AN APPLICATION OF THE DISTRIBUTED HYDROLOGICAL MODEL (BTOPMC) IN THE SUNKOSHI RIVER BASIN

Dissertation Submitted to the Central Department of Hydrology and Meteorology in partial fulfillment of the requirements for the degree of Master of Science in Meteorology

By

Raju Dhar Pradhananga

Central Department of Hydrology and Meteorology

Tribhuvan University, Kirtipur

T.U. Regd. No: 5-2-37-444-97

Kathmandu, Nepal

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RECOMMENDATION LETTER

This is to certify that Mr. Raju Dhar Pradhananga has prepared the Dissertation entitled, AN APPLICATION OF THE DISTRIBUTED HYDROLOGICAL MODEL (BTOPMC) IN THE SUNKOSHI RIVER BASIN" to fulfill the Degree of Master of Science in Meteorology of the Tribhuvan University is the record of the candidates own work carried by him under our supervision and guidance.

Dissertation Supervisor

……

Mr Tirtha Raj Adhikari (Lecturer)

Central Department of Hydrology & Meteorology

Tribhuvan University

Kirtipur

LETTER OF APPROVAL

This Dissertation entitled “AN APPLICATION OF THE DISTRIBUTED HYDROLOGICAL MODEL (BTOPMC) IN THE SUNKOSHI RIVER BASIN” submitted by Mr. Raju Dhar Pradhananga has been approved as a partial fulfillment for the Master of Science in Meteorology.

Prof. Dr. Lochan Prasad Devkota

(Internal Examinar & Head of Department)

Central Department of Hydrology & Meteorology

Tribhuvan University

Kirtipur, Nepal

Dr. Sunil Adhikari (Associate Professor)

(External Examinar)

Head of Department, Department of Meteorology

Trichandra Multiple College

Ghantaghar, Nepal

Mr. Tirtha Raj Adhikari (Lecturer)

(Dissertation Supervisor)

Central Department of Hydrology & Meteorology

Tribhuvan University

Kirtipur, Nepal

ABSTRACT

The BTOPMC refers to “Blockwise use of TOPMODEL with Muskingum-Cunge routing”. This model was developed at University of Yamanashi, Japan. It implements the concepts of TOPMODEL with Muskingum-Cunge method for flow routing. The model performs distributed calculations of flows, but it is conceptually semi-distributed in terms of parameterizations.

In Nepal, most of the river basins are data poor or ungauged so it may be the better option to use a runoff simulating tool that uses a global public domain datasets. Therefore, to calibrate and validate the model in the Sunkoshi river basin using local available hydrometeorological data and global public domain dataset was the main objective of the study.

The Sunkoshi river basin lies in the central northern part of the Nepal and is one of the river basins with good hydrology with a suitable topography for planning any type of hydropower projects. The total basin area of the Sunkoshi river basin at Pachhuwarghat gauging station is 4920 sq. km. It mainly covers two districts of Nepal (Sindhupalchok and Kavrepalanchok) and about 27 % of the total basin area lies in Tibet, China. The elevations in the basin under study range from 602 m, at gauging station in Pachhuwarghat, to 7786 m at high Himalaya. Owing to large differences in the elevations of the topography the basin is characterized by diversified climatic patterns. The study area receives an annual rainfall of 2300 mm.

The study covers eight years period from 1994 to 2001. The period of 1991 to 1997 was used for calibrating the model and the period of 1998 to 2001 was used for validating the same. The local available hydro meteorological data (discharge, rainfall, and temperature) were collected from DHM whereas other various global datasets were collected from different public domains. The model requires feed various kinds of data into its own standard format. To prepare data into the standard format, different tools like Arc view/Arc Info, MS Excel, Google Earth, Win BTOPMC preprocessor tool and other different tools provided by COE-UY were used. The processed data were finally fed into the model and results were analyzed to meet the objectives of the study. The model was calibrated and validated using the options “calculate using land cover and soil data” and “calibrate” for Srmax computation. The Nash Sutcliffe efficiency of 81.41 % and 82.87 % were obtained from using the former option for Srmax computation and the Nash Sutcliffe efficiency of 81.67 % and 82.01 % from the latter option. The annual potential evapotranspiration from the Shuttleworth-Wallace model were estimated as 833 mm in 1994, 856 mm in 1995, 811 mm in 1996, 876 mm in 1997, 815 mm in 1998, 841 mm in 1999, 759 mm in 2000, and 806 mm in 2001. Finally, it was concluded that the BTOPMC is an applicable and reliable model for carrying out research in large river basins such as Sunkoshi River basin.

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ABBREVIATIONS

1. amsl = above mean sea level
2. AR = Autoregressive
3. ARMA = Autoregressive Moving Average
4. ASCII = American Standard Code for Information Interchange
5. AVHRR = Advanced Very High Resolution Radiometer
6. BTOPMC = Blockwise use of TOPMODEL with Muskingum-Cunge routing
7. COE-UY = Centre of Excellence- University of Yamanashi
8. CREEW = Centre of Research for Environment, Energy, and Water
9. CRU = Climate Research Unit
10. DDM = Data Driven Model
11. DEM = Digital Elevation Module
12. DHM = Department of Hydrology and Meteorology
13. DR = Deep Rooted
14. FAO = Food and Agriculture Organization
15. GIS = Geographic Information System
16. GLOF = Glacier Lake Outburst Flood
17. HEC-HMS = Hydraulic Engineering Center - Hydrologic Modeling System
18. IGBP = International Geosphere Biosphere Program
19. IMP = Impervious
20. MFD = Meteorological Forecasting Division
21. NAM = North American Mesoscale
22. NDVI = Normalized Difference Vegetation Index
23. NEA = Nepal Electricity Authority
24. NOAA = National Oceanic and Atmospheric Administration
25. NSE = Nash-Sutcliffe Effeciency
26. PET = Potential Evapotranspiration
27. RD = Root Depth
28. SCS-CN = Soil Conservation Service Curve Number
29. SD = Saturation Deficit
30. SR = Shallow Rooted
31. SRI = Shallow Rooted and Irrigated
32. USDA = United States Department of Agriculture
33. USGS = United States Geological Survey
34. VB = Volume Bias
35. WECS = Water and Energy Commission Secretariat
36. WMO = World Meteorological Organization