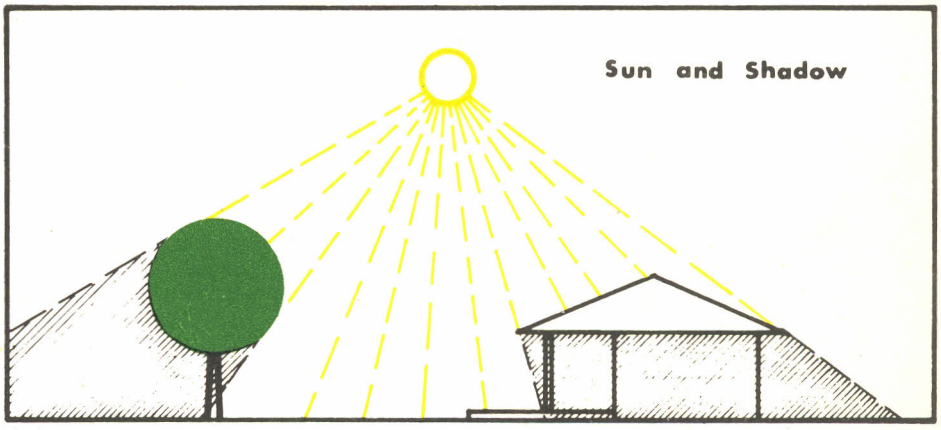


CLIMATE and BUILDING

A PRELIMINARY STUDY BY

UNO WINBLAD and SYDNEY LITHERLAND

OCTOBER 1966

CONTENTS

APPENDIX

ACKNOWLEDGMENT

We wish to express our thanks to Mr. I. A. Channon, Assistant Director of the East African Meteorological Department, who has provided all information tabulated in the Appendix.

INTRODUCTION

This study presents some climatic data for Kampala together with a brief interpretation and some comments on the most common faults in the design and layout of buildings from a climatic point of view Finally there are some recommendations on how to design for the local climate.

Kampala-Mengo Region has a warm-humid climate without extremes. It need not present any particular difficulties to the designer and indoor comfort conditions can be maintained without mechanical ventilation or air conditioning, provided the building is designed to suit the climate. This however, is often not the case. Through negligence or sheer incompetence many buildings are designed without the slightest regard for local conditions. Common faults are: wrong orientation[1], unsuitable roof construction[2], excessive through ventilation[3], and lack of space for outdoor living.

CLIMATIC DATA

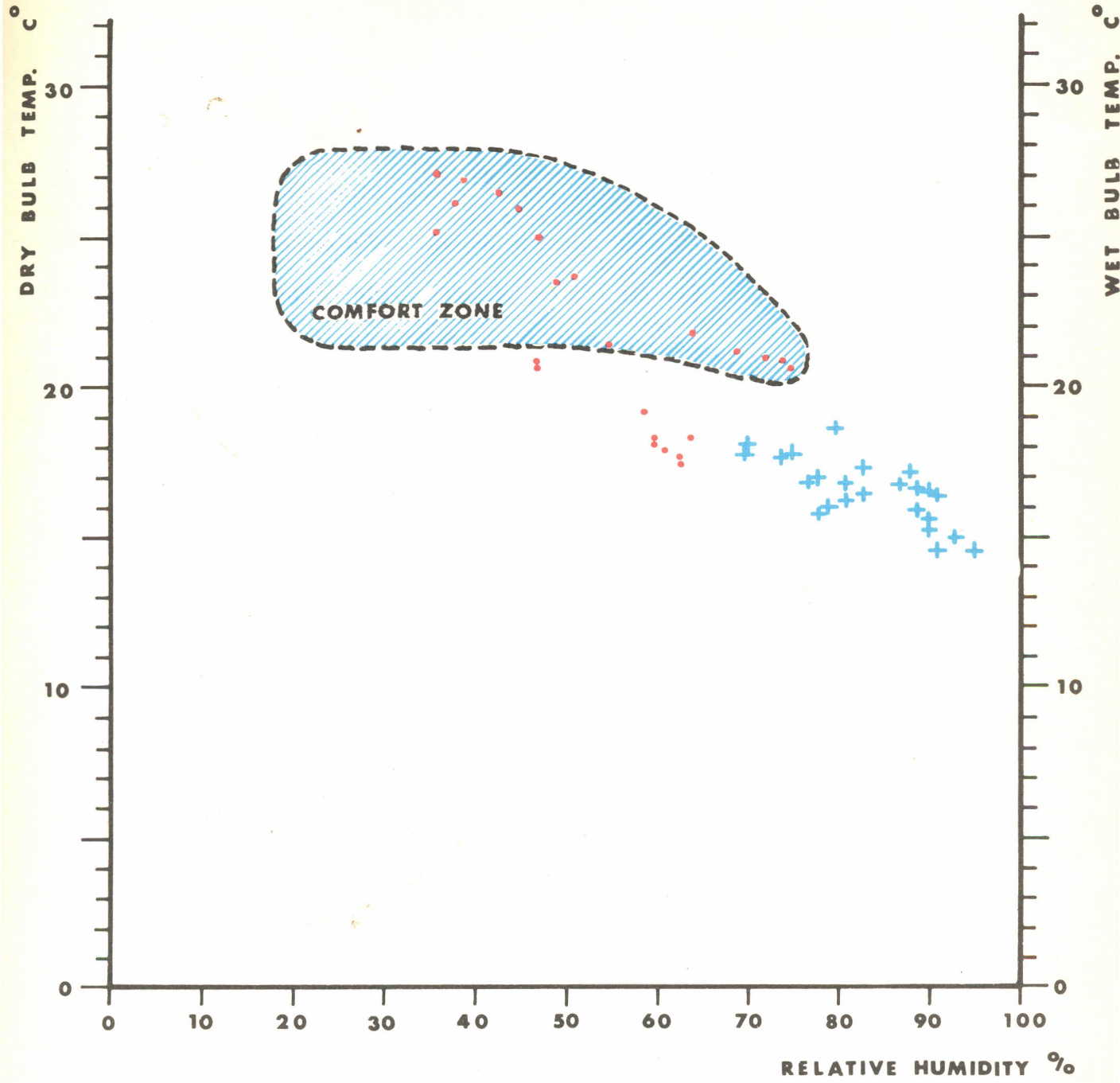
A typical 'warm' and a typical 'cold' day have provided the weather data for design (*see* Appendix). In figure 1 each point represents hourly data for the 'warm' day and each cross the 'cold' day. The 'comfort zone' indicated is directly applicable only to inhabitants of the temperate zones of the United States.[4] For Uganda the zone may be elevated one or two °C. The figure clearly shows that on a typical 'warm' day indoor comfort conditions can be maintained without artificial cooling providing heat gain through windows and excessive radiation from inside surfaces can be prevented. On such days through ventilation is not desirable but often difficult to avoid with the large permanent ventilation openings so common in the Kampala area, and required by building regulations.

The highest temperature recorded in Kampala (1931–1954) is 36.2°C (97.16°F) and the lowest is 13.3°C (55.94°F). Such extreme temperatures are, however, very rare and need not be taken into consideration in building design.

Some climatic tabulations are given in the appendix. The figures for temperature, precipitation and wind were obtained on the top of Kololo Hill in Kampala (lat. 00°20′N, long. 32°36′E at 1,312 metres = 4,304 ft.). Solar radiation was measured at the Namulonge Cotton Research Station, about 15 miles from Kampala.

The appendix also includes monthly surface wind-roses for Kampala Hill, a well-exposed site. The extreme winds for Kololo Hill have not been analysed but they are likely to be similar to those which occur at Entebbe. The maximum wind recorded there is 66 m.p.h. and, on the average, winds in excess of 50 m.p.h. occur twice per year. Extreme winds in Uganda are invariably associated with thunderstorms, have considerable variations over short distances, and are only for short time periods.

Morning mists are frequent in the bottom of the valleys but are rare on the hillsides. There are no persistent mists.



each • represents hourly data for an average 'warm' day (January)

each + represents hourly data for an average 'cold' day (August)

represents 'Comfort Zone' based on United States practice 4/

Figure 1

RECOMMENDATIONS

Climatic factors should be taken into consideration at an early stage in town planning and in the design and lay-out of buildings. The best orientations for main elevations are due north/south, or towards north-east/south-west, and all windows should be protected from direct solar radiation from 7 a.m. to 6 p.m.[5]

All rooms should be provided with a ceiling to brake the heat radiation from the roof.

External surfaces of roofs should be heat reflective and not heat transmissive.

All ventilation openings to be made closable.

