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ROLE OF ECOCLIMATOLOGY IN RURAL PLANNING

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ABSTRACT

Using the two basic ecological parameters, temperature and rainfall, water balances on monthly and yearly basis have been computed for assessing the ecological potentialities utilising the revised scheme of Thornthwaite and Mather for three selected stations in Andhra Pradesh viz. 1. The Coastal semiarid station — Visakhapatnam. 2. The inland dry subhumid station — Narsipatnam and 3. The moist sub-humid station — Araku.

Different components of the water balance of these three faces have been discussed in relation to different crop potentialities. The study records that Visakhapatnam and Narsipatnam do not have water surplus while Araku shows a water surplus of 241 mm annually. The soil moisture at Araku attains saturation. The aridity indices suggest that the coastal areas are seen to prove to "large water defficiency" whereas the Central areas has "moderate water defficiency" and the interior high land has almost "no water defficiency".

Key-words: Ecoclimatology, water balance, temperature, rainfall, Visakhapatnam.

INTRODUCTION

Climate, defined as the average physical state of the atmosphere at a given location has a vital role to play in all environmental activities of man. Ecoclimate is the climate as affected by and/or affecting the living environment and is an integral ingredient of the ecosystem. A thorough knowledge about the ecosystem is essential for almost any aspect of planning, especially in the context of rural development. The two basic parameters that characterize the ecoclimate are temperature and rainfall which respectively represent the thermal and hygric potentials of the atmospheric environment for biological development.

Temperature is deemed as an extremely important ecological factor, for it affects most of the living organisms and often it works as a limiting factor for the growth and distribution of plants and animals. This is particularly more so when the study area has a vast latitudinal extent or strong altitudinal contrasts.

Since Visakhapatnam district (17° 15′ to 18° 30′ N), which has been taken as the region for the present study, does not extend latitudinally beyond two degrees within the tropical belt, the temperature factor is almost uniform

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all over the area and is therefore not an inhibiting factor either for agricultural production or in animal husbandry in view of their wide ecological ranges. On the other hand, rainfall amount and its monthly and seasonal distribution have tremendous ecological importance in environmental studies with special reference to ecology. It is the abundance or scarcity of rainfall that determines the growth and distribution of natural or introduced vegetation. While high rainfall enables a wide choice of promising crops, deficient rainfall permits only a narrow range of potential crops and is frequently accompanied by climatic hazards to successful agriculture Wilsie (1962).

Mean monthly variations of temperature and rainfall for the various stations in the Visakhapatnam district are shown in Fig. 1. All the coastal stations are seen to record almost uniform maximum rainfall during October

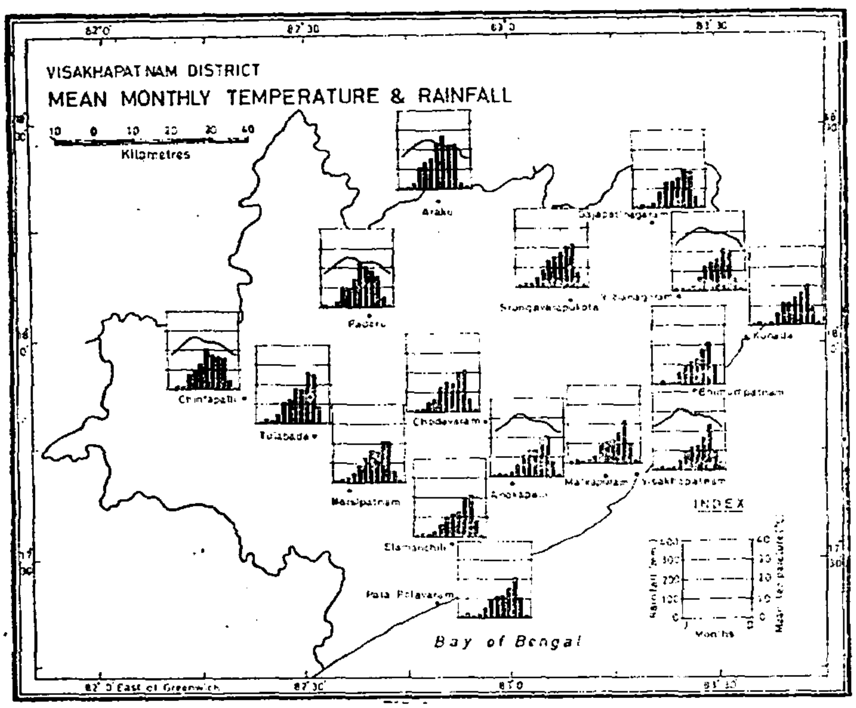

Fig. 1.

