Prediction of stage-discharge of a meandering channel using ANFIS

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Introduction

Prediction discharge in a meandering river is required in several river hydraulic problems such as river engineering, environmental engineering, and intake designs. From a practical point of view it is very essential in flood prediction, the bank protection, navigation, water intakes, and sediment transport-depositional patterns etc. Influencing parameters are slope, geometry, sinuosity, roughness coefficient. But to estimate accurate discharge proper value of roughness plays a major role in this context. The main aim of this study is to investigate the method that developed for roughness and hence the discharge calculation in comparison with experimental data sets, developing a new and accurate methodology for roughness coefficient determination. Using ANFIS the roughness value is evaluated that performs quite better to find out discharge than other methods.

Materials & Methods

▪**Shino&Knight (1999)**

$$n = \frac{(s/10)*R^{1/6}}{8^{1/2}}$$

▪**LSCS method**
James and Wark (1992)

$$n'/n = 0.43s + 0.5$$ **For s>1.7**

$$n'/n = 1.3$$ **For s<1.7**

▪**Khatua et. al (2011)**

$$n = \frac{S_r v^{0.72} S^{0.07} m^{0.29}}{7k\alpha g^{0.86} R^{1.2}}$$

▪**Adptive –neuro fuzzy inference system (Jang & Gully , 1995)**

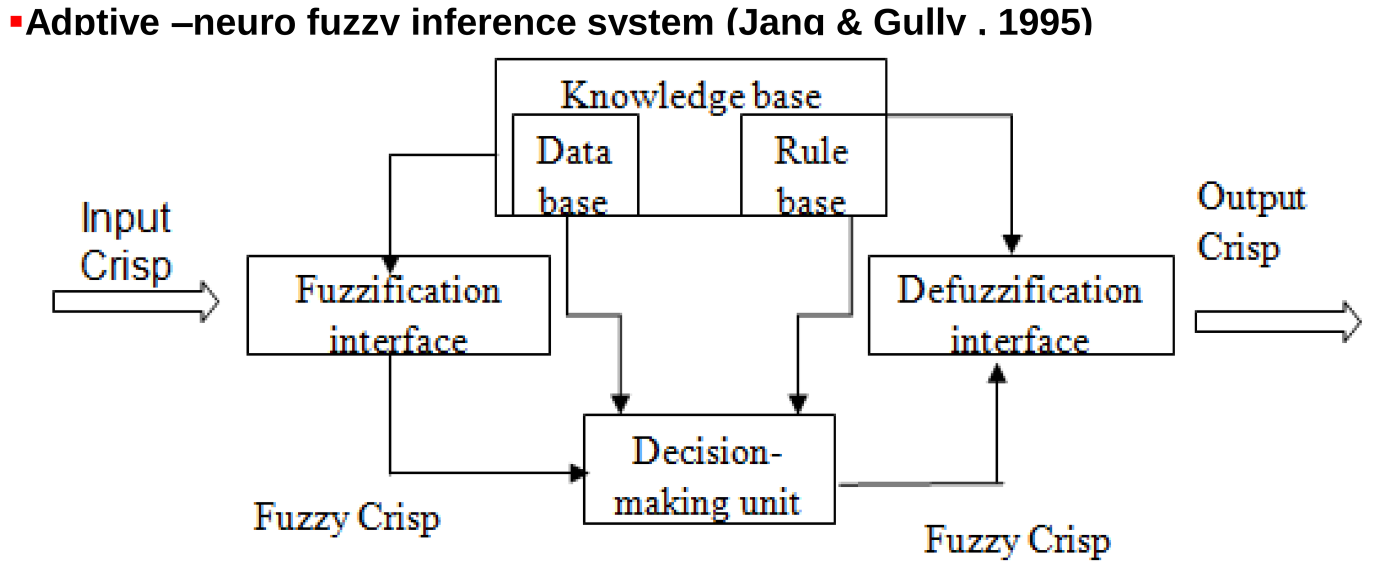

Fig.1 Schematic diagram of fuzzy based inference system

Table 1 Range of Collected data Set

Sl. No	Source of Data	Parameters			
		Bed slope of channel (S_0)	Sinuosity (S_r)	Aspect ratio (α)	Hydraulic Radius (R)
1	Hydraulics Lab. At NIT Rourkela (Khatua et.al,2008, Pinaki 2010)	0.0019 – 0.021	1 – 1.91	1.043 – 10.909	0.003 – 0.039
2	Hydraulics lab. At IIT Kharagpur (Patra and Kar, 2000)	0.001 – 0.0061	1.043 – 1.438	0.49 - 5.116	0.022 – 0.115
3	University of Bradford (Shino and Knight, 1999)	0.0005 – 0.002	1.092 – 1.571	2.885 – 24.482	0.002 – 0.031

