Acceptance of Abstract for International Workshop on River Management (IWRM-2010)- Abstract Number IWRM-129

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Reference: Abstract Number IWRM-129

Dear Mr. Thomas,
The technical committee of the IWRM-2010 is pleased to inform you that the abstract entittled "Daily runoff simulation in Sonar and Bearma basins of Ken river system"is accepted for Oral presentation in the International Workshop on River Management (IWRM-2010) to be held at NASC Complex, DPS Marg, Pusa, New Delhi during December 14-16, 2010.

You are requested to submit the full length paper and register for the conference on or before 05 November 2010. You are cordially invited to present your paper in the International Workshop. Once again, we thank you for your interest in IWRM-2010 and we look forward to meeting you at New Delhi in the Workshop.

Yours Sincerely

(Ashish Pandey)

Joint Organizing Secretary, IWRM-2010

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Attachments: (1). Information Brochure.
(2). Guidelines for preparation of manuscript

DAILY RUNOFF SIMULATION OF SONAR AND BEARMA BASINS OF KEN RIVER SYSTEM

T. Thomas, R. V. Galkate, R. K. Jaiswal & N. C. Ghosh

ABSTRACT

The understanding of the rainfall-runoff process and the time distribution of runoff are the basic components of water resources planning and design. Hydrologic modeling of stream flow is very important to ascertain, forecast and distribute the river flows properly, optimally and judiciously and the conceptual mathematical models are useful tools for simulation of the non-linear rainfall-runoff process. Tank model is one of the important models used extensively for the daily runoff simulation in humid as well as non-humid basins. Even though its model structure is simple, it is capable of representing some of the complex hydrological processes while simulating the rainfall-runoff response. The Tank model has been applied for Sonar and Bearma basins of Ken river system in Madhya Pradesh. The calibration of the model has been carried out for the period of three years from 1992 to 1994 for both the basins. The model efficiency during calibration for Sonar basin varies from 0.70 to 0.84 whereas the model efficiency during calibration for Bearma basin varies from 0.65 to 0.80. The model has been tested with the independent data of 1995, and the model efficiency during the validation period is 0.78 and 0.71 for Sonar and Bearma basin, respectively. The overall performance of the Tank model is satisfactory and can be applied to simulate the rainfall-runoff response of other basins in Central India for the water resources management in these river basins.

Key words: rainfall-runoff, response, simulation, Tank model, conceptual.

INTRODUCTION

The hydrologic behavior of a catchment is very complicated and is controlled by the climatic and physiographic factors that vary in time and space. The hydrologic response of a basin is dependent on its geology, soil characteristics, topography, vegetation and climate. The section of the hydrological cycle involving rainfall, basin characteristics, water flow, evaporation and infiltration is known as rainfall-runoff process. The process of transformation of rainfall to runoff involves a mechanism in which various factors including hydrometeorology, vegetation, and land use of the river basin are compounded and this complex process is fluctuated into a model. Hydrologic simulation models of a catchment based on physical and mathematical concepts have been developed by several researchers to simulate the rainfall-runoff processes since they are non-linear and time-variant. But in such catchments where hydro-meteorological and hydrological information are generally not available, the conceptual modeling approach can provide solution to many hydrological problems. The mathematical models, in a conceptual way are capable of simulating the most significant components of the runoff generation process.

The Tank model has been considered as one of the models in the inter-comparison of conceptual models by World Meteorological Organization and has been included in the WMO Report No. 429 (1975) titled 'Inter-comparison of conceptual models used in operational hydrological forecasting'. Tank model has been applied extensively in Japan and also been applied to data of river basins in other countries like Malaysia, Thailand, Canada and some African countries. The model also considers the snowmelt component and irrigation water applied to some part of the basin and can be applied to both humid and non-humid basins. The Tank model which has a merit of simplicity in data requirement, however, has a drawback, in that it needs much time and effort to calibrate its too many model parameters. There have been many researches on parameter calibration of the tank models. Nagai and Kadoya (1979) applied three optimization algorithms of Powell's method, DFP (Davidon, Fletcher and Powell) method, and QG (combined techniques of Quasi-linearization and Golden section) and proved the capability of Powell's method and DFP method in parameter identification. Kim, H. Y. and Park, S. W. (1986) evaluated parameter variations with watershed characteristic for six watersheds in Korea. Cooper et al. (1997) investigated the performance of three optimization algorithms, that is, SA (Simulated Annealing), GA, and SCE (Shuffled Complex Evolution) for calibrating the tank model that contains only two tanks

Application of Tank model for hydrological studies in India has been rather limited. Datta et. al. (1985) has used the Tank model for the simulation of daily runoff for Chota Tawa river at Ginnore. Ekbote et. al. (1982) has used the Tank model for daily runoff analysis for Venna catchment in Western Ghats. They used the data of 1975 for calibration of the model and reported good comparison of observed and simulated flows. However no attempt was made to test the performance of the model with independent data. Jain et. al. (1994) has applied the Tank model for the daily runoff simulation of Hemvati river at Sakleshpur. The data from 1975 to 1977 was used for the calibration of the parameters and the model was tested with the independent data for 1978 to 1980. Vijayakumar et. al. (1993), have applied the Tank model for the daily runoff simulation for Sarada river upto Anakapalli and obtained satisfactory results. Ramasheshan et. al. (1984) have simulated the daily runoff of two sub-basins of river Narmada using Tank model. Ramasastri et. al. (1988-89) applied the Tank model for simulation of daily runoff of two sub-basins of river Krishna.

Gustavo et. al. (2008) coupled the tank model with an artificial neural network (ANN) for modeling the rainfall runoff process in the Brue catchment in South West of England. The ANN was adapted to the Tank model to modify six model parameters to make it adaptable to time variations so as to improve the efficiency. Chen et. al. (2006) used the semi-distributed form of the Tank model coupled with ANN, by which the spatial variations in the rainfall and model parameters were accounted for by sub-dividing the basins into a number of sub-catchments. Also, in contrast to the linear summation commonly used in watershed routing that usually regards the total simulated runoff at the entire catchment outlet as a linear superposition of the routed runoff from all individual sub-catchments, artificial neural networks have been employed to explore nonlinear transformations of the runoff generated from the individual sub-catchments into the total runoff at the entire watershed outlet. These studies illustrated that coupling ANNs with traditional conceptual models reveals a promising new approach to catchment rainfall-runoff modeling.