whereas in the central interior both September and October have almost the same amounts of precipitation; hill stations record the highest rainfall amounts either in July or August. Rural agriculturists can make better use of this rainfall distribution if they select and raise such of the crops whose water requirements are matched with the march of rainfall at the respective stations during the southwest monsoon season.

Methodology

For assessing the ecological potentialities of a given region, using the two basic parameters namely temperature and rainfall, water balances have been computed both on monthly and yearly bases according to the revised scheme proposed by Thornthwaite and Mather (1955). The water balance procedure provides rational ecologically more sensitive parameters like Potential Evapotranspiration (PE — water need), Soil Moisture status, Actual Evapotranspiration (AE — actual water use), Water Deficiency (WD — irrigation requirement) and Water Surplus (WS — irrigation potential).

RESULTS AND DISCUSSION

Fig. 2. illustrates the climatic water balances for some selected stations in the area of study. The coastal semiarid station, Visakhapatnam, and the inland dry subhumid station, Narsipatnam, do not climatically show any water surplus. But there is considerable difference in their water deficiencies; while

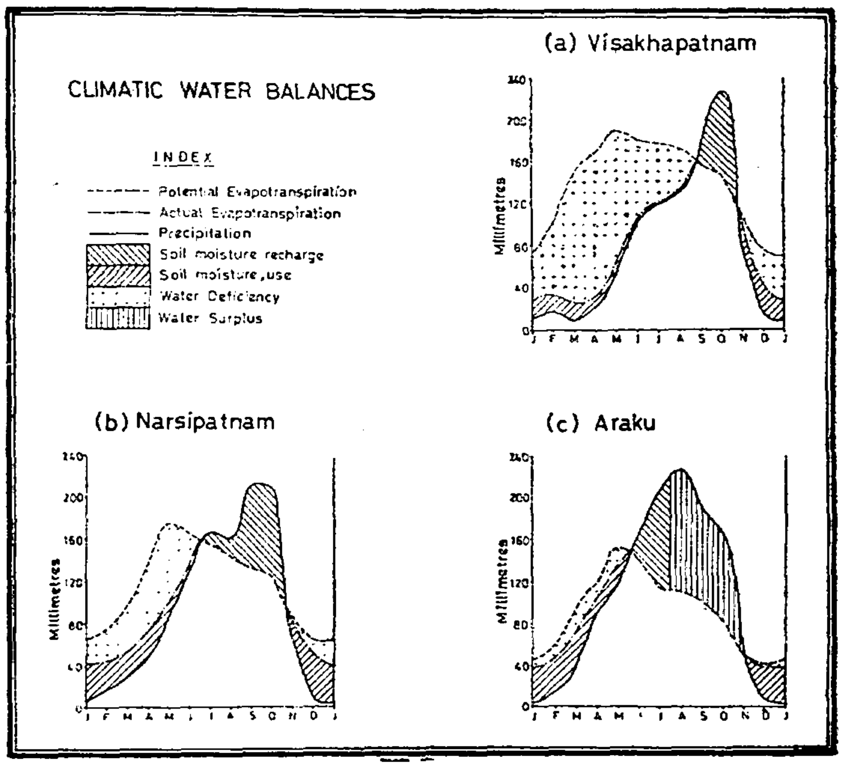

Fig. 2.

