II-38 STREAM FLOW MODELLING OF A SRI LANKAN CATCHMENT CONSIDERING SPATIAL VARIATION OF RAINFALL

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INTRODUCTION: Sri Lanka is an island in the Indian Ocean between the latitudes 5°55′ - 9°50′N and longitudes 79°42′ - 81°52′E. River Mahaweli is the longest river in the island starting from the central hills and ending at Trincomalie in the north eastern coast. In the present work, the daily stream flow at Peradeniya gauging station(1167 km²) is simiulated using daily rainfall data collected at four stations(Fig 1) during the period from 1969 to 1980.

MODEL: A simple tank model(Sugawara 1961) with four tanks was used to simulate stream flow and the Powell search technique (Powell 1965) was incorporated to optimise model parameters. The optimised parameters were evaluated using, 1) The Ratio of Absolute Error to Mean, which had been used by the World Meteorological Organization (WMO 1975) for numerical comparison, and which is defined as,

$[1/n]\times[\ \Sigma\ \mathrm{Abs}(y_o - y_c)/\Sigma(y_o)]$, where y_c is the computed discharge; y_o is the observed discharge; and n is the number of observations; 2) The graphical comparison of semi-log plots of outflow hydrographs and flow duration curves; 3) Realism of optimised parameters and the storages pertaining to the tank structure.

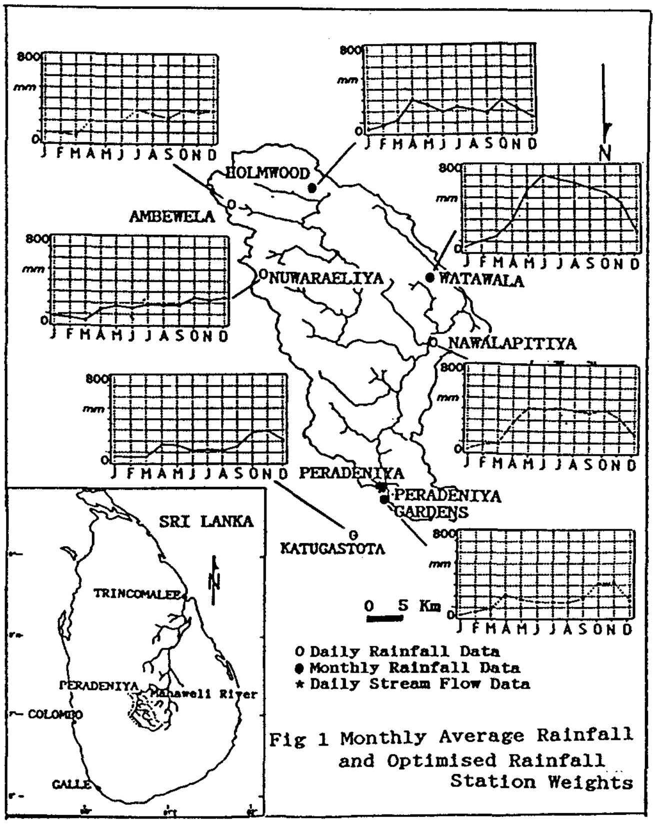

Fig 1 Monthly Average Rainfall and Optimised Rainfall Station Weights

APPLICATION:
Weighting parameters were assigned to the rainfall stations to incorporate the spatial variability of rainfall. These station weights and the tank parameters were treated as two sets and optimisation was carried out in a cyclic manner, optimising one set at a time while the other was kept constant. The model Parameters were rescaled to aid smoothening of objective function surface during parameter optimisation (Pilgrim 1975, Kadoya 1980). Mean square error of the logarithms of discharges was taken as the objective function since they reflect the differences in both high and low flows.

Data from 1969 to 1973 were used for calibration while the data from 1976 to 1980 were taken for verification. The Data during years 1974 and 1975 appeared to be erroneous and hence were not used in the calculations.

At the beginning, an estimate of the catchment lag was obtained by trial & error, incorporating uniform rainfall with an approximate set of tank parameters and using the ratio of absolute error to mean as criterion for comparison. Inputs for estimation of parameters consist of the catchment lag, initially assumed parameters for model, the monthly evaporation indices and, the rainfall and stream flow data. The evaporation indices calculated using the annual pattern of pan evaporation data were used to apportion the annual water balance values as the daily evapotranspiration values for model calculations.

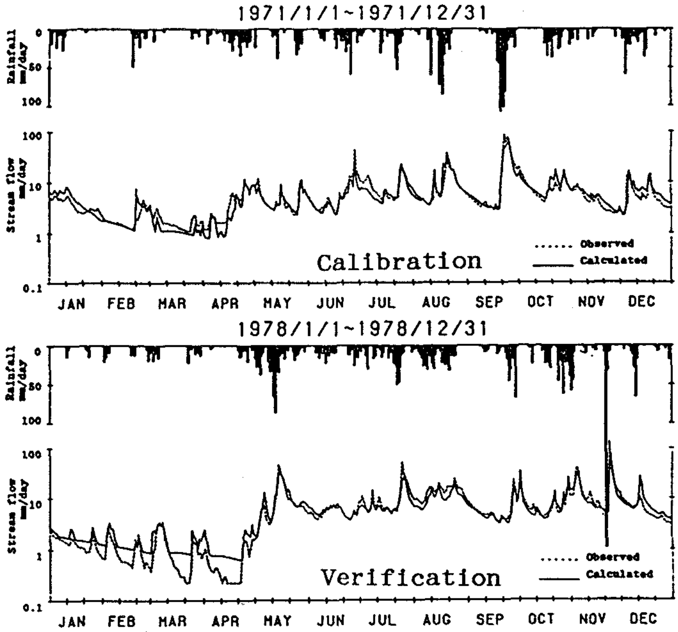

Fig 2 Observed and Calculated Hydrographs

Initially tank parameters were optimised assuming a uniform spatial variation of rainfall. The station weights were then optimised keeping the tank parameters constant. The calculations were repeated cyclically until the evaluation criteria were satisfied. The ratio of absolute error to mean in cases of uniform and spatially varied rainfall were 0.2733 and 0.2399 respectively, showing a significant improvement in the matching of observed and calculated outflows. The optimised rainfall station weights along with the temporal distribution of rainfall within the year are shown in Fig 1. The outflow hydrographs for years 1971 and 1978 in calibration and verification periods are shown in Fig 2.

CONCLUDING REMARKS:

Stream flow modelling using a tank model and parameter optimization by a search technique considering spatial variability of rainfall is presented. The agreement of the computed results and the observed data significantly improved with the introduction of spatial variability of rain. The optimized weighting parameters seems justifiable when compared with the rainfall distrbutions and the location of stations.

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