THE STUDY AREA

The Ken river basin lies between latitudes 23° 20' and 25° 20' N and longitudes of 78° 30' and 80° 32' E with a catchment area of 28058 sq. kms. The map showing Ken river system and its tributaries is presented in Fig.1.

The Sonar basin upto Garhakota gauging site with a catchment area of 1384.41 sq. km. and Bearma basin upto Gaisabad gauging site with a catchment area of 5709.0 sq. km. have been considered for carrying out the modelling studies. The major tributaries of Sonar are Bewas, Dehar, Kaith and Baink on the left bank and Kopra and Bearma on the right bank. Some of the important tributaries of river Bearma are Lamti, Sun, Bamner, Guraiya, Godhar and Mala. Black cotton soils are mostly found in the both the basins. The major crops grown are wheat, paddy, maize, and sunflower among other crops like jowar, groundnut and soyabean.

Most of the districts lying in the catchment area of Ken river face acute water shortages year after year during the peak summer season. The flow in most of the tributaries is very meager and depends entirely on the south-west monsoon which occurs from mid-June to the end of September. The average annual rainfall in the basin is fairly good and ranges between 1200 to 1250 mm, but owing to the poor water management practices, the percentage of irrigated area in the study area is hardly 2-3% of the total geographical area. Due to the limited data availability for the region, application of the complex hydrological

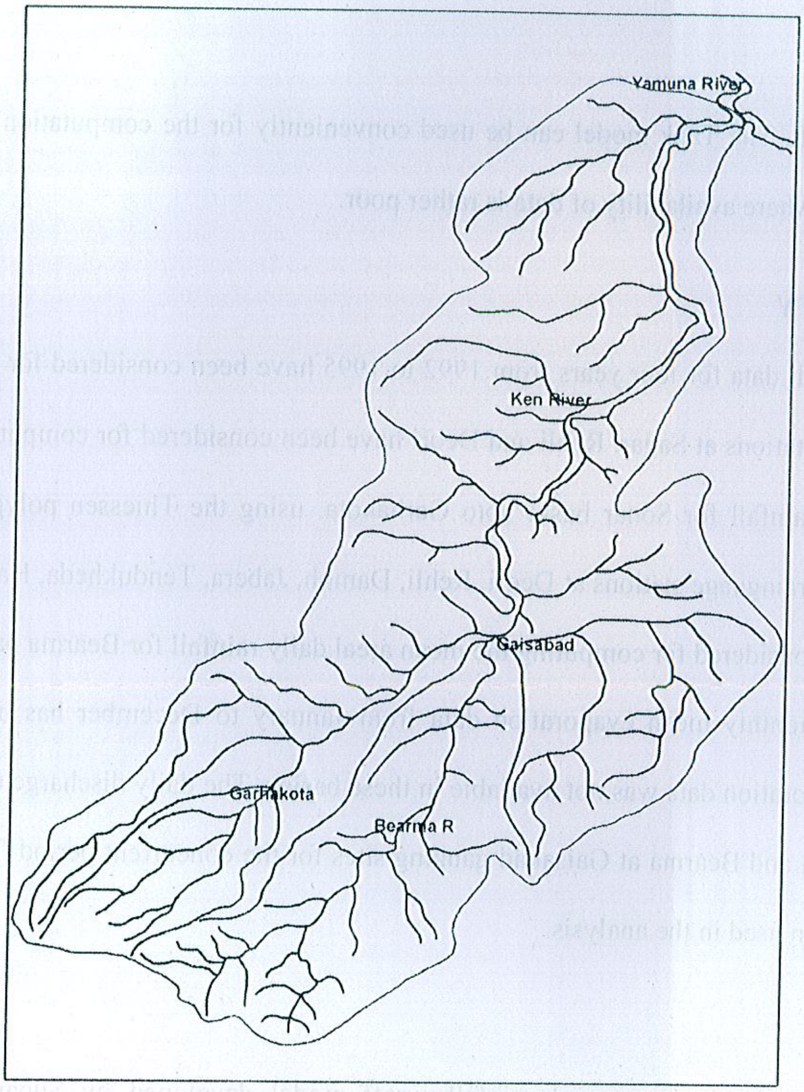

Fig. 1: Ken river system showing Sonar and Bearma rivers

models is rather difficult. The Tank model can be used conveniently for the computation of runoff for such basins, where availability of data is rather poor.

DATA AVAILABILITY

The daily rainfall data for four years from 1992 to 1995 have been considered for the study. The rain gauge stations at Sagar, Rehli and Deori have been considered for computing the mean areal daily rainfall for Sonar basin upto Garhakota, using the Thiessen polygon method. Similarly, the rainguage stations at Deori, Rehli, Damoh, Jabera, Tendukheda, Hatta, and Pawai have been considered for computing the mean areal daily rainfall for Bearma basin upto Gaisabad. The monthly mean evaporation data from January to December has been used, as the daily evaporation data was not available in these basins. The daily discharge data for Sonar at Garhakota and Bearma at Gaisabad gauging sites for the concurrent period from 1992 to 1995 have been used in the analysis.

