

## Climate and Environmental Factors

Environmental factors are a major determinant on the pattern of living and ways of building for the population of the Caspian region. Houses were designed and positioned so as to respond to the local climate and to create comfortable conditions for the inhabitants. Features, as for example roof details, make use of locally available materials to protect living spaces against severe climatic conditions. Roofs often slope to the ground on the sides of the house facing the heavy rains and winds, protecting the walls as well as covered indoor and outdoor spaces. Porches (aivans) are positioned to accept solar radiation during the winter months and provide a dry outdoor living space for most of the year. Outdoor covered living and sleeping spaces for summer use are located in well ventilated areas so that air movement can help cool the body by evaporation. Houses on the coastal plain are distributed so that the breeze, which is essential for comfort in the warm humid summers, is allowed to move through the settlement relatively unobstructed. Such climatic responses are maximised in the indigenous built environment and are studied for the lessons which can be learned in contemporary building.

In our discussion of climatic factors we will first look at major climatic influences in the region. The "macro-climate" of the Caspian differs dramatically from other areas of Iran, but also shows variations as one moves from west to east. Local topographical conditions also affect the climate, such as proximity to the sea and the mountains. More particularly, the micro-climate within which the house or settlement is situated is important in terms of comfort conditions for inhabitants. These micro-climatic factors may be easily modified to suit human comfort requirements by controlling elements in the built environment. Micro-climatic studies of particular houses were carried out by the authors using portable meteor-

ological equipment in order to discover responses of the house to particular environmental conditions.

### Macro-Climate:

The coastal plain of the Caspian Sea and the northern slopes of the mountains that overlook this sea, are climatically very different from the rest of the country. This Caspian type of climate is best characterised by moderate temperatures, small annual and diurnal ranges, very high humidity, strong land and sea breezes and local winds, and very high precipitation, varying normally between 1,000 and 2,000 mm. spread over the different seasons. The combined result of the above-mentioned conditions can be seen in the luxuriant subtropical forests which cover the northern slopes of the Elburz to a height of about 2500 mm.

Average annual precipitation: dry subhumid = 250-500 mm.  
moist subhumid = 500-1,000 mm.  
humid = 1,000-2,000 mm.

Minimum rainfall is in June, but no actual drought; atmosphere humid. Difference between July and January mean temperatures is about 20°C. Annual precipitation is over 600 mm. and generally much more. Mean temperature for January is below 8°C.

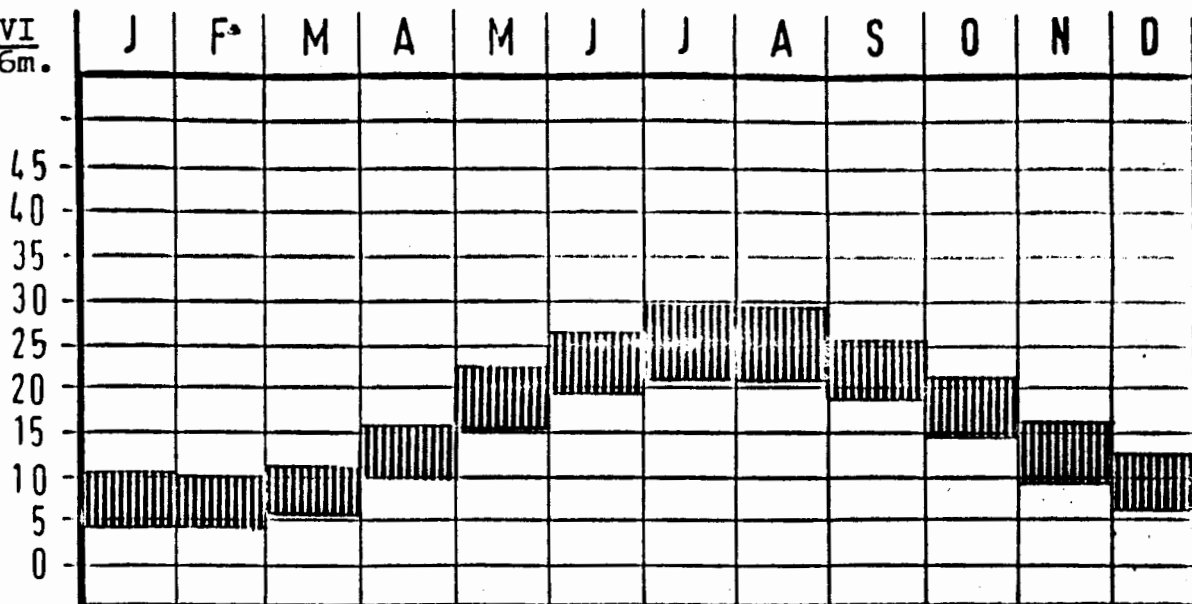
In this report general macro-climatic data is illustrated for each region on a standard chart (see accompanying chart for Bandar Pahlavi).

- i) The range of average monthly maximum and minimum temperatures.
- ii) The range of average monthly maximum and minimum relative humidities.

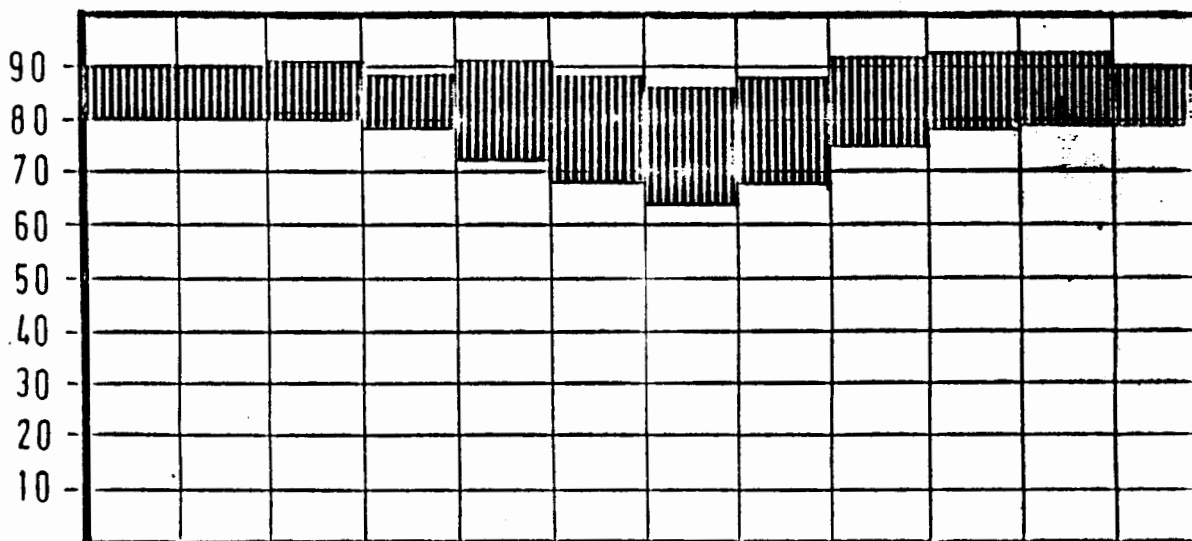
Meteorological (for macro-climate) data is listed for each region in chart form to provide a climatic profile for each area studied. Since the method of presentation is graphic, the climatic variations between regions can easily be com-

BANDAR PAHLAVI  
Elevation -16m.

