SESSION-9 :

SEDIMENT YIELD, RAINWATER HARVESTING, MODELING ETC.

14th National Symposium on Hydrology with focal theme on "Management of Water Resources under Drought Situation", 21-22 December, 2010, Organized by National Institute of Hydrology, Roorkee and Malaviya National Institute of Technology, Jaipur at Jaipur, Rajasthan

RAINWATER HARVESTING AT N.I.T. ROURKELA

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ABSTRACT

At the rate in which India population is increasing, it is said that India will surely replace China from its number one position of most densely populated country of the world after 20-30 years from here on. These will lead to high rate of consumption of most valuable natural resource "Water" resulting in augmentation of pressures on the permitted freshwater resources. Ancient method of damming river and transporting water to urban area has its own issues of eternal troubles of social and political. In order to conserve and meet our daily demand of water requirement, we need to think for alternative cost effective and relatively easier technological methods of conserving water.

Rain water harvesting is one of the best methods fulfilling those requirements. The technical aspects of this paper are rainwater harvesting collected from rooftop which is considered to be catchment areas from all hostels and Institutes departmental building at N.I.T. Rourkela Campus. First of all, required data are collected i.e. catchment areas & hydrological rainfall data. Water harvesting potential for the hostels and faculty apartments was calculated, and the tank capacity with suitable design is being considered. Volume of tank has been calculated with most appropriate method of estimation. Optimum location of tank on the basis of hydrological analysis and GIS analysis was done in the campus. Finally, Gutter design, its analysis, first flush and filtration mechanism are also dealt with in detail.

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EFFECTS OF BOAT MOVEMENT ON CANAL BANK EROSION A CASE STUDY OF KUTTANADU REGION OF KERALA

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ABSTRACT

The life of Kuttanad people in Kerala State is mobilized around the canals and backwaters. The paddy cultivation in Kuttanad area is done below the mean sea level (MSL). The breaching of canals in rainy season and due to fast movement of boats is reported. The Government of India and Government of Kerala spend crores of rupees for giving compensation for loss of life and crops. The movement of regular ferry services and tourist boat services makes the situation more critical. The safety of weak embankments against the wave generated by boat movement and flood wave are of prime concern. The fast movement of boats also disrupts the habitat, re-suspension of bottom sediments, damage to aquatic plants are other areas of concern.

The present study attempts to correlate the boat, soil and canal characteristics and suggest possible solutions for strengthening the existing embankment. The wave pattern is recorded using a wave height gauge. The other parameters measured include: height of wave (H_{wave}), time period of wave, boat speed (Km/hr), power of the engine, depth of flow, width of flow, soil type (mainly clay soil with vegetative growth is observed in the region), boat characteristics. The collected data are analysed to obtain the correlation between boat-generated waves at bank, flow characteristics, erosion of bank. Based on the soil type (Kuttanadu Clay) the safe velocity of movement of boat in canal area is estimated and suggested to Government for required safety measures

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SUPPORT VECTOR MACHINES APPROACH FOR RATING CURVE MODELLING

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ABSTRACT

Establishment of rating curves are often required by the hydrologists for flow estimates in the streams, rivers etc. Accurate prediction of a stage-discharge curve is of immense importance for reliable planning, design and management of the water resources projects. Since the measurement of discharge in a river is a time-consuming, expensive, and difficult process and the conventional approach of regression analysis of stage-discharge relation does not provide encouraging results especially during the floods. Therefore, present study is aimed at the application of soft computing techniques such as polynomial and radial basis functions kernels of Support Vector Machines and multi-linear regression for modelling stage-discharge relation and discharge prediction on a data set of an Indian river. . The input data set is divided into several parts (a number defined by the user), with each part in turn used to test a model fitted to the remaining parts. For this study, a ten-fold cross-validation was used by using a software. The performance of each model has been compared by calculating correlation coefficient and root mean square error. The outcome of the study suggests that the SVM (polynomial & radial basis function) approach works quite well for the data sets in comparison to the multi- linear regression technique in prediction of water level discharge relationship/rating curve.

