

CLIMATIC STUDIES OF MADHYA PRADESH

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ABSTRACT: The paper discusses the climate of Madhya Pradesh giving in outline the distribution of climatic elements including the variability of rainfall, water balance and climatic types.

The state of Madhya Pradesh situated in the central part of India is bounded between 18°N and 27°N latitude and 74°E and 84°E longitude. Geographical location and orographic features have profound influence on the climate of the state, which is practically free from maritime influence. The period from October to March is generally pleasant over the entire state except during a few spells when severe cold waves associated with western disturbances affect northern parts of the state in winter months. The months of April and May are hot, very dry and generally uncomfortable. Weather tends to be oppressive during June due to high humidity and temperature. The period from July to September is fairly comfortable due to reduced day temperatures and high humidity conditions.

Temperature: Figs. 1 and 2 show the distributions of mean maximum and mean minimum temperatures, respectively for selected months i.e. the warmest month and the coldest month in the year. May is the hottest month with mean maximum temperature of 41°C in the plains. The plateau regions and elevated places recording 2 to 5°C lower. December is the coldest month when the mean minimum

temperature for the state as a whole is 10°C, varying from 7°C in the northwest to about 15°C in the south. During winter, much lower temperatures may be experienced in the wake of western disturbances. On such occasions minimum temperature below the freezing point can be registered at few stations to the north of Vindhyas. Therefore, both day and night temperatures are lower over the plateau and at high level stations than over the plains.

Figs. 3 and 4 give the extremes of temperatures based on the data upto 1978. The highest temperature ever recorded at Sidhi situated in the plains is 48.8°C on 10th April 1959 which is 6.8°C higher than the normal for the warmest month. The lowest temperature ever recorded is at Shivpuri which was -4°C on 13th January 1967 and this is 9°C below the normal of the coldest month.

July and August have the smallest diurnal range of temperature (about 6°C) in the state. The diurnal range increases after withdrawal of monsoon during the period from December to May. The diurnal range is of the order of 15°C to 17°C, being greatest in March.

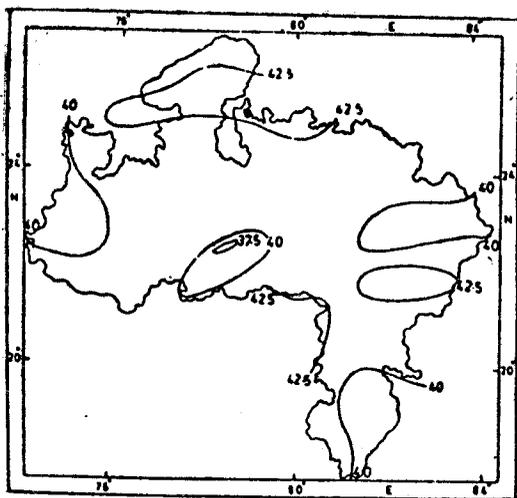


FIG. 1 MEAN MAXIMUM TEMPERATURE (°C)-MAY

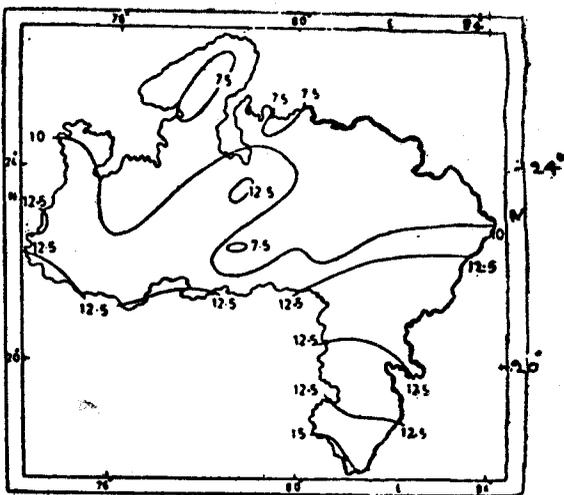


FIG. 2 MEAN MINIMUM TEMPERATURE (°C)-DEC.