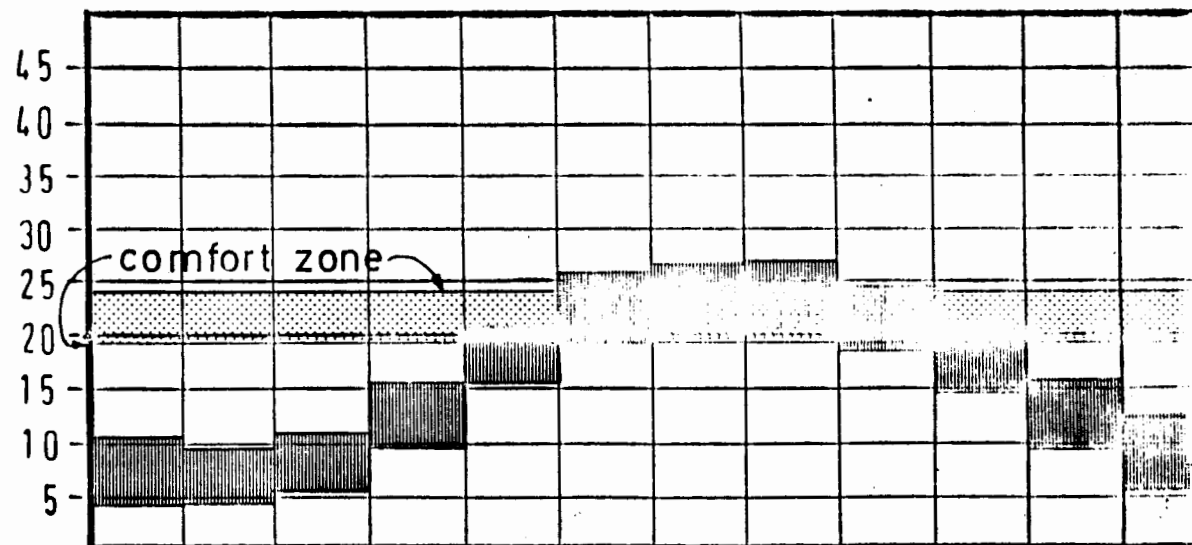
AIR TEMPERATURE °C



RELATIVE HUMIDITY %



WIND EFFECTIVE TEMPERATURE °C



RAIN mm.



pared. In reference to the example chart for Bandar Pahlavi, the continuous vertical columns represent months of the year, while the various aspects of the climate are listed down the left hand side. The first three - air temperature, relative humidity and effective temperatures - are drawn as bar graphs representing the average daily ranges for each month. The upper limit indicates the average maximum and the lower limit of the bar indicates average minimum. Wind directions when available are shown as monthly averages. Rainfall is shown by a bar graph, indicating the amount of monthly rainfall in millimetres.

- i) Temperature is presented measured in metric units ( $^{\circ}\text{C}.$ ).
- ii) Relative Humidity represents the percentage of water vapour in the air. 100% relative humidity indicates that the air is completely saturated with water vapour. The quantity of water vapour in the air influences the human body's perception of temperature. When air temperatures are high a person is more likely to feel thermally comfortable if the air is dry (i.e. a low relative humidity). This is due to the physiological function of perspiration. The water on the skin's surface evaporates into the air (thus causing evaporative cooling) at a rate depending on the degree of relative humidity. The Caspian's high relative humidity means that the human body has difficulty in cooling itself by perspiration. Therefore one feels uncomfortably hot during the summer season even when temperatures are only moderately warm.
- iii) Effective Temperature is a useful indication of how the average person senses heat or cold. It has been shown that the body's feeling of temperature is related to the rate at which it can cool itself, which is partly dependent on relative humidity. The effective temperature is therefore a measurement of the body's sense of temperature and is calculated from a combination of the measured temperature, the relative humidity and the air movement.
- iv) Air Movement assists the body in cooling itself as it

aids evaporation from the skin's surface by replacing the saturated air. Air movement is particularly important in regions having a moist atmosphere such as coastal areas of the Caspian.

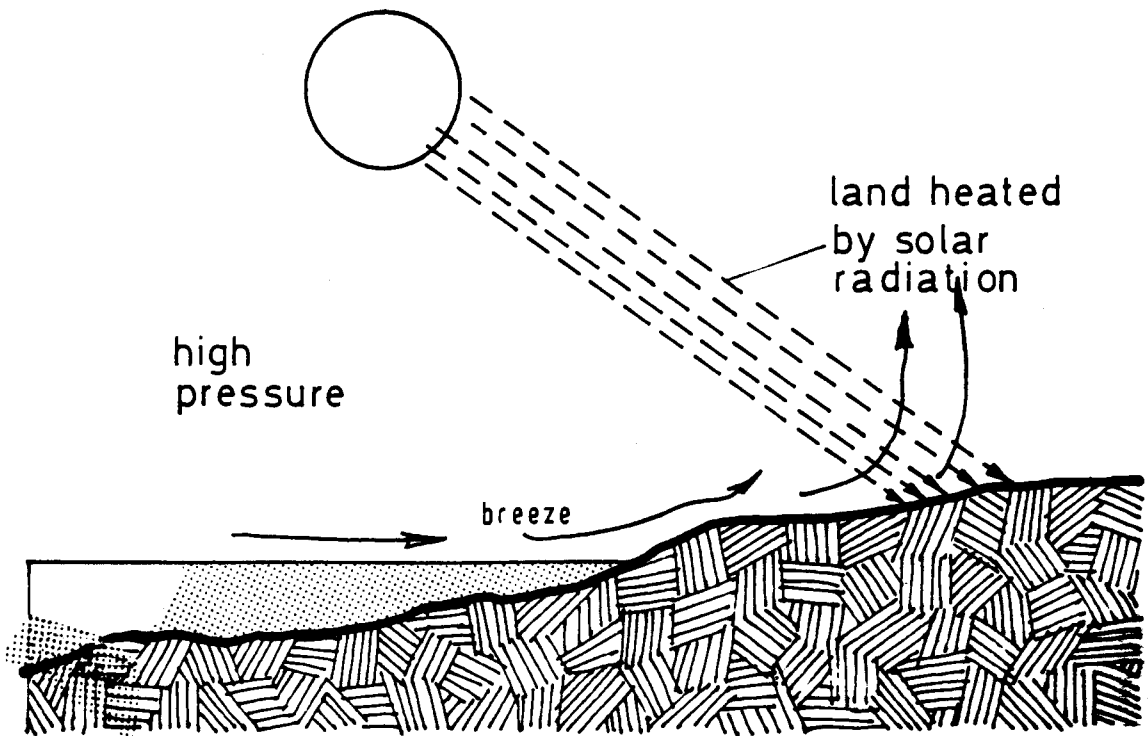
- v) Thermal Comfort Conditions are a physiological state at which an individual feels neither too warm nor too cold, and at which the body can lose its excess heat at an optimum level. Generally, people become to a degree acclimatized to their local conditions. Therefore the "Comfort Zone", or range of comfort conditions, is variable and is dependent upon the local environment. The Comfort Zone noted in this report is calculated from local statistics and employs a formula developed by the Development Planning Unit in the United Kingdom. In general, in the Caspian region the comfort zone has been calculated to extend from 19.2°C. to 24.2°C. The comfort zone has been superimposed upon the effective temperature bar chart. From this chart it is now possible to establish critical times when one finds environmental conditions to be too hot or too cold. From the accompanying climatic chart for Bandar Pahlavi it can be seen that during the summer months of June, July, August and to a much lesser extent September, daytime effective temperatures are in excess of the comfort zone. During these times air movement may assist in cooling the body. It can also be seen from the same chart that for six months, from November until April, even daytime temperatures are cold and below the comfort zone.

#### Local Climatic Factors:

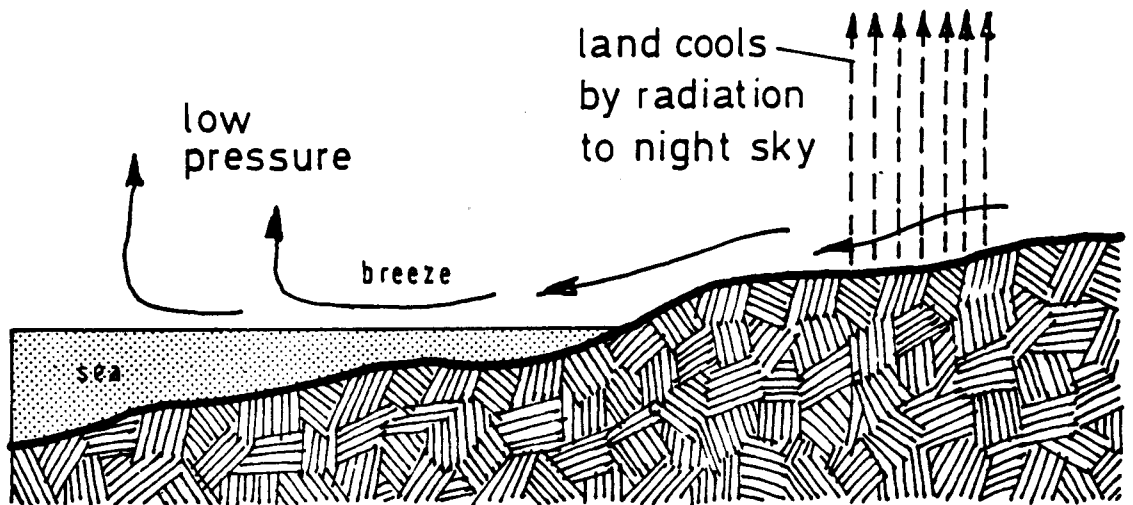
##### Sea Winds

Bodies of water are known to moderate the temperatures of land nearby, because water heats up and cools at a rate much slower than land. The difference in temperatures of air over the land and water causes pressure differences which in turn

