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RESEARCH REPORT

SOIL MOISTURE AND SOIL TEMPERATURE REGIMES IN ZIMBABWE ESTIMATED FROM CLIMATIC DATA

THE PURPOSE OF this paper is to present information on soil temperature and soil moisture regimes in Zimbabwe in order to facilitate classification of soil according to the United States system (United States, 1975).

The terms of 'soil moisture regime' and 'soil temperature regime' refer to variations in soil moisture and soil temperature with time. Moisture regimes of freely drained soils are defined in terms of the presence or absence of water held at a tension of less than 1500 kPa in the moisture-control section. The upper boundary of the moisture-control section is the depth to which a dry soil is moistened by 25 mm water within 24 hours and the lower boundary is the depth to which a dry soil is moistened by 75 mm water within 48 hours. The soil temperature regime is defined in terms of the mean annual soil temperature, and the difference between mean winter and mean summer soil temperatures at a depth of 50 cm.

ESTIMATION OF MOISTURE AND TEMPERATURE REGIMES

Owing to the scarcity of data on variations in soil moisture and temperature throughout the year in Zimbabwe, it is worth considering the possibility of using climatic data. Newhall (United States, 1975) has developed a procedure for calculating soil-moisture regimes of freely drained soils from mean monthly precipitation, mean monthly temperature and latitude. The model assumes that half the monthly precipitation is depleted at the full rate of potential evaporation and half is evaporated at a rate linked to the amount and the location of available water remaining in the soil. He estimates evaporation by a slightly modified Thornthwaite (1948) procedure.

One of the authors of this study, Van Wambeke, has transcribed parts of the original Cobol programme of Newhall into Fortran. It estimates soil moisture and temperature regimes. The mean annual soil temperature is obtained by adding 2.5°C to the mean annual air temperature. Seasonal amplitude in soil temperature at 50 cm depth is estimated from the difference between mean winter (average of June, July and August) air temperature and mean summer (average of December, January and February) air temperature multiplied by a factor (0.66).

The climatic data used in the analysis was taken from seventy-two meteorological stations listed in the *Climate Handbook Supplement, No. 5* (Rhodesia, 1968).

CLASSIFICATION

The udic, ustic and aridic classes of soil moisture regime are defined in detail in *Soil Taxonomy* (United States, 1975), and the following short descriptions are given only as a guide to their meaning. The udic soil moisture regime is common to soils of humid climates that have well distributed rainfall. Water moves down through the

Table I

NUMBERS AND NAMES OF METEOROLOGICAL STATIONS

No.	*Name*	*No.*	*Name*	*No.*	*Name*
1	Banket Research Station	i25	Harare Research Station	49	Mutoko
2	Beitbridge	26	Henderson	50	Mvuma
3	Bindura	27	Hope Mapopo	51	Mvurwi
4	Binga	28	Hope Patrol	52	Ncema
5	Birchenough Bridge	29	Hot Springs	53	Nkayi
6	Buhera	30	Hwange	54	Nuanetsi
7	Bulawayo Airport	31	Hwange Main Park	55	Nyamandhlovu Experiment Station
8	Bulawayo Goetz Observatory	32	Inyanga Experimental Station Orchard	56	Nyanda
9	Chegutu			57	Nyangadzi
10	Chibero	33	Inyangani Luleche	58	Plumtree
11	Chinhoyi	34	Kadoma	59	Rusape
12	Chipinge	35	Kariba Gorge	60	Sabi Valley Experiment Station
13	Chipinge Experimental Station	36	Karoi	61	Shamva Panmure
14	Chipuriro	37	Kezi	62	Southdown
15	Chirundu	38	Kwekwe	63	Tjolotjo
16	Chivhu	39	Lupane	64	Trelawney
17	Gokwe	40	Lusulu	65	Triangle Mill
18	Grand Reef	41	Makoholi	66	Tuli Estate
19	Gutu	42	Marondera	67	Victoria Falls Police
20	Gwebi	43	Martin Forest	68	Vumba National Park
21	Gweru Thornhill	44	Matopos Nursery	69	Wedza
22	Harare Airport	45	Matopos Sandveld	70	West Nicholson
23	Harare Belvedere	46	Mondoro	71	Zaka
24	Harare Kutsaga	47	Mount Darwin	72	Zvishavane
		48	Mutare Fire Station		