The shading effect of trees and shrubs should be widely used in residential developments.

NOTES

1. Rooms with windows in western directions tend to become uncomfortably hot on warm days. For example the houses along Hunter Avenue on Bugolobi are placed and designed in such a way that the rooms receive a maximum of sun. At Makerere University there are some newly built Y-shaped blocks of flats impossible to orientate correctly. Here the effect of wrong orientation is somewhat off-set by high trees, which shade most of the windows. The shading effect of trees can, however, not be relied upon in the centre of the town. At the Embassy House, e.g., the south-western facade has instead been designed as a decoration only and does not provide enough shade.

2. Low-cost houses are often built with a metal roof without ceiling. This construction makes the rooms unbearably hot. Another unsuitable construction is the massive concrete or clay/concrete roof used a.o. at Nakawa Housing Estate for the newly built red-bricks terrace houses. This roof radiates heat thus causing discomfort during afternoons and evenings.

3. Large ventilation openings over all windows are a common feature in Uganda, especially in Government housing. The openings are not provided with any closing device. During rainy days and often at night this permanent ventilation is undesirable and uncomfortable because it causes a raw draught.

4. See p. 18–19 in V. Olgyay: Design with Climate (Princeton University Press), New Jersey 1963.

5. Early morning sun is normally acceptable except when the rays of the sun shine directly in a person's eyes. Late afternoon sun is intolerable in offices and living rooms; this is partly due to glare and partly to the fact that afternoon air temperatures are about 5°C (9°F) higher than morning (8.0 a.m.) air temperatures.

Generally speaking rooms with westward facing windows are the hottest and those with eastward facing windows the coolest.

REFERENCE

Collected Climatological Statistics for East Africa and Seychelles.
Part 2—Uganda.
East African Meteorological Department, August 1964.
East African Common Services Organisation.

APPENDIX

'WARM' DAY

'COLD' DAY

Time E.A.S.T.	22–1–49 Temperatures °C Dry Bulb	Wet Bulb	Humidity %	26–8–49 Temperatures °C Dry Bulb	Wet Bulb	Humidity %
00 ..	24·5	16·7	47	20·4	16·8	70
01 ..	24·3	16·7	47	18·9	16·4	78
02 ..	21·4	16·7	64	18·6	16·4	81
03 ..	20·7	16·0	63	18·0	15·9	81
04 ..	21·3	16·1	60	17·9	15·6	79
05 ..	21·6	16·3	60	17·0	15·6	78
06 ..	21·0	16·0	61	15·7	15·0	93
07 ..	20·5	15·8	63	15·1	14·5	94
08 ..	22·5	16·9	59	15·4	14·5	91
09 ..	25·0	18·5	55	16·2	15·2	90
10 ..	27·4	19·5	49	16·8	15·6	90
11 ..	28·3	19·6	36	17·1	15·8	89
12 ..	30·2	19·6	38	17·4	16·3	91
13 ..	31·2	20·0	36	18·0	16·1	83
14 ..	31·0	20·5	39	18·7	16·1	77
15 ..	30·7	20·9	43	20·4	18·1	80
16 ..	30·2	20·9	45	20·0	16·9	74
17 ..	29·1	20·5	47	20·8	17·0	70
18 ..	27·6	20·0	51	20·0	17·0	75
19 ..	25·0	20·0	64	19·0	17·0	83
20 ..	24·2	19·9	69	18·5	17·0	88
21 ..	23·7	20·0	72	18·1	16·6	87
22 ..	23·3	20·0	74	17·8	16·6	90
23 ..	23·0	19·8	75	17·9	16·6	89
Mean ..	25·3	18·7		18·0	16·2	

TEMPERATURE

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Average Daily Maximum Temperature °C	28·4	28·3	27·5	26·1	25·4	25·2	25·1	25·6	26·6	27·2	27·2	27·2	26·7
Average Daily Minimum Temperature °C	18·1	18·1	18·0	17·6	17·5	17·2	16·5	16·4	16·6	16·9	17·3	17·4	17·3
Percentage of Time Temperature lies between 20° and 25°C	52	50	51	52	50	47	41	40	40	43	45	43	46
Number of Days with Maximum Temperature above 30°C	7	9	7	0	0	0	0	0	0	2	3	2	31
Number of Days with Minimum Temperature below 18°C	14	12	17	19	22	24	29	30	29	26	23	21	266

PRECIPITATION

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Average Total Rainfall MM.	51	62	113	182	140	75	50	86	101	109	114	97	1,180
Highest Monthly and Annual Totals Recorded MM.	139	111	260	378	197	172	115	120	159	189	273	289	1,763
Lowest Monthly and Annual Recorded. MM.	5	9	27	48	52	21	3	16	35	40	23	25	925

Maximum Rainfall Intensities (in MM./Hour) for Certain Time Intervals
15 minutes: —151 mm./hour.
30 minutes: —112 mm./hour.
1 hour: — 71 mm./hour.