## Daytime On-Shore Sea Breeze



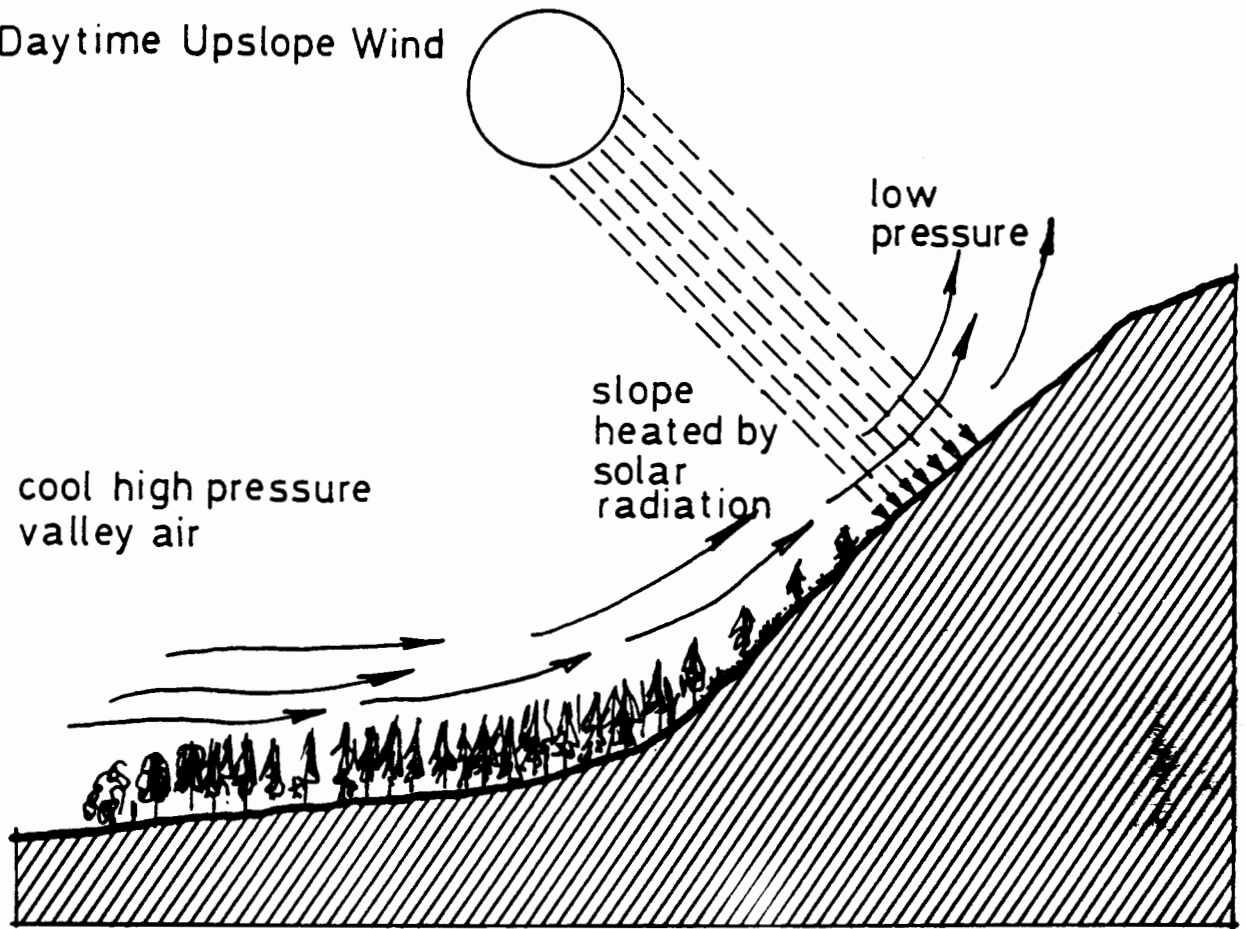
## Night-time Off-Shore Land Breeze



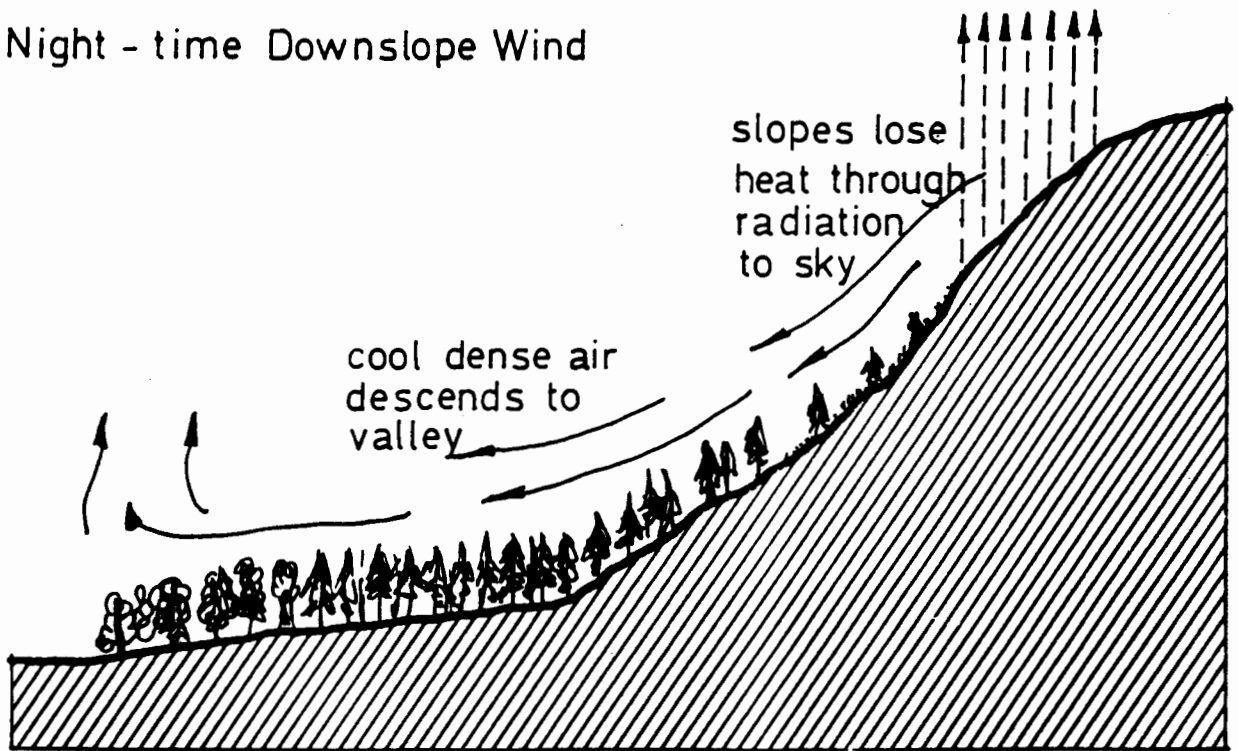
induce localised winds. Air movement occurs from areas of high pressures to areas of low pressures. During the daytime both the land and the sea are subject to the same intensity of solar radiation, but the temperature of the land rises faster than that of the sea. Because the land has become hotter, a relatively low pressure area is created. A convection system is set up with air moving from the cool higher pressure area over the sea to the land. As the land cools in the afternoon and the pressure differences equalise, the velocity of air movement drops. In the evening, land temperatures drop below sea temperatures when the land begins to lose heat radiation to the night sky. A high pressure area is formed over the land and therefore offshore land breezes prevail.