Visakhapatnam experiences 726 mm of water deficiency spread over a period of ten months, Narsipatnam exhibits only 286 mm of deficiency over seven months. This shows that the area around Narsipatnam can successfully support crops for longer periods with less risks than the coastal area. At the moist sub-humid station, Araku, the available moisture not only meets most of the water demand but the water deficiency here is also meagre (74 mm) and distributed over five months. Secondly, while the first two stations do not practically have any water surplus, Araku shows an overall water surplus of

241 mm which, with suitable means of conservatton and storage, may be profitably utilized during the period of water deficiency for agricultural purposes. The moisture content of the soil at Araku is at its field capacity for nearly five months.

Table–I shows the monthly soil moisture availabilities i.e., monthly moisture content of the soil at the three stations as a percentage of the total field capacity.

Table I. Soil moisture availabilities (%)

Station	J	F	M	A	M	J	J	A	S	O	N	D
Visakhapatnam	24	16	8	4	2	2	1	1	8	48	45	33
Narsipatnam	51	40	31	22	15	13	18	24	55	89	82	65
Araku	78	67	55	50	44	51	81	100	100	100	100	89

From the climatic point of view neither Visakhapatnam nor Narsipatnam has any month with full soil field capacity. At Araku alone, the soil attains saturation with water for more than four months from August to November. Since most of the vegetation types, thrive successfully where the soil moisture is over 50% of the field capacity, and since their performance fails when the soil moisture storage is less than 25%, the following arbitrary and qualitative limits can be set for assessing the success or otherwise of vegetation performance.

Table II. Soil moisture percentage and vegetation performance.

Soil moisture content as percentage of the field capacity	Vegetation performance
75%	Luxuriant
50 to 75%	Moderate
25 to 50%	Uncertain
25%	Poor

Figure 3(a) shows the monthly variation of soil moisture availability of the three stations and Figure 3(b) represents the length of the period of successful crop growth during the year at each station according to the above scheme. While at Visakhapatnam there is no month with over 50% soil moisture availability, Narsipatnam has five months and Araku has eleven months of assured soil moisture for optimal vegetation development and agriculture. Medium to long duration crops like paddy and sugarcane can thus be successfully grown at Narsipatnam whereas successive or relay cropping and plantation agriculture can be attempted at Araku. Similarly considering the soil moisture availability at and above 25%, Visakhapatnam, Narsipatnam and

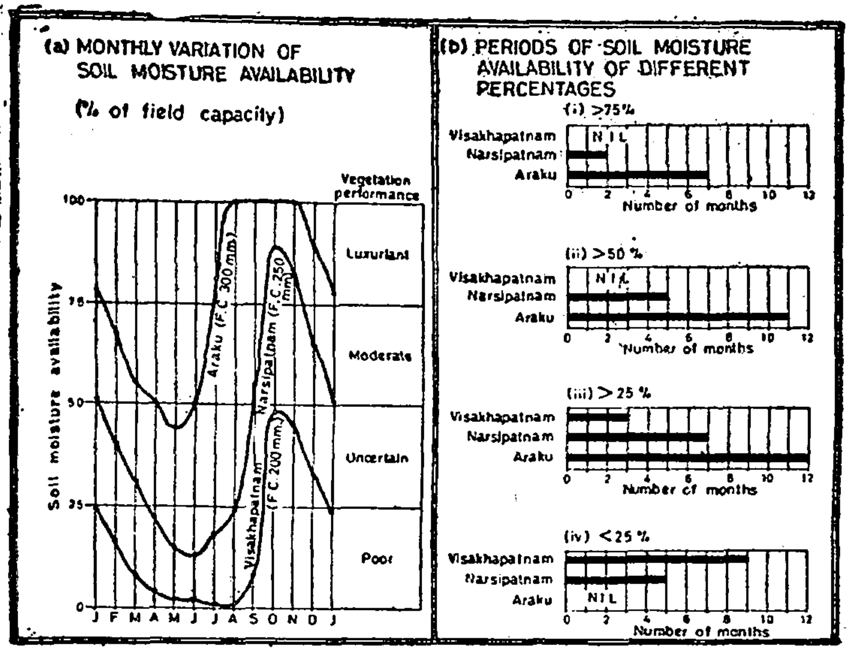

Fig. 3.