Table II

SOIL MOISTURE AND SOIL TEMPERATURE AT TEN SITES AS ESTIMATED BY THE NEWHALL PROCEDURE

		Soil Moisture Control Section							*Soil Temperature*		
		Cumulative Days in a Year			*Maximum Consecutive Days in a Year*						
No. of Station	*Name of Station*	*Dry*	*Part Dry/ Part Moist*	*Moist*	*Moist in Some Part*	*Dry after Summer Solstice*	*Moist after Winter Solstice*	*Moisture Regime*	*Mean Annual °C*	*Seasonal Amplitude at 50 cm Depth °C*	*Temperature Regime*
2	Beitbridge	340	20	0	10	95	0	Aridic	25.6	6.4	Hyperthermic
3	Bulawayo Goetz Laboratory	140	96	124	220	0	0	Ustic	21.7	4.4	Isothermic
12	Chipinge	0	42	318	360	0	93	Udic	21.4	3.7	Isothermic
21	Gweru Thornhill	50	87	223	310	0	28	Ustic	20.2	4.8	Isothermic
25	Harare Research Station	41	88	231	319	0	36	Ustic	20.9	4.0	Isothermic
30	Hwange	248	112	0	77	28	0	Aridic	27.2	4.4	Isohyper-thermic
32	Inyanga Experimental Station Orchard	0	31	329	360	0	104	Udic	17.2	3.3	Isothermic
48	Mutare Fire Station	37	101	222	323	0	27	Ustic	21.7	4.6	Isothermic
56	Nyanda	96	120	144	264	0	0	Ustic	21.7	5.2	Thermic
65	Triangle Mill	238	122	0	83	22	0	Aridic	24.8	6.0	Hyperthermic

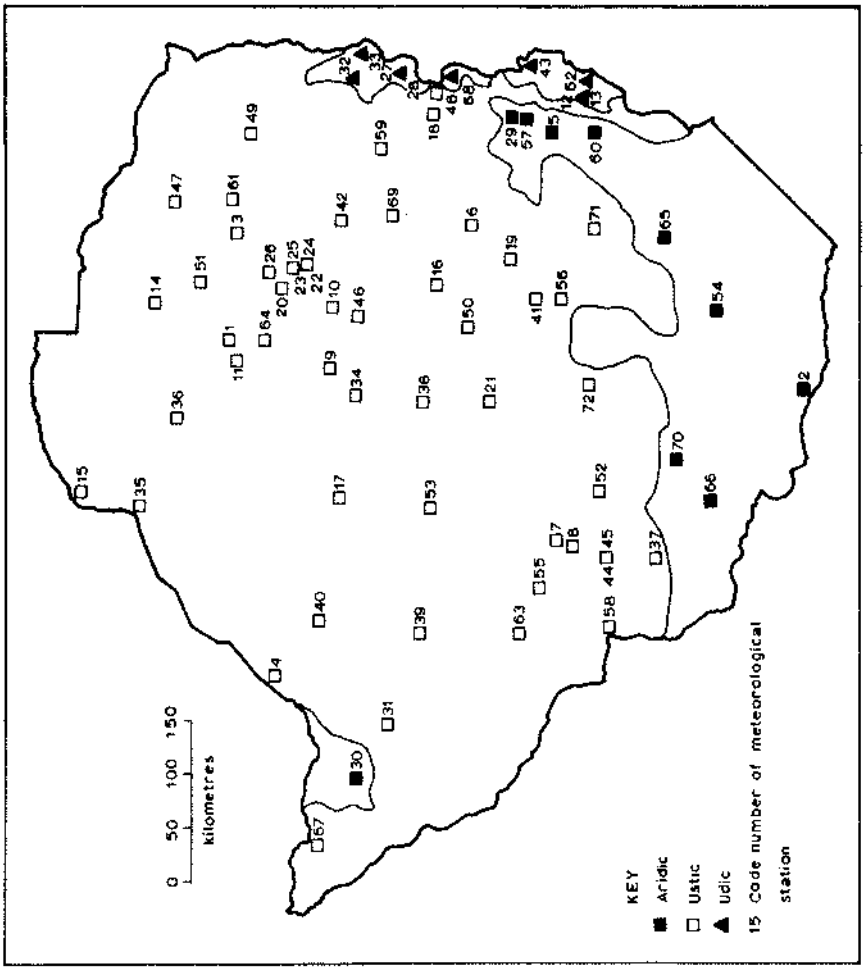

Figure 1: SOIL MOISTURE REGIMES IN ZIMBABWE.