TANK MODEL

Tank model is simple conceptual rainfall-runoff model developed by Sugawara (1961) of Japan to simulate the daily runoff of a basin. The model used for daily flow analysis is composed of several tanks laid vertically in series representing soil moisture and ground water in different soil strata of the basin as shown in Fig. 2. Each tank has one side outlet and one bottom outlet except the top tank, which has two side outlets, and the bottom tank, which does not have any bottom outlet. The top tank corresponds to the structure of the ground surface and the discharge through the side outlets represents the surface flow, while the discharge through the bottom outlet represents infiltration. Similarly, discharges through the side outlets of the second, third and fourth tank represents inter-flow, sub-surface flow and base flow respectively. The sum of the outflows through the side outlets of the four tanks represents the total runoff from the basin. The heads (threshold levels) of the two side outlets

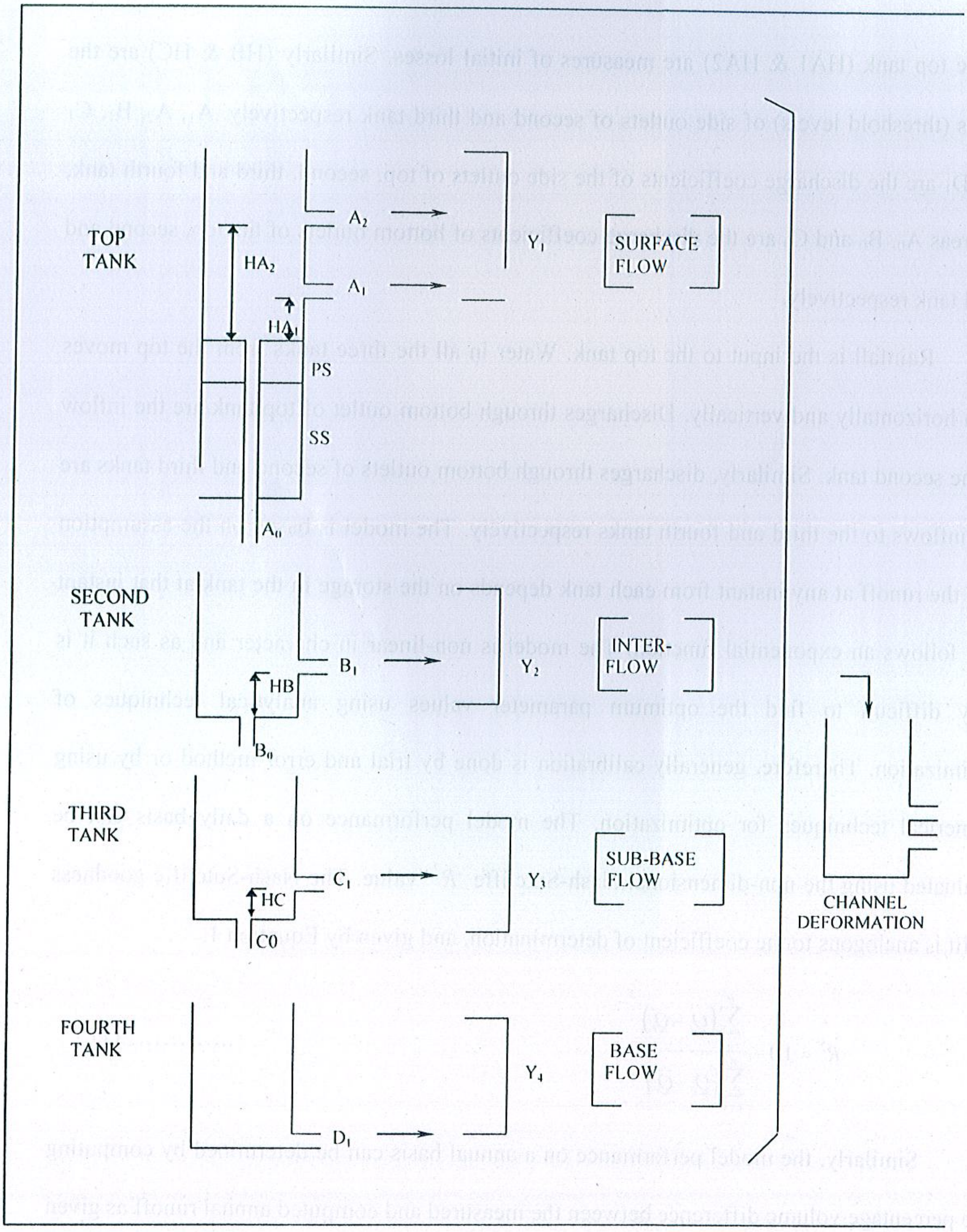

Fig. 2 : 4 x 1 Tank model structure for a humid basin

of the top tank (HA1 & HA2) are measures of initial losses. Similarly (HB & HC) are the heads (threshold levels) of side outlets of second and third tank respectively. A_1, A_2, B_1, C_1 and D_1 are the discharge coefficients of the side outlets of top, second, third and fourth tank, whereas A_0, B_0 and C_0 are the discharge coefficients of bottom outlets of the top, second and third tank respectively.

Rainfall is the input to the top tank. Water in all the three tanks from the top moves both horizontally and vertically. Discharges through bottom outlet of top tank are the inflow to the second tank. Similarly, discharges through bottom outlets of second and third tanks are the inflows to the third and fourth tanks respectively. The model is based on the assumption that the runoff at any instant from each tank depends on the storage in the tank at that instant and follows an exponential function. The model is non-linear in character and as such it is very difficult to find the optimum parameter values using analytical techniques of optimization. Therefore, generally calibration is done by trial and error method or by using numerical techniques for optimization. The model performance on a daily basis can be evaluated using the non-dimensional Nash-Sutcliffe 'R^2' value. The Nash-Sutcliffe goodness of fit is analogous to the coefficient of determination, and given by Equation 1,

$$R^2 = 1.0 - \frac{\sum_{i=1}^{n}\left(Q_i - Q_i^{'}\right)^2}{\sum_{i=1}^{n}\left(Q_i - \overline{Q}_i\right)^2} \qquad \text{.............(1)}$$

Similarly, the model performance on a annual basis can be determined by computing the percentage volume difference between the measured and computed annual runoff as given by Equation 2,

$$D_v = 100\frac{\sum_{i=1}^{n} Q_i - \sum Q_i^{'}}{\sum_{i=1}^{n} Q_i} \qquad \text{............(2)}$$

where, R^2 = Nash-Sutcliffe goodness of fit; Q_i = observed daily discharge on ith day; Q_i'= simulated daily discharge on ith day; $\overline{Q_i}$ = mean of observed discharge; D_v = percentage volume difference between the measured and computed runoff; n = number of days in simulation period

METHODOLOGY

A period of ten years continuous data containing both wet and dry years is a good choice but a minimum of four years of continuous daily discharge, rainfall and evaporation data is sufficient to calibrate and validate the model. The observed discharge is plotted in logarithmic scale against time in natural scale. A rough estimation of time constant (TC) of runoff, is made from the recession slope of the flow hydrograph. The initial Tank model parameters are then evaluated. The decreasing ratio (α) is calculated as 1/TC. From the value of (α) the discharge coefficients and initial losses are calculated for top tank, second tank and third tank using the equations

$$A_0 = A_1 = A_2 = \alpha/2;\ B_0 = B_1 = \alpha/10;\ C_0 = C_1 = \alpha/50 \qquad \text{............ (3)}$$

The values of initial losses are selected from the following ranges.

