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INDEXES FOR COMFORT ANALYSIS

The nature of climatic indexes — A number of bioclimatic studies regarding human comfort are now available for India. A glance through these articles clearly indicates a preference for the use of bioclimatic indexes. Strain indexes are used to signify different categories of comfort or discomfort under varying climatic conditions. Two points need to be kept in mind when using these indexes :

(1) Physiological reactions of the body are largely subjective while strain indexes are used for analysing data regarding atmospheric variables which are objectively recorded by instruments.

(2) Physiological reactions to climate result from the influence of the total ambient atmosphere, acclimatisation to a particular type of climate and one's economic condition. On the other hand bioclimatic indexes are based on a few selected atmospheric variables.

Some bioclimatic indexes used in India — Keeping the above in mind it is pertinent to raise a few points regarding the use of methods in the analysis of climatic comfort in India.

(1) Lee's scheme has been used to work out a bioclimatic classification of India (Subrahmanyam and Sivaramakrishnaiah 1964). This scheme is based on the use of temperature and humidity for the hottest and coolest months. While this system is well suited to the study of climates in the mid-latitudes where there are two distinct temperature regimes, that is, summer and winter; and two transitional ones, spiring and autumn, it is inadequate for monsoon countries. This is so because here there are three distinct seasons, *viz.*, summer, monsoon and the cool season. The use of temperature and humidity for the hottest and coolest months completely overshadows the bioclimatically significant sultry months.

(2) Thom's Discomfort Index has also been used to study physioclimatic regimes over India (Chowdhury and Ganesan 1981; Lakshmanan 1984). Also known as the Temperature-Humidity Index and used by the U. S. National Weather Service, it was developed in the U.S.A. by conducting tests on a large population in the mid-latitudes. Its utility in a tropical country like India with different clothing and shelter conditions and requirements, without suitable changes based on tests carried out on a large population, is doubtful. Sarget and Tromp (1964) state that the model comfortable temperature in the temperate zone is 23 deg. C. and in the tropical zone it is 27 deg. C. Since physiological reactions are largely a result of economic condition, acclimatisation and natural physiological reactions to the climatic environment, the bioclimatic index category limits chosen with a particular environment in view cannot be satisfactorily used in another..

(3) When day and night conditions are not considered separately, the results can be quite misleading.

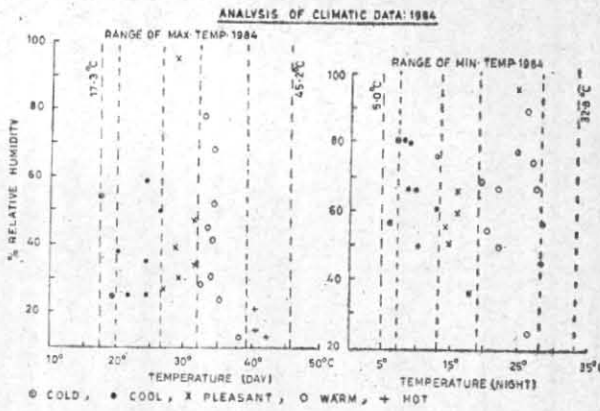

Fig. 1. Scatter diagrams showing comfort conditions by day and night in Delhi at different temperature and humidity levels

This is so because in a number of months of the year, the day and night comfort conditions are quite different. In Delhi, the days are hot in April while the nights are quite pleasant. Again, in January and February the nights are cold while the days are pleasant.

(4) When using bioclimatic indexes it is necessary to fix the reference points for research. It should be indicated whether the results are applicable to outdoor or indoor conditions, since the choice of climatic elements will depend on this; or if it applies to sedentary or manual workers since body metabolism is closely related to nature of activity and influences the feeling of comfort.

An empirical study of climatic comfort and discomfort — With a view to working out the limits of comfort, a total of 650 responses of individuals were recorded on 26 different days from 1 January to 31 December 1984. The respondents were all students in the age group 18 to 25 years. They were asked what sensation they felt regarding the previous day's weather, as they experienced it indoor. They were asked to choose one of a number of categories of physioclimatic sensations-cold, pleasant with warm clothes on, very pleasant with light clothes on, pleasant under the fan, unpleasantly hot during the day. For the night the categories were unpleasantly cold, pleasant under blanket or quilt, very pleasant with light clothes on, or under light cover, pleasant under the fan and unpleasantly hot.

Two graphs were made (Fig. 1), one each for day and night conditions, showing temperature on the x-axis and relative humidity on the y-axis. Temperature and relative humidity data for the 26 days was obtained from IMD for New Delhi (Safdarjung station) and plotted on both graphs. Then for each date, the response for any category that was over 50% positive response was indicated separately for day and night. In this way the upper and lower limits of each bioclimatic category was determined. As the graphs indicate, some generalisations can be made regarding young adults involved in non-manul activities.

1. The temperature limits during the day are :

(a) Cold : Below 20 deg. C. — Unpleasant
(b) Cool : 20 deg. C to 27 deg.C — Pleasant with warm clothes on
(c) Pleasant : Above 27 deg. C but below 32 deg. C
(d) Warm : 32 deg. C. to 39 deg C.— Pleasant under the fan
(e) Hot : Above 39 deg. C. — Unpleasant

2. The temperature limits of different catagories at night are:

(a) Very cold : Below 6 deg. C — Unpleasant
(b) Cold : 6 deg. C to 13 deg. C — Pleasant under blanket or quilt
(c) Pleasant : Above 13 deg. C but below 18 deg. C
(d) Warm : 18 deg. C to 27 deg. C— Pleasant under the fan
(e) Hot : Above 27 deg. C — Unpleasant

(3) Very high humidity, which is experienced in Delhi only in the monsoon months, is not considered unpleasant. On four different dates between mid-July to mid-September, high humidity is considered pleasant under the fan. This is explained by the fact evaporative cooling from the surface of the skin is encouraged by moving air even under conditions of high heat and humidity.

(4) In Delhi, the temperature limits for each bioclimatic category appear to vary significantly from those in mid-latitudes. On the whole it is seen that threshold temperature levels for each category is higher than those of temperate lands, *e.g.*, Lee considers as hot more than 30 deg. C, warm 20 to 30 deg. C, temperate 10 to 20 deg. C and cool less than 10 deg. C.

(5) Temperature, irrespective of humidity appears to be a fair indicator of comfort in Delhi. This may be because for most of the year humidity is reasonably low.

A bioclimatic index for Indian cities — The method explained above is a sound and simple way of studying subjective response to climate in different places. Owing to organisational and physical limitations it was not possible to conduct this survey at different stations. However, by gathering such information from individuals by using a stratified random sample based on economic level and years of acclimatisation, very useful data can be collected. This could be used to define limits of bioclimatic categories which would be realistic under Indian conditions.

While the above method is adequate in studying climatic comfort at individual stations, for the purpose of comparison of stations or getting an idea of a part of or the entire country, an index would be essential. For this, numerical scores can be given to the sensation of comfort or discomfort signifying the degree of it, *e.g.*, 1 for very pleasant, 2 for cool and warm, 3 for cold and hot. The scores for day and night can then be added giving the bioclimatic index for that place. Spatial analysis of comfort conditions can easily be done also by drawing isolines using bioclimatic indexes for a number of stations.

(6) The scope for developing an index for the purpose of bioclimatic studies with regard to comfort conditions in India is immense. However, it is not only necessary to keep in mind our climatic characteristics, but also that our cultural environment which includes our food, clothing and shelter, is quite distinct from the mid-latitudes where most of the biometeoroligical indexes have been developed. Should these indexes be used, suitable modifications must be made for Indian conditions.

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