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AGROMETEOROLOGICAL STUDIES FOR OPTIMAL UTILISATION OF WATER RESOURCES IN KOZHIKODE DISTRICT OF KERALA STATE

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ABSTRACT: Potential Evaportranspiration of climatological stations in the district of kozhikode were estimated using Penman's method. Consumptive use and effective rainfall under different land uses viz. coconut and rice crops were evaluated using climatological methods. The rainfall frequency analysis carried out to bring out rainfall amounts for durations of 1 to 10 days with return periods of 2 to 100 years will be useful for planning and design of small Hydraulic structures. Frequency analysis carried out using the flood data available from the gauging stations in the district will be useful for planning and design of large hydraulic structures for irrigation purposes.

INTRODUCTION

Kozhikode district of Kerala state lying along the Arabian Sea coast (fig.1) encompasses an area of about 2345 sq. km and receives an average annual rainfall of the order of about 3800 mm. The important rivers passing through this district are Kuttiyadi, Korapuzha, Kallai, Chaliar and Mahe on their way to the Arabian sea. Rice is the main food crop of the district and other cash crops are coconut, rubber and cashew.

Agrometeorological parameters like evapotranspiration, consumptive use of crops, effective rainfall under different agricultural land uses, frequencies of rainfalls and floods etc. are of paramount importance in the development and mangement of available water resources of any place. A key element in the design of any irrigation system is the determination of the total water requirement - the consumptive use less the expected contribution from precipitation plus any losses associated with delivery and application of the water (Linsely et al. 1988). Precipitation is effective only when it remains in the soil and is available to plants, or otherwise offsets a requirement for leaching water. Local runoff is not available to crops and thus the effectiveness of rainfall is dependent on its fortuitous occurrence following irrigation. It is believed that improved results can be expected by modifying a more reliable estimate of potential evapotranspiration, which is the accepted upper limit. Actual consumption will be some what less, depending on the crop and its stage of development

The ever increasing demands of water for varied purposes in every aspect of human life calls for optimal utilisation of water resources available over a place in a scientifc way. In the scientific exploration of available water resources over any place the flood frequency analysis has an important place. Flood frequency studies are often used for arriving at suitable design variables for the construction

of hydraulic structures to bring it to the safer side in extreme conditions.

The objective of the present study is to analyse the long term climatological and flood data available in the district so as to quantify evapotranspiration, effective rainfall under different land uses, frequencies of rainfall and floods for different durations.

DATA

Normal values of meteorological parameters such as temperature, vapour pressure, total cloud amount, wind speed and rainfall were taken from climatological tables (IMD 1970) for different months of the year for estimating evapotranspiration and effective rainfall. The daily rainfall data from raingauge stations maintained by the India Meteorological Department (Fig. 1) for the period 1901 to 1980 were utilised for the rainfall frequency analysis. Flood data available from 5 stations in the district of Kozhikode have been made use of for the flood studies (Fig. 1).

METHODOLOGY

Many methods have been proposed for the estimation of potential evapotranspiration. In the present study Penman's (1948) method modified by Rao *et al* (1971) was employed. The Potential evapotranspiration (ET_o) and consumptive use of crops (ET crop) are related by

ETcrop = $ET_o \times k_c$ where K_c is the crop coefficient.

A crop coefficient of 0.73 has been adopted for the cocount crop. Monthly ET crop values were calculated for different months of the year. Using the monthly ET crop values and mean monthly rainfall values, mean monthly effective rainfall values were calculated making use of the table published by soil conservation service of the United States, Department of Agriculture based on extensive field data (USDA,SCS,1969). In the case of rice based land use, since percolation loss forms unavoidable part of the effective rainfall, an average percolation loss of 6 mm /day for the lateritic soil in the region (ARS, 1948) has been added to the computed effective rainfall.

The use of EV-1 distribution in the frequency analysis of extreme events in hydrology is widely accepted (Sokolov, 1976). The EV-1 distribution is defined by its probability density function,

$$P(x) = \exp - \{\exp-(x-u)/\alpha\} \quad \ldots\ldots(1)$$

where u and α are location and scale parameters of distribution. Equation (1) can be written in the reduced variate form as

$$P(x) = \exp-(\exp-(y)) \quad \ldots\ldots(2)$$

$$\text{where } y= (x-u) / \alpha \quad \ldots\ldots (3)$$

The reduced variate y can be written in terms of the return period

$$T \text{ as } y = -\text{In } (T/T-1) \quad \ldots\ldots(4)$$

$$\text{now } x = u+ \alpha y \quad \ldots\ldots (5)$$

An alternate form of equation (5) is given as

$$x=\mu+\sigma kT \quad \ldots\ldots (6)$$

Where u is the population mean of the annual maximum series, is the population standard deviation of the annual maximum series and kT is the frequency factor given by

$$K_T = \sqrt{6/\pi} \ (0.5772+\text{In } 1n \ (T/T-1) \quad \ldots\ldots(7)$$

The EV-1 distribution was fitted by the method of maximum likelihood. The parameters of distribution were estimated by the method suggested by Panchang (1970). The required estimate corresponding to return period T was computed using equation (6)

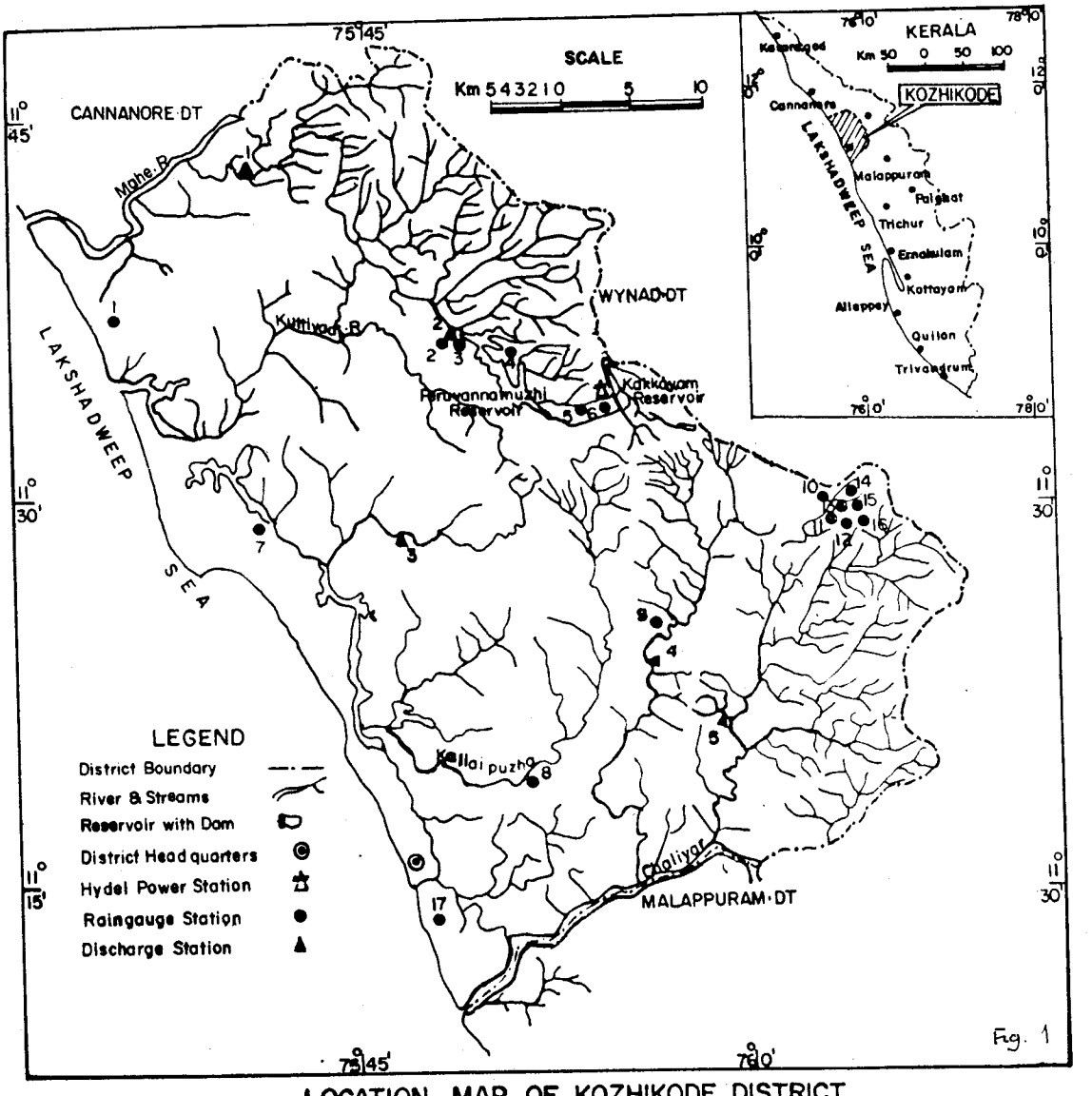

Fig. 1

LOCATION MAP OF KOZHIKODE DISTRICT

● RAINGAUGE STATIONS

1	Badagara
5	Kuttiyadi
7	Quilandi
17	Kozhikkode

▲ DISCHARGE STATIONS

1	Vallayam bridge
2	Peruvannamuzhi
3	Kollikkal
4	Koodathai
5	Mukkom

Fig.No. 1

Table 2.

