

THESIS

**MODELING SNOWMELT RUNOFF FOR SMALL CATCHMENTS  
WITH LIMITED DATA**



By

**KASHIF SAJJAD**  
(2003-PG-WRE-21)

For the Degree of

**MASTER OF SCIENCE**

IN

**WATER RESOURCES ENGINEERING**

**CENTRE OF EXCELLENCE IN WATER RESOURCES ENGINEERING,**  
University of Engineering and Technology, Lahore-Pakistan.

2005

## ABSTRACT

This study is related to simulation of snowmelt runoff for Satpara and Naltar catchments, located in northern areas of Pakistan, using the metrological data. Precipitation usually falls as snow in the winter or early spring in northern areas of Pakistan and water is temporarily stored as snowpack. Satpara and Naltar catchments having areas of 274 Km<sup>2</sup> and 246 Km<sup>2</sup> respectively. Although these are small catchments but having much importance due to hydropower projects. These streams having flow data of limited periods, e.g. at Satpara stream, data is from April,2002 to March, 2003 and at Naltar stream, from 1997 to 1999. These data are not considered sufficient for the estimation of design floods and availability of water for hydropower generation. As a result, design flood and water availability for Satpara project was estimated by imposing the flows of Kachura stream which has catchment area of 112665 km<sup>2</sup> and Naltar project was estimated by imposing the flows of Dainyor which has catchment area of 13151 km<sup>2</sup>. There was a huge difference in the areas of Satpara and Kachura, Naltar and Dainyor stream. It is well understood that the response of snowmelt to stream flows in large catchments are hydrologically different as compared to small catchments. At the same time, climatic data of sufficiently long periods are available at Satpara and Naltar which could be helpful in relating with stream flows. It was logical to use a suitable watershed model to simulate streams flow values from climatic data. After examining different watershed models, the University of British Columbia (UBC) Watershed Model was selected to use for calibration of available limited data with climatic data, from the calibrated models of Satpara and Naltar streams, the stream flow values from 1994 to

2003 are simulated. This research can be used to develop a relationship between snowmelt (at Satpara and Naltar catchments) and snow water equivalent values. This study gives the data for stream flows of sufficiently long duration which will help to evaluate the previous design of dams and reservoir operational studies for Satpara and Naltar hydropower projects. Moreover, long duration stream flow data will give confidence to the hydrologists in planning the hydropower projects at these sites. This will open a new window for the design of different hydropower projects at these sites where the stream flow data of short duration are available. This study will give a new vision to the professionals associated with design consultants and faculty engaged in the field of water resources and hydropower development. On Indus river d/s of Skardu city. Skardu dam is proposed, just before this site Satpara stream is merged to Indus River, so due to this study the flood frequency analysis of Indus River at this site and influence of Satpara flow is comprehensively possible. The flows of Naltar catchment is merged to Hunza River d/s of confluence point, the study of flood frequency analysis is possible and influence of Naltar flow is comprehensively possible to determine. This research can also be used for the study of climatic change provided the expected weather patterns are designed in accordance with the possible changed climate.

Engr. Kashif Sajjad