Explanatory notes on the bioclimate maps of the Western Ghats

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ON THE

BIOCLIMATE MAPS OF THE WESTERN GHATS

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The bioclimate maps provide the complementary climatic information that is required for understanding the distribution of plant formations in the Western Ghats.

1. What is a Bioclimate?

Bioclimates correspond to the biological climates defined by BAGNOULS and GAUSSEN (1957) (1). They take into account the main climatic parameters *i.e.* rainfall and temperature but give emphasis to their regime (monthly values) and interannual variability, and to the length, intensity and season of occurrence of the dry periods.

Also considered are the extreme values of these factors resulting in conditions unfavourable to biological activity. Examples are extremes of low or high temperature, low rainfall, long or intense drought period.

2. Availability of Climatic Data

In the mapped region about ten synoptic (primary) stations are available. Most of them are outside the forested areas. Other data sources have been consulted like the Bureau of Economic and Statistics, India Meteorological Department, Electricity Boards, Forest Departments and Estates. In all, data from more than 3000 raingauges have been collected.

The rainfall data were carefully examined regarding their continuity and number of years observed, as well as the reliability of readings; doubtful data have been omitted.

Temperature recording stations are only about 50. Most of them are in coastal areas, not representative of the forest conditions. Some are located near important projects and have records for a few years only.

In between recording stations, estimated monthly temperatures were interpolated along the calculated temperature gradients, taking also into account conditions of exposure.

3. Methodology for Data Treatment

3.1. *Rainfall*

For mapping purpose data must be grouped into classes. Isohyets delineate the limits of classes on the map. Seven classes have been chosen to get the best possible matching of the isohyets with the limits of the main vegetation types. For instance: the isohyet 2000 mm of annual rainfall usually corresponds to the minimum required by the evergreen, the 1500 mm to the limits between moist and dry deciduous forests, and 900 mm to changes in the structure and floristic composition of the dry deciduous types.

**Rainfall regimes*

The rainfall distribution during the course of the year is also one of the factors controlling the vegetation. This distribution depends on the rain-producing mechanisms. In this region they are of three types:

- Monsoon rains (June-July-August) linked to the arrival of masses of moisture bearing clouds over the reliefs of the Ghats. These rains affect the entire western part of the mapped region. They result in what we have called the "Allepey-Mangalore" type of regime.
- Rainfall resulting from thermic ascending convection and high atmospheric humidity. They are linked to the passages of the sun at the zenith.

Rainfall of such origin are mainly encountered in the extreme south-west and in the most continental part of the map.

Differences in the relative importance of the two maxima of rain and their dates of occurrence can be observed in relation to latitude - e.g.: Kanniyakumari, Trivandrum regimes and Madurai, Mysore, Arsikere and Ramdurg regimes.

- Highly variable precipitation linked to cyclonic disturbances affecting the Bay of Bengal during the withdrawal monsoon (November-December): Tuticorin type of regime.

Obviously some stations would have transitional regimes according to the relative importance of these three sources of rainfall.

- The gradually decreasing importance of the monsoon rains would result in the Shimoga type of regime and subsequently in the Pollachi, Ootacamund (Uthagamandalam), Hassan and Dharwar types of subregimes according to latitude.
- The combined influence of the monsoon and autumn rains characterise the Biligiri Rangan type of regime.

The rainfall distribution is illustrated on the map by 93 diagrams representing typical reliable stations.

** Inter annual variability*

The variability is shown on the above mentioned climatic diagrams. For each month are given the maximum and minimum values of rainfall recorded during the period of observation. The quartiles indicate the values reached in 75 %, 50 % and 25 % of the year.

3.2 *Temperature*

** Thermic parameters and classes of temperature*

We are mainly interested in the effect of minimum temperature on the limits of the plant formations by using as thermic parameter the mean temperature of the coldest month (t). Four classes of temperature have been defined according to the changes observed in the vegetation. It also appeared necessary to subdivide the class $16° < t < 23°$ to explain the differences between certain plant formations. For this purpose using the value of the mean of the minimum of the coldest month (m); we have introduced two supplementary classes: $m > 15°$ and $m < 15°$.