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STUDY ON CHAOTIC BEHAVIOUR OF RESERVOIR INFLOW

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ABSTRACT

Time series analysis of data is required to find the pattern of a hydrological process to prepare for the input data in hydrological modeling to predict the future value. Usually time series analysis has been carried by stochastic and deterministic models. The recent development depicts that time series can be analyzed and modeled by chaos. The nonlinear dynamic chaotic analysis of time series results in stochastic, deterministic or chaotic behavior. The non linear dynamic analysis through chaotic theory results in the chaotic behaviour of time series low, medium or high. Depending upon the type of chaotic behaviour, the duration for which time series can be predicted is evolved. (high chaotic behaviour - short duration prediction and low chaotic behaviour - long duration prediction).

The word Chaos is derived from the Greek and typically refers to unpredictability. Chaos theory attempts to explain the fact that complex and unpredictable results can and will occur in systems that are sensitive to their initial conditions. Chaotic time series looks like irregular but it can have simple causes. The main aim of the study is to find whether there is any chaotic behaviour in Koyna reservoir inflow using Chaos Theory. The most widely used method is the Correlation Dimension Method and has been used in the present study to analyze the process of inflow into a reservoir. Ten years of daily historical inflow data from 2000-2009 pertaining to Koyna reservoir has been used in the present study. On analyzing the Koyna inflow time series through chaotic theory, it is found that the Koyna reservoir inflow has low chaotic behaviour.

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SIMULATION OF SEDIMENT YIELD AT BHAKRA RESERVOIR

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ABSTRACT

Unpredicted land use changes in the catchment of the reservoirs contribute more sediment yield at the reservoir site. It is reported that reservoirs in India receive 200 percent more average sediment inflow than the assumed value during the design of the reservoirs. So, proper estimation of sediment yield during the life of the reservoir is essential to plan the future objectives of the reservoir operation. Black box models such as regression based models have been developed for computing the sediment yield under limited data availability conditions. However, the performance of these models is not always satisfactory. Recent applications of Artificial Neural Networks (ANN) in modelling the simulation of sediment yield demonstrate its better performance over the traditional models. This paper presents the method to simulate the sediment yield at Bhakra reservoir for future 25, 50, 75 and 100 years using ANN and time series modelling. The sediment yield at Bhakra reservoir located in Sutlej was modelled using ANN by considering the rainfall and flow volume as input to the model. The sediment yield was converted into sediment volume by the unit weight of the sediment. The sediment volume obtained from the simulation of ANN model was compared with sediment volume computed by empirical formula. The sediment volume computed by ANN model was very close to the observed sediment volume. The data of rainfall and flow volume for future 25, 50, 75 and 100 years were generated by the time series modelling. The sediment yield for the same period was estimated using the best ANN model with the input data as generated series of rainfall and flow volume. The simulated data of sediment yield would be helpful in revising the elevation-area- capacity table of the reservoir.

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CATCHMENT AND CHANNEL DELINEATION USING DIGITAL ELEVATION MODEL

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ABSTRACT

Accurate delineation of catchment plays an extremely important role in the management of a river basin. In earlier days, basin delineation was mainly conducted by digitization or hand delineation. Recently GIS tools are being widely used for delineation of catchments and identifying stream network. GIS delineation is mainly based digital elevation model (DEM) data and there are several sources of DEM. In this study comparison of the catchment delineation between the digitized boundary and the one obtained from GIS analysis has been carried out, The DEM is available from the different sources, e.g. Global Land One- kilometer Base Elevation (GLOBE), SRTM, ASTER etc. These data are available over the internet. Delineation was done on DEM of 90m and 1000m resolution. Latter was created from SRTM 90m DEM. Coarse resolution DEM are in general useful in hydrological models. In this study, the catchment and river network has been delineated using SRTM data for the Upper Bhima basin. The catchment area of the basin is 14950 Km^2 upto Ujjani dam. The result shows close match between the catchement boundary digitized from toposheets, DEM of 90m and 1000m

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STUDY ON CONSOLIDATION OF SEDIMENT IN A RESERVOIR

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ABSTRACT

The sedimentation in a reservoