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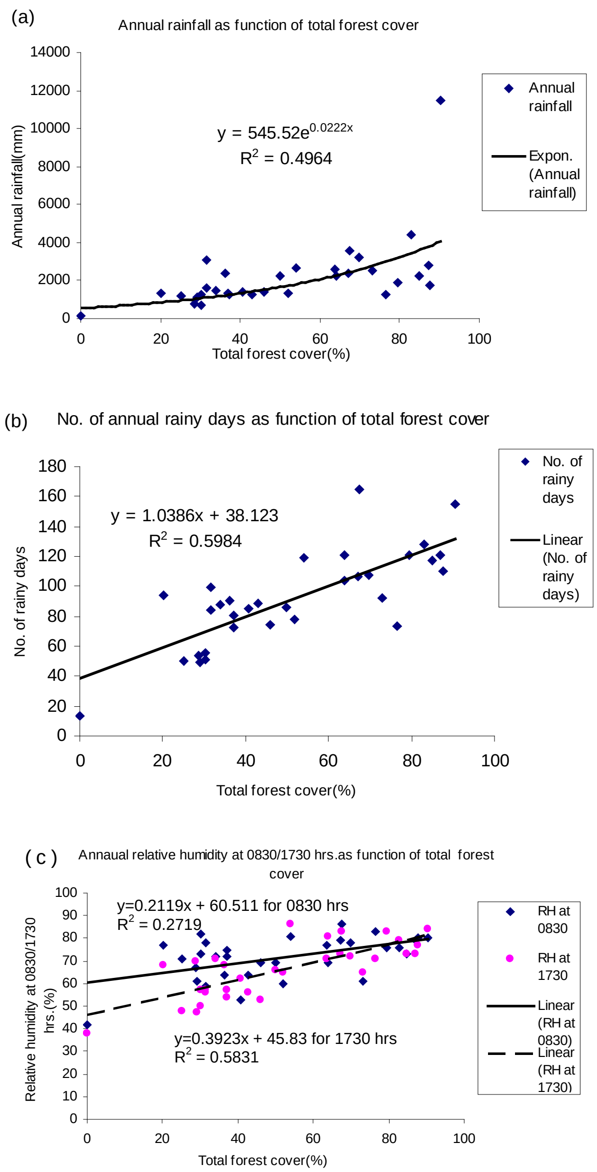
THE EFFECTS OF FOREST COVER ON CLIMATOLOGY OF NORTHERN MOUNTAINS REGION - A STATISTICAL APPROACH

1. No surface on earth can be considered as flat, as it is a patch work of different slopes and materials. Each surface possesses its own combination of radiative, thermal, moisture and aerodynamic properties. Each surface therefore tends to regulate and partition the available energy and water in different manner. In an area of varied topography and orography, climatic responses are varied. Solar loading differences would arise because of differences of slope and aspect. Moisture availability would vary because of precipitation and drainage characteristics. The energy balance is likely to be modified by a new set of thermal, moisture and aerodynamic characteristics. One of the greatest challenges in modem atmospheric science is to understand the way in which these interactions take place.

There are many and varied climatic side effects due to human activities. They are the result of interference in the operation of natural systems. Tampering with natural energy and water cycles often results in rather complex ramifications. It is important that our knowledge of inter-relationships increases so that we may develop models which accurately mimic the operation of natural systems. Only then will it be possible to predict the climatic effects of pursuing alternative land use management strategies and hence avoid understandable inadvertent modification. The effects of forest clearance, irrigation and flooding are some of the more obvious examples of activities leading



Figs. 1(a-c). Relationship of forest cover with annual (a) Rainfall, (b) No. of annual rainy days (c) Relative humidity at 0830/1730 hrs (IST)

to climate modification. Forests and the oceans are natural CO_2 sinks but they do not seem to be keeping pace with increasing rate of anthropogenic production so that global concentrations are generally increasing and thus affecting earth's temperature (Oke, 1987).

2. For the present study, forest covers of 53 hill districts of Northern Mountains Region, comprising Uttaranchal, Himachal Pradesh, Jammu & Kashmir, Sikkim, Arunachal Pradesh, Nagaland, Manipur, Mizoram, Tripura, Meghalaya and some parts of Assam and West Bengal states have been taken. Forest covers of hill districts of the country are being included in the State of Forest Reports (SFRs) from 1997 assessment. In order to obtain consolidated figures for the districts, wherever possible, forest covers of 1997, 1999 and 2001 assessments have been averaged and used for the study. The classification of hill districts is based on the criterion of an area having an elevation of more than 500 metres above mean sea level and total area of the hill talukas exceeds 50 % of the geographic area of the district (SFR 1997, 1999, 2001).