HA_1 = 0 – 15 (mm); HA_2 = 15 – 40 (mm); HB = 5 – 15 (mm); HC = 5 – 15 (mm)

For simplicity, the arithmetic mean of the rainfall values of the various rain guage stations in and around the basin can be considered. However, the mean areal values of daily precipitation have been considered in the study. The unit of time lag is one day. Initial time lag is considered to be zero. If the observed daily evaporation data is available for a number of stations within the basin or near the basin, then the mean daily evaporation values can be computed and used for the analysis. However as no such data is available for the period under consideration, the monthly mean of daily evaporation value for a nearby region have been used in the study. The initial amount of storage of the fourth tank can be derived from the long duration of dry period. For the first trial, the initial values of all the tanks were set to zero.

ANALYSIS OF RESULTS

Calibration of the Model

The observed discharge have been plotted in logarithmic scale against time in natural scale. From the recession slope of the flow hydrograph the decreasing ratio (α) is evaluated to be 0.28 and 0.45 for Sonar and Bearma basin respectively. The initial Tank model parameters have been adopted as discussed earlier. The initial storage's XA, XB, XC and XD are initially assumed to be zero. With these initial set of parameters the model is run. The model then simulates the outflow hydrograph. Comparison is made between the observed and simulated hydrograph based on the peak flow value, time to peak and recession slopes of the hydrograph. The calibration of the parameters is done by trial and error method. The value of each parameter is successively changed and from the comparison of fit of observed hydrograph with the simulated hydrograph, the best-fit parameter value is ascertained. The parameters were changed and adjusted one by one in successive trials till an overall good fit is obtained. The final tank model parameters after calibration for Sonar and Bearma basin is given in Table 1 and Table 2 respectively.

Table 1: Final tank model parameters for Sonar basin

S.No	Tank details	Discharge coefficients		Initial losses (mm)
		Side Outlet	Bottom Outlet	
1.	Top tank	A1 = 0.148	A0 = 0.108	HA1 = 15.0
2.	Second tank	B1 = 0.026	B0 = 0.026	HB = 15.0
3.	Third tank	C1 = 0.005	C0 = 0.005	HC = 15.0
4.	Bottom tank	D1 = 0.001	D0 = 0.000	HD = 0.0
5.	Saturation capacity of Primary Soil Moisture			PS = 45.0
6.	Saturation capacity of Secondary Soil Moisture			SS = 225.0

Table 2: Final tank model parameters for Bearma basin

S.No	Tank details	Discharge coefficients		Initial losses
		Side Outlet	Bottom Outlet	
1.	Top tank	A1 = 0.200 A2 = 0.200	A0 = 0.150	HA1 = 15.0 HA2 = 40.0
2.	Second tank	B1 = 0.04	B0 = 0.04	HB = 15.0
3.	Third tank	C1 = 0.008	C0 = 0.008	HC = 15.0
4.	Bottom tank	D1 = 0.002	D0 = 0.000	HD = 0.0
5.	Saturation capacity of Primary Soil Moisture			PS = 40.0
6.	Saturation capacity of Secondary Soil Moisture			SS = 200.0

The graph showing the comparison of calculated and observed daily runoff during one of the calibration years of 1992 for Sonar and Bearma basin is presented in Fig. 3 and Fig. 4 respectively. From Fig. 3 it is observed that the model is able to simulate the flows quite appreciably, even though a few peaks remain underestimated. Similarly, from Fig. 4 it is observed that the model is able to simulate the flows reasonably well except for one peak. The Nash-Sutcliffe goodness of fit for Bearma basin during the calibration period varies from0.65 to 0.80 and the seasonal percentage difference in volume varies between –28.20% and 20.14%. It is observed that the calibration is in the acceptable stage and the calibrated parameters are subsequently used for the validation of the model.

2. Validation of the Model

The model has been validated with the independent data for the year 1995 with the same set of final parameters as obtained during the calibration for both the basins. The graph showing the comparison of the calculated and observed daily runoff for the year 1995 is given in Fig. 5 and Fig. 6, for Sonar and Bearma basin respectively, shows that the model is able to simulate the flows reasonably well.