# Mountain Winds

## Daytime Upslope Wind



## Night - time Downslope Wind



## Mountain Winds

Mountains or hills have the affect of physically altering wind patterns by simple deflection or by channelling winds down valleys.

Local winds are induced on mountain slopes by the stratification of air of different temperatures. During the daytime the slopes receiving solar radiation heat up. Warm air on these slopes is light and therefore ascends, creating a low pressure area. Cool air which has collected in the valley during the night, being of a higher pressure, moves up the slope towards the low pressure area. Daytime upslope cool breezes are created in this manner.

During the night, the valley slopes lose heat by radiation to the sky and become cooler. Air on the slopes is cooled and becomes denser and heavier and descends down the valley slope, creating night-time down slope breezes.<sup>1</sup>

### Effect of Altitude on Climate

The accompanying climatic charts<sup>2</sup> clearly demonstrate the effect of increasing altitude on climatic factors. The stations chosen follow a section through the Sari plain in Mazandaran and the Alborz mountains adjacent.

| Stations      | Altitude - metres |
|---------------|-------------------|
| A. Babol      | 0                 |
| B. Shahi      | 150               |
| C. Kareh Sang | 500               |
| D. Sargat     | 700               |
| E. Afra Chal  | 1,000             |
| F. Lar        | 2,400             |

Temperatures and relative humidities show a clear tendency to fall with increasing altitude and exhibit greater range. Similarly, rainfall declines as altitude increases.

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<sup>1</sup> Rudolf Geiger, The Climate Near the Ground, 1965, chap.VII.  
<sup>2</sup> Iraninan Meteorological Dept., Meteorological Year Book, 1966.

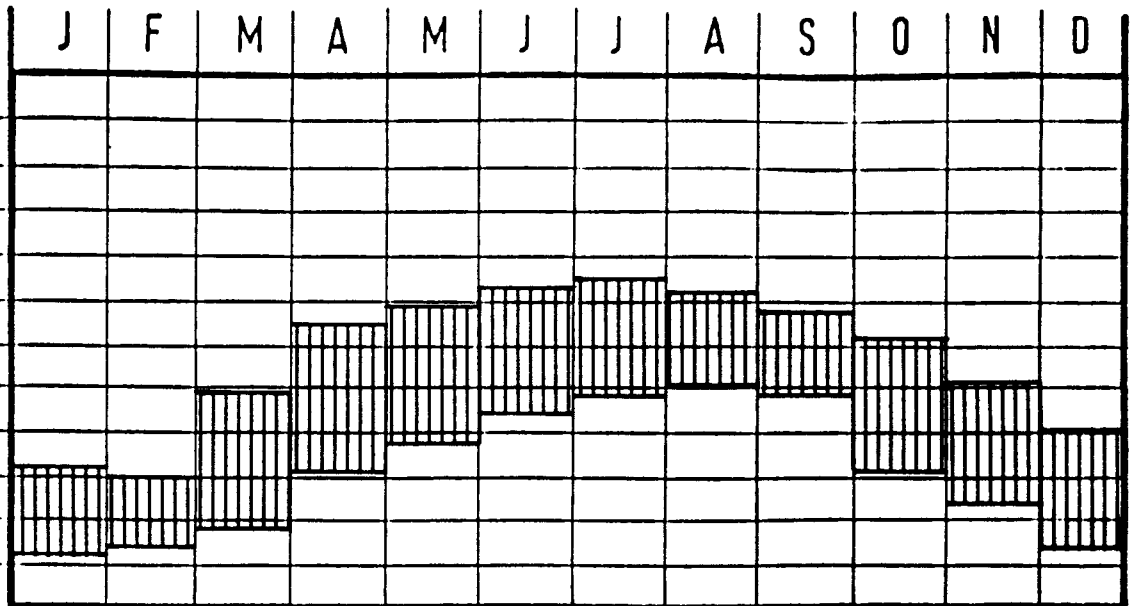
# A

BABOL

Elevation Om.

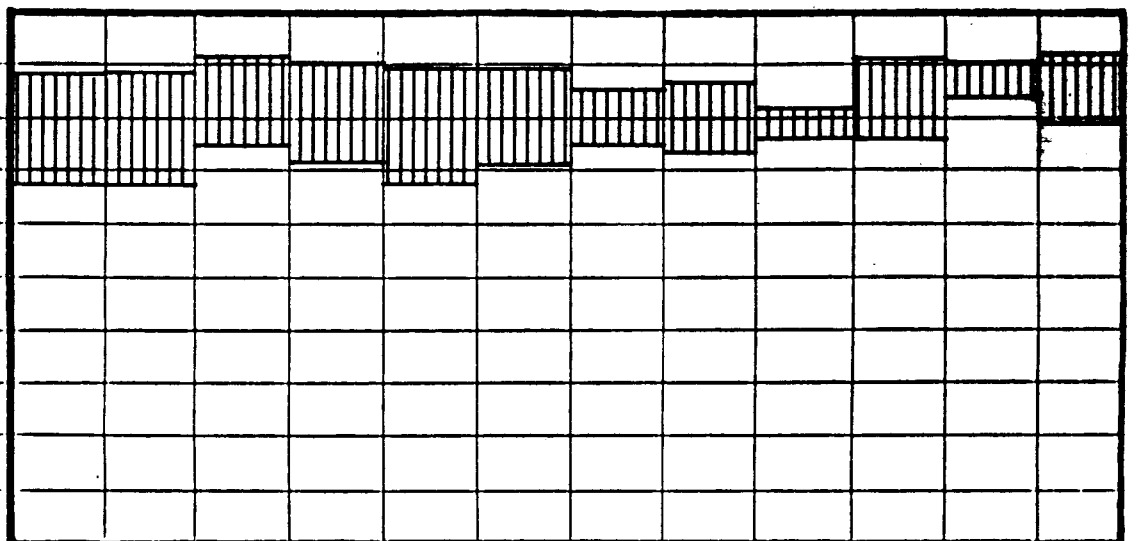
AIR TEMPERATURE °C

45  
40  
35  
30  
25  
20  
15  
10  
5  
0



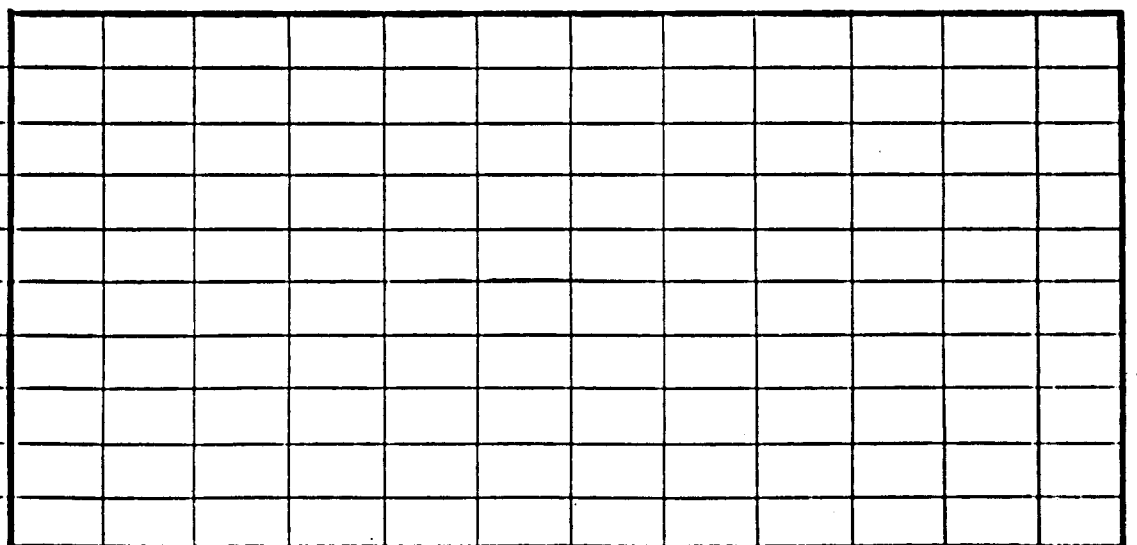
RELATIVE HUMIDITY %

90  
80  
70  
60  
50  
40  
30  
20  
10



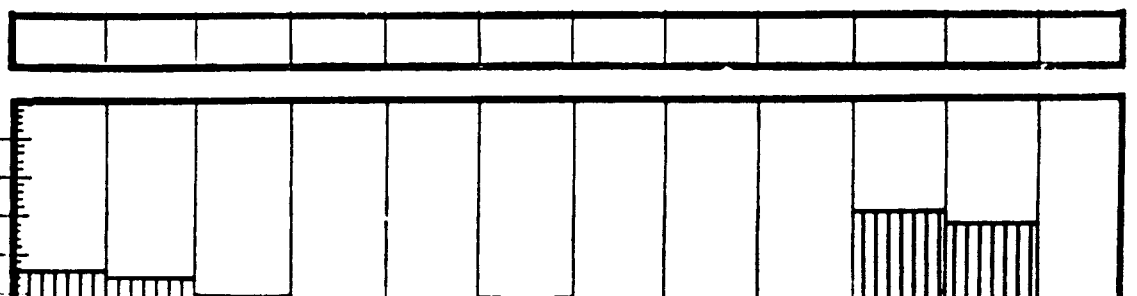
EFFECTIVE TEMPERATURE °C

45  
40  
35  
30  
25  
20  
15  
10  
5



RAIN mm.

150  
100  
50



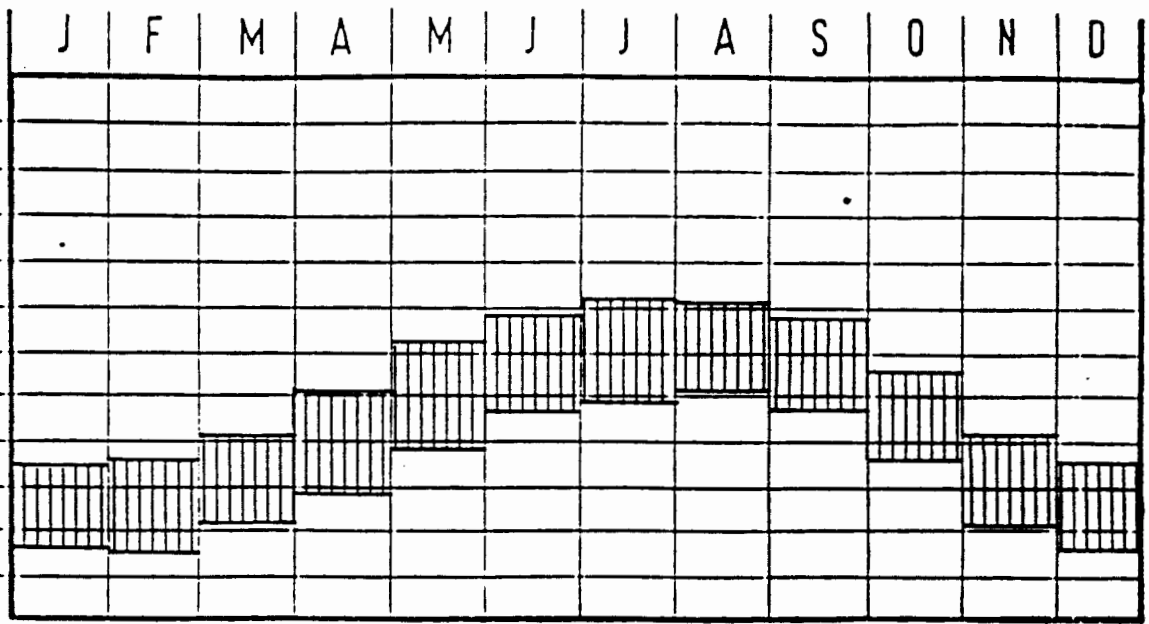
**B**

SHAHI

Elevation 150m.

