Development Workshop
on Building & Planning in the Third World

Box 133
238 Davenport Road
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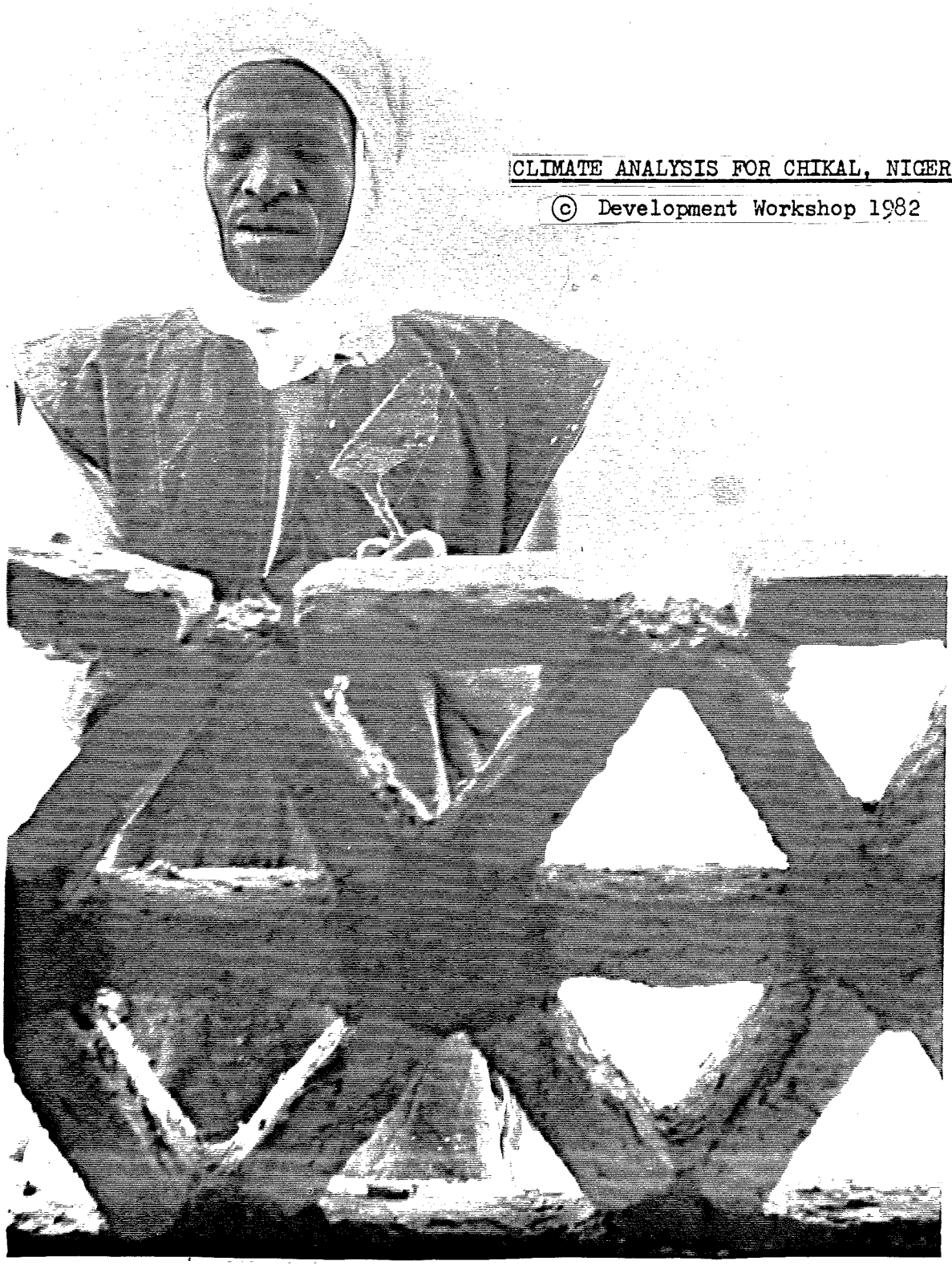
Canada

CLIMATE ANALYSIS FOR CHIKAL, NIGER



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CLIMATE ANALYSIS FOR CHIKAL, NIGER

CLIMATIC ANALYSIS

The base data for this analysis comes from, firstly, the meteorological data collected at Chikal, which unfortunately was somewhat incomplete since the station has not been running long enough to give good averages.

We have therefore taken the data for Tahoua and Niamey *1 and looked at how these compare with each other and with the Chikal data. Niamey's micro climate is affected by the proximity of the Niger River and associated vegetation, which raises the humidity levels. There is on average a higher annual rainfall in Niamey than Tahoua, to be expected since the overall precipitation decreases from SSW to NNE (fig. 'a').

However, the analysis of both stations produces similar characteristics.

The figures given here for Chikal are thus a combination of:

a. local data, confirmed and completed by

b. an extrapolated climate profile using Niamey and Tahoua data.

You will see that the molcator totals (which are one way of identifying climate design parameters) shown here at the bottom of the Niamey and Tahoua data analysis sheets (charts 9 and 10) are actually very similar to those of the Chikal analysis (chart 2).

The documents we have included are:

Chart 1. The basic climatic data histogram.

A combination of the dry bulb temperature and the relative humidity and air movement give the effective temperature - ie the temperature which the human body experiences. This is shown graphically in the mid column, and overlayed on it, are the upper and lower limits within which a person wearing ordinary clothing will feel comfortable. This comfort zone is calculated using the specific characteristics of the station.