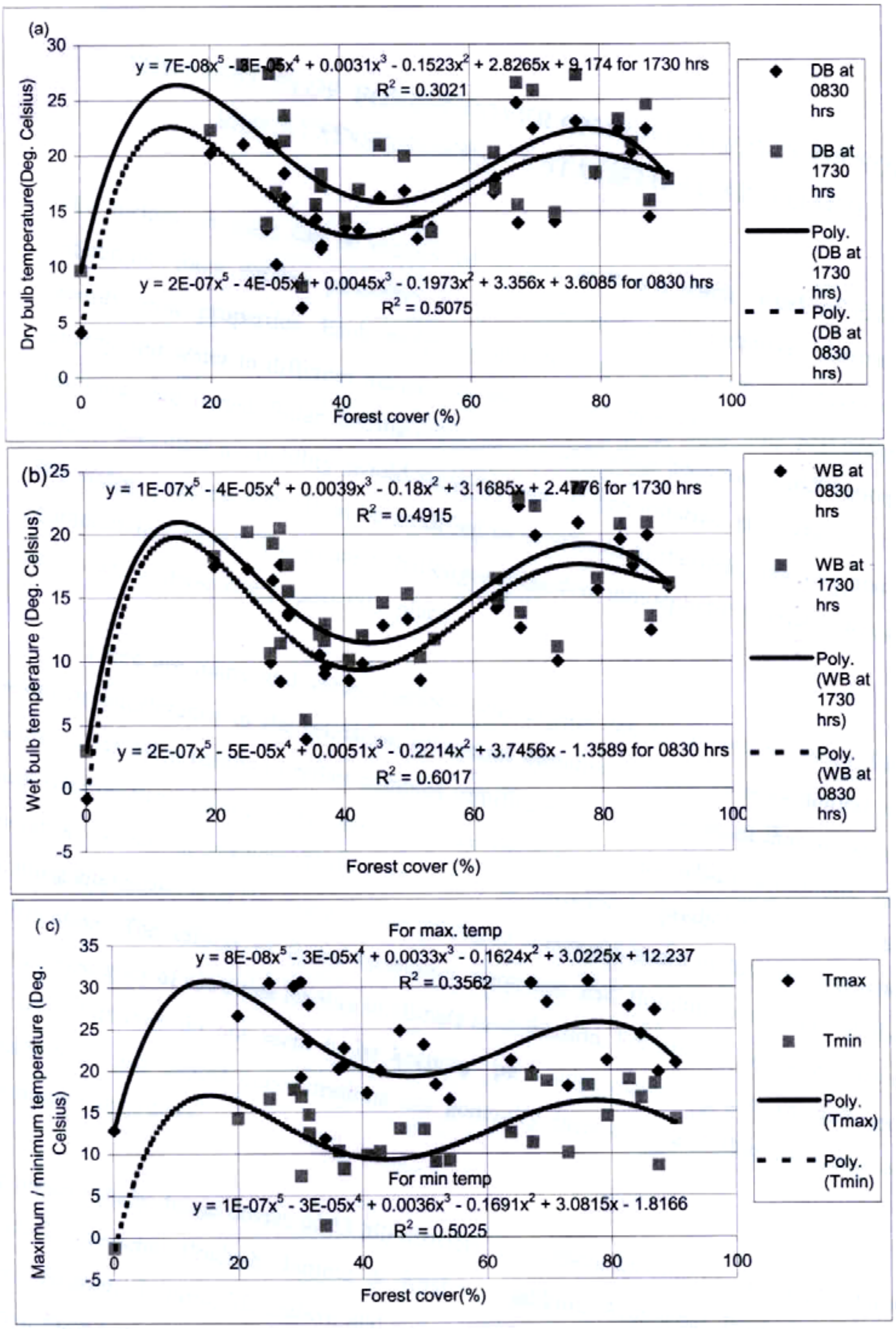
The India Meteorological Department has been bringing out climatological normals of important meteorological parameters from time to time. These climatological normals give a comprehensive account of the climate of a place. Values of the normals are given for 0830 hrs IST and 1730 hrs (IST) observations for various meteorological parameters. Annual normal values of some of the climatological parameters of the Northern Mountains Region have been collected and used for the study (Climatological Tables - 1999).

