	MPAME2	1.34	1.59
21	NYAMUGARI1	1.18	1.44
22	NYAMUGARI2	1.19	1.46
23	RUCONGO1	1.25	1.51
24	MASAKE	1.26	1.52
25	NTUNDA1	1.27	1.53
26	NTUNDA2	1.21	1.48
27	GATWARO1	1.21	1.48
28	KIRAMBI1	1.19	1.45
29	KIRAMBI2	1.21	1.47
30	SENGA1	1.21	1.47
31	SENGA2	1.23	1.49
32	KIRASYRA1	1.19	1.45
33	KIRASYRA2	1.22	1.48
34	RUGOTI1	1.18	1.44
35	RUGOTI2	1.28	1.54
36	GITWA1	1.24	1.50
37	GITWA2	1.22	1.48
38	NYABIGUGO1	1.18	1.44
39	NYABIGUGO2	1.22	1.48
40	TITI1	1.20	1.46
42	MUHWAZI1	1.25	1.50
43	MUHWAZI2	1.37	1.62
44	NYAKIBINGO1	1.39	1.63
45	VUMWE1	1.44	1.68
46	KINYINIA1	1.36	1.61
47	KINYINIA2	1.19	1.45
48	KABANGA1	1.24	1.50
49	KABANGA2	1.19	1.46
51	NYAMIGINA2	1.30	1.56
52	NYABITSINDA1	1.21	1.48
53	NYABITSINDA2	1.35	1.60
54	NYABITSINDA3	1.25	1.51
55	KABUYENGE1	1.24	1.50
56	KABUYENGE2	1.52	1.76
58	KAVUMWE2	1.29	1.54
59	BUSORO1	1.39	1.64
60	BUSORO2	1.27	1.53
61	GASENYI1	1.17	1.43
62	CAGA1	1.18	1.45
63	CAGA2	1.18	1.44
64	KANISHA	1.20	1.46
66	BWAGIRIZA2	1.20	1.47
67	MUNYINYA1	1.21	1.48
68	MUNYINYA2	1.19	1.45
69	KINAMA1	1.19	1.45
70	KINAMA2	1.19	1.46
72	NYABIGOZI2	1.28	1.53
73	RUHUNI1	1.20	1.47
74	RUHUNI2	1.20	1.47

Statistic	$\rho_{b,L}$	$\rho_{b,U}$
Sample Size, N	69	69
Minimum, min	1.15	1.42
Maximum, max	1.52	1.76
Mean, M	1.25	1.51
Coefficient of variation, CV (%)	6.4	4.9

5

SUMMARY AND CONCLUSIONS

A characterization of both the climate and the soils of the Ruyigi province was carried out in this investigation.

The rainfall and temperature data were collected at the Cankuzo, Kinyinya, Muriza, Musasa and Muyaga stations. A complete record of daily rainfall data was available for 370 to 528 months, depending on the station. A complete record of daily air temperature data was available for 336 to 428 months.

The analysis of the rainfall data suggested that the considered stations had similar values of annual rainfall (1157 – 1215 mm). In all cases, a large percentage (75 – 82%, depending on the station) of annual rainfall occurred during a half-year period (i.e., from November to April). Rainfall was practically negligible for the three consecutive months of June, July and August. Depending on the station, 28 to 43% of the days of the year were rainy. For each considered station, the basic information on the monthly rainfall depth (minimum, maximum, and mean values) was found to be deducible using the number of rainy days. Moreover, a knowledge of the mean value of the monthly rainfall depth and the monthly number of rainy days was found to be enough to predict the variability of the individual monthly values.

Slightly higher air temperatures were detected for the Kinyinia and Musasa stations (annual values of the average temperature equal to 21.6 – 21.9 °C) than for the Cankuzo and Muriza ones (18.6 – 19.8 °C). The maximum difference between the monthly values of the average temperature determined for each month of the year at a given station was of 3 °C. Therefore, this analysis suggested that the average temperature did not vary appreciably with the month.

