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MODELING OF THE YAMUNA RIVER CATCHMENT USING FUZZY LOGIC SIMULATION AND RUNOFF RAINFALL DATA YAMUNANAGAR

PRABESH SINGH KATHAYAT

Under Graduate students, Department of Civil Engineering,

Guru Nanak Institute of Technology, Ambala, India

Er. DEEPAK KUMAR, Er. JATIN THEREJA, Er. ASHU RANA

Assistant professor, Department of Civil Engineering

Guru Nanak Institute of Technology, Ambala, India

Abstract

This study deals with the basic concepts and steps involved within the " **MODELING OF THE YAMUNA RIVER CATCHMENT USING FUZZY LOGIC SIMULATION AND RUNOFF RAINFALL DATA YAMUNANAGAR".** This paper is focused on the monitoring of the runoff rainfall modelling confining the River Yamuna in Yamuna Nagar . The present study is based on **Fuzzy logic simulation** Model which integrates the GIS information with attribute database to estimate the runoff of Yamuna River catchment. The Fuzzy logic simulation Model works in conjunction with Arc GIS. In the present study the catchment area has been delineated using the DEM (Digital Elevation Model) .The sub basins are further divided into 223 HRUs which stands for Hydrological Response Unit. Then by using 30 years of daily rainfall data and daily maximum and minimum temperature data Fuzzy logic simulation is done for daily, monthly and yearly basis to find out Runoff for corresponding Rainfall. The coefficient of correlation (r) for rainfall in a period and the corresponding runoff is found to be 0.9419. Keywords: Runoff; Rainfall; **FUZZY LOGIC SIMULATION**.

1. INTRODUCTION

GENERAL (Study area description)

Total geographical area of the district is 1756 sq.km. Administratively, Yamuna Nagar district is divided into one sub-division and six-development blocks viz. Bilaspur, Chachrauli, Jagadhri, Mustafabad, Radaur and Sadhaura. Yamuna Nagar is thickly populated district. The population of the district is 12,14,205 as per 2011 census.

The normal annual rainfall of the district is 1107 mm, and is unevenly distributed over the area. The average rainy days are 43. The south west monsoon, sets in from last week of June and withdraws in the end of September, contributing about 81% of normal annual rainfall. July and August are the wettest months. Rest 19% rainfall is received during non-monsoon period in the wake of western disturbances and thunderstorms.

PHYSIOGRAPHY

The district is divided into five Physiographic units

• Siwalik Hills

• Dissected Rolling Plains (Kandi)

• Interfluvial Plains

• Active and Recent Flood Plains

• Relict Wedge Plains

Siwalik Hills – Siwalik hill ranges occupy the northern fringe of Yamuna Nagar district and attain the height up to 950m AMSL. The hills are about 500m high with respect to the adjacent alluvial plains. These are characterized by the broad tableland topography that has been carved into quite sharp slopes by numerous ephemeral streams come down to the outer slopes of the Siwalik and spread much of gravels boulders, pebbles in the beds of these streams.

Kandi Belt - A dissected rolling plain in the northern parts of district is a transitional tract between Siwalik hills and alluvial plains. It is about 25 km wide and elevation varies between 250 and 375m AMSL.