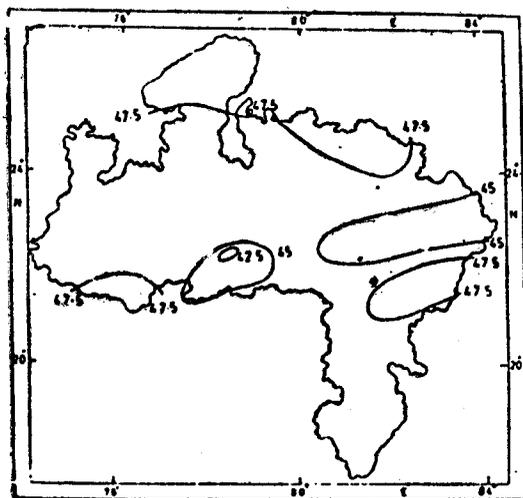


FIG. 3 HIGHEST MAXIMUM TEMPERATURE (°C)

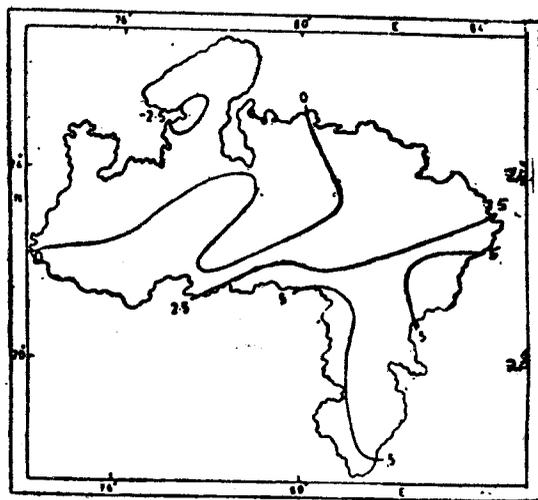


FIG. 4 LOWEST MINIMUM TEMPERATURE (°C)

Rainfall: Fig. 5 shows the annual distribution of rainfall. The total annual rainfall in the state varies from 70 cms. over the NW parts to 160 cms. over the southern parts. The northern most districts of Morena, Bhind, Gwalior and Datia receive less than 70 cms of rain which is the lowest annual amount in the state and it constitutes the semi arid zone. The mean annual rainfall in east Madhya Pradesh is about 135 cms. and for west

Madhya Pradesh is 100 cms.

July and August are the rainiest months, each accounting individually for about 30% of annual rainfall. In each of these months there are 15 rainy days for the west Madhya Pradesh and 15 to 20 rainy days for east Madhya Pradesh. During winter (January and February) east Madhya Pradesh and adjoining parts of west Madhya Pradesh

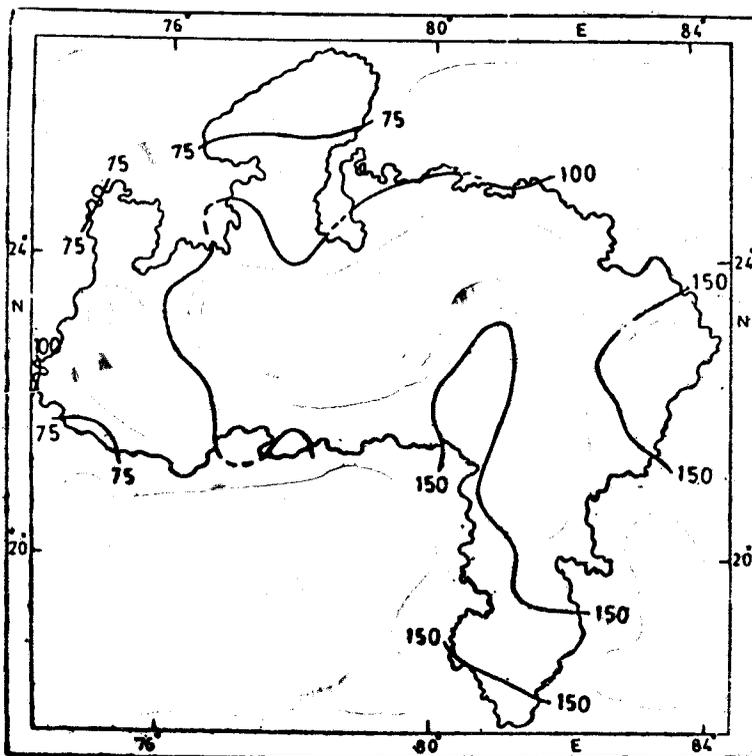


FIG. 5 RAINFALL (Cm) - ANNUAL

receive rainfall exceeding 2.5 cms. which is a small amount, but it is of great significance for Agriculture. During winter, rainfall occurs in association with western disturbances.

Rainfall variability: Fig. 6 shows that the coefficient of variation of annual rainfall is less than 20% for the eastern and SW districts of east Madhya Pradesh. Else where, it ranges between 20 to 25%. In west Madhya Pradesh the coefficient of variation of annual rainfall ranges from 25% over Seoni district in the east to nearly 40% in Morena district in the extreme northwest (Fig. 6). Coefficient of variation of rainfall is very high in winter, hot weather and post monsoon seasons over the state. It is above 80% during these seasons in the state.

Climatic types: On the basis of Koppens classification the state has been divided into three climatic types (Fig. 7). The NW districts are under the type of semi arid or steppe (Bsh). Over the plateaus of Vindhyas and Satpura ranges and adjoining northern plains, the climate is warm temperate rainy climate i.e. with dry winter and hot summer (Caw) and finally a tropical wet and dry (AW) climate with distinct dry season in winter over the southern portion of the state.

Water balance studies: On the basis of Thornthwaite's Book keeping procedure, the water balances of 21 stations in Madhya Pradesh has been calculated for a period of 30 years. The various elements of water balance such as precipitation, Potential Evapotranspiration, water de-

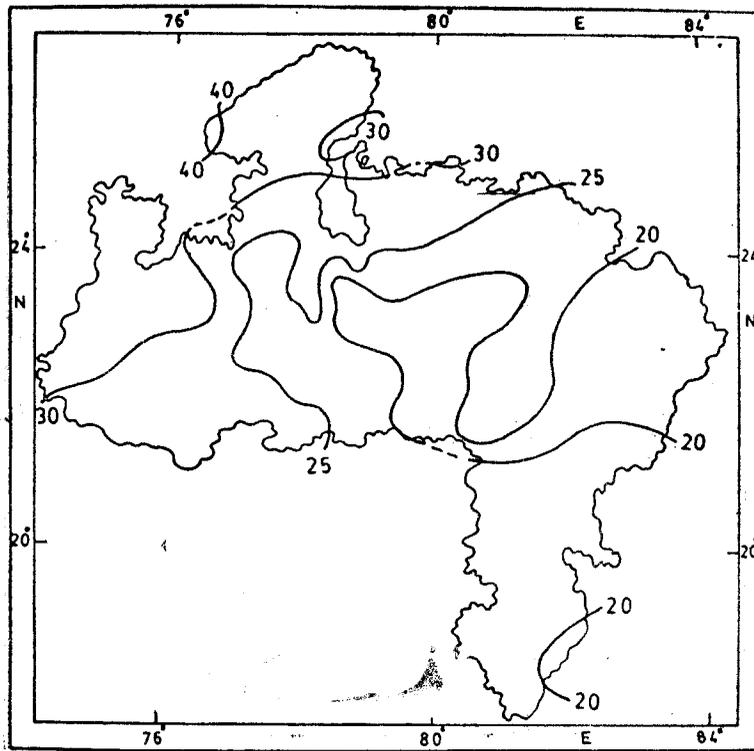


FIG. 6 COEFFICIENT OF VARIATION OF RAINFALL-ANNUAL.

ficit and water surplus are illustrated and discussed.

The most important climatic parameters are precipitation, and potential evapotranspiration. The mean annual rainfall distribution of the Madhya Pradesh is shown in the figure 5. From the figure it can be seen that the rainfall increases from the western to eastern part of the state. The mean annual rainfall ranges from 75 cms. to 150 cms.

The PE values have been derived from the climatic data, using Thornthwaite's formula and are cartographically presented in the fig. 8(a). The figure shows that the mean annual PE in Madhya Pradesh ranges from 1200 to 1600 mms. The eastern part of the state experiences

maximum water need. The northern and western tips of the state show PE more than 1400 mms.

