

Hydroclimatic studies of the Western Ghats

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सारा—सर्वविदित है कि दक्षिण-पश्चिमी मानसून पश्चिमी घाटों, विशेषकर पवनाभिमुख दिशाओं में, जल आपूर्ति का मुख्य संसाधन है। वर्तमान अध्ययन में थोर्न्थवाइट की जल संतुलन तकनीक का उपयोग करते हुए इस क्षेत्र के जलीय विभवों की जलवायु संबंधीय समीक्षा पर विचार किया गया है। पश्चिमी घाट क्षेत्र में वार्षिक तथा मौसमी आधार पर जल संतुलनों का अध्ययन करने के लिए 32 प्रतिनिधि स्टेशनों का चयन किया गया है।

वास्तविक वाष्पोत्सर्जन, ट्यूनोफ तथा जलावरोधों जैसे जल संतुलन प्रक्रिया के व्युत्पन्न तत्वों पर जल संसाधन विकास की दृष्टि से विचार किया गया है। उपलब्ध जल संसाधनों का विभिन्न उद्देश्यों से ईष्टतम उपयोग के निर्धारण तथा अभिकल्पन में यह सूचना पर्याप्त उपयोगी एवं महत्वपूर्ण होगी।

ABSTRACT. It is well-known that the southwest monsoon is the main source of water supply for the Western Ghats, especially over the windward side. The present study envisages a climatological appraisal of the water potentialities of the region using Thornthwaite's water balance techniques. Thirtytwo representative stations in the Western Ghats region have been chosen for studying the water balances on an annual and seasonal basis.

The derived elements of the water balance procedure, namely, actual evapotranspiration, runoff and water detentions are then discussed from the viewpoint of water resources development. This information will be of particular significance and utility in the determination and design of optimum utilization of available water resources for various purposes.

1. Introduction

The Western Ghats, oriented north-south, lies between 9° N and 21° N in Peninsular India. They have an average height of 900 metres and run in an unbroken range of hills from Maharashtra to south Kerala and play an important role in determining the climate of south India. The windward (westward) side of the Ghats experiences heavy rainfall while the leeward (eastward) side has scanty precipitation resulting in the dry climates of interior Peninsula.

2. Materials and methods

In the present study, climatic data of monthly temperature and precipitation from *Climatological Tables of Observatories in India (1931-1960)* published by the India Meteorological Department is used to study the hydroclimatology of the Ghats, using the water balance model of Thornthwaite (1948) and the modified book-keeping procedure of Thornthwaite and Mather (1955). Monthly values of Potential Evapotranspiration (P.E.) are computed from monthly temperature data using Thornthwaite's (1948) method.

The soil stores the water when precipitation (P) exceeds P.E. and releases it for meeting the water need when precipitation falls short of P.E. When precipitation occurs, part of the water is used for evapotranspi-

ration, another part adds to soil moisture and the remaining part (water surplus) contributes to groundwater, subsurface runoff or surface runoff. According to the water balance concepts, water surplus represents the excess of rainfall over P.E. and is the water available for runoff and streamflow. Details of the water balance procedure and its applications have been reported earlier [Ram Mohan and Subrahmanyam 1983, Ram Mohan 1984, Subrahmanyam 1956, Subrahmanyam 1958, Subba Rao and Subrahmanyam 1961, Subrahmanyam *et al.* 1979].

According to Thornthwaite (1948), half of the water surplus of a month appears as runoff in the same month and the other half is retained in the soil as detention water and contributes to next month's surplus. This assumption is valid when the soil is flat, semi-pervious and devoid of vegetation. This is quite realistic for large basins where a variety of surface covers, soil types and gradients are found. But, for small basins, these divergences are strong and few and a new coefficient is to be used based on the soil type, slope and vegetation cover to convert water surplus into runoff. Subrahmanyam and Parthasarathy (1980) evolved a runoff coefficient based on the above factors. Modified coefficients to suit the physical characteristics of the Godavari river basin by Ali (1982) are adopted here (Table 1).

