WATERSHED MODELLING USING GEOGRAPHICAL INFORMATION SYSTEM

by

ASHUTOSH PASRICHA
DEPARTMENT OF CIVIL ENGINEERING

Submitted
in fulfilment of the requirements of the degree of
DOCTOR OF PHILOSOPHY

to the

INDIAN INSTITUTE OF TECHNOLOGY, DELHI

JULY, 1999

24/7/24

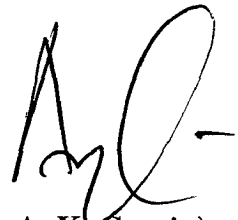
Watershed

2) Geographical information systems

DEDICATED
TO
MY PARENTS

CERTIFICATE

This is to certify that the thesis entitled **'WATERSHED MODELLING USING GEOGRAPHICAL INFORMATION SYSTEM'** being submitted by **Ashutosh Pasricha** to the ***Indian Institute of Technology, Delhi*** for the award of the ***Degree of Philosophy*** is a record of bonafide research work carried out by him under my guidance and supervision. The thesis work, in my opinion, has reached the standard, fulfilling the requirements for 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.



(Dr.. A. K. Gosain)
Professor
Department of Civil Engineering
Indian Institute of Technology, Delhi
New Delhi-110016, India

ACKNOWLEDGMENTS

I wish to express my earnest gratitude to **Prof. A. K. Gosain,** Professor in Civil Engineering Department, Indian Institute of Technology (IIT) Delhi, who has supervised my research work with a keen interest. His ever-helping attitude, excellent leadership and dynamic personality have been a constant source of encouragement for me. And also, It is a great appreciation to him that he has provided a lot of facilities for working easily in the GIS Laboratory.

I wish to express my thanks to **Dr. R. Srinivasan,** Backland research center, Texas Agricultural Equipment station, Temple Texas 76502 for providing me SWAT model.

I wish to express my gratitude to **Dr. David G. Tarboton,** Associate Professor, Civil and Environmental Engineering Deptt., Utah State University Logan, UT 84322-4110 for D∞ (D-infinity) approach as ArcView extension.

I am thankful to Damodar Valley Corporation staff for providing me the necessary data for creation of DEMs.

I wish to express my gratitude to **Dr. Y. P. Yadav,** Project Co-ordinator, Indo-German Bilateral Projects, Ministry of Agriculture, Govt. of India, for providing permission to utilize the hydrological data of the Karso watershed.

I am extremely grateful to **Mr. G. Honore**, German Project Coordinator, Indo-German Bilateral Projects, New Delhi and his staff for providing me the necessary data required for the modelling purposes.

My special thanks are also due to the faculty members of Water Resources Engineering for their kind help during the course of study.

I am also thankful to Head of the Department, Civil Engg. Deptt.. IIT Delhi, for providing me the necessary administrative support.

My special thanks to Mr. Saeid Morid and Dr. (Mrs.) Sandhya Rao for their valuable help during the course of my study.

I am very thankful to my wife Neelima for her excellent cooperation and support during the entire period of this research and my daughter Saumya who beard with me during day and nights.

My special thanks are to my Parents for their blessings and encouragement during the period of the study.

I wish to express my thanks to my brother, sister and their family members for their blessings and encouragement throughout the period of the study.

I take my responsibility to express my thanks to Mr. Angshuman Dutta, Mr. V. S. Chalapathi and other research scholars who have always been around in time of need during the course of the study.

I wish to extend my thanks to my friends Dr. R. K. Gupta and Mr. Anuj Saxena for their kind help during the course of the study. .

New Delhi,

July, 1999

Ashutosh Pasricha

(ASHUTOSH PASRICHA)

ABSTRACT

The deterioration of natural resources in an area can be contained and the resources properly developed, only by adopting the watershed approach in which the basic unit of development is a watershed, a manageable hydrological unit. The integrated watershed management approach requires the spatial information on the complete terrain of the watershed including the drainage system. One of the basic problem which is generally encountered by the watershed managers is to get the accurate watershed area which is the major watershed spatial parameter, from existing topographic maps of 1:50,000 scale usually available in most of the countries.

Automatic techniques using Digital elevation models as basic input are available for parameterization of watershed. Two approaches D8 (D-eight, Single direction approach) and a recently developed approach D∞ (D-infinity, Infinite number of possible directions) have been selected and applied for parameterization of a small Indian watershed named Karso from Damodar Valley Corporation in Bihar having an area of 2734 hectare. In view of the present problems of limited data availability, the evaluation of performance of automatic techniques for extraction of drainage network and watershed boundary is necessary at different scales of data availability. The errors caused due to method of interpolation have also been explored to evaluate their impact on the DEM and cell size aggregation.

It has been found that D8 approach does well under situations where large-scale data (≈ 5m contour interval) is available. At the same time D∞ approach also gives results at such large scale which are equally good or rather better than those given by D8 approach. Deterioration sets in for watershed delineation with the increase in contour interval

(reduction in scale) for both the approaches. It has also been observed that method of interpolation plays an important role for generation of DEMs. The errors are also caused due to resolution of grid cell selection which in turn affects the drainage network and hence the watershed area delineation.

The study has also proved that the SWAT model has the basic capability of being used on small watersheds for the water yield assessment.

So, the success of the integrated watershed management approach being put forward globally as the holistic approach with high level of sustainability, is in turn dependent to a large extent on the success of the approaches in question which shall serve as the pre-processor for the watershed modelling. Therefore, evaluation of these approaches and the quantification of their performance shall go a long way in acceptance of these methodologies. It is concluded that the D8 technique which have been provided with most of the commercial GIS software do not provide acceptable results while using small scale data for small watersheds. The recent technique of D∞ which perform much better for the similar data should replace the D8 procedure. Such actions shall build confidence into the watershed management community to use these technologies.

TABLE OF CONTENTS

CHAPTER 3 DESCRIPTION OF SELECTED DELINEATION APPROACHES

CHAPTER 4 DESCRIPTION OF THE SELECTED HYDROLOGICAL MODEL