3. In this study efforts have been made to establish statistical relationships between some climatological parameters *viz*., relative humidity, rainfall, number of rainy days, maximum/minimum temperatures and dry bulb/wet bulb temperatures of the hill districts with the forest cover of corresponding districts. While testing the significance of correlation it is noted that the coefficients of correlation of all the relationships are significant at 99 % level of significance. The findings of the study are summarized as under :

(*i*) Scattered diagram in Fig. 1 (a) gives a relationship between forest cover and annual rainfall. It may be seen from this diagram that with the increase in forest cover, annual rainfall increases exponentially where as Fig. 1(b), which gives relationship with annual number of rainy days, indicates that rainy days increase linearly with forest cover.

(*ii*) Fig. 1(c) is a scattered diagram of relationship between forest cover and annual relative humidity at 0830 hrs and 1730 hrs (IST). Relative humidity (RH) has linear relationship with forest cover. The increase in the humidity at 1730 hrs (IST) with the increase in forest cover is more as compared to RH at 0830 hrs (IST). Thus RH of the morning and the evening hours start coming closer with the increase in forest cover and when forest cover exceeds 75 %, the values tend to merge together.

(*iii*) RH showing increasing trend with the increase in vegetation cover is probably due to the facts that the



Figs. 2(a-c). Relationship of forest cover with annual (a) Dry bulb temperature at 0830/1730 hrs (IST), (b) Wet bulb temperature at 0830/1730 hrs (IST) and (c) Maximum/minimum temperature

rainfall and rainy days have respectively exponential and linear relationships with vegetation cover. It may be the increasing forest cover which enhances the evapo-transpiration and more capillary action during day time and thus increase is more in humidity at 1730 hrs (IST) as compared to 0830 hrs (IST).

(*iv*) Scattered diagrams of annual dry bulb/wet bulb temperatures at 0830 / 1730 hrs (IST) and annual maximum/minimum temperatures with the forest cover are depicted in Fig. 2. Polynomials of five degrees have been fitted in all the scatters. From the curves it is observed that there are two maxima and two minima. Altitudinal/latitudinal and orographic/topographic effects on temperatures of respective meteorological station seem to contribute to the existence of two maxima and two minima in these temperature curves. However, further discussions on variations of temperatures with forest cover with respect to relative humidity are enunciated below.

(a) It is noted from Figs. 2(a&b) that the trends of dry bulb and wet bulb temperatures are similar. When forest cover approaches 80 %, the temperatures at 0830 hrs (IST) and at 1730 hrs (IST) start merging together for both dry bulb and wet bulb temperatures. This is similar to RH trend wherein the values of RH at 0830 hrs (IST) and 1730 hrs (IST) start merging beyond 75 % forest cover. The trends of temperatures indicate increase with the increase in forest cover up to 15 % but due to insufficient data in this range, no conclusion can be drawn.

(b) From Fig. 1(c) and Figs. 2(a&b) it may be noted that for annual mean RH values varying from 58% to 68%, the temperatures decrease with the increase in forest cover from 15% to 45%; for RH values ranging from 68% to 78%, the temperatures increase with the increase in forest cover from 45% to 80% while for RH values over 78%, the temperatures again show decreasing trend with the increasing forest cover. From maximum and minimum temperature curves [Fig. 2(c)] it is observed that, except the trend lines do not merge beyond 80 % forest cover, they also show similar trend as that of dry bulb and the wet bulb temperature curves.

4. Owing to the limitations of availability of meteorological data, only 53 districts out of 95 districts of the Northern Mountains Region could be taken for the study. In some cases meteorological data of those observatories falling in the hill districts/nearby district and not having elevation of over 500 metres above msl, but considered to be representative of the climatology of the areas, have also been taken. In some cases where there is only one observatory with in two or more districts, forest covers of those districts have been clubbed together and where there is more than one observatory in one district, the meteorological data have been further averaged and used for the study.

5. It is observed that the annual rainfall, number of rainy days, relative humidity and temperatures have highly significant positive correlation with the forest cover. It is evident from this study that forest covers have significant effects on the climate of Northern Mountains Region. This obviously indicates that the forests have an important role in the management of climate. With the proper forest management and by identifying potential areas of sources and sinks of heat, water vapour, CO_2 etc., ecological balance can be maintained and the climatic conditions which are suitable to living organism can be obtained. Withdrawal of forest resources should be restricted to such areas which do not adversely affect climatic conditions of that area. In this study the meteorological data that have been used may not be the true representative of climatology of the selected hill districts in a few cases, particularly where the observatory areas are greatly influenced by the urbanization. It is, as such, suggested that meteorological data from forest/rural areas should also be collected and some further studies need to be done.

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