TABLE 2
Climatic water balance for Kodaikanal (values in mm) (Field capacity 250 mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
P.E.	45	46	59	68	75	67	62	61	58	55	47	45	688
P	63	32	64	166	157	104	117	163	161	250	274	121	1672
P-P.E.	18	-14	5	98	82	34	55	102	103	195	227	76	
APWL		-14											
St	250	236	241	250	250	250	250	250	250	250	250	250	
Δ St	0	-14	5	9	0								
A.E.	45	46	59	68	75	67	62	61	58	55	47	45	688
D	0	0	0	0	0	0	0	0	0	0	0	0	
S	18	0	0	89	82	34	55	102	103	195	227	76	981
RO	45	12	4	65	77	46	53	88	99	168	210	114	981
Dt	16	4	0	24	29	17	19	33	37	64	81	43	

P.E. : Potential evapotranspiration,
A.E. : Actual evapotranspiration,

APWL : Accumulated potential water loss,
S : Water surplus, Dt : Water detention.,

P : Precipitation, St : Storage,
D : Water deficit, RO : Runoff,

3. Results and discussion

3.1. Rainfall distribution

On the windward (western) side of the Ghats, annual rainfall is very high (Fig. 1), ranging between 150 cm and 300 cm. But, on the leeward (eastern) side, rainfall decreases to about 50 cm.

80% of the annual rainfall occur during the southwest monsoon season. During this season (as also on an annual basis) northern parts of the Ghats experiences maximum rainfall which decreases progressively southwards. During the other three seasons, rainfall is highest over the southern section and decreases northwards. The isohyets generally run in a north-south direction parallel to the Ghats.

3.2. Annual and seasonal runoff

The annual runoff map (Fig. 2a) reveals that on the western side of the Ghats runoff values upto 240 cm are noted in the region around Honaver and Mercara. Runoff values more than 400 cm are seen at Mahabaleswar. On the lee side of the Ghats, runoff is non-existent on an annual basis. In general, the isolines of runoff follow the isohyets.

On a seasonal basis, runoff values during the pre-monsoon season range from 1 cm to 5 cm over the region. Higher values are noted around Alleppey (10 cm) and Kodaikanal (15 cm). In the southwest monsoon season (Fig. 2b), runoff is increased and the values range from 50 cm to 150 cm. Maximum values are around Mahabaleswar (500 cm) and Mercara (200 cm). During the post-monsoon season, runoff

values decrease to the range of 10 cm to 40 cm. In the winter season runoff again decreases to the range of 5 cm to 20 cm, values generally increasing towards the south.

3.3. Water detention

There is no water detention in the northern parts of the Ghats during the pre-monsoon season. Values of 1 cm to 5 cm are noted in the central and southern parts. Detention values are higher in the southwest monsoon season (Fig. 3). Values upto 200 cm are found in the coastal regions. Values decrease to the 15 cm to 60 cm range in the post-monsoon season with higher values in the southern parts. Detention values again decrease in the winter season. Values range from 10 cm to 30 cm mainly in the southern region.

4. Conclusion

The above investigation reveals that the coastal region between the Arabian Sea and the Western Ghats has abundant water potential for exploitation for hydrological and agricultural purposes. The large runoff and water detention in the Ghats region find their way either towards the west (Arabian Sea) or drains eastwards across the drier climates of Peninsular India. The water surpluses accumulate seasonally and annually and are responsible for the maintenance of groundwater in the region.

Both the surface runoff and detention water are available for utilization for irrigation in agriculture, reservoir storage for municipal or industrial use, canal water supply for navigation or irrigation or even for generation of hydroelectric power. However, the seasonal fluctuations in the runoff and detention have to be taken

care of through the construction of suitable reservoirs and river valley projects. Judicious use of the available water resources in the Western Ghats is not only important, but also urgent for the overall development of the region.

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