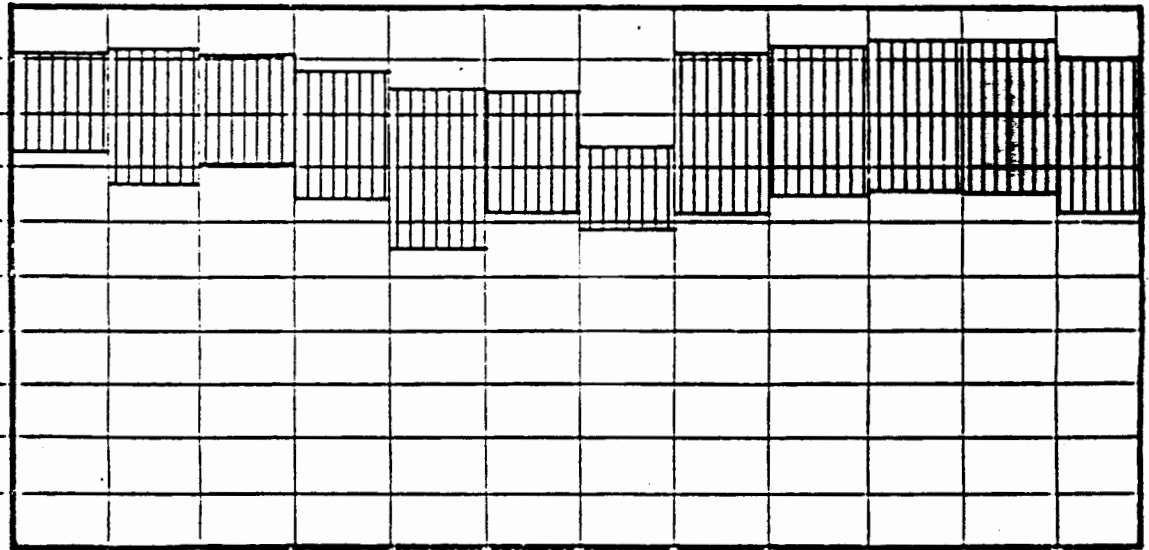
AIR TEMPERATURE °C

45  
40  
35  
30  
25  
20  
15  
10  
5  
0



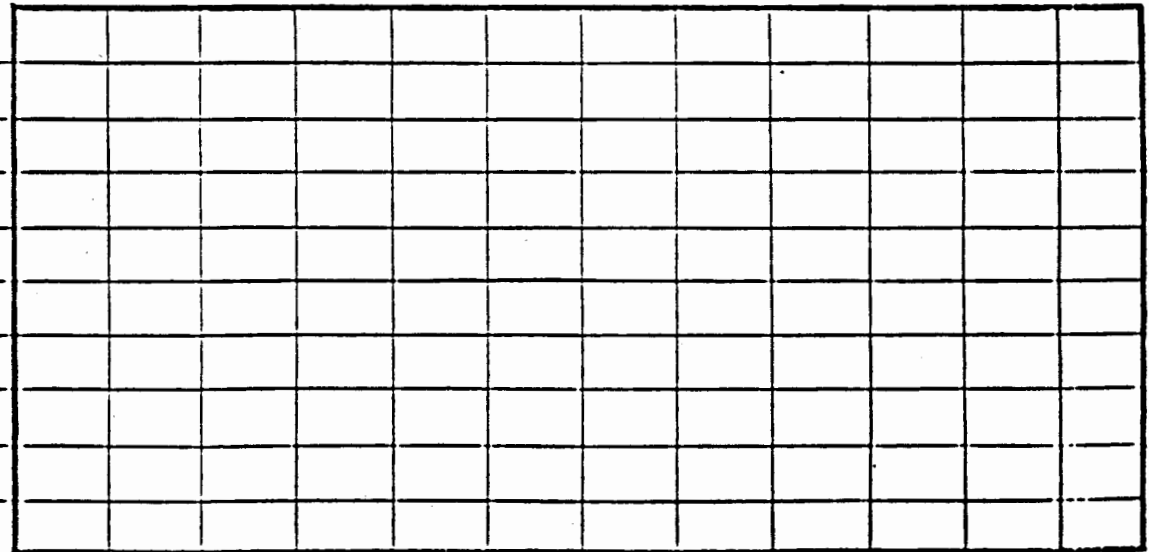
RELATIVE HUMIDITY %

90  
80  
70  
60  
50  
40  
30  
20  
10



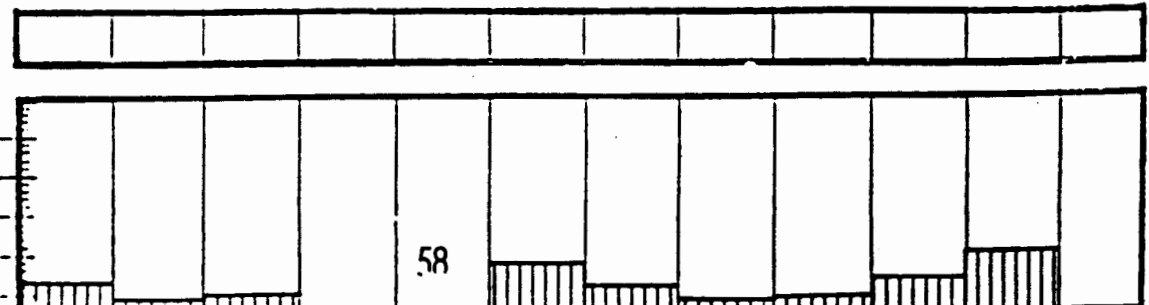
WIND EFFECTIVE TEMPERATURE °C

45  
40  
35  
30  
25  
20  
15  
10  
5



RAIN mm.

150  
100  
50

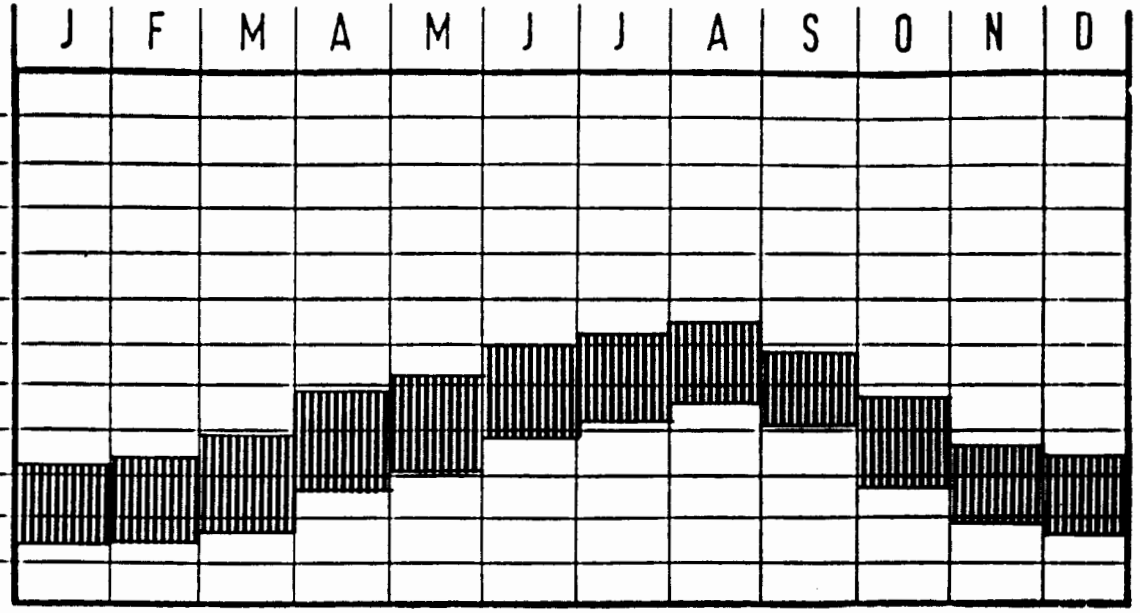




KAREH SANG  
Elevation 500m.

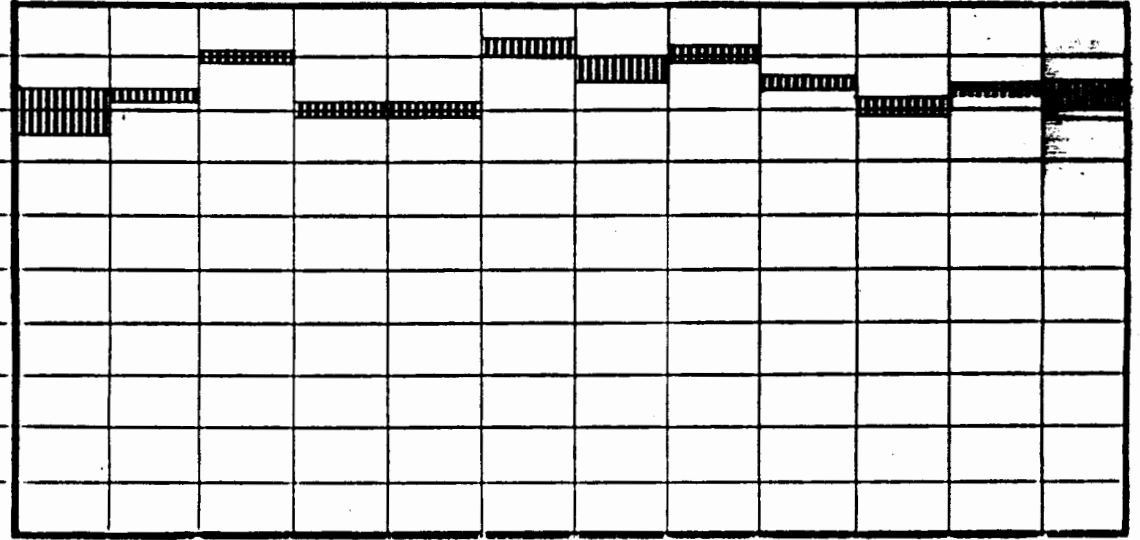
AIR TEMPERATURE °C

45  
40  
35  
30  
25  
20  
15  
10  
5  
0



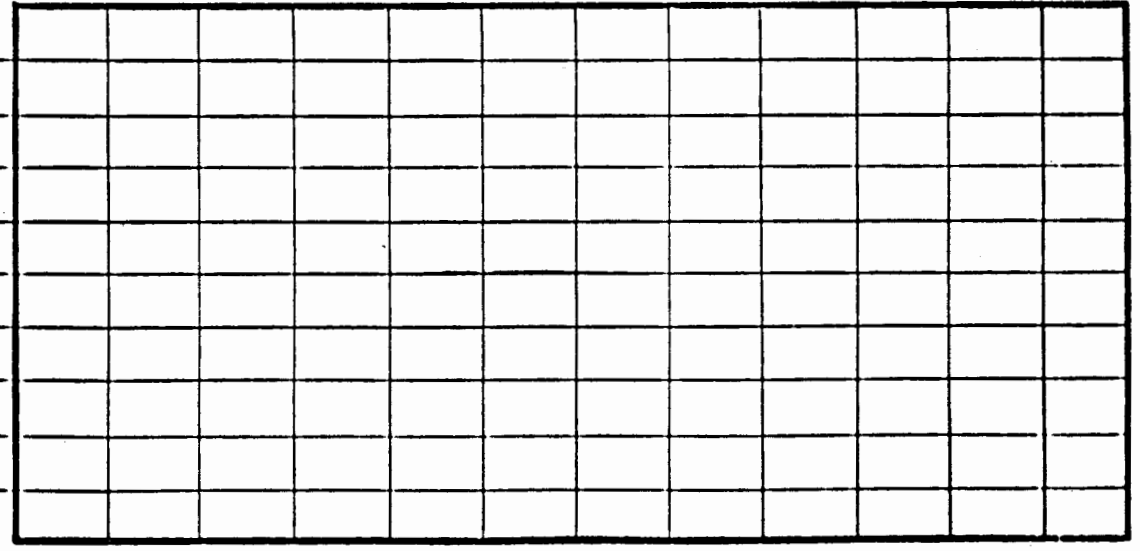
RELATIVE HUMIDITY %

90  
80  
70  
60  
50  
40  
30  
20  
10



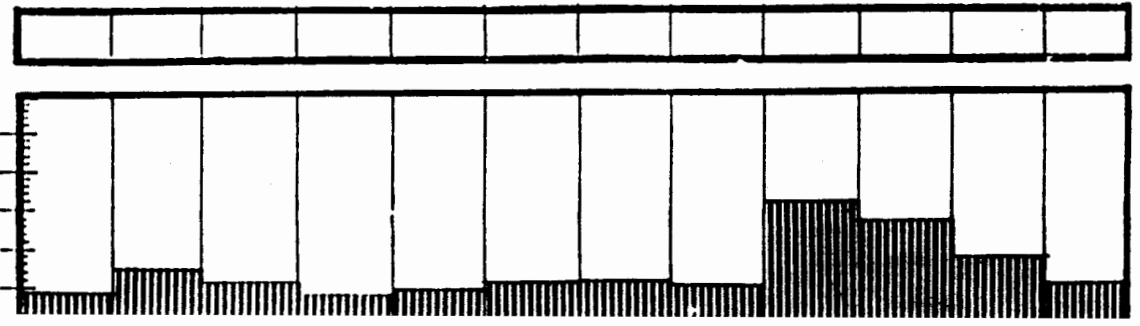
WIND EFFECTIVE TEMPERATURE °C

45  
40  
35  
30  
25  
20  
15  
10  
5



RAIN mm.