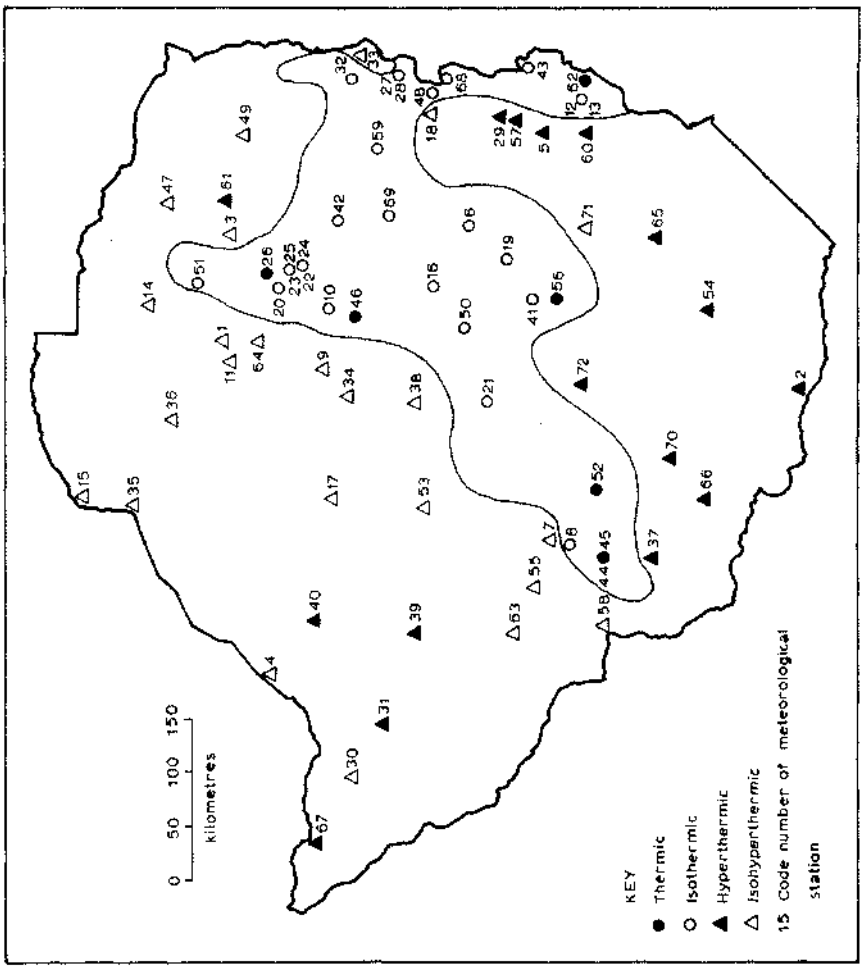

Figure 2: SOIL TEMPERATURE REGIMES IN ZIMBABWE.

soil at some time in most years. Soils with aridic moisture regimes are found in arid climates. They undergo little or no leaching and soluble salts sometimes accumulate in the profile. The ustic moisture regime is intermediate between the udic and the aridic regime, and is one of limited moisture; but the moisture is present in summer when conditions are suitable for plant growth.

The classes of soil temperature regime applicable to Zimbabwe are defined as follows. The thermic soil temperature regime has a mean annual soil temperature of 15°C or higher but lower than 22°C and the difference between mean winter and mean summer soil temperature is more than 5°C. The hyperthemic soil temperature regime has a mean annual soil temperature of 22°C or higher and the difference between mean winter and mean summer soil temperature is more than 5°C. The prefix 'iso–' to the name of a soil temperature regime indicates that the mean summer and winter soil temperatures differ by less than 5°C.

MAPPING

The placement of boundaries in Figures 1 and 2 has been guided by reference to contours on the 1:2,500,000 map of Zimbabwe (Rhodesia, 1976), natural region boundaries of the 1:1,000,000 *Natural Regions and Farming Areas* map of Zimbabwe (Zimbabwe, 1980) and rainfall class boundaries shown in the *Mean Annual Rainfall* map of Zimbabwe (Rhodesia, 1968).

The percentage areas of Zimbabwe covered by the three moisture regime classes shown in Figure 1 are as follows: udic 2 per cent, ustic 79 per cent and aridic 19 per cent.

The only boundary drawn on Figure 2 is between thermal and isothermal temperature regimes on one side of the line and hyperthemic and isohyperthermic temperature regimes on the other side of the line. The percentage area of Zimbabwe occupied by thermic and isothermic temperature regimes is 23 per cent, and by hyperthermic and isohyperthermic, 77 per cent.

Table I gives the names of the meteorological stations listed in Figures 1 and 2 and Table II gives some of the data from the computer printout.

CONCLUSION

Newhall's soil moisture model has been tested against observations on soil moisture on the Great Plains of the United States over a period of 20 years. The correlation between calculated and observed soil moisture is about 0.8.

Although the methods of estimating soil moisture and soil temperature regimes from climatic data have not been tested in Zimbabwe they are believed to be reasonable ones for use in classifying soil according to the United States system.

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