

STOCHASTIC MODELS FOR
STREAMFLOW SIMULATION

BY

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CERTIFICATE

This is to certify that the thesis entitled " Stochastic Models for Streamflow Simulation", which is being submitted by Mr. S.K.Spolia to the Indian Institute of Technology, Delhi, for the award of the degree of Doctor of Philosophy, is a bonafide research work carried out by him under my guidance and supervision. His thesis has reached the standard, fulfilling the requirements of the regulations relating the degree.

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The results contained in this thesis have not been submitted in part or full to any other University or institution for the award of any degree or diploma.


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SYNOPSIS

This study has been divided in two parts - Part A entitled "Modelling of Surface Runoff Systems" and part B entitled "Stream Flow Synthesis".

In part A, various approaches of parametric hydrology for modelling surface run off system are reviewed. It is found that discrete models of stochastic hydrology have not found their use in modelling surface run off systems. A discrete model equivalent to Nash's type cascade of linear reservoirs is specified. Structural relationship between the parameters of the two types of models is obtained. Various constraints on the parameters of the discrete model to obtain a physically realizable response function are derived. Use of these constraints in obtaining a permissible parameter space of a second-order system is demonstrated.

A method for the estimation of parameters of the discrete model and in turn those of the Nash' model for computation of IUH is derived. The proposed method is based on the estimation of the parameters from the autocorrelation function, derived in the form of Hypergeometric function, of direct surface run off hydrograph. The method does not require the use of rainfall excess - a major source of error. The procedure of computation of

the IUH by the proposed method has been tested on ten gauged catchments (six British and four American). The validity of the method is established through close agreement between the computed and observed hydrographs. General conclusions drawn from the study are summarised and further work involving the extension of the investigation is indicated.

In part B, the techniques required in time series analysis and models evolved for stream flow synthesis are reviewed. It is found that the models in vogue have the following deficiencies/drawbacks:

- i) these models require the use of too many parameters for seasonal streamflow synthesis.
- ii) Lag-one or multiple correlation coefficient, depending upon the order of the model, often exceed unity and has to be set equal to unity in the generator.
- iii) the models have to be fitted to actual data before these can be used for streamflow synthesis. The procedure of fitting being iterative is very cumbersome.
- iv) To make these models adaptable for generation of stationary sequences, a random component proportional to the standard error of estimate of stream-

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flow needs to be added to the model. This component requires the estimation of additional parameter, multiple correlation coefficient or lag-one correlation coefficient, for the model

In this study, two models have been evolved to overcome these deficiencies/drawbacks. One of the models, based on the principle of autoregression, uses same regression coefficients, correlation coefficients and multiple correlation coefficient for all the seasons. The proposed model of a given order is shown to be parsimonious in number of parameters than an AR-model of the same order. The validity of the model is established through comparison of statistics generated by the proposed model, AR-model of the same order and those of the historical sequence. Data of the Beas-river is used.

The second model is based on the principle of canonical expansions. This model dispenses with the requirement of an additive component responsible for rendering the synthetic sequences stationary and the iterative procedure of model fitting. The model is shown to have a distinguishing feature of preserving the entire correlation-cross correlation

matrix in addition to the preservice of the mean and the variance of the recorded seasonal sequences of streamflows. The model has been used to generate seasonal sequences of streamflows using the data of the Beas, the Satluj and the Ravi rivers.

General conclusions are summarised and the scope of future work is indicated.

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