Results & Discussion

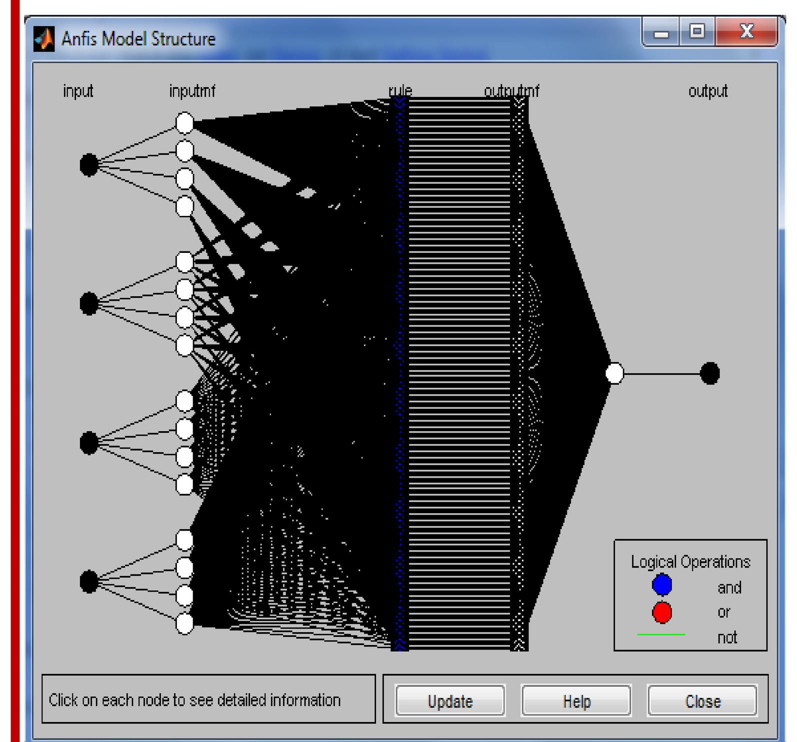

Fig. 2 Architecture of ANFIS model

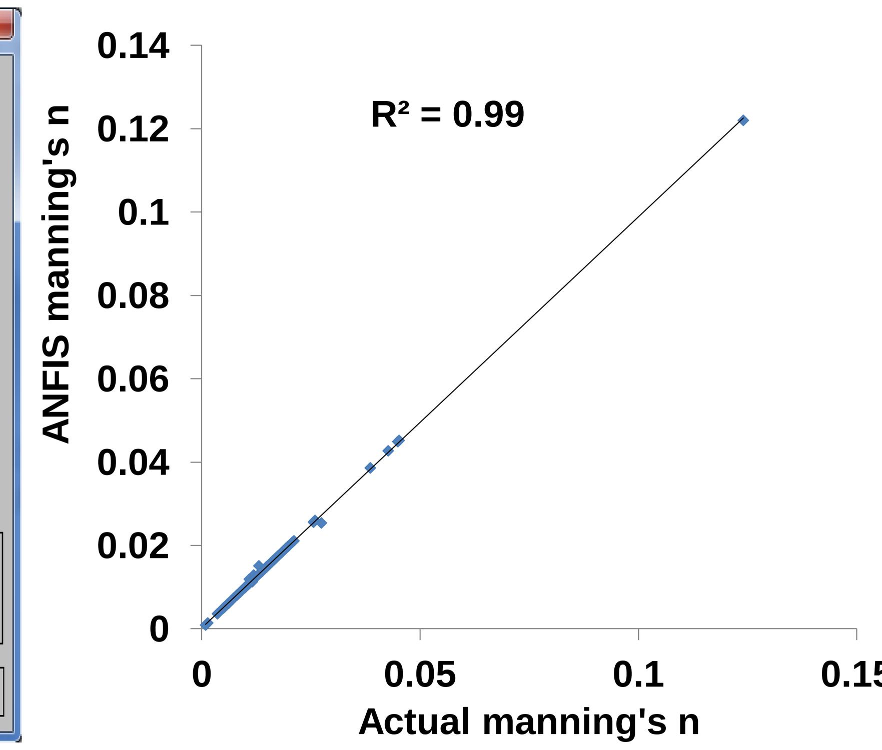

Fig.3 distribution of Training Data

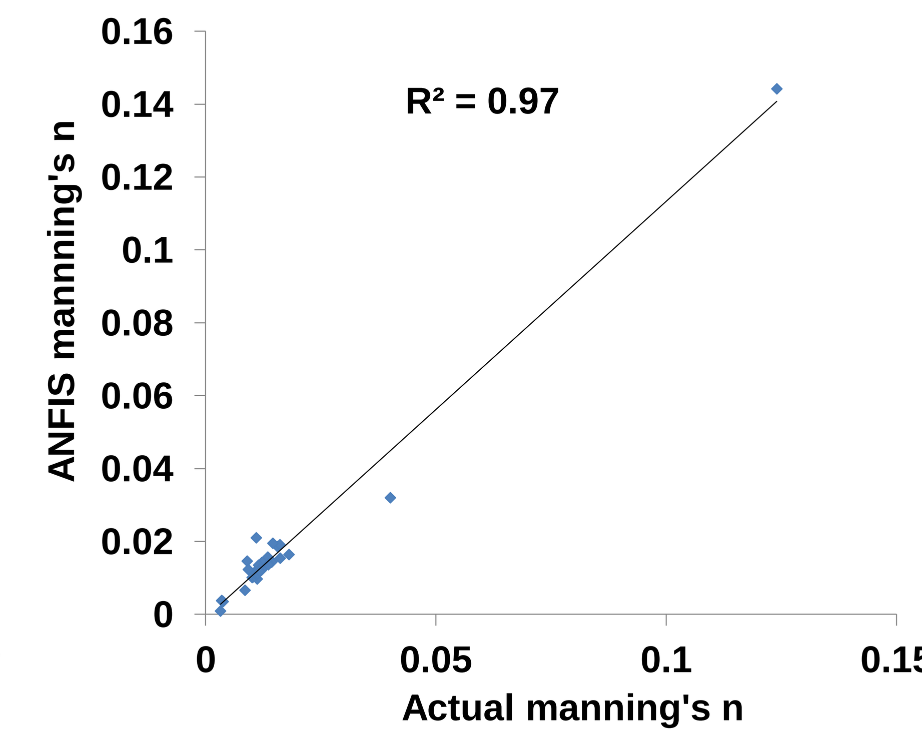

Fig.4 Distribution of Testing Data

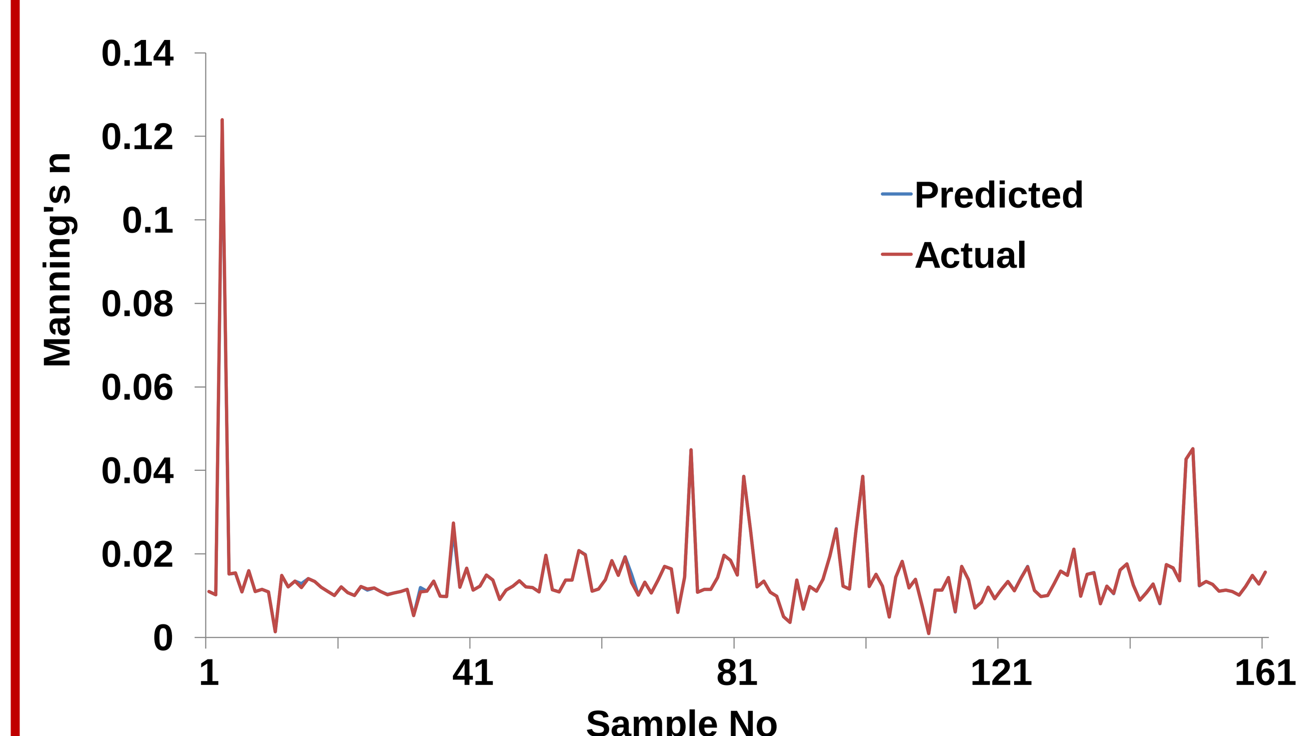

Fig.5 Performance of ANFIS result in Training

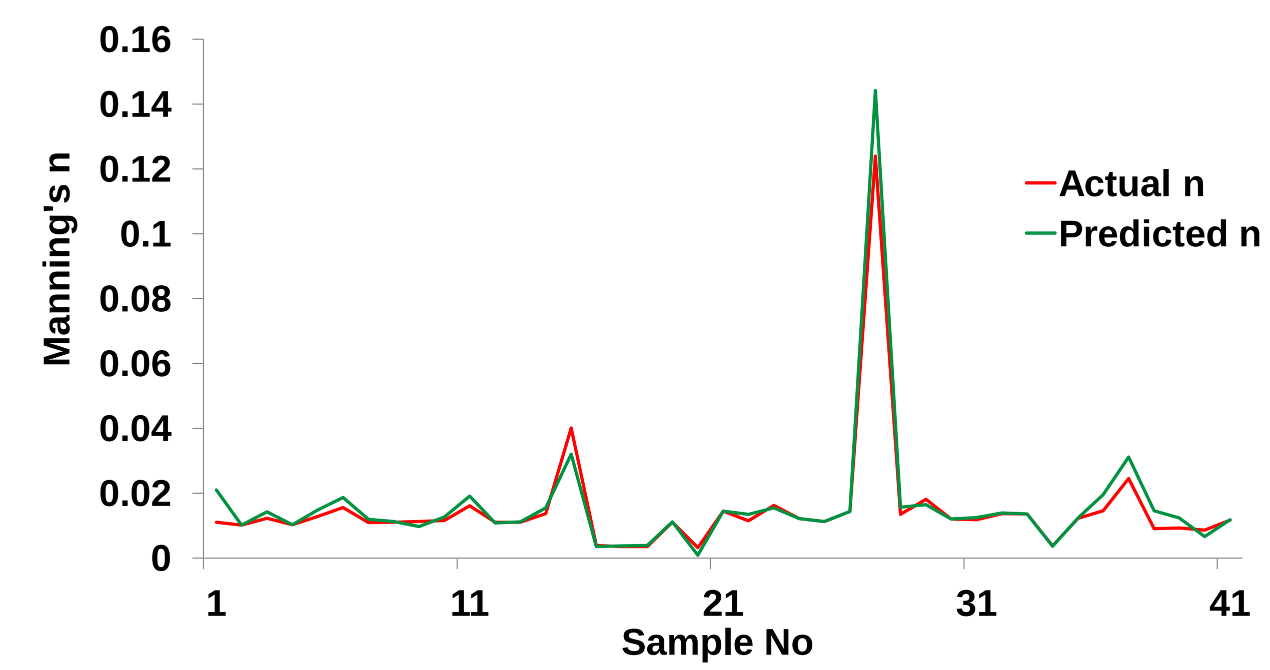

Fig. 6 Performance of ANFIS result in Testing

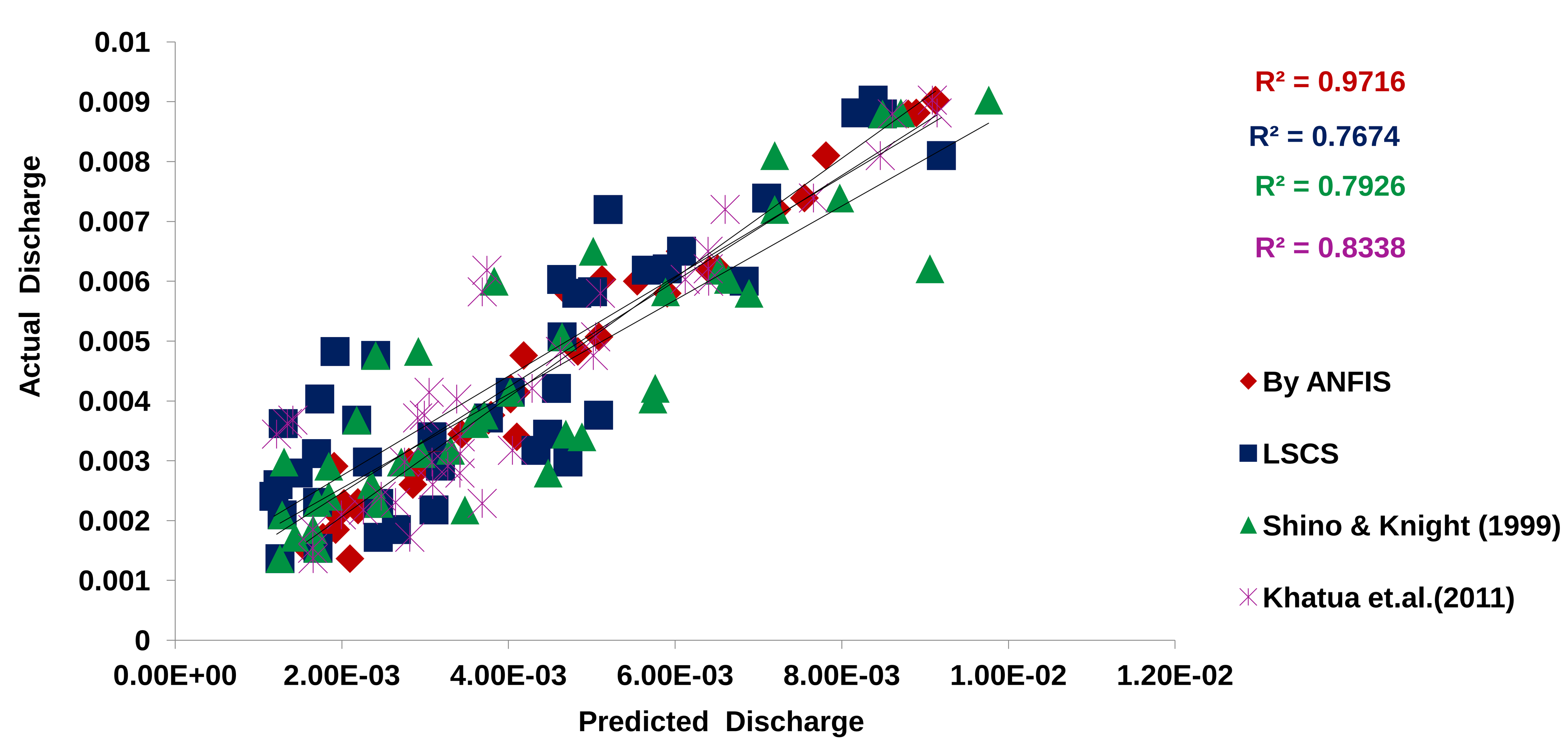

Fig. 7 Comparison of discharge

Conclusions