Araku experience 3, 7 and 12 months respectively. At Araku soil moisture availability never falls below 44% which again is just for one month, i.e., May.

Such analysis of soil moisture content and periods and duration of soil moisture availability of different magnitudes will be of great help to planners in rural planning in general and of agricultural development in particular. For areas experiencing low soil moisture availability for long periods, either short duration crops in the kharif season or drought resistant long duration crops in the other seasons can be recommended.

This kind of soil moisture analysis gains further importance, if the lengths of growing periods of various crops and their water requirements at different phenostages are also taken into account. The possibilities of introducing longer duration crops can be explored provided supplementary irrigation facilities are available before and after the moisture-rich periods. In this sense, for example, Narsipatnam may be recommended for raising sugarcane by the provision of irrigation water in appropriate quantities for five months from April to August. The water defficiency obtainable from the water balance technique will be a very useful parameter in this respect since it gives not only the magnitudes but also the times and durations of irrigation need for different crops in their different growth-phases.

Since water defficiency (WD) has been derived by subtracting the actual from the potential evapotranspiration, it represents that portion of the water demand for crop cultivation that has not been met either from rainfall or from soil moisture or both. This is thus, another sensitive measure for estimating the magnitudes of irrigation water to be supplemented in any region. Figure 4 shows graphically the water deficiency over the area of study. Isodeficients (lines of equal water deficiency) of the highest value (750 mm) run parallel to the coast line indicating that prosperous agriculture can hardly be carried out in the coastal tract. Proceeding inland, the deficiency is seen to decrease slowly and reach the minimum value of 74 mm. At Araku, indicating that plantations can be successfully undertaken in this zone.

Another important requisite of rural planning is a thorough knowledge about droughts or spells of dryness due to water scarcity. Climatology of droughts can be studied employing water deficiency expressed as a percentage ratio of the water need. Aridity index, as this ratio is called, can be employed for the delineation of drought-prone areas. The isolines of aridity indices in

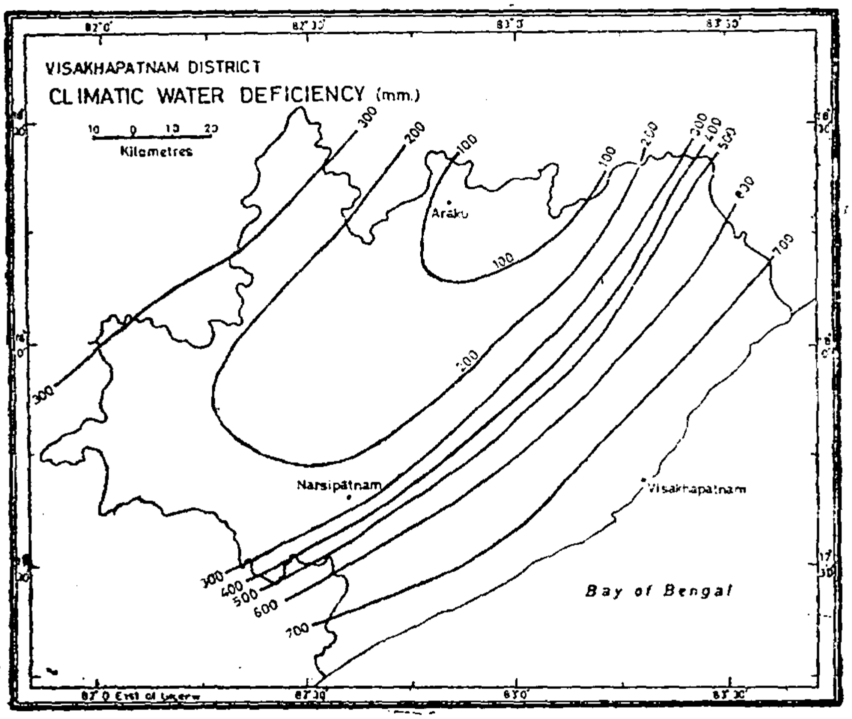

Fig. 4.