In general, monthly rainfall was lower than the corresponding monthly reference evapotranspiration during a half-year period. For a single station (Musasa), the period with a rainfall amount lower than the reference evapotranspiration was appreciably longer (10 months). A total of 68 individual years were considered to calculate the annual values of both reference evapotranspiration and rainfall amount. The largest percentage of these years (i.e., 90%) was characterized by a reference evapotranspiration value higher than the associated rainfall amount. This result suggested that problems of water availability to agricultural crops can occur.

A total of 69 soil samples were collected from the surface layer. The geographical coordinates of each soil sampling location were determined by a Global Position System. For each sampling point, the particle size distribution, PSD, of the soil material was determined. The measured PSD was used to determine or estimate the clay, silt and sand content, the geometric mean particle diameter, the plant available water capacity, the saturated and near-saturated soil hydraulic conductivity, the soil erodibility factor, and the critical bulk density. The clay, silt and sand content and the geometric mean particle diameter were determined using the measured PSD. Pedotransfer functions (PTFs) were applied to estimate the other soil properties. Maps of clay, silt and sand content, plant available water capacity, and soil erodibility factor were developed.

A large variability was detected for each textural fraction (clay, silt, sand). However, most sampled soils were fine textured. Relationships were developed to estimate silt and sand content according to the USDA scheme when the data are summarized according to the ISSS scheme.

The relationships between the geometric mean particle diameter values obtained by using a different starting information (i.e., measured PSD, clay, silt and sand content defined according to either the USDA or the ISSS classification scheme) were also established.

The plant available water capacity (PAWC) results varied with the considered PTF. In particular, a PTF suggested that the investigated area is characterized by a near-optimal PAWC with individual locations exhibiting problems in crop water availability. Another PTF showed that a lower PAWC than the optimal one is a common occurrence in the Ruyigi area, suggesting that crop water availability is an important factor limiting crop growth.

The predicted saturated soil hydraulic conductivity, K_s, values varied by approximately an order of magnitude. The observed range was rather narrow as compared to the range of possible K_s values (several orders of magnitude). A wider range was detected for the near-saturated hydraulic conductivity (approximately, two orders of magnitude).

The soil erodibility values calculated in this investigation included the maximum predictable one, suggesting that the investigated area includes zones with an appreciable susceptibility to rainfall erosion.

Finally, a noticeable range of the critical bulk density values was detected because they were calculated on the basis of the clay plus silt content, that varied widely in the investigated area.

The data-base reported in this investigation report might be used by agronomists, engineers and zoo-technicians for planning reliable development programs. Obviously, collecting additional agro-meteorological data is important to improve our knowledge of the climatic characteristics of the Ruyigi province. An effort to obtain rainfall data collected at short time intervals (e.g., minutes) should be carried out to make evaluations of rainfall erosivity, given that the investigated area has a large presence of undulating ground. The plant available water capacity, soil hydraulic conductivity and soil erodibility values reported in this investigation have to be used with caution because the applied pedotransfer functions were not tested with specific reference to the soils of Burundi. There is an urgent need to increase the number of soil sampling locations and to directly measure the soil hydraulic properties to improve the quality of the individual predictions, to develop tools usable to characterize the soil at the farm scale and to develop pedotransfer functions usable specifically for the soils of Ruyigi.

ACKNOWLEDGEMENTS

This investigation was partially funded by the University of Palermo with the project CORI 2006 titled "Determinazione delle caratteristiche agrometeorologiche del territorio del Burundi".

The contribution of each author was the following: *V.Bagarello*, associate professor: data processing, writing and revision of the report; *C. Di Stefano*, researcher: mapping soil properties; *G. Lo Piccolo*, student: soil sampling; *Alexis Ntamavukiro*, agronomist Maison Shalom ONG: revision of the report; *G. Provenzano*, associate professor: collection of agro-meteorological data, data processing, writing and revision of the report; *P. Schillaci*, student: soil sampling. *S. Tudisca*, full professor, dean of the Agricultural Faculty of Palermo's University: coordination of all activities related to the Burundi Project and carried out by the Agricultural Faculty of Palermo's University.

Special thanks to Dr. *Alexis Nimubona* (Geographic Institute of Burundi, IGEBU, Gitega) for making available the agro-meteorological data, and to Dr. *Giovanni Rallo* for his precious help in data collection and processing.

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