**Thermic regimes*

They are established according to the following criteria:

- annual variations of the mean monthly temperature
- place in the year and mean temperature of the coldest month
- annual thermic amplitude
- mean temperature of the hottest month.

The following 9 regimes have been distinguished:

- Kanniyakumari-Trivandrum and Allepey-Mangalore regimes: these are characterized by the lowering of the mean temperature during the monsoon. The coldest month according to the mean temperature is July.
- Goa-Bombay regime: this follows the preceding regimes on the western side with increase in latitude. The coldest month with lowest mean temperature shifts from July to January.
- Coimbatore-Mysore regime: this is a more continental regime with the minimum in December and mean temperature relatively constant from July to October.
- Hassan-Belgaum regime: a transitional regime between the Allepey-Mangalore and Coimbatore-Mysore types where the minimum is already in December but the influence of the monsoon is still pronounced.
- Madras-Madurai and Tuticorin regimes: both regimes situated in the eastern region, not influenced by the S.W. monsoon.

- Ootacamund (Uthagamandalam) - Kodaikanal regime: a montane regime characterized by the low temperature.

—Silent Valley-Agumbe regime: a regime characterising the exposed regions of the crests of the Ghats.

3.3 *Dry season*

**Definition*

For defining the dry season it would have been desirable to use global formulae like those of Thornthwaite or Penman which take into consideration factors such as the evapotranspiration and insolation. Unfortunately, the data needed for their calculation are very rarely available and then also only for the large cities where the conditions are rather peculiar. So we have adopted the definition of BAGNOULS and GAUSSEN (2): a month is considered as dry when the rainfall (in mm) is equal to or less than twice the value of its mean temperature (in°C). This empirical definition has the advantage of being based on easily available data.

The number of dry months is worked out for each year. The average of these figures gives the mean number of dry months of the station.

Some stations show two dry periods in a year. We have considered them as *Bixeric* when in 70 per cent of the years, each dry season is at least of two months duration.

** Variability*

Variability of the dry season is expressed by means of quartiles in the 93 illustrated diagrams. For example, at Hosdurga (Arsikere-Hassan) rainfall regime), the extreme values range from 4 to 11 dry months. 75 per cent of the years have at least 7 dry months, 50 per cent 8 dry months and 25 per cent 9 dry months i.e. at least 50 per cent years have a dry season ranging between 7 and 9 months.

4. **Cartographic Expression**

The map is presented in two sheets. On each sheet the main map is surrounded by climatic diagrams classified according to the regimes, and 3 insets at a small scale (1 : 4,000,000).

In the main map, the flat colours correspond to the rainfall classes (dark violet, light violet, golden brown, yellow, orange, red). Overprints in blue (horizontal or vertical lines, or crosses) over these flat colours indicate temperature classes.

Referring to the table of the legend one could easily make out the values of rainfall and temperature. The precision of the limits between the classes may be estimated by the proximity and density of stations (triangles for temperature and circles for rainfall), and by their degree of reliability (black circles: station with more than 30 years of data; blank circles: station with 5 to 30 years of data).

The limits of rainfall and temperature regimes have been indicated on the main map by a red dotted line and a continuous blue line respectively. The general distribution of the regimes is more clearly apparent on the two synthetic inset maps.

The black colour is used particularly for the dry season. Thus the discontinuous black lines, black figures and a pattern of black dots correspond respectively to the limits and values of the classes of dry season and to the regions affected by a bixeric climate. A separate inset also shows the general distribution of this important factor.

(1) BAGNOULS, F. & H. GAUSSEN. 1957. Les climats biologiques et leur classification. *Annales de Geographie* 355: 193-220.
(2) BAGNOULS, F. & H. GAUSSEN. 1953. Saison seche et indice xerothermique. *Documents pour les cartes des productions végétales*. t. III, Vol. 1, Art. 8, 47 p. Toulouse.