SUN

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Maximum Possible Hours of Sunshine	374	339	375	363	375	363	375	375	363	375	363	375	4,415
Average Hours of Sunshine	239	221	205	180	192	189	174	180	183	195	189	220	2,367
Average Number of Cloudy Days	6	8	10	14	15	13	17	17	15	17	12	13	157
Average Number of Sunny Days	10	6	5	1	2	1	2	2	1	2	3	4	39
Average Daily Solar Radiation on a Horizontal Surface. Cals./CM^{-2}	413	437	447	423	388	367	368	357	407	410	400	405	402
Highest Recorded Solar Radiation in One Day. Cals./CM^{-2}	628	610	630	598	565	540	516	591	578	602	622	587	630
Lowest Recorded Solar Radiation in One day. Cals./CM^{-2}	128	126	155	202	191	155	70	134	137	188	126	118	70

RELATIVE HUMIDITY

Hour	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
01	83	84	87	90	90	86	81	83	86	85	83	85	85
02	84	84	88	91	90	86	80	84	87	87	84	86	86
03	84	85	89	91	91	87	81	86	89	89	86	87	87
04	84	85	89	92	91	89	83	89	91	91	87	87	88
05	83	85	90	93	92	90	86	90	92	92	86	87	89
06	83	84	91	92	92	91	88	92	93	91	86	87	89
07	83	84	90	92	93	91	90	93	93	90	83	86	89
08	80	84	87	90	91	90	89	89	90	87	80	84	87
09	76	80	83	85	86	86	84	83	83	80	75	79	82
10	67	71	76	78	80	78	78	76	76	73	69	73	75
11	60	64	70	73	76	73	72	69	69	68	64	68	69
12	56	60	67	71	73	71	68	66	67	65	62	65	66
13	55	58	65	70	72	69	66	66	66	64	60	64	65
14	54	59	64	69	72	68	65	66	67	67	61	63	65
15	55	59	64	68	71	68	66	67	70	68	62	64	65
16	58	61	66	68	71	69	67	67	71	69	63	65	66
17	61	64	68	72	74	72	69	70	74	71	66	69	69
18	68	70	73	77	81	79	76	77	80	77	73	74	75
19	75	77	80	83	86	84	81	81	83	80	77	79	81
20	78	79	82	86	87	85	83	83	83	82	78	81	82
21	79	80	83	87	87	86	83	84	85	82	78	82	83
22	80	81	84	88	88	86	83	85	85	83	79	83	84
23	81	82	85	89	89	86	82	84	85	83	80	83	84
24	83	83	86	90	89	86	80	83	85	84	80	85	85
Mean	72	74	78	82	83	81	78	79	81	79	75	77	78

(Times: East African Standard Time).

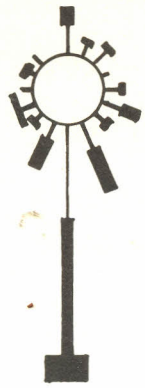
VAPOUR PRESSURE

Millibars

Hour	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
01	19·3	19·2	19·8	20·2	20·0	19·0	17·5	17·9	18·4	18·7	18·6	18·9	19·0
02	19·2	19·1	19·6	20·1	19·8	18·8	17·2	17·7	18·3	18·6	18·4	18·6	18·8
03	18·9	18·9	19·5	19·8	19·7	18·6	17·2	17·8	18·2	18·5	18·3	18·5	18·7
04	18·7	18·7	19·4	19·7	19·5	18·6	17·3	17·8	18·3	18·4	18·0	18·3	18·6
05	18·4	18·5	19·3	19·6	19·4	18·6	17·4	17·8	18·2	18·4	17·8	18·1	18·5
06	18·2	18·2	19·3	19·4	19·3	18·5	17·4	17·8	18·1	18·2	17·8	18·0	18·4
07	18·4	18·3	19·1	19·5	19·5	18·4	17·5	18·1	18·4	18·5	17·9	18·2	18·5
08	18·9	18·9	19·7	20·2	20·2	19·2	18·1	18·7	19·4	19·4	18·8	19·0	19·2
09	19·6	19·7	20·6	21·0	20·9	20·0	19·0	19·5	20·2	20·2	19·5	19·7	20·0
10	19·5	19·5	20·7	21·1	21·1	20·0	19·3	19·9	20·4	20·4	19·7	19·9	20·1
11	19·0	19·3	20·7	21·2	21·0	19·9	19·2	19·5	20·4	20·4	19·6	19·9	20·0
12	18·7	18·8	20·8	21·2	21·0	19·8	18·9	19·2	20·2	20·3	19·7	19·8	19·9
13	18·6	18·6	20·5	21·3	20·8	19·6	18·7	19·1	20·1	20·2	19·6	19·6	19·7
14	18·7	18·8	20·4	21·2	20·9	19·4	18·6	19·0	19·9	20·2	19·8	19·7	19·7
15	18·9	19·0	20·2	21·0	20·7	19·4	18·5	18·9	19·6	20·1	19·7	19·9	19·7
16	19·2	19·1	20·2	20·8	20·5	19·4	18·4	18·8	19·7	20·0	19·8	19·6	19·6
17	19·3	19·5	20·2	20·8	20·5	19·4	18·3	18·8	19·8	20·0	19·9	19·9	19·7
18	19·6	19·7	20·1	20·6	20·4	19·4	18·5	19·0	19·8	19·7	19·8	19·6	19·7
19	19·4	19·7	20·1	20·4	20·3	19·4	18·6	18·8	19·6	19·5	19·5	19·3	19·6
20	19·5	19·6	20·1	20·4	20·2	19·3	18·5	18·8	19·4	19·3	19·2	19·2	19·5
21	19·5	19·6	20·0	20·4	20·1	19·3	18·5	18·8	19·3	19·2	19·1	19·1	19·4
22	19·5	19·5	20·0	20·4	20·1	19·3	18·4	18·8	19·1	19·2	18·9	19·0	19·3
23	19·4	19·5	20·0	20·3	20·1	19·3	18·2	18·6	18·9	19·0	18·9	19·1	19·3
24	19·5	19·5	20·0	20·3	20·0	19·1	17·8	18·1	18·6	18·8	18·7	19·0	19·1
Mean	19·0	19·1	19·9	20·4	20·2	19·2	18·2	18·6	19·2	19·3	19·0	19·1	19·3

(Times: East African Standard Time).

WIND


January

February


March

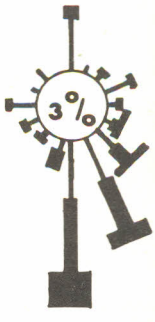
April

May

June

July

August

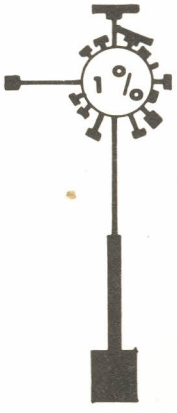


September

KAMPALA

October

November



December

KAMPALA-MENGO REGIONAL PLANNING STUDIES

No. 1 Population and Land Requirement.—*Uno Winblad and Mario Ponzio.* February, 1965.

No. 2 Regional Definitions.—*Sydney Litherland.* April, 1965.

No. 3 Survey of Public Housing Development for Low Income Groups.—*Lars Danielsson.* April, 1965.

No. 4 Metropolitan Co-ordination.—*Sydney Litherland.* July, 1965.

No. 5 Physical Planning: System, Organisation, Legislation.—*Sydney Litherland.* March, 1966.

No. 6 A Metropolitan Growth Model.—*Uno Winblad.* May, 1966.

No. 7 Transportation (In course of preparation).—*Sydney Litherland and Uno Winblad.*

No. 8 A Residential Unit.—*Lars Danielsson.* August, 1966.

No. 9 Climate and Building (In course of preparation).—*Uno Winblad.*

No. 10 Airport Location (In course of preparation).—*Sydney Litherland.*

No. 11 Industrial Location (In course of preparation).—*Sydney Litherland.*