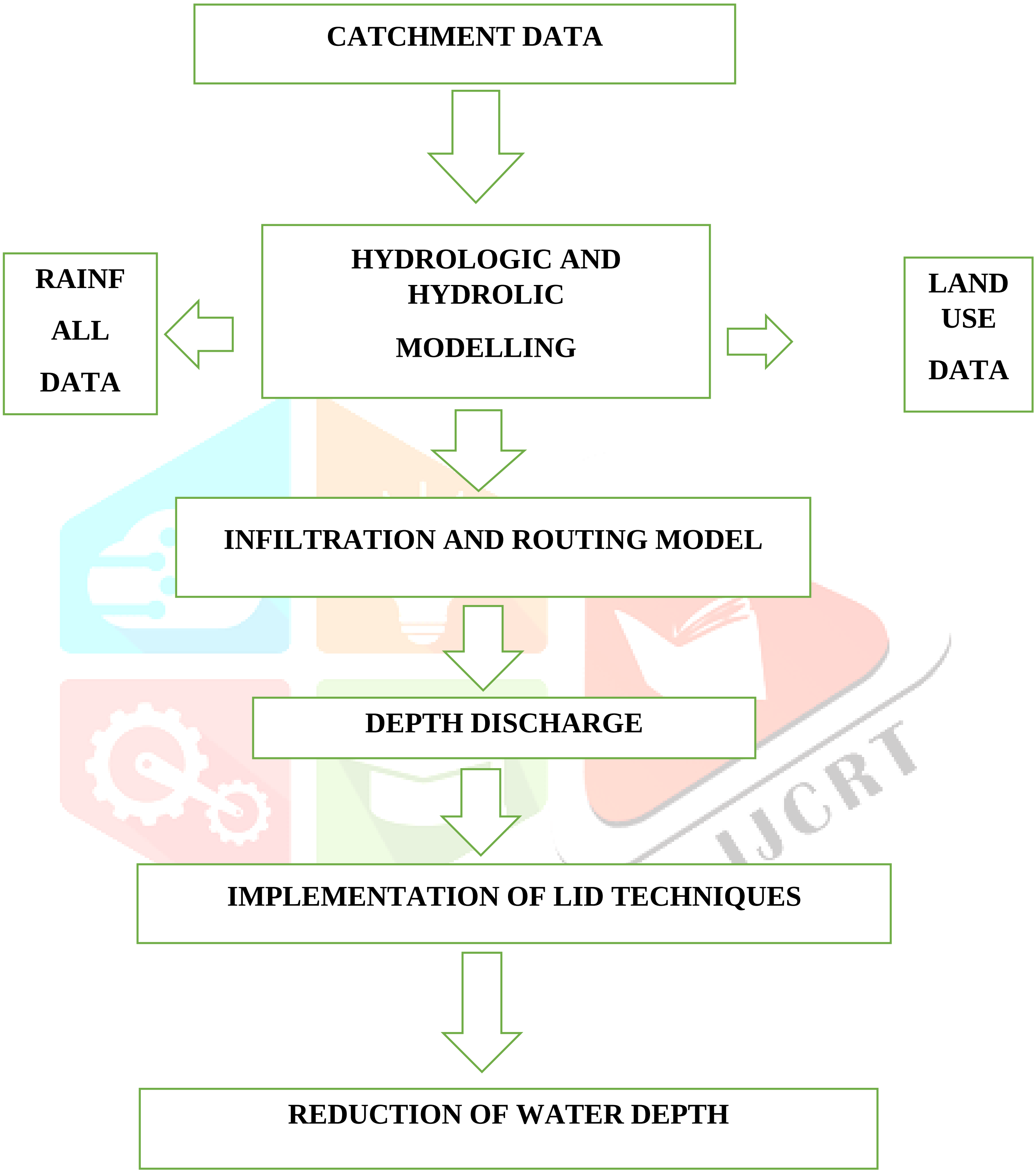
Interfluvial plains - This tract is part of higher ground between Ghaggar and Chautang and includes high mounds and valleys. In general, the slope is from northeast to southwest.

Relict wedge plain - This is almost in alignment to the surface water divide between the westward flowing Ghaggar and eastward flowing Somb river.

Fig 2. Yamuna River Start And End

Fig 3. Map of Yamuna Nagar District

2. METHODOLOGY



STEPS

1. CATCHMENT DATA
2. HYDROLOGY AND HYDROLIC MODELING
   I. RAIN ALL DATA
   II.LAND USE DATA
3. INFILTRATION AND ROUTING MODEL

4. DEPTH DISCHARGE
5. IMPLEMENTATION OF LID TECHNIQUES
6. REDUCTION OF WATER DEPTH

Rainfall

Normal Annual Rainfall	1107 mm
Normal monsoon Rainfall	898 mm

Temperature

Mean Maximum	48.8°C (May &June)
Mean Minimum	6.8 °C(January)
Normal Rainy days	43