➤**Selection of roughness coefficient of a meandering channel depends on aspect ratio, longitudinal slope, relative roughness and sinuosity are the most influencing parameters.**

➤**Using global data sets, a ANFIS model to predict roughness coefficient and hence the discharge of a meandering channel has been developed. Data are well fitted because a high degree of coefficient of determination (R^2) as 0.99 for training and 0.97 for testing data are obtained.**

➤ **The MAPE was found to be 8.67, 2.49, 1.53 and 0.36 in LSCS, Shino & knight (1999), Khatua et al(2011) and present ANFIS models respectively which proves the adequacy of the present model.**

References

▪**Acrement, G. J., Jr; and Schneider, V. R. (1989) "Guide for selecting Manning's roughness coefficients for natural channels and flood plains" *U.S. Geological Survey Water-Supply paper* 2339, Federal Center, Colo.**

▪**Barnes, H.H., Jr.(1967) "Roughness Characteristics of Natural Channels" *U.S. Geological Survey Water-Supply* Paper 1849, Federal Center, Colo.**

▪**Chow, Ven Te (1959), "Open-Channel Hydraulics" New York, McGraw- Hill Book Co.**

▪**James, C. S., and Wark, J. B. (1992). "Conveyance estimation for meandering channels." Rep. SR 329, HR Wallingford, Wallingford, U.K., Dec.**

•**Shino, K., Al-Romaih, J.S., and Knight, D.W.,(1999)."Stage-Discharge Assessment in Compound Meandering Channels", Journal of Hydraulics Engg., ASCE, vol.125, No.1. Pp.66-77.**

•**Patra, K.C., and Khatua, K. K. (2006), "Energy Loss and Discharge Estimation in Two Stage Meandering and Straight Compound Channel", EWRI of ASCE and IIT Kanpur. New Delhi.**

•**Khatua, K. K. ,Patra, K.C.& P. Nayak(2011) "Meandering effect for evaluation of roughness coefficients in open channel flow" Sixth int conf on river basin management-VI, Pp213-227, Vol 146 of WIT Transactions on Ecology and the Environment (ISSN 1743-3541), and modified version is accepted for Int Journal of CMEM(2012), WIT Press.**

• **Toebes, G. H., and Sooky. A. (1967). "Hydraulics of meandering rivers with floodplains". *Journal of Waterways and Harbors Division, American Society of Civil Engineers* 93(2): 213-236.**