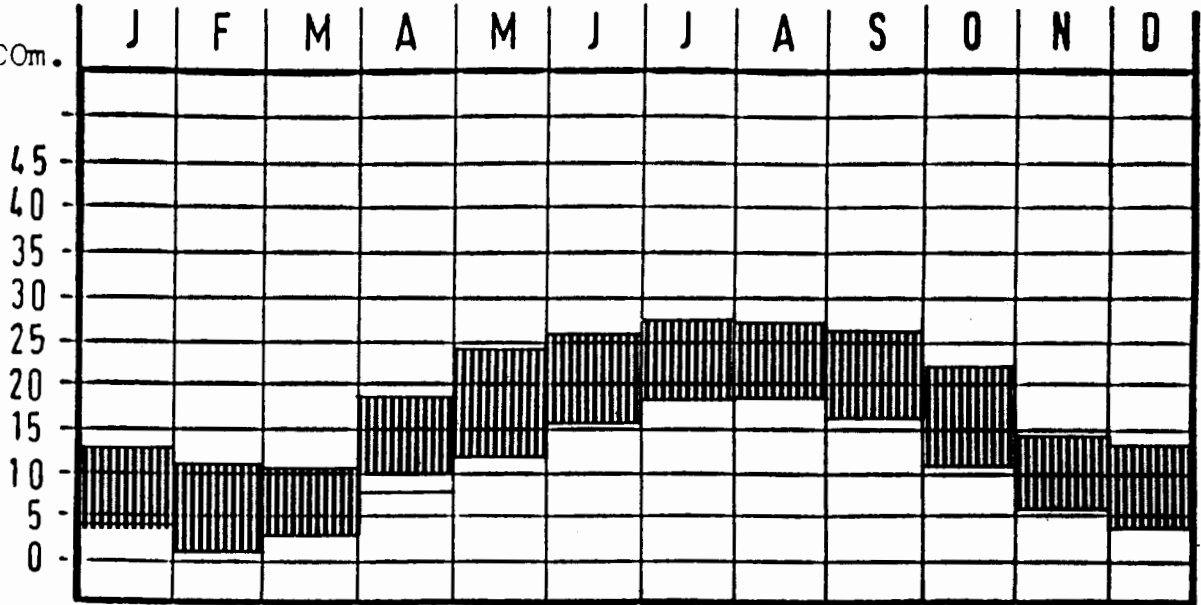
150  
100  
50



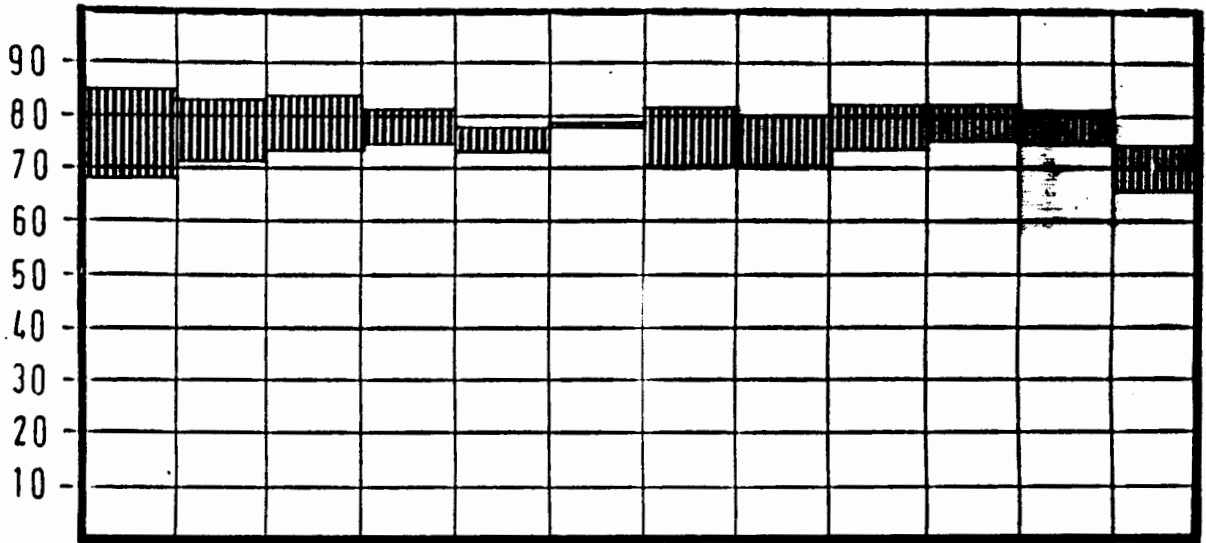
D

SARGAT  
Elevation 700m.