Fig. 5 delimit the drought-prone areas of different intensities in the are of study. Coastal tract may be seen to be prone to 'large water deficiency' (I_a above 20%) whereas the central area has 'moderate water deficiency' (I_a between 10 and 20%) and the interior highland has almost 'no water deficiency' (I_a less than 10%).

Aridity indices may also be used for categorizing years of drought according to magnitudes. The yearly marches of aridity indices of different stations were computed for this purpose for a period of 27 years (1952 to 1978)

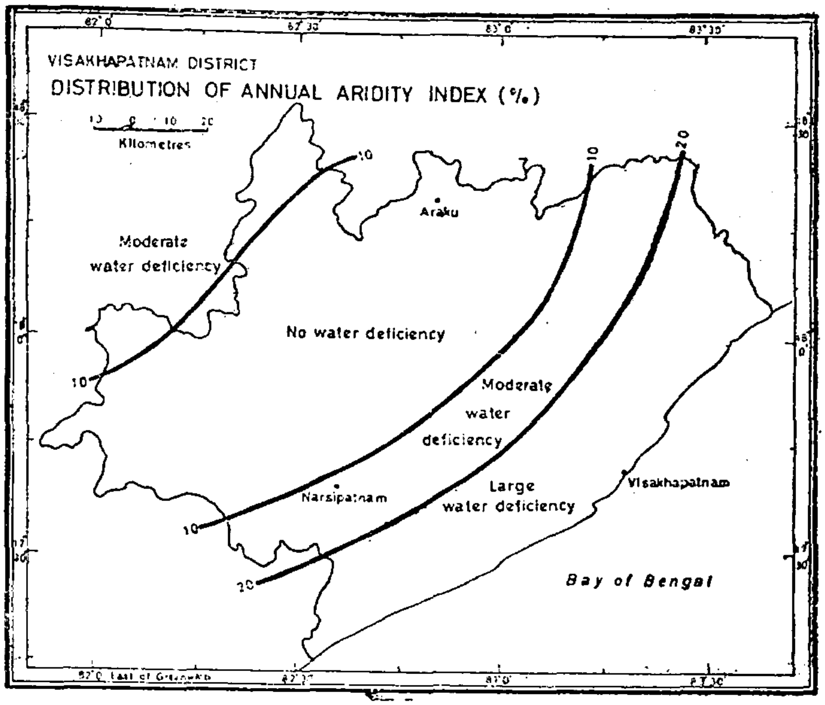

Fig. 5.

from the yearly water balance records. Taking the median value of the series of yearly aridity indices for each station as the base, percentage departures of the aridity indices from the median have been computed for each year. This helps to understand the tendency of a particular station to become drier or wetter than normal during the period of study. For identifying the drought intensities, limits of departure for the yearly aridity indices were fixed employing the standard deviation (σ) scheme adopted formerly by Subrahmanyam and Subramaniam (1965) as shown below:

Table III. Drought categorization

Departure of aridity index from median	Category of drought
$< 1/2\sigma$	Moderate
$1/2\sigma$ to σ	Large
σ to 2σ	Severe
$> 2\sigma$	Disastrous

The marches of the yearly values of aridity indices and their departures from the respective median values for the three stations are shown in Fig 6. Table IV summarizes the occurrence of different categories of droughts at the three stations during the period of 27 years already referred to above. Since regular temperature data were not available for Narsipatnam, Ankapalli, a closeby station, was taken for the purpose.