3. LITERATURE REVIEW

S.no	Year	Authors	Focus on the Paper	Key points In Coverage	Techniques Used
1.	2002	Abdulla FA, JA, Hossain AH(2002)	simulating runoff hydrograph in desert regions.	Water Resources Management	Hydrograph
2.	2005	Al-Abed, N., F. Abdulla, and A. Abu Khyarah	water resources in the Zarqa River basin	Environmental Geology,	GIS-hydrological
3.	2007	Beven K. J.	Uncertainty, data, and modelling	planning for the future	Model calibration
4.	2000	Brazier R. E., Beven K. J., Freer J	uncertainty in physically-based soil erosion models	GLUE methodology to WEPP – the water erosion prediction project	
5.	2009	Kirchner J. W	Catchment characterization, rainfall–runoff modelling	Catchments as simple dynamical systems	simple dynamical system
6.	1997	Kazmi AA, Hansen IS	study for the Yamuna river (India)	Numeric models in water quality management	Water Sci Techno
7.	2005	Kazmi AA, Agrawal L	water quality management of Yamuna river, India.	water environment	

Rainfall Data:

Year	Rainfall in mm	Surplus /Deficiency In %
2015	563.8	-13
2016	595.7	-8
2017	579.8	-11
2018	750.0	15
2019	359.0	-44
2020	535.6	-17
2021	408.3	-36
2022(so far)	71.5 (June 1-10)	-61

Table 1. Rainfall during (2015-2022)

4. RESULT AND DISCUSSION

This study shows the structure of the Fuzzy logic-based model used in modelling of the Rainfall Runoff process. Fuzzy logic simulation is done for daily, monthly and yearly basis. Average runoff for average yearly rainfall from which it can be seen that the maximum runoff occurred in the year 1984. The rainfall runoff correlation has also been done for 30 years data and a good correlation is found with value 0.8872. Fuzzy logic also gives daily Runoff for corresponding daily Rainfall value throughout the year. Here the graphical representation of daily maximum Rainfall-Runoff values for each year for 30 years period.

5.CONCLUSION

Fuzzy logic model for the catchment produced good simulation results for daily, monthly and yearly runoff values as for the other water balance components. In this context, the observed correlation coefficient(r) is 0.9419. The evaluation of the model performance was carried out successfully with the recommended statistical coefficients. These performances can be enhanced further more using more accurate input data especially for the soil, land use and DEM data that were estimated in this study with global data. The integration of climatic data such as rainfall data, temperature data also helps to compute accurate rainfall-runoff correlation. With the help of observed runoff data of the catchment, model validation can be done.

6.FUTURE SCOPE OF THE PROJECT

Our study had many limitations, of which the time was a major concern. Fuzzy logic was best for runoff-rainfall simulation. This method was more complex than other method . This method helps to control runoff and maximum amount of water to utilized power generation.

BOOKS

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Irrigation and water Resources Engineering (Santos Kumar Garg)

Water Resources and Irrigation Engineering (G L Asawa)

Water Resources and Development (Clive Agnew and Philip Woodhouse)

Water Resources and Water Management (Milan K Jemar)

Groundwater Hydrology (David Keith Todd)

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AUTHORS:

AUTHOR 1

Prabesh Singh Kathayat is the student of Civil Department of GNIT, Mullana (Ambala). Pursuing his B.tech in Civil Engineering. His research area lies in water resources (Catchment area).

Email: prabeshsinghkathayat128@gmail.com

AUTHOR 2

Er. Deepak Kumar is working as assistant professor in Department of civil engineering, Guru Nanak Institute of Technology, Mullana (Ambala). He has done Master of Technology in Geotechnical engineering and pursing his Ph.D . He has 7 years of teaching experience. He has publishing 36 papers in various international journals including journals indexed in Scopes. He has presented major paper in various international conferences and attended many seminars. He is acting as reviewer in many international journals.

Email: deepak@gni.edu.in

agarwaldeepakbarara@gmail.com

AUTHOR 3

Er. Jatin Thereja is working as assistant professor in Department of civil engineering, Guru Nanak Institute of Technology, Mullana (Ambala). He has done B. tech . He has 7 years of teaching experience. He has published 9 papers in various international journals including journals indexed in scopes.

Email:

AUTHOR 4

Er. Ashu Rana is working as assistant professor in Department of civil engineering, Guru Nanak Institute of Technology, Mullana (Ambala). He has 2 years of teaching experience. He has published 5 papers in various international journals including journals indexed in Scope.

Email: ashuranamullana@gmail.com