Seasonal Effective Rainfall

Season	Rainfall (cm)	Effective rainfall under coconut (cm)	rice (cm)
South west monsoon	235.08	30.38	108.56
North east monsoon	46.03	18.83	46.03
Winter	1.70	1.70	1.70
Hot weather	45.46	19.73	45.46

the south west rainfall, 100% of north east monsoon rainfall, 100% of the winter season rainfall and 100% of the hot weather season rainfall were found to be effective.

Rainfall amounts for durations of 1 to 10 days with return periods of 2 to 100 years, for the four raingauge stations were computed (Table 3). Rainfall for a duration of 1 day with a return period of 2 years vary from 16 to 19 cm and that with a return priod 100 years vary from 32 to 38 cm. Rainfall for a duration of 10 days with a return period of 2 years vary from 67 to 73 *cm* and that with a return period of 100 years vary from 117 to 165 cm. Flood frequency analysis were carried out for the stations considere (Table 4). The stream gauging stations at Mukkom and Kollikkal show the highest and lowest values of peak flood respectively. These results are important for planning and design of Hydraulic structures.

Table 3.

Rainfall (cm) for Different durations and return periods

Station : Kozhikode

Duration (days)	Return 2	5	period 10	25	(years) 50	100
1	17	22	26	30	34	38
2	25	33	36	46	53	58
3	33	40	46	53	62	65
5	45	54	62	71	78	85
7	52	66	79	94	106	119
10	67	81	93	107	121	132

Station : Badagara

Duration (days)	Return 2	5	period 10	25	(years) 50	100
1	17	20	23	26	29	32
2	27	32	36	41	45	49
3	35	40	45	50	55	60
5	48	54	60	67	74	80
7	59	67	75	84	92	100
10	72	81	89	99	108	117

Station : Kuttiyadi

Duration (days)	Return 2	5	period 10	25	(years) 50	100
1	19	23	27	31	34	38
2	30	36	41	47	52	57
3	39	46	52	59	65	72
5	53	62	69	78	86	94
7	66	76	84	95	104	114
10	82	94	104	118	128	140

Station : Quilandi

Duration (days)	Return 2	5	period 10	25	(years) 50	100
1	16	20	23	26	29	32
2	27	34	41	48	54	60
3	34	43	51	61	67	75
5	46	58	67	78	85	95
7	57	74	90	107	120	136
10	73	93	111	131	149	165

Table 4.

Flood Frequency analysis (values of peak flood in m^3/sec)

Station	Return period (years)						
	2	5	10	25	50	100	1000
Vallayam bridge	198.19	322.72	405.18	509.35	586.64	663.35	916.84
Peruvannamuzhi	363.03	523.16	629.19	763.15	862.53	961.18	1287.14
Kollikkal	9509	138.88	167.86	204.52	231.70	258.68	347.23
Koodathai	241.24	348.21	419.03	508.51	574.90	640.79	858.53
Mukkom	538.53	716.37	834.17	892.89	1093.26	1202.81	1564.81

CONCLUSIONS

Mean monthly potential evapotranspiration was quantified using Penman's method. Mean monthly effective rainfall and consumptive use under cocount and rice based land uses were evaluated. These results will be useful for the planning and scheduling of irrigation for these crops in the district. Rainfall amounts for durations of 1 to 10 days with return periods of 2 to 100 years were estimated. These results will be highly useful for planning and design of minor and major irrigation schemes in the district. The results of flood frequency analysis will be helpful in planning and design of hydraulic structures.

REFERENCES

ARS (1984). Annual report of 1976-77, Agronomic Research station, Chalakudy, Kerala, India.

India Meterorological Department (IMD), (1961-1970). Climatological tables of observatories in India, IMD Publications.

Linsely, K. Roy Jr., Kohler, A. Max and Paulhus, L.H. Joseph. (1988). *Hyrology for engineers*, MCGrow - Hill.

Panchang, G.M. (1970). Imporved precision of furture high floods, Proceedings of the symposium on floods and their computations, Leningrad, pp 51-59.

Penman, H.L. (1948). Natural evaporation from open water, bare soil and grass, *Proc, R. Soc. London*, Ser A. 193 : 120-146.

Rao, K.N. George, C.J. and Ramasastri, K.S. (1971). Potential evaportanspiration over India, Scientific Report, No. 136, India Meteorological Department publication.

Sokolov, A.A., Rantz, S.E. and Roche, M. (1976). Flood flow computation methods compiled from world experience. The UNESCO press, Paris.

U.S. Dept. of Agri. (Soil Cons. Services). (1969). Engineering Field Manual for Conservation Practices.

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