The figure 8(b) shows that the state experiences a mean annual actual evapotranspiration ranging between 700 to 1000 mms. while the eastern and the southern parts experiences more (> 900 mms.) actual evapotranspiration than the rest of the state.

Distribution of water deficit (Fig. 8(c)) shows that a major portion of the state has more than 500 mms of annual water deficiencies with a small portion in the east registering less than 500 mms. It is also evident that the western part of the state experiences the maximum amount (> 600 mms.) of water deficiency.

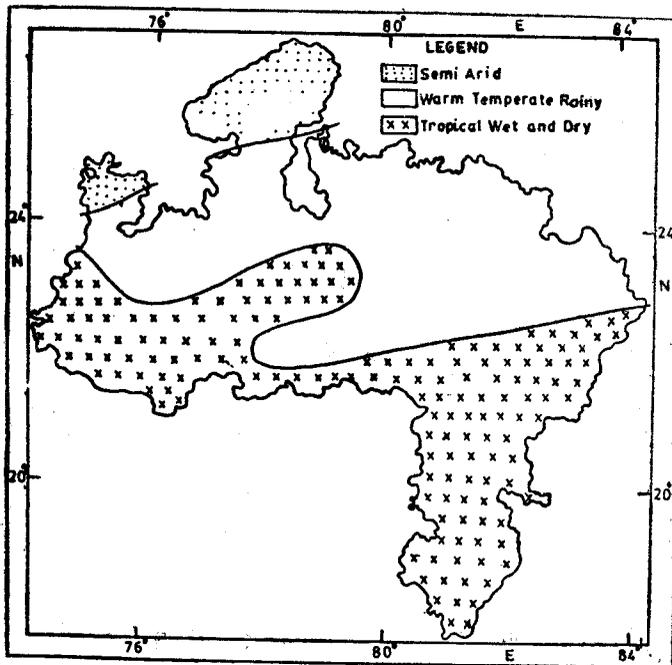


FIG. 7 CLIMATIC CLASSIFICATION.

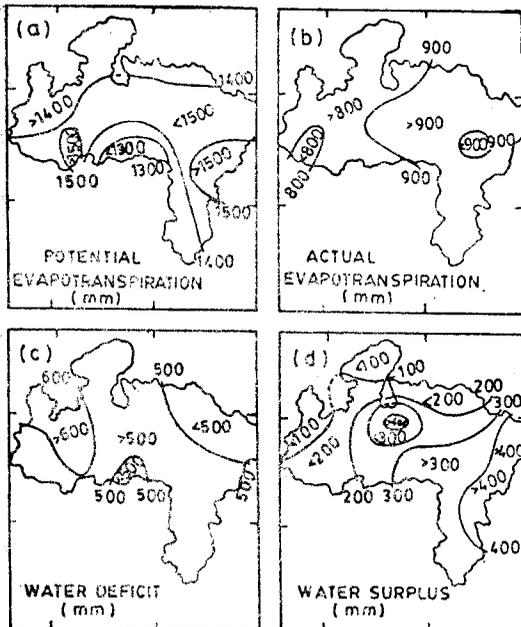


FIG.8 DISTRIBUTION OF WATER BALANCE ELEMENTS IN MADHYA PRADESH

Figure 8(d) shows that the mean annual water surplus is more than 400 mm. in the eastern side and less than 100 mm. in the western and northern portions.

Ratio of AE to PE known as the index of moisture adequacy (expressed as percentage): The mean annual distribution of moisture adequacy in Madhya Pradesh is presented in the figure 9. The figure shows that Ima ranges from 56 to 70 only. A major portion of the state has moisture adequacy in excess of 60%. The western and northern extremities experiences lower values. The percentage ratio of AE to PE (Ima %) values of different stations (21) are shown in the Table 1.