It is easy to see which months are critically hot.

Chart 2

A numerical analysis using the Mahoney system. *2

Chart 3

For simplicity we have taken all the main design characteristics that need to be followed in order to have a comfortable environment

and presented them graphically. It is meant to serve simply as a guide.

Chart 4

In order to calculate shading requirements it is necessary to know at what times of day for any period of the year the effective temperature will be too high for comfort.

This page produces a two hourly breakdown of effective temperatures by month for Chikal.

Charts 5 and 6

These are sunpath diagrams. Each one is for six months. The data from the previous page allows one to plot hourly effective temperature in relation to the exact position of the sun in the sky for any given daytime moment. With the use of a shadow angle protractor shading angles can be calculated which will exclude solar radiation during those times when it is undesirable.

Because surface temperature rises faster than air temperature, direct solar radiation is excluded from the time that temperatures enter the lower end of the comfort zone. On the other hand, the intensity of radiation decreases as the sun gets lower in the sky and in calculating the shading angles for each respective orientation, the lower solar radiation intensity of the late afternoon period has been taken into account.

Chart 7

This chart shows recommended optimum horizontal and vertical shading angles with explanatory notes.

Chart 8

Shows you some ways of interpreting the shading angles in physical design terms. Because it is in fact possible to design for extremely accurate shading if one wishes, the suggestions given here are a few of the more obvious solutions.

1. Niamey and Tahoua meteorological data from periods 31 - 40, 49 - 55. Dakar, Service Meteorologique de l'Afrique Occidentale Francaise Meteorological Office tables of temperature, relative humidity and precipitation for the world, Part IV, HMSO, London.

2. C Mahoney. 'Climate and House Design'. UNCHBP, New York.

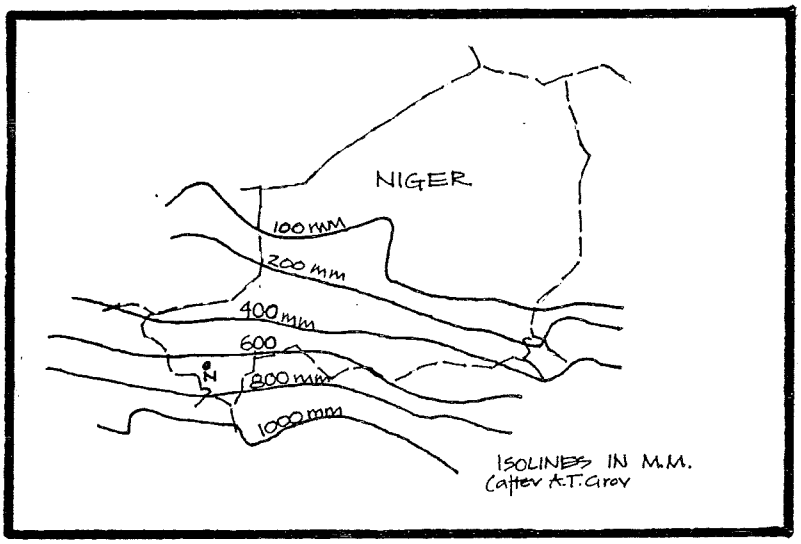
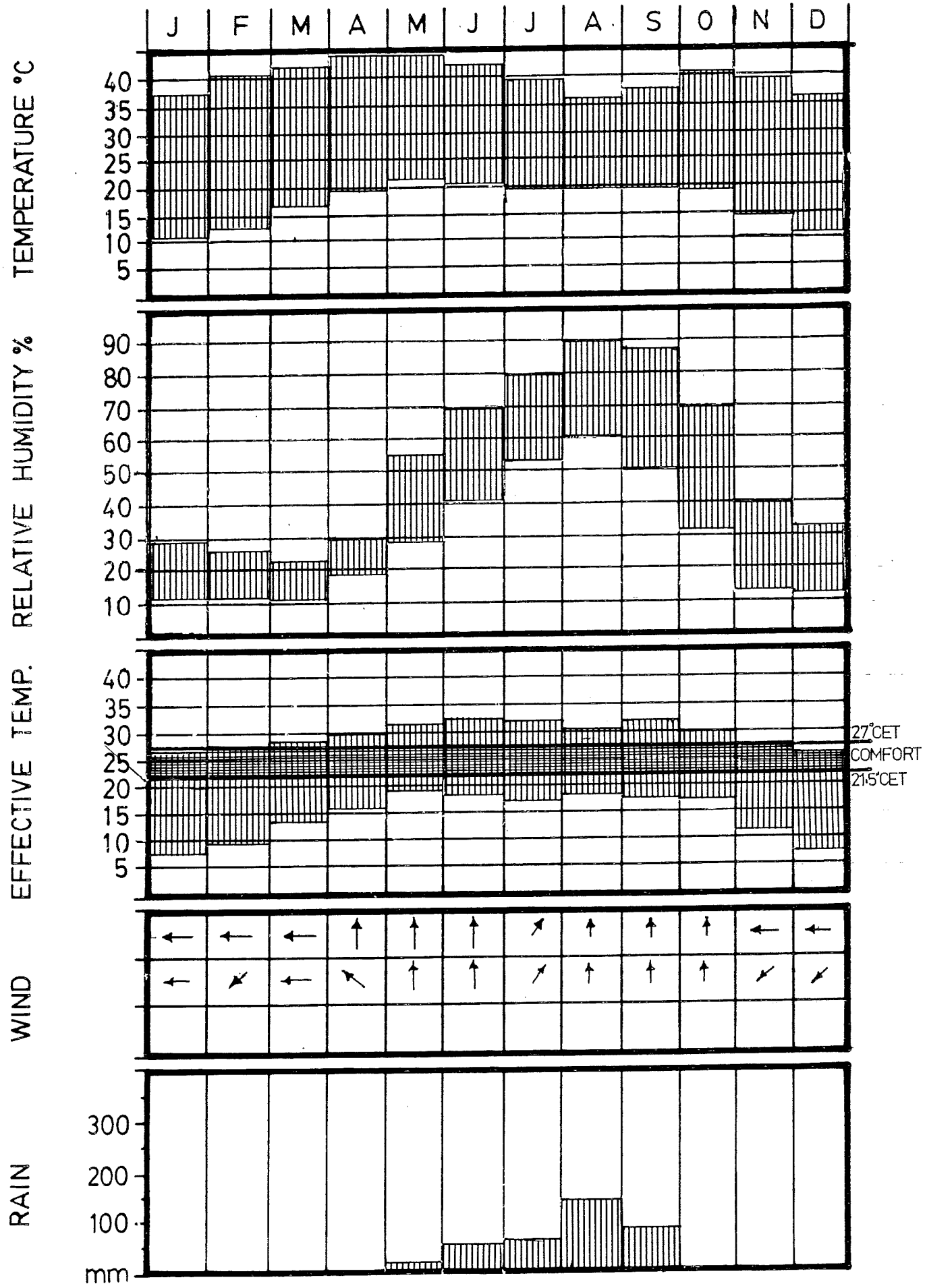


Fig. 'a' Precipitation in Niger.

Chart 1

CHIKAL



Location: CHIKALDARA		
Longitude	Latitude	Altitude

BASE CLIMATIC DATA

Air temperature °C	J	F	M	A	M	J	J	A	S	O	N	D
Monthly mean max.	38	40	42	44	44	42	39	36	38	40	39	36
Monthly mean min.	10	12	17	19	21	20	19	19	19	19	14	10
Mean range	28	28	25	25	23	22	20	17	19	21	25	26

high AMT: 44 | 27 / 10 | 34 — low AMR

Relative humidity %												
Mean max. a.m.	29	26	22	30	55	70	80	90	87	70	40	32
Mean min. p.m.	12	12	11	18	28	41	53	60	50	32	14	13
Average	20.5	19	16.5	24	41.5	55.5	66.5	75	68.5	51	27	22.5
Humidity group	1	1	1	1	2	3	3	4	3	3	1	1

Rainfall mm	—	—	—	—	12	44	55	131	73	—	—	—

315 total

Wind, prevailing	E	E	E	S	S	S	SW	S	S	S	E	E
Time												
Wind, secondary		NE		SE						SE	N	NE
Time												

DIAGNOSIS

Diagnosis: °C	J	F	M	A	M	J	J	A	S	O	N	D
Mean max. temp.	38	40	42	44	44	42	39	36	38	40	39	36
Day comfort; max	34	34	34	34	31	29	29	27	29	29	34	34
min	26	26	26	26	25	23	23	22	23	23	26	26
Mean min. temp.	10	12	17	19	21	20	19	19	19	19	14	10
Night comfort max	25	25	25	25	24	23	23	21	23	23	25	25
min	17	17	17	17	17	17	17	17	17	17	17	17
Thermal stress: day	H	H	H	H	H	H	H	H	H	H	H	H
night	C	C	O	O	O	O	O	O	O	O	C	C

INDICATORS

Humid:	H1								✓				1
	H2												0
	H3												0
Arid	A1	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓ 11
	A2			✓	✓	✓							3
	A3												0

totals

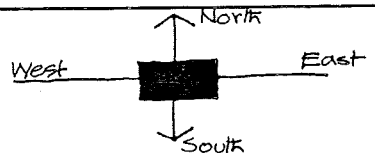
CLIMATIC DESIGN RECOMMENDATIONS

Location. CHIKAL		
Longitude E	Latitude N.	Altitude

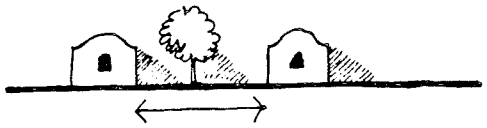
NOTE. Variations will be necessary according to detailed micro-climate conditions and must be taken into account.

Specification

Building should orientate towards north and south, with minimal wall area towards east and west.



Distance between buildings can be small, and shaded areas should be maximised. Large open spaces heat up more and are dustier, so should be avoided.

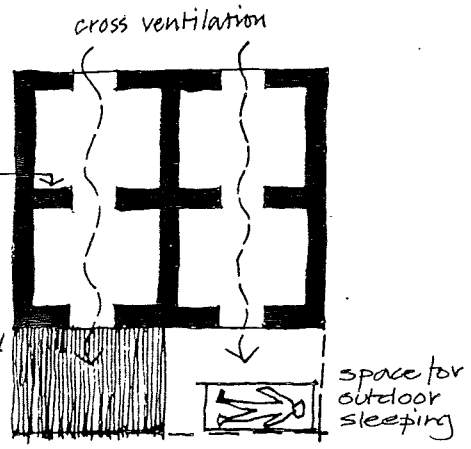


Can have double rows of rooms but allow for temporary provision of cross-ventilation during humid season. Openings in internal as well as external walls

Walls should be of massive construction to provide at least 8 hour time lag for delayed heat transfer to interior.

