Distributed Watershed Modelling of a Mountainous Catchment

Submitted by

Shaban Ali Gholami

Thesis Submitted in fulfilment of the requirement for the degree of Doctor of Philosophy

Department of Civil Engineering

INDIAN INSTITUTE OF TECHNOLOGY

NEW DELHI - 110 016

MAY 1999

Certificate

This is to certify that the thesis titled **"Distributed watershed Modelling of a Mountainous catchment"** being submitted by **Mr. SHABAN ALI GHOLAMI**., 94RCE 022 to the Indian Institute of Technology, Delhi, India, for the award of the degree of **DOCTOR OF PHILOSOPHY**, is a record of bonafide research work carried out by him under my supervision and guidance. The thesis work, in my opinion, has reached the standard, fulfilling the requirements of the regulation relating to the said degree. The research report and the results presented in this thesis have not been submitted, in part or in full, to any other university or institute, for the award of any degree or diploma.

Prof. A. K. Gosain
Professor
Department of Civil Engineering
Indian Institute of Technology
New Delhi-110016, INDIA

ACKNOWLEDGEMENTS

I am immensely grateful and deeply indebted to my supervisor **Prof. A.K. Gosain,** Professor of Civil Engineering, Indian Institute of Technology (IIT) Delhi, for his keen interest, constant encouragement supervision and guidance throughout the course of present investigations. His ever helping attitude, excellent leadership and dynamic personality has been or constant source of encouragement for me and also. It is appreciated to him which he has been prepared good facility for working easily in the GIS Laboratory. I am extremely thankful to **Dr. (Mrs.) Sandhya Rao** for valuable help and useful suggestions in the present study.

Sincere thanks are due to the **soil conservation and watershed management** research organization of **Ministry of Jihad-e-Sazandegi;** for providing the adequate data, topographic maps and Aireal photo and also for perusing my financial and administrative works. I am thankful to the **Authorities of Research and Training of Deputy of Jihad-e-Sazandegi Ministry** under the government of Islamic Republic of IRAN who awarded scholarship and financially supported to do this research.

I also wish to express my sincerest thanks to all my friends in the GIS Laboratory for their affectionate assistance.

I would like to record my special heart full thank to my wife **Mrs. Z.B. Taherian** for her excellent cooperation and support during the entire period of this research and also my childrens who were a great companion for their mother.

I would like to express my gratefulness to the **Ministry of Culture and High Education (MCHE)** under the Islamic Republic of IRAN for supporting me to do this research.

New Delhi.
April, 1999

(SHABAN ALI GHOLAMI)

Abstract

Watershed management has been recognised as a widely accepted approach for optimal use of soil and water resources. Therefore, watershed-modelling incorporating hydrological processes takes a crucial role for proper planning and development of these local resources. Invariably, one of the major difficulties encountered in the use of hydrological models is the requirement of calibration of the model on the target area. For the purpose of calibration, most of the hydrological models require a long series of observed runoff data. These long series of data are usually not available on most of the small watersheds. Therefore, it is imperative that hydrological models should be formulated/ identified which can overcome this requirement. One such hydrological model, namely, SWAT (Soil and Water Assessment Tool) model has been identified and implemented on Tehran-Amameh, a mountainous, snow bound, 37.20 sq. km watershed in Iran.

The study has provided an in-sight into the working of the continuous, distributed water balance model, SWAT. The major objective of the study has been to assess the applicability of the model on ungauged watersheds, which has become a necessity in view of the fact that it shall be impracticable to gauge the small watersheds which are accepted as the viable planning and management units in all the countries around the globe.

It has been shown that the ability of the model to be used on ungauged watersheds is not very good since it is not always possible to define the model parameters through the observable characteristics. It has been depicted furthermore that through the use of a small series of observed flow data (about one year), the model performance has appreciably enhanced. It is therefore inferred that the character of the watershed, which is reflected through the observed flows, is not attainable through any other form of information. The structure of the SWAT model has proved to be very stable

but for the snow component of the model which needed improvement and had been modified.

During the course of simulation analysis it has also been observed that the selection of an appropriate interval for analysis is very important. It is not necessary that if the simulation results appear to be good at the monthly interval then they shall also be good at the daily interval. However, the other way round may be true.

The capability of the model to simulate the sediment yield has also been proven. It was very interesting to note that the improvement in the water yield simulation kept on bringing about the corresponding improvement in the sediment yield. This proves the capability of the model for sediment yield simulation beyond doubt.

The capability of SWAT model to generate various management scenarios has also been explored. The present catchment being predominantly a rangeland, there were very limited feasible alternatives that were considered. The impact assessment due to changes in rate of grazing, duration of grazing, and crop rotation, as well as changes due to utilization of fertilizer (Nitrate and Phosphate), has been evaluated on the catchment. It has been observed that the various alternatives considered have not made appreciable difference in the outputs. However, it may be said that this ability of the SWAT model shall go a long way in enhancing the acceptability of the model with the end-users and shall make the model very effective tool of the future.

Table of Contents