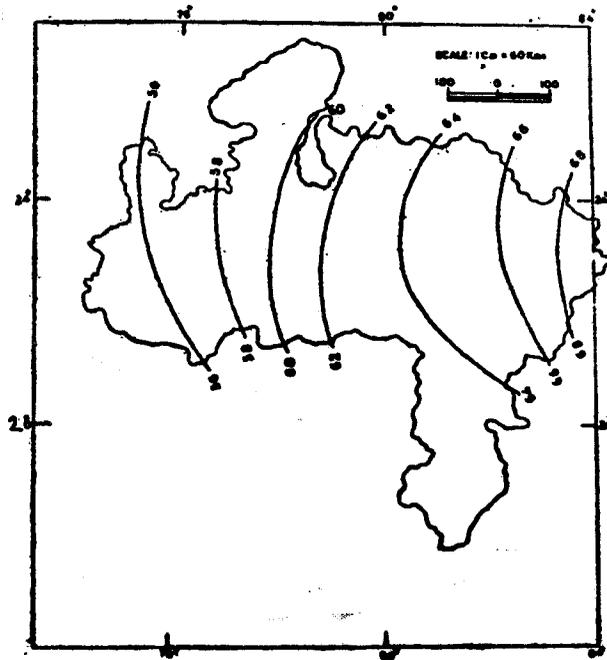


FIG.9 MOISTURE ADEQUACY IN MADHYA PRADESH.

Table 1 Annual Moisture adequacy in Madhya Pradesh (Ima %)

Station	Ima (%) = (AE/PE x 100)	Station	Ima (%) = (AE/PE x 100)
Ambikapur	68.9	Jhabna	55.2
Betul	60.8	Khandwa	56.6
Bhopal	58.6	Mandasaur	55.9
Bilaspur	63.7	Raigarh	63.2
Chatrapur	61.9	Raipur	62.9
Guna	58.5	Rajgarh	56.5
Gwalior	59.1	Saugar	60.6
Hoshangabad	59.7	Satna	63.8
Indore	58.2	Seoni	65.2
Jabalpore	64.0	Umeria (Shahdol)	64.0
Jagdulpur	69.0		

The income and expenditure of water and the manner in which it is utilized, stored or in deficiency are depicted through water balance diagrams (Fig. 10). The water balance diagrams of the stations viz., Gwalior, Bhopal and Saugar each depicting a different climatic type are given in the figure 10.

Gwalior comes under the type of semi arid (D) climate experiencing surplus (34 mm) in August only while the accumulated soil moisture is utilised from September onwards. Bhopal, the capital city of Madhya Pradesh belongs to the dry sub humid (C_1) type of climate but it experiences water surplus from July to