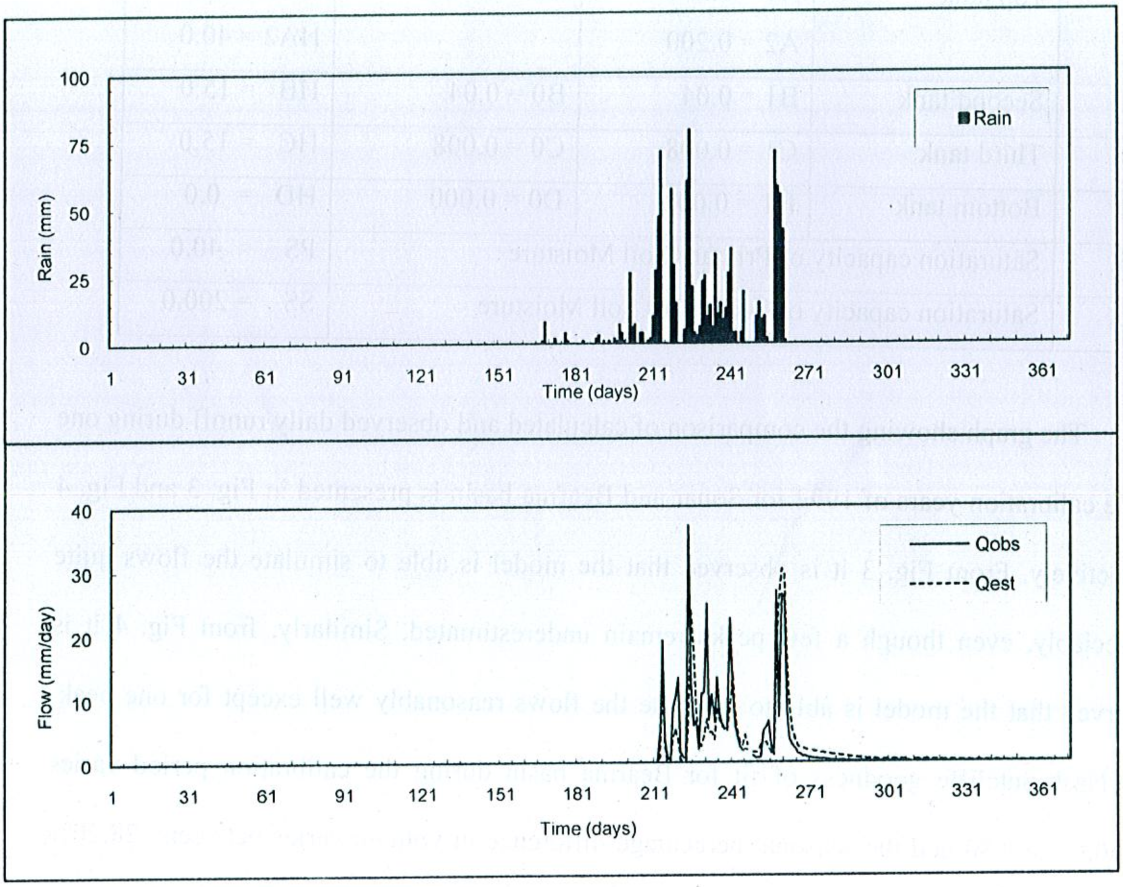

Fig. 3: Comparison of observed and simulated flows for Sonar during calibration (1992)

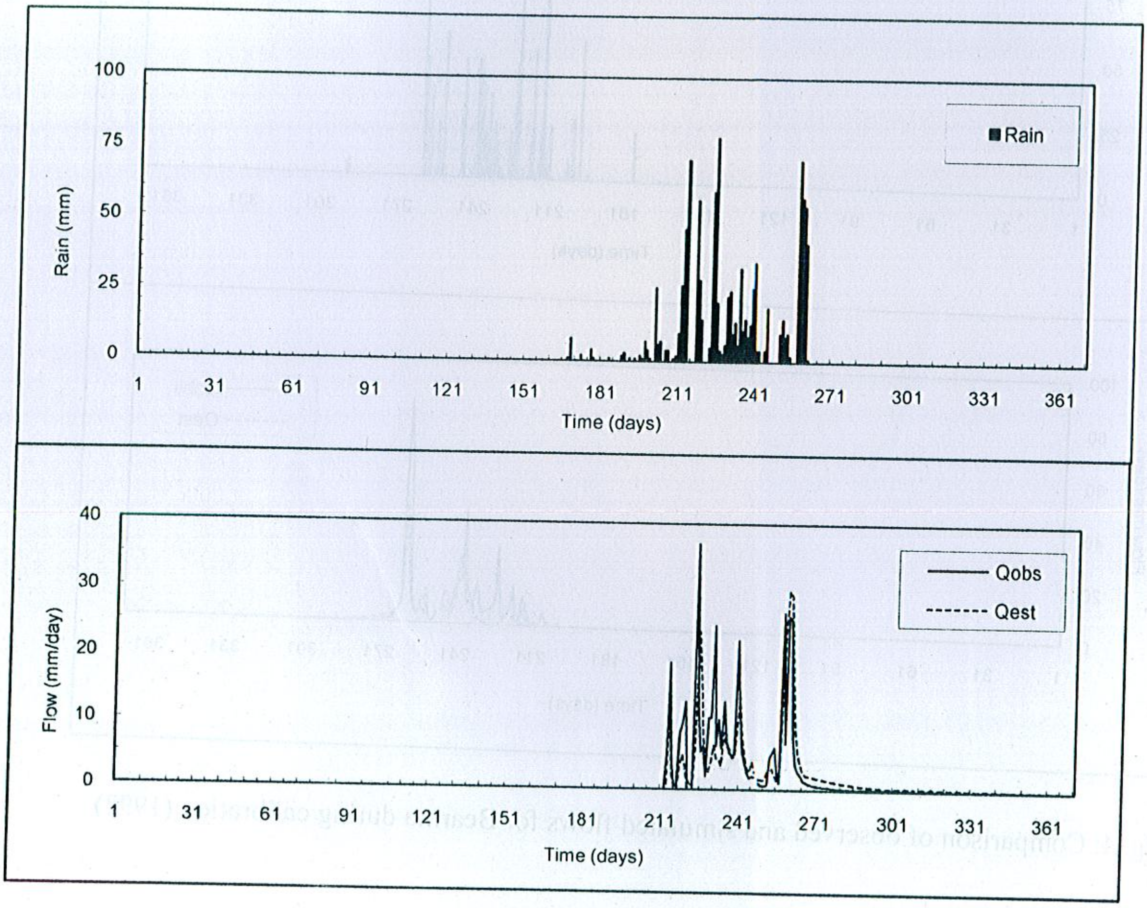

Fig. 5: Comparison of observed and simulated flows for Sonar during validation (1995)