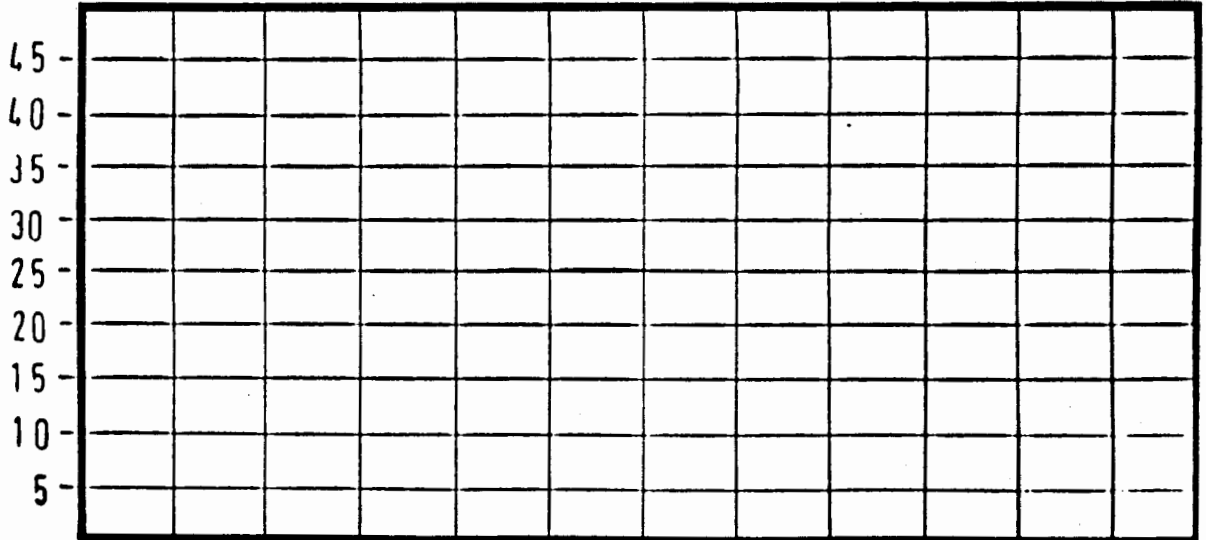
AIR TEMPERATURE °C



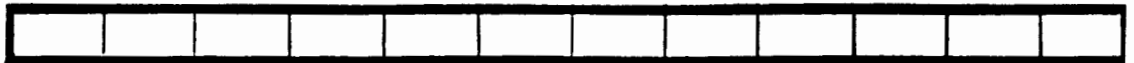
RELATIVE HUMIDITY %



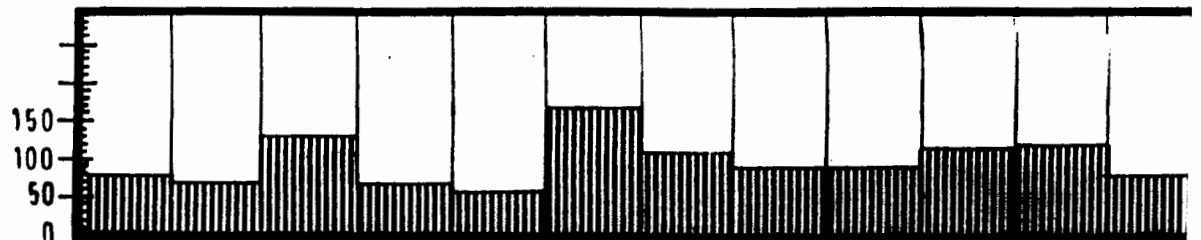
WIND EFFECTIVE TEMPERATURE °C



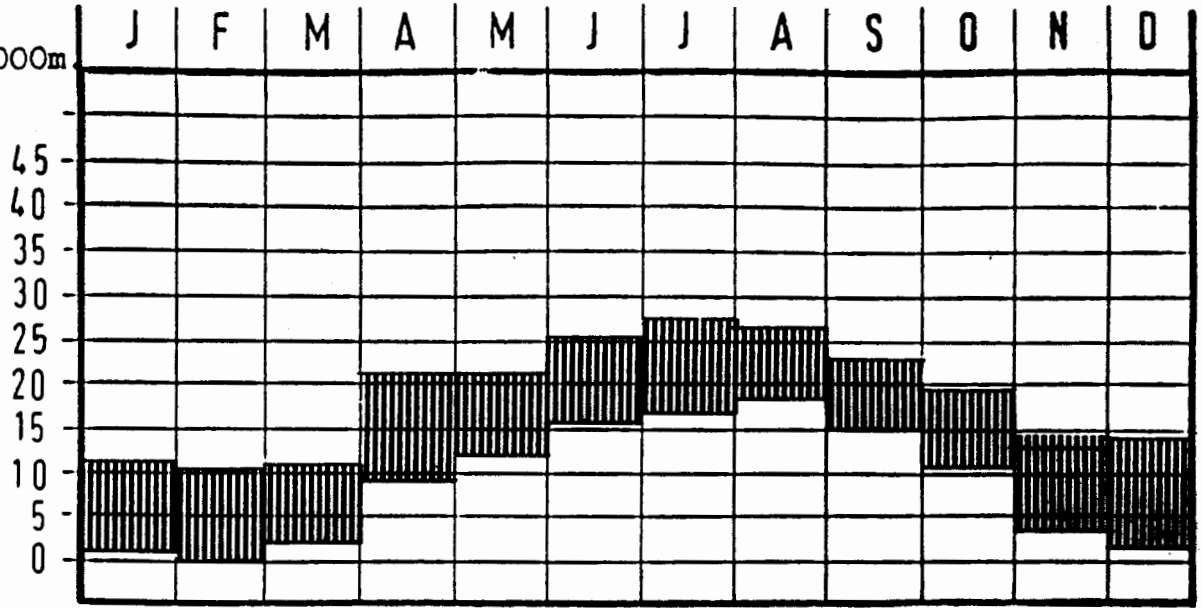
WIND



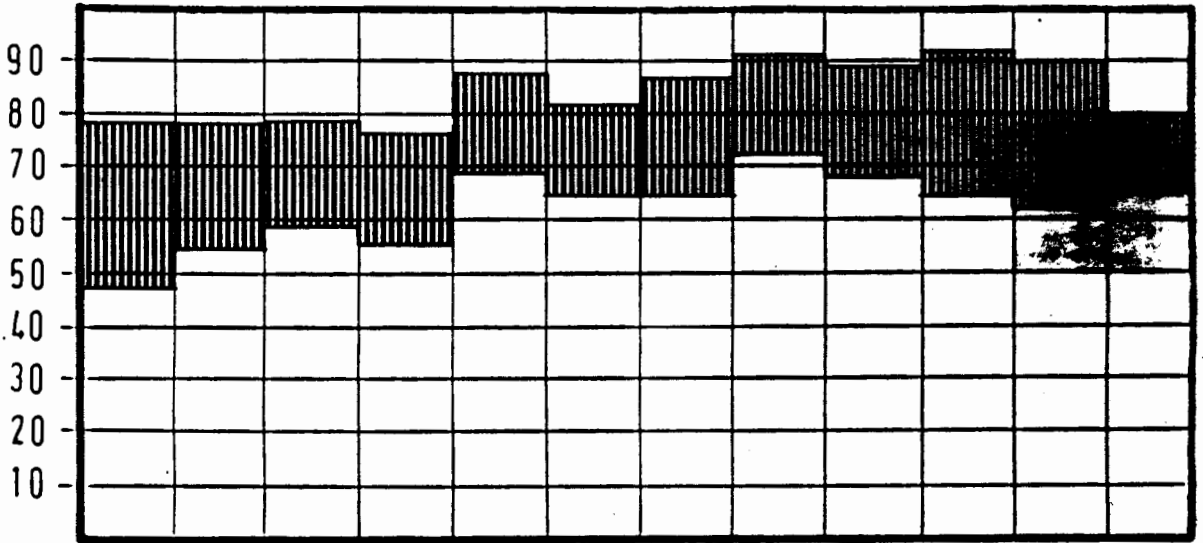
RAIN mm.



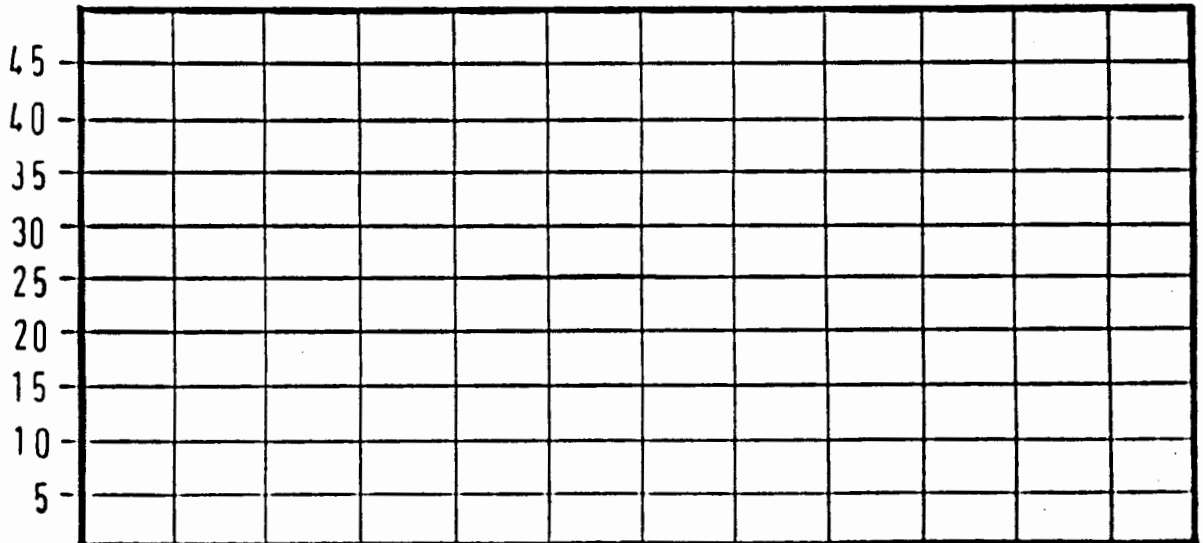
AIR TEMPERATURE °C



RELATIVE HUMIDITY %



WIND EFFECTIVE TEMPERATURE °C



RAIN mm.



PAR  
Elevation 2400m.

AIR TEMPERATURE °C

RELATIVE HUMIDITY %

WIND EFFECTIVE TEMPERATURE °C

RAIN mm.

2400m