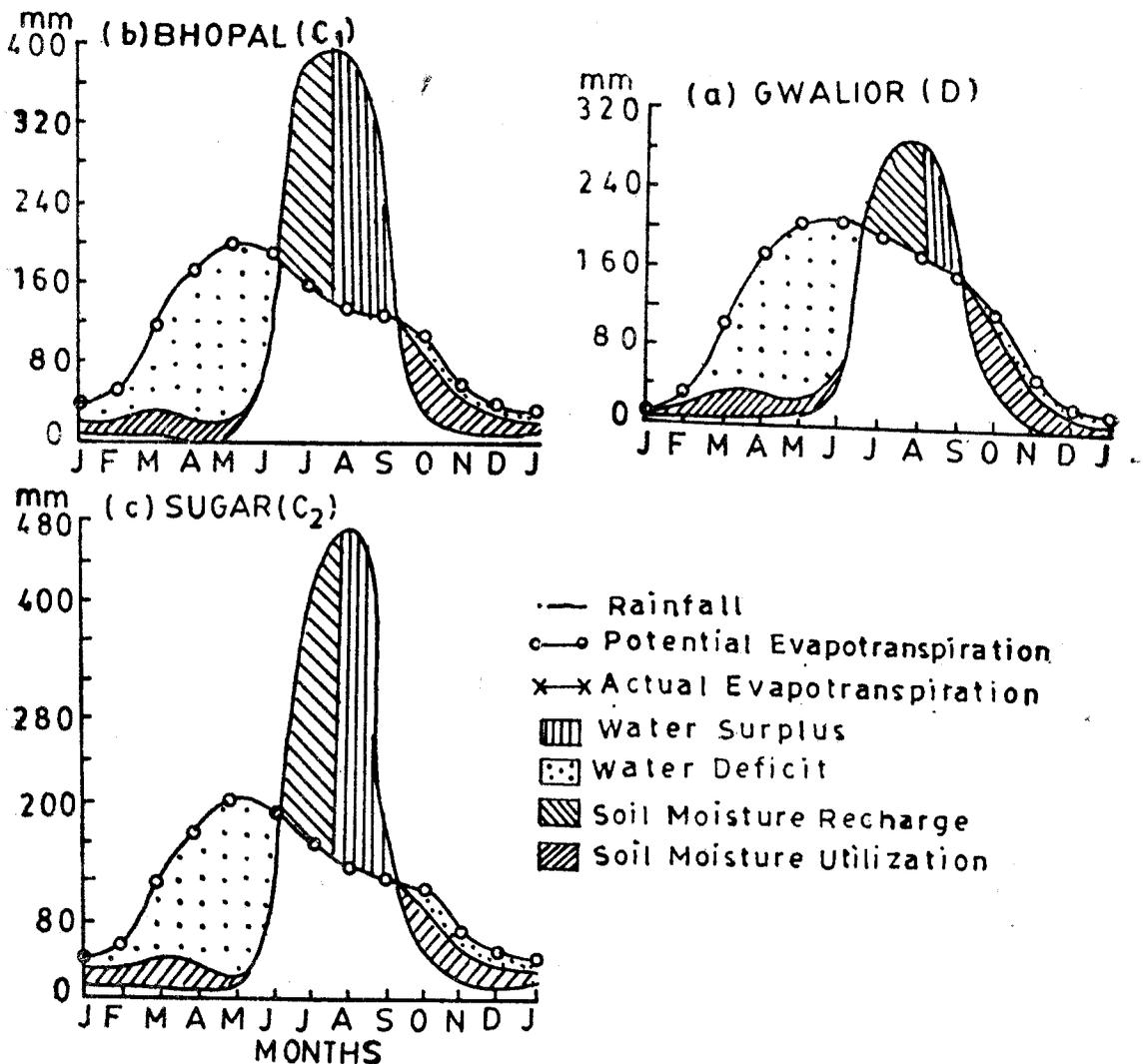


FIG. 10 CLIMATIC WATER BALANCE OF MADHYA PRADESH

September. On the other hand Saugar experiences water deficiencies from January to June and surpluses from June to October.

Using the values of the water balance elements, the climatic types of Madhya Pradesh based on the moisture and thermal regimes using Thornthwaite's scheme are given in the figure 11. From the figure it is evident that the state experiences three types of climate, viz., Moist, sub-humid (C_2), dry sub-humid (C_1) and the semi arid (D), of which the dry sub-humid type occupies a major portion. According to the thermal regime

(Fig. 11a) Madhya Pradesh comes under the mega thermal type where as the central part of the state is under A_2 . Raigarh is the only station under A_3 and the other stations vary from A_2 to A_3 of the thermal regime.

According to Thornthwaite's classification the climatic types and sub types of Madhya Pradesh are given in the Table 2.

This paper is a preliminary study of the climate of Madhya Pradesh and further investigations are being made to report in a future publication.