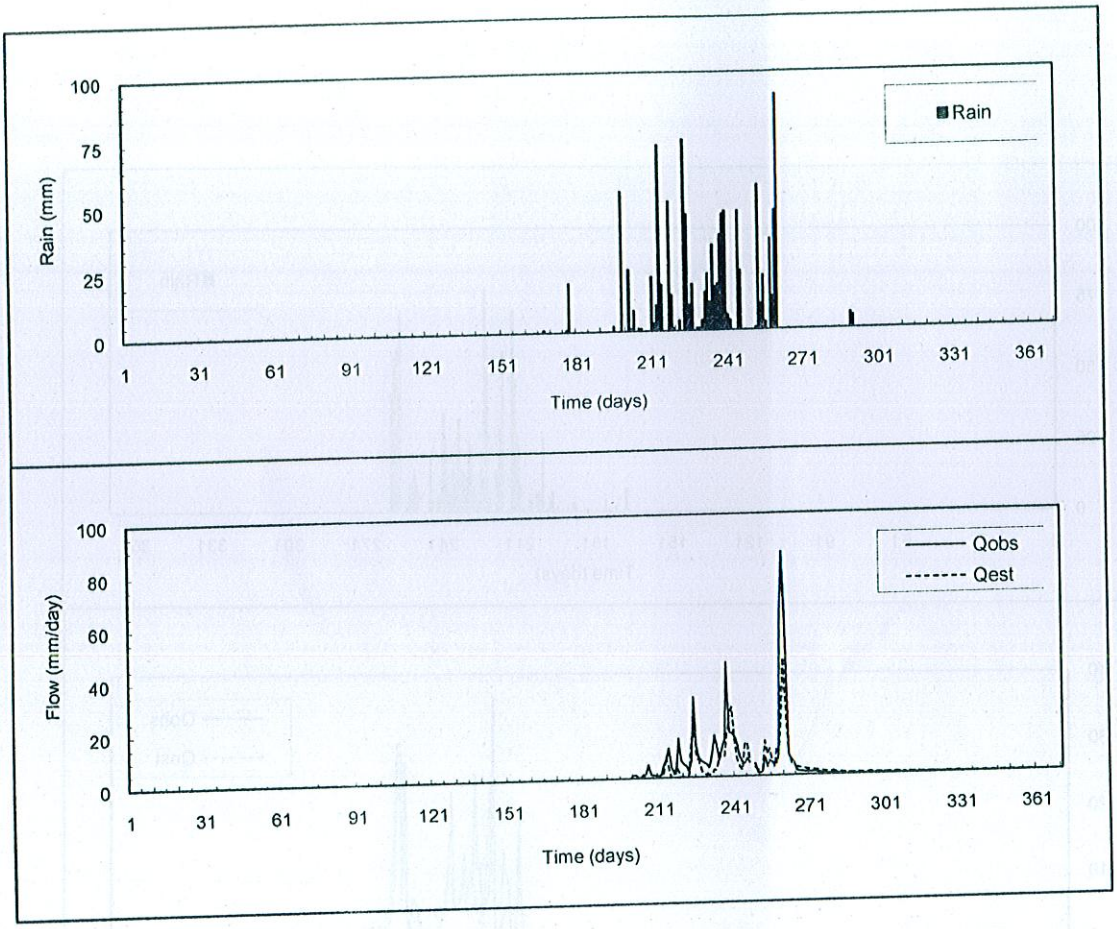

Fig. 4: Comparison of observed and simulated flows for Bearma during calibration (1992)

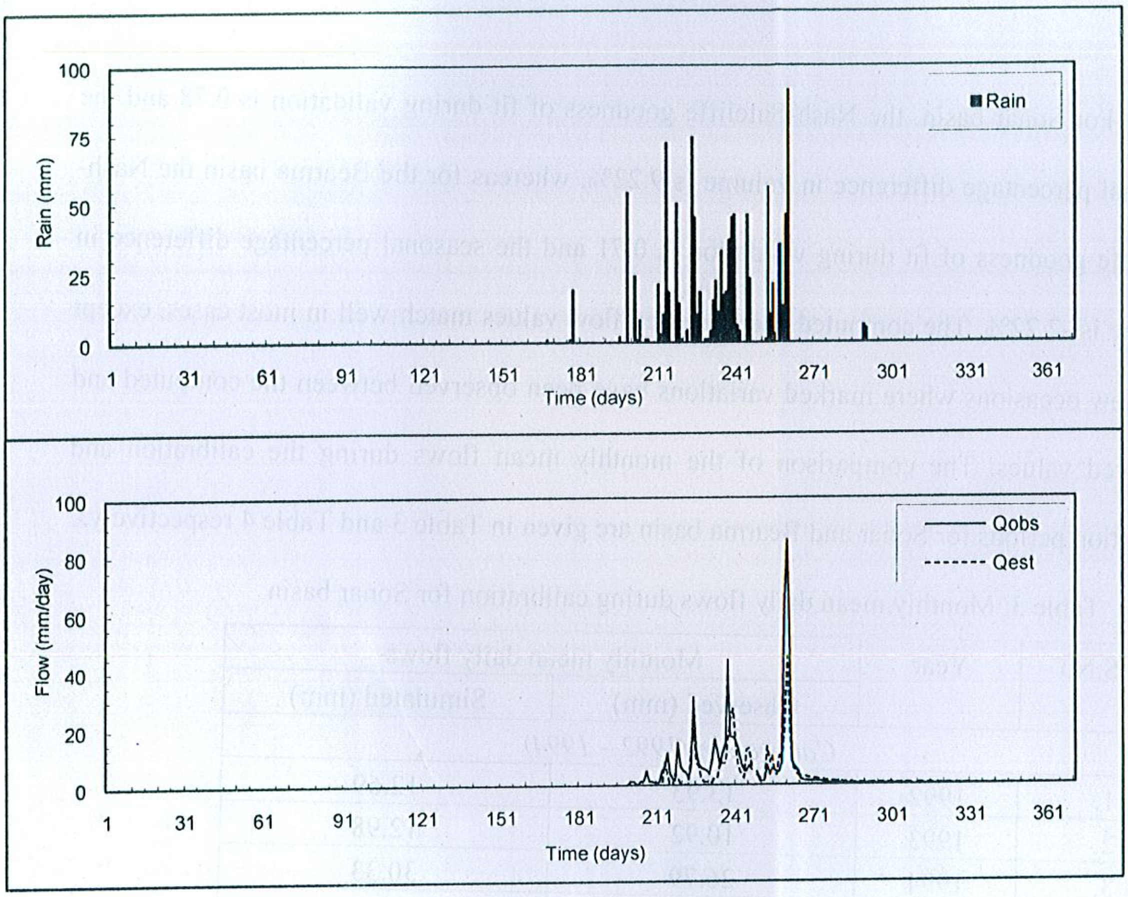

Fig. 6: Comparison of observed and simulated flows for Bearma during validation (1995)

For Sonar basin, the Nash-Sutcliffe goodness of fit during validation is 0.78 and the seasonal percentage difference in volume is 9.22%, whereas for the Bearma basin the Nash-Sutcliffe goodness of fit during validation is 0.71 and the seasonal percentage difference in volume is -2.22%. The computed and observed flow values match well in most cases, except on a few occasions where marked variations have been observed between the computed and observed values. The comparison of the monthly mean flows during the calibration and validation periods for Sonar and Bearma basin are given in Table 3 and Table 4 respectively.

Table 3: Monthly mean daily flows during calibration for Sonar basin

S.No	Year	Monthly mean daily flows	
		Observed (mm)	Simulated (mm)
Calibration (1992 – 1994)			
1.	1992	13.93	12.69
2.	1993	10.92	12.98
3.	1994	26.79	30.33
	Total	*51.64*	*56.19*
Validation (1995)			
4.	1995	7.29	6.61

Table 4: Monthly mean daily flows during calibration for Bearma basin

S.No	Year	Monthly mean daily flows	
		Observed (mm)	Simulated (mm)
Calibration (1992 – 1994)			
1.	1992	21.09	14.72
2.	1993	11.85	16.33
3.	1994	33.93	27.11
	Total	*66.87*	*58.16*
Validation (1995)			
4.	1995	11.02	11.29

CONCLUSIONS

As all the rivers and its tributaries falling under the study area are rain-fed and as there is acute water scarcity during the summer season, it is necessary to store the rainwater through check dams on these tributaries of river Ken. Due to the limited availability of hydrological and hydro-meteorological data in Ken basin, a model with minimum data requirement and simple structure is to be applied for simulating the flows. Tank model being simple and versatile has been used for this purpose. The overall performance of the Tank model in simulating the daily runoff during the calibration and validation period is reasonably good. On comparison of the simulated and observed hydrographs it is observed that few peaks are underestimated. The parameters of the Tank model have been calibrated using the trial and error approach. However an optimization technique together with the trial and error procedure may be a better alternative for calibration, which may further improve the results. It can be concluded that as the model is able to simulate the flows with reasonable degree of accuracy and can be applied effectively in the basins of the Ken river system to harness the scarce water resources of the region, which is the prime requirement for alleviating the acute water scarcity.

REFERENCES

1. Chen, J. & Adams, B. J., 2006. Semi-distributed Form of the Tank Model Coupled with Artificial Neural Networks. ASCE Journal of Hydrologic Engineering, 5: 408-417.

2. Cooper, V. A., Nguyen, V. T. V., and Nicell, J. A., 1997. Evaluation of Global Optimization Methods for Conceptual Rainfall-Runoff Model Calibration. Water Science and Technology, 36(5), 53-60.

3. Datta, B. & Seth, S. M., 1985. Simulation of Daily Runoff of river Chota Tawa at Ginnore using Tank model. Proc. 52nd Annual R&D Session of Central Board of Irrigation and Power, Civil, Vol. 2, February 3-6, Aurangabad.

4. Ekbote, A and Bhave, V. G., 1982. Application of a Conceptual Model for a Mountainous Watershed. Proc. of the International Symposium on Hydrological aspects of Mountainous Watersheds, Nov. 4-6, Roorkee.

5. Gustavo, C.V., Sergio, E. L.O & Efren, G. R., 2008. Tank Model Coupled with an Artificial Neural Network. Advances in Artifical Intelligence, 5317, 343-350.

6. Jain, M. K., 1993-94. Daily runoff Simulation of Hemvathy at Sakleshpur using 4 x 4 Tank model. CS(AR)-134, Rep. NIH, Roorkee.

7. Kim, H.Y. and Park, S.W., 1986. An Evaluation of Parameter Variation for a Linear Reservoir (TANK) Model with Watershed Characteristics. Journal of Korean Society of Agricultural Engineers, 28(2), 42-52.

8. Nagai, A., & Kadoya, M., 1979. Optimization Techniques for Parameter Identification of Runoff Models. Annual Report of Disaster Prevention Research Institute in Kyoto University, 22, B-2.

9. Ramasastri, K. S. & Arya, G. C., 1988-89. Simulation of Daily Runoff of two sub-basins of river Krishna using Tank model. TR-68, Rep. NIH, Roorkee.

10. Ramasheshan, S., Seth S. M., & Datta, B., 1983-84. Simulation of Daily Runoff of two sub-basins of river Narmada using Tank model. Rep. NIH, Roorkee.

11. Sugawara, M., 1961. On the analysis of runoff structure about several Japanese rivers. Japanese Journal of Geophysics, 2(4), 1-76.

12. Vijayakumar, S. V. V., 1992-93. Hydrologic modelling of river Sarada using Tank model. CS-106, Rep. NIH, Roorkee.

13. WMO., 1975. Inter-comparison of conceptual models used in operational hydrological forecasting. No. 429, Operational Hydrology, Report No. 7, WMO, Geneva, Switzerland.

Background

River management is a big challenge of the 21st century for the scientific community associated with water resources. River basins are complex systems. They are open systems with sometimes ill-defined boundaries. It refers to various aspects essential to achieve a sustainable development of river basins, including water demand and river management. Rivers may have shared delta, watershed limits in flatland areas are either vague or man-made (and alterable), and watershed limits often do not correspond exactly with aquifer limits. On top of this, river basins interact continuously with the atmosphere (precipitation and evaporation, airborne pollution) and the receiving waters (seas and sometimes lakes). Furthermore, the uses made of river basins often transcend river basin boundaries (eg. Inter-basin water transfers). Rivers are important as they fulfill many important functions, such as water supply for households, industry and agriculture, navigation, fishing, recreation, and 'living space'. Economic and social development and even life itself cannot be sustained without sufficient water at the right time and place and of right quality. Integrated river management is about all these things. It is much broader than traditional water management and includes significant parts of land-use planning, agricultural policy and erosion control, environmental management and other policy areas. It covers all human activities that use or affect freshwater systems. In brief, integrated river basin management is the management of water systems as part of the broader natural environment and in relation to their socio-economic environment. The problem has further been compounded by deforestation in catchment areas, siltation of rivers, diversion of water for irrigation and construction of cross structures such as bridges. India is largely lagging behind in river management. Many rivers like Brahmaputra, Ganga, Gandak, Koshi, etc. are facing problems of river course shifting, excessive bank erosion, excessive sediment load etc. These problems are the major concerns in India for maintaining essential ecological system, water needs, flows to deal with water scarcity during drought. The problems faced in river management are further complicated by the rigours of climate change phenomenon which is yet to be properly Understood.