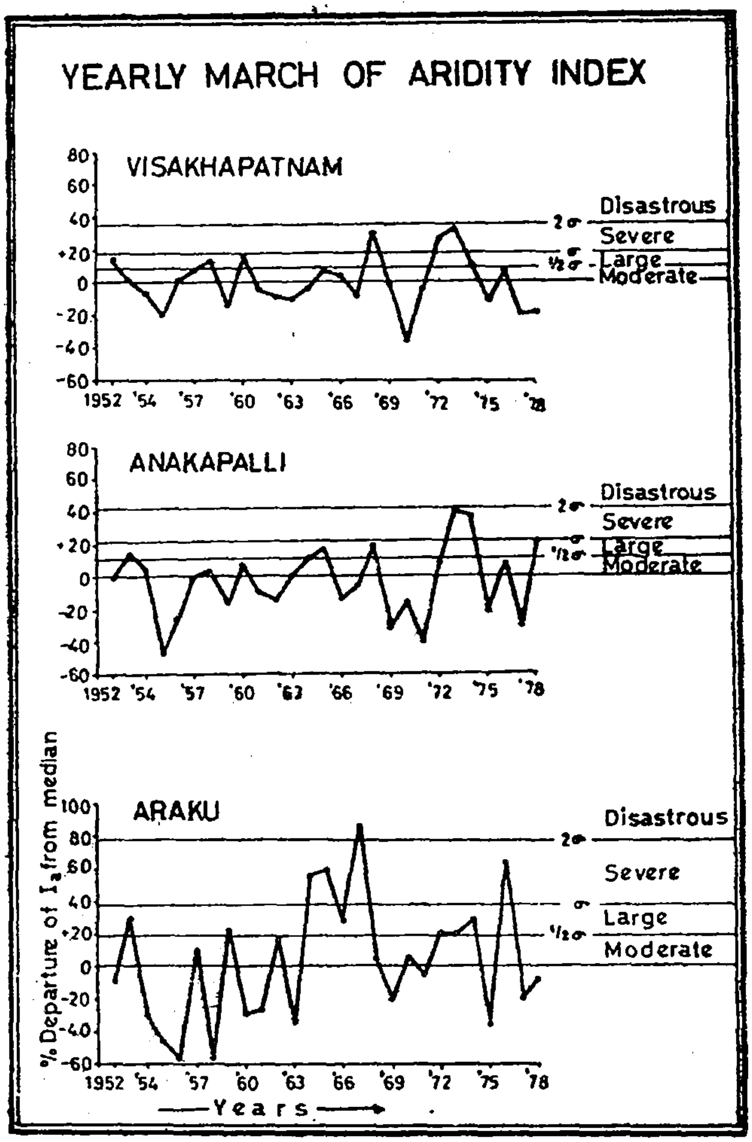

Fig. 6.

Table IV. Years of drought occurrence.

Station	Number of drought years			
	Moderate	Large	Severe	Disastrous
Visakhapatnam	6	4	3	0
	(22)	(15)	(11)	(0)
Anakapalli	7	3	3	0
	(26)	(11)	(11)	(0)
Araku	4	6	3	1
	(15)	(22)	(11)	(4)

(Figures in brackets indicate the percentage frequency of drought years)

From the above table and the map (Fig. 6) it can be concluded that of three stations, Visakhapatnam and Anakapalli do not show any marked tendency to move towards wetter or drier climates. Araku experienced a relatively larger number of 'large droughts' than at Visakhapatnam or Anakapalli. The only disastrous drought in the region during the period of study occurred at Araku in 1967. While the marches of aridity index at Visakhapatnam and Anakapalli show no mentionable trend, at Araku a clear tendency towards dryness is evident.

The above discussion points to the conservation or stability of the moisture regime of a climate which is very useful in agricultural planning for understanding the amount of risk the farmer has to take in growing a given crop in the area concerned. While the magnitude of the aridity index determines the types of crops that can be cultivated, the frequency or probability of occurrence of droughts of different categories enables one to assess the degree of success that one can hope to achieve by undertaking cultivation of the so chosen crops.

REFERENCES

Subrahmanyam, V.P. and A.R. Subramaniam, 1965. "Some characteristics and Frequencies of Ocurrence of Droughts in the Dry climatic zones of India". *Bulletin. International Association of Scientific Hydrology*, Xe, Annee No. 3, p. 31–37.

Thornthwaite, C.M. and J.R. Mather, 1955. The Water Balance, *Publications in Climatology*: Vol. VIII, No. 1.

Wilsie Carroll, P. 1962. "Crop Adaptation and Distribution". Eurasia Publishing House, New Delhi.