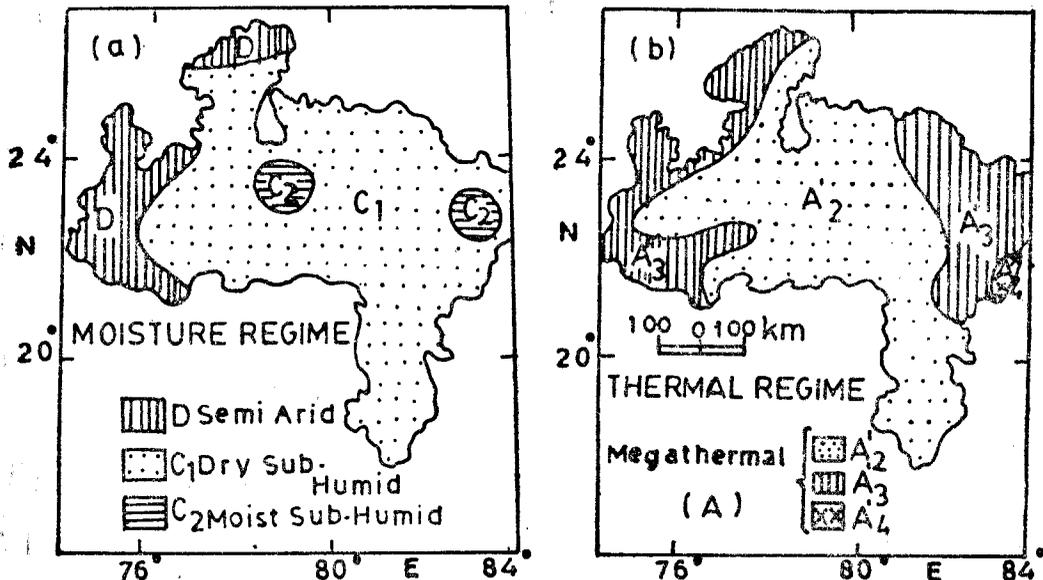


FIG. 11 CLIMATIC TYPES OF MADHYA PRADESH (Thornthwaite)

Table 2: Climatic types and Sub-types of Madhya Pradesh according to Thornthwaite.

Station	Moisture Regime		Thermal Regime		Station	Moisture Regime		Thermal Regime	
	Type	Sub-type	Type	Sub-type		Type	Sub-type	Type	Sub-type
Ambikapur	C ₂	S ₂	A ₂ ¹	b ₂ ¹	Jhabna	D ₁	d	A ₈ ¹	b ₃ ¹
Betul	C ₁	S	A ₂ ¹	b ₃ ¹	Khandwa	D	d	A ₃ ¹	b ₂ ¹
Bhopal	C ₁	s	A ₂ ¹	b ₂ ¹	Mandsaur	D ₁	d	A ₃ ¹	b ₂ ¹
Bilaspur	C ₁	s	A ₃ ¹	b ₂ ¹	Raigarh	C ₁	s	A ₄ ¹	b ₂ ¹
Chatrapur	C ₁	s	A ₂ ¹	b ₂ ¹	Raipur	C ₁	d	A ₃ ¹	b ₂ ¹
Guna	C ₁	d	A ₃ ¹	b ₂ ¹	Rajgarh	D	d	A ₃ ¹	b ₂ ¹
Gwalior	D	d	A ₃ ¹	b ₂ ¹	Saugar	C ₂	S ₂	A ₂ ¹	b ₂ ¹
Hoshangabad	C ₁	s	A ₃ ¹	b ₂ ¹	Satna	C ₁	d	A ₃ ¹	b ₂ ¹
Indore	C ₁	d	A ₂ ¹	b ₃ ¹	Seoni	C ₁	s	A ₂ ¹	b ₃ ¹
Jabalpore	C ₁	s	A ₂ ¹	b ₃ ¹	Umaria	C ₁	s	A ₃ ¹	b ₂ ¹
Jagdalpore	C ₁	s	A ₂ ¹	b ₃ ¹					

REFERENCES :

1. India Meteorological Department, (1981): Climate of Madhya Pradesh State.
2. Subramaniam, A. R. and Uma Devi, K. (1979): Water balance and cropping pattern of Orissa state. Geographical Review of India, Vol. 41, No. 4, pp. 362-369.
3. Subramaniam, A. R. and Uma Devi, K. (1982): Water balance studies of Madhya Pradesh, Published by Assoc. of Hydrologists of India, pp. 179-184.
4. Subrahmanyam, V. P. and Subramaniam, A. R. (1964): Application of Water balance concepts for the climate study of droughts in South India, I.J.M.S. Vol. 15, No. 3, pp. 393-402.
5. Thornthwaite, C. W. (1947): Climate and moisture conservation, Annals. Assoc. Amer. Geogr. 37 (2), 87-100.
6. Thornthwaite, C. W. (1955): An approach towards a rational classification of climates, Geogr. 38 (1), 55-94.
7. Thornthwaite, C. W. and Mather, J. R. (1957): Instructions and Tables for computing potential evapotranspiration and the water balance Pub. in Climatology, Drexel Inst. of Tech. Lab. Climatology, 10, pp. 185-311.
8. Umadevi, K. (1981): Some Studies on Agroclimatic aspects of Orissa, Ph.D. thesis submitted to Andhra University, Waltair.