This workshop is proposed to advance the profession of river management by providing managers, researchers, educators and others with a forum for sharing information about the appropriate use and management of river resources and developing expertise in all aspects of river management and stewardship including an ecosystem approach to recreation, water quality, riparian health, and watershed management.

Workshop Themes

This International workshop will provide a platform to the experienced and related expert professionals for intensive and threadbare deliberations to explore possible solutions to the vexed problem of stream flow management, channel improvement, sustainability of river eco-system & IWRM and inland water ways. The focuses of the workshop are as follows:

- Importance and challenges in river Management and channel improvement techniques in the backdrop of climate change.
- Canalization, flood control and erosion control.
- River morphology changes of large braided alluvial rivers
- Environmental friendly river management & sustainable development of ecosystem.
- Relevant Case Studies

After detailed deliberations on the issues listed above, it is proposed to hold an exclusive session which will be devoted to open Discussion and Documentation of Recommendation.

Workshop Sessions

Apart from Inaugural and Valedictory Sessions, the Technical Sessions & One Open discussion and Documentation Session will be arranged. The Key Note and Invited Speakers from abroad and India will present their valuable experience. The delegates will have enough opportunities for interaction during floor discussion and open discussion. All the accepted papers will be published in the proceedings of the workshop. The workshop papers will be peer reviewed and published in IWRS Journal. The detailed programme of the Inaugural, Technical and Valedictory Sessions will be published in the Final Announcement brochure which will be available to all the delegates well in advance.

About IIT Roorkee

The Indian Institute of Technology is the successor of the University of Roorkee and is the oldest technical institution of the country established as the Roorkee College in 1847 and rechristened as the Thomason College of Civil Engineering in 1857. It was elevated to the first Technical University of Independent India on November 25, 1949. In the year 2001, it was declared as the Institute of national importance and converted into the Indian Institute of Technology Roorkee on September 21, 2001.

About Indian Water Resources Society (IWRS)

Indian Water Resources Society (IWRS) was founded in 1980 as a society registered under the Societies Registration Act. IWRS Registered office is located in the Department of Water Resources Development & Management, IIT Roorkee. In addition, IWRS has local centers in most of the major cities. Subject to approval by the executive committee, membership of IWRS is open to any person who is interested in water sector. Presently, IWRS has about 7250 life members; 262 fellow members; and 22 institutional members,

The main objective of IWRS is advancement of knowledge in technical and policy aspects of water resources development and management. IWRS serves as a platform for free and frank discussions amongst those concerned with water related issues.

INTERNATIONAL WORKSHOP

ON

RIVER MANAGEMENT (IWRM-2010)

New Delhi, India
December 14-16, 2010

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About Department of Water Resources Development & Management (WRD&M)

Department of Water Resources Development and Management (WRD&M), Indian Institute of Technology Roorkee (IITR) is a premier place for learning of international standing in post-graduate education, training and research in the discipline of water resources development and management. Since its creation in 1955 under the stewardship of ECAFE (now ESCAP) of the United Nations, the department has imparted post graduate education and training on water resources development and management to 2234 water resources professionals from 41 countries of Asia, Africa and Latin America. The department has creditably undertaken numerous national and international sponsored research and consultancy projects on hydraulic & hydrological modelling, remote sensing & GIS based studies for river basin geomorphology & flood-plain changes, stream bank protection & erosion control, flood estimation & management, hydro power development, irrigation water management, river engineering including inland navigation, planning & design of hydraulic structures for water resources management. Besides regular post-graduation programmes, the department has been conducting many short-term national and international training courses in different themes of water resources management for the purpose of capacity building of water resources professionals from India and abroad. The department has successfully completed major R&D projects on action research for effecting improvement in specific under-performing large irrigation systems in India under sponsorships from Ford Foundation, IWMI etc.

Registration Fee

The Registration fee for the Workshop will be Rs. 3000 per Indian delegates and US$ 200 per foreign delegates. Registration fees for Indian students will be Rs. 1000/- only. The fee may be paid in the form of Demand Draft in favour of IWRM-2010 payable at Roorkee.

Date & Venue

The workshop will be held during December 14-16, 2010 in NASC Complex, DPS Marg, Pusa, New Delhi.

Call for Papers for Special Session

Papers from selected speakers on various themes will be invited from professionals in India and abroad. Also, abstract of papers of 100 words on the above session themes of the Workshop are invited latest by Sept. 15, 2010 and the acceptance will be notified by September 30, 2010. The full length papers will be submitted by November 5, 2010. The abstract of the papers can be emailed to the Conference organizers at secretaryiwrs@gmail.com OR nayanfwt@gmail.com

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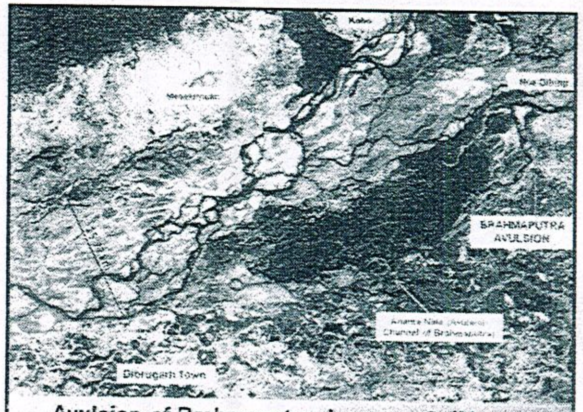
First Announcement

INTERNATIONAL WORKSHOP

ON

RIVER MANAGEMENT (IWRM-2010)

New Delhi, India
December 14-16, 2010



Avulsion of Brahmaputra river near Saikhowa

Organized by

IWRS

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Indian Institute of Technology Roorkee
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