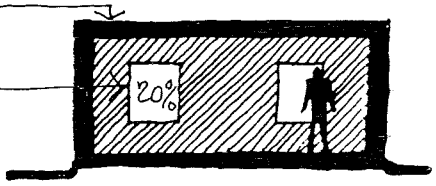
Provide outdoor shaded area

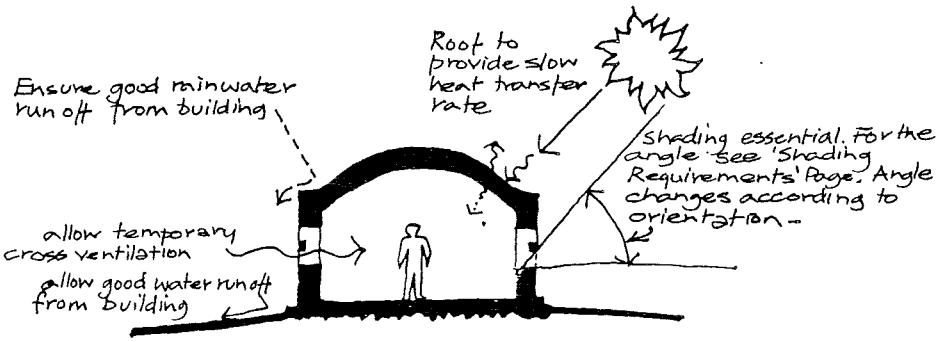
Small shaded courtyards also valuable for conserving cool nighttime air during day.



Roof should be heavy with 8 hour time lag for delayed heat transfer to interior.

Windows small, about 20% of wall area at maximum.





Location: CHIKAL		
Longitude	Latitude	Altitude

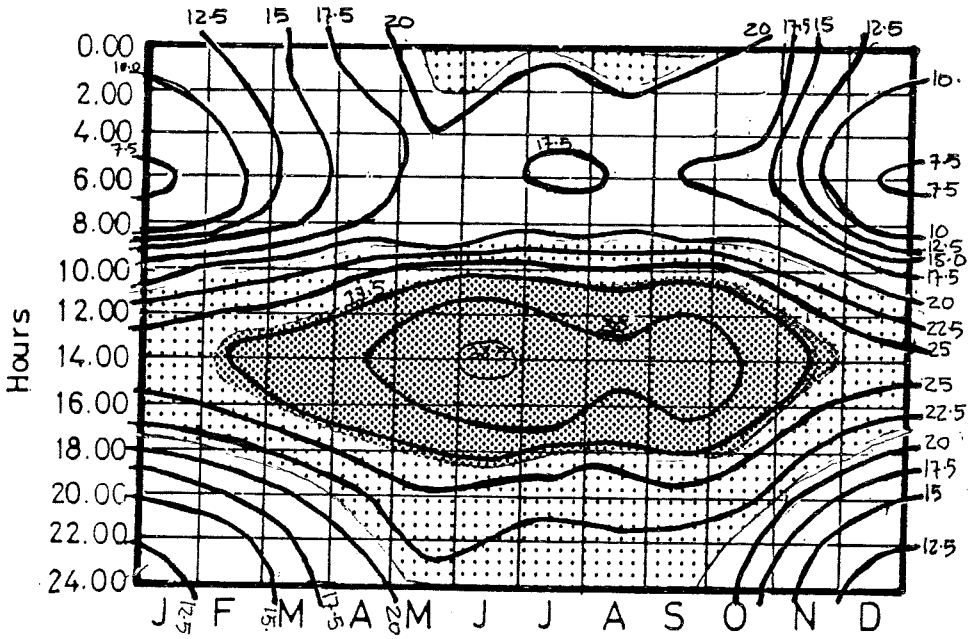
BASE DATA

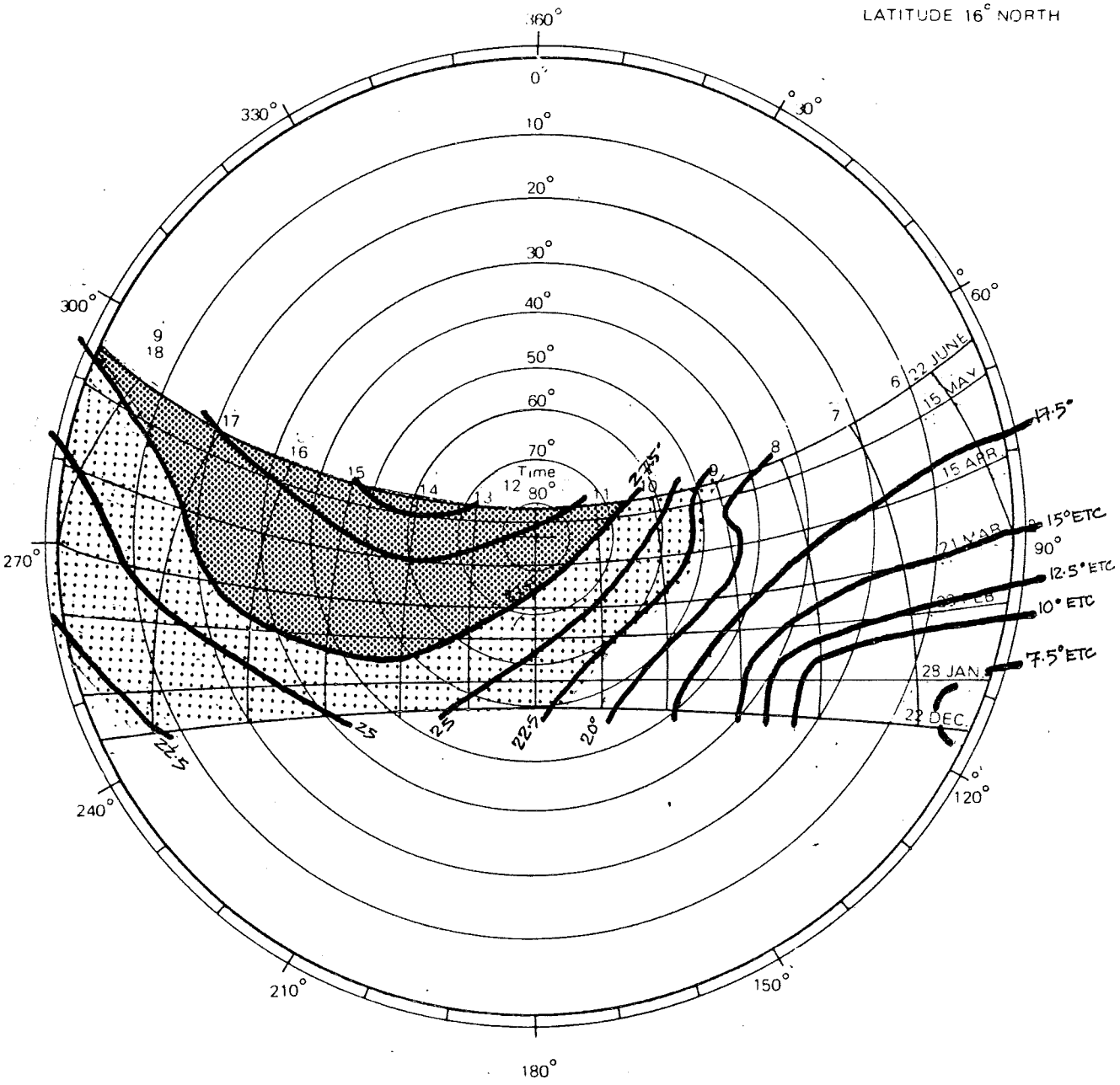
	J	F	M	A	M	J	J	A	S	O	N	D
Mean max. DBT°C	38	40	42	44	44	42	39	36	38	40	39	36
R.H. p.m. %	12	12	11	18	28	41	53	60	50	32	14	13
WBT °C	18	19·5	20·5	24	27	29·5	30	29	31	26	20	17·5
ET max °C	26·5	27·5	28·5	30	31·5	32·5	32	30·5	32	30	27·5	26
Mean min DBT°C	10	12	17	19	21	20	19	19	19	19	14	10
RH. a.m. %	29	26	22	30	55	70	80	90	87	70	40	32
WBT °C	3·5	5	7·5	10·5	15·5	16·5	16·5	18	17·5	15·5	7·5	4·0
ET min °C	7·5	9·5	13·5	16	19	18	17	18	17·5	17	11	7·5

HOURLY EFFECTIVE TEMPS.

Hours	J	F	M	A	M	J	J	A	S	O	N	D
0.00	11·5	13·5	16·5	19	21·5	21	20·5	21	20·5	20	15	11·5
2.00	10	12	15·5	18	21	20	19	20	19·5	19	13·5	10·0
4.00	8·5	10·5	14·0	17	20	19	18	19	18·5	18	12	8·5
6.00	7·5	9·5	13·5	16	19	18	17	18	17·5	17	11	7·5
8.00	9	11	15	17·5	20·5	19·5	18·5	19·5	19	18·5	13	9
10.00	18·5	20	22	24	26	26·5	26	25·5	26	24·5	21	18
12.00	23·5	25	26·5	28	30	30·5	30	29	30	28	25	23
14.00	26·5	27·5	28·5	30	31·5	32·5	32	30·5	32	30	27·5	26
16.00	25	26	27·5	29	30·5	31·5	31	29·5	31	29	26	24·5
18.00	20·5	22	24	25·5	27·5	28	27	26·5	27·5	26	22·5	20
20.00	16·5	17	20	22	24·5	24	23·5	23·5	23·5	23	18	15·5
22.00	13	15	18	20·5	23	22·5	21·5	22	22	21	16·5	13·5

E.T. ISOPLETH.





SUN PATH DIAGRAM

CHIKAL

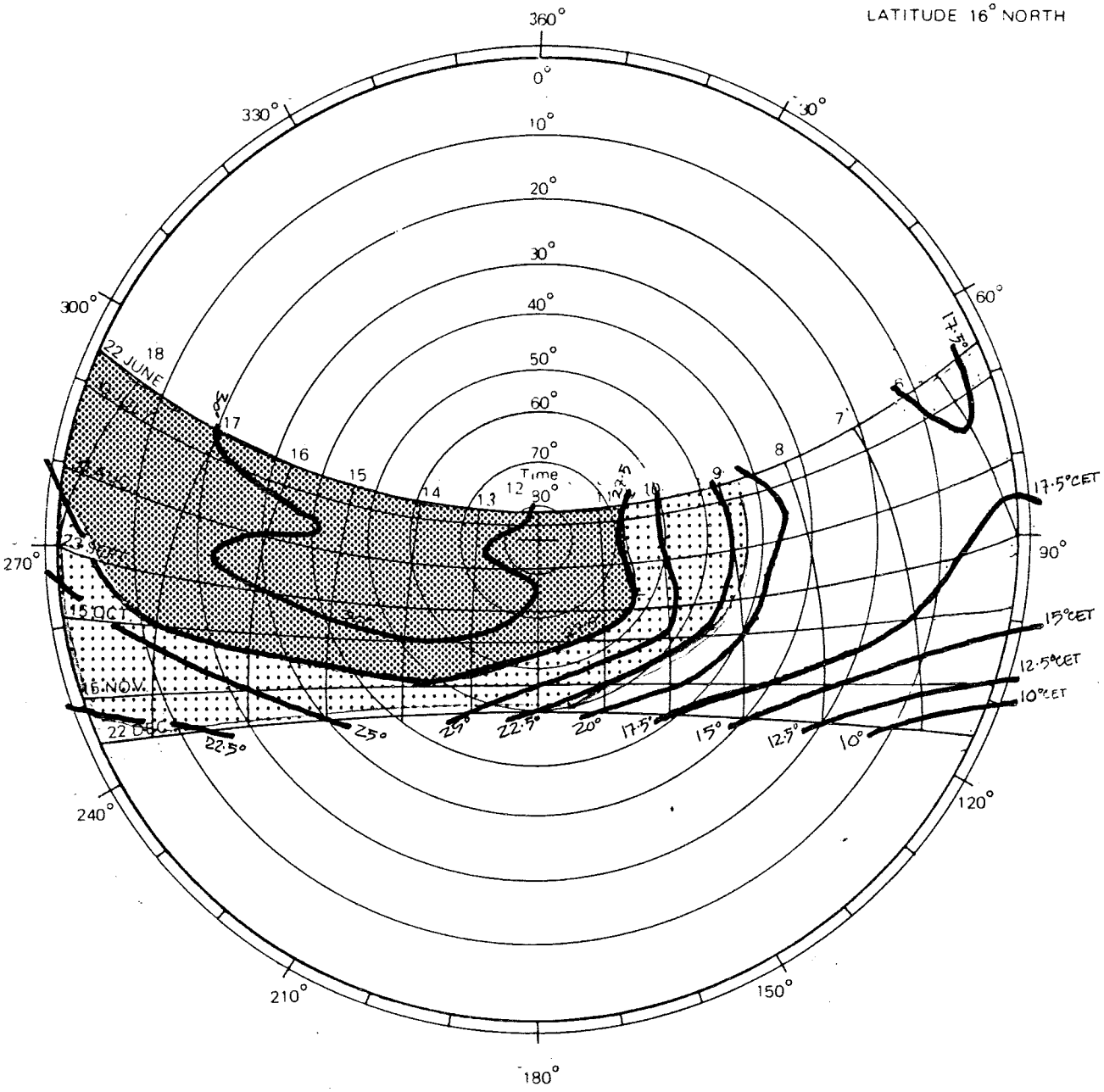
January - June period.

Effective temp. below comfort zone.

Effective temp. within comfort zone.

Effective temp. too hot

LATITUDE 16° NORTH



SUN PATH DIAGRAM

CHIKAL

July - December period.

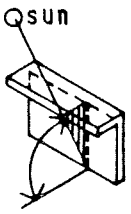
Effective temp. below comfort zone.

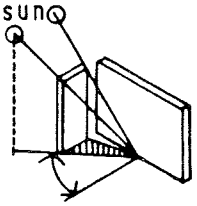
Effective temp. within comfort zone.

Effective temp. too hot

SHADING REQUIREMENTS.

Location: CHIKAL		
Longitude	Latitude	Altitude





NORTH

VERTICAL ANGLES.

HORIZONTAL ANGLES.

ORIENTATION OF ELEVATIONS

N

NW

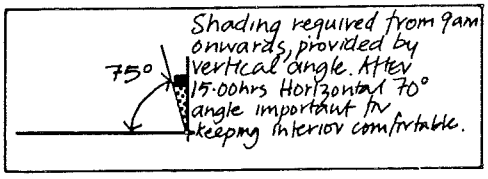
W

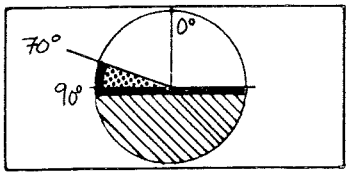
SW

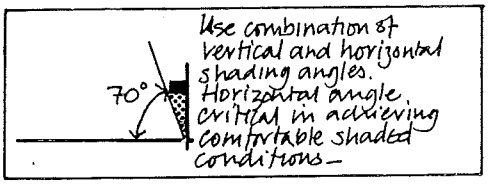
SE

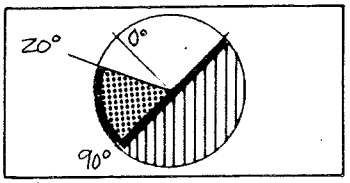
E

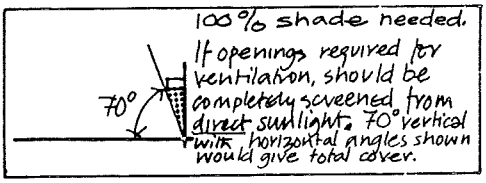
NE

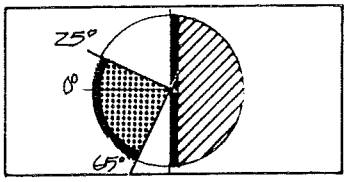


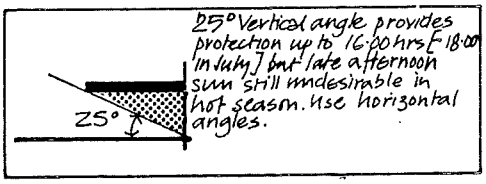


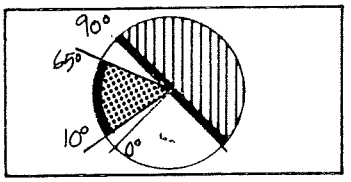


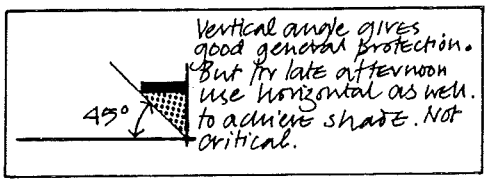


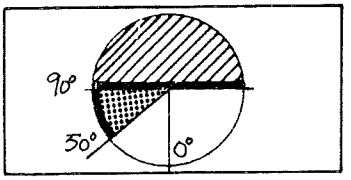


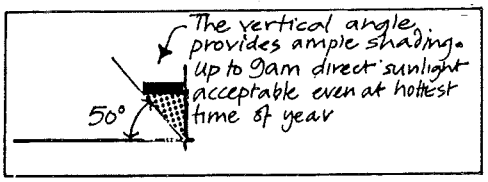


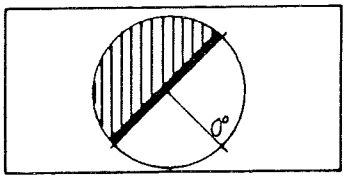


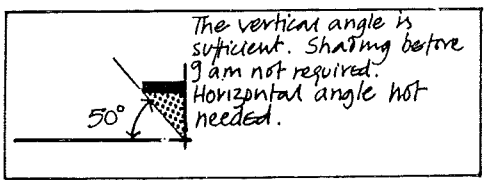


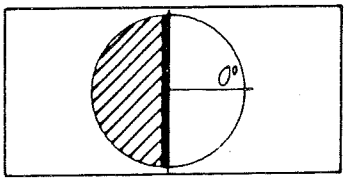


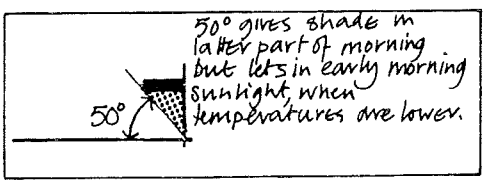


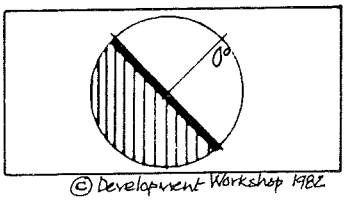




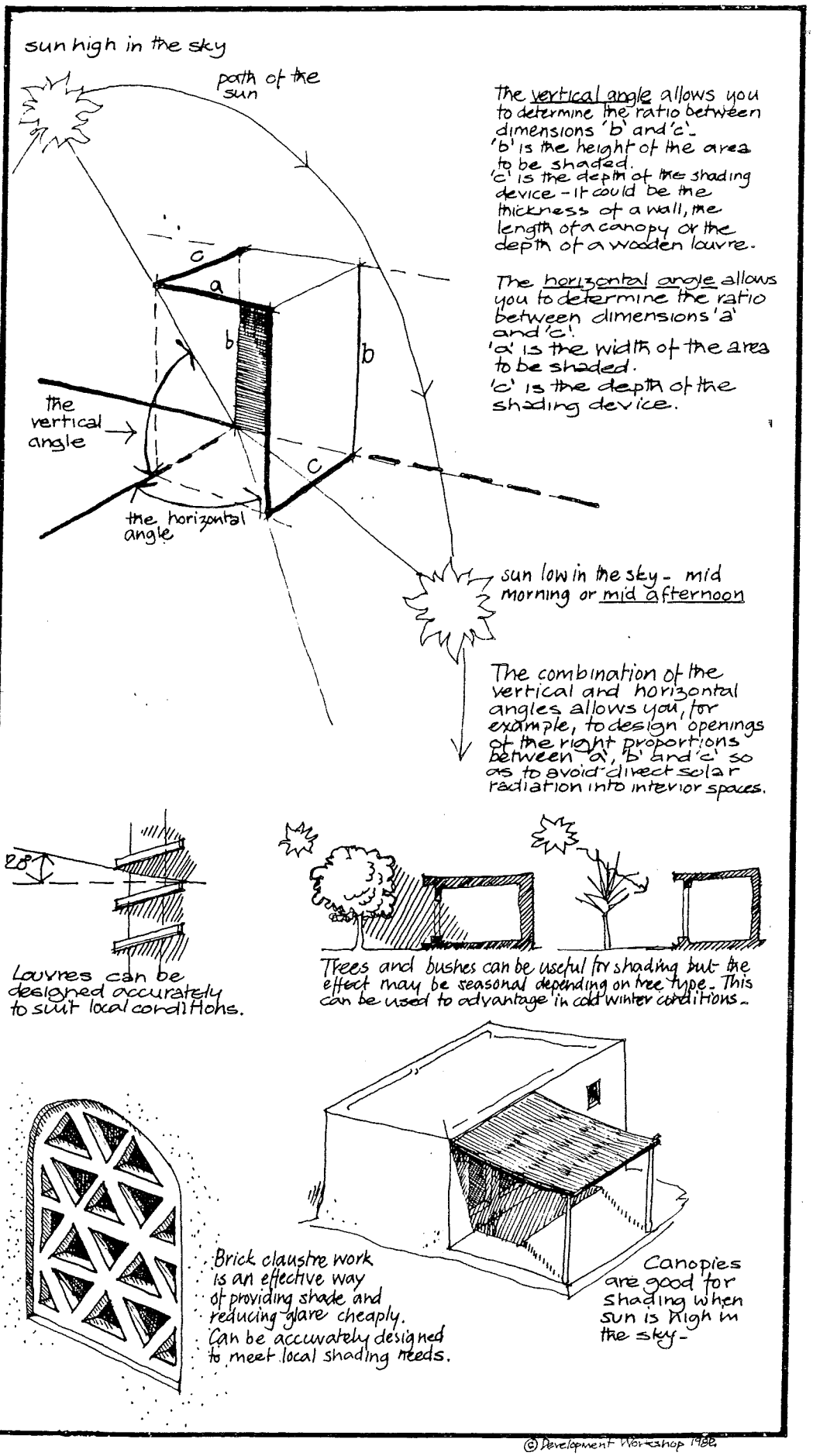








WAYS OF INTERPRETING SHADING ANGLES



Location: TAHOUA		
Longitude 5°15'E	Latitude 14°54'N	Altitude 482.6 metres

BASE CLIMATIC DATA

Air temperature °C	J	F	M	A	M	J	J	A	S	O	N	D
Monthly mean max.	37.5	39.5	42.0	44	44	42	39.5	36	38.5	40.0	38.5	37.0
Monthly mean min.	10.5	12	17.5	20.0	21.5	20.5	19.5	19.5	19.5	18.5	15.0	10.5
Mean range	27	27.5	24.5	24	22.5	21.5	20	16.5	19	21.5	23.5	20.5

high AMT: 44 / 27.25
low AMR: 10.5 / 33.5

Relative humidity %												
Mean max. a.m.	27	24	19	23	50	66	80	89	86	61	29	28
Mean min. p.m.	13	11	9	12	27	37	49	63	50	27	12	12
Average	20	17.5	14	17.5	38.5	51.5	64.5	76	68	44	20.5	20
Humidity group	1	1	1	1	2	3	3	4	3	2	1	1

Rainfall mm	0	0	2,5	2,5	18.0	48	109	137	50.5	18	0	0

385 totals

Wind, prevailing												
Time												
Wind, secondary												
Time												

DIAGNOSIS

Diagnosis: °C	J	F	M	A	M	J	J	A	S	O	N	D
Mean max. temp.	37.5	39.5	42	44	44	42	39.5	36	38.5	40	38.5	35.
Day comfort; max	34	34	34	34	31	29	29	27	29	31	34	34
min	26	26	26	26	25	23	23	22	23	25	26	26
Mean min. temp.	10.5	12	17.5	20.0	21.5	20.5	19.5	19.5	19.5	18.5	15.	10.5
Night comfort max	25	25	25	25	24	23	23	21	23	24	25	25
min	17	17	17	17	17	17	17	17	17	17	17	17
Thermal stress: day	H	H	H	H	H	H	H	H	H	H.	H	H
night	C	C	O	O	O	O	O	O	O	O	C	C

INDICATORS

Humid:	H1								✓					1 totals
	H2													0
	H3													0
Arid	A1	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	11
	A2			✓	✓	✓					✓			4
	A3													0

Location: NIAMEY		
Longitude 2°06' E	Latitude 13°31'N	Altitude 216 metres

BASE CLIMATIC DATA

Air temperature °C	J	F	M	A	M	J	J	A	S	O	N	D
Monthly mean max.	38·0	41·0	43·5	44·5	44·5	42·5	39·0	36·0	37·5	41·0	41·0	37·5
Monthly mean min.	10·5	13	16·5	19·5	21·0	20·5	19·5	19·5	20·0	20·0	14·5	11·0
Mean range	27·5	28·5	27	25	23·5	22	19·5	16·5	17·5	21	26·5	26·5

high AMT: 44·5 | 27·5 | 10·5 | 34

low AMT:

Relative humidity %												
Mean max. a.m.	32	28	26	37	61	74	83	91	89	78	52	39
Mean min. p.m.	12	12	11	18	35	44	56	68	60	40	17	14
Average	22	20	18·5	27·5	48	59	69·5	79·5	74·5	59	34·5	26·5
Humidity group	1	1	1	1	2	3	3	4	4	3	2	1

Rainfall mm	2·5	2·5	5	7,5	33	81	132	183	94	12·5	2·5	0

555 total

Wind, prevailing												
Time												
Wind, secondary												
Time												

DIAGNOSIS

Diagnosis: °C	J	F	M	A	M	J	J	A	S	O	N	D
Mean max. temp.	38·	41	43·5	44·5	44·5	42·5	39	36	37·5	41·0	41·0	37·5
Day comfort: max	34	34	34	34	31	29	29	27	27	29	31	34
min	26	26	26	26	25	23	23	22	22	23	25	26
Mean min. temp.	10·5	13	16·5	19·5	21·0	20·5	19·5	19·5	20·	20	14·5	11·0
Night comfort max	25	25	25	25	24	23	23	21	21	23	24	25
min	17	17	17	17	17	17	17	17	17	17	17	17
Thermal stress: day	H	H	H	H	H	H	H	H	H	H	H	H
night	C	C	C	O	O	O	O	O	O	O	C	C

INDICATORS

Humid:	H 1								✓	✓			
	H 2												
	H 3												
Arid	A 1	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓
	A 2				✓	✓							
	A 3												

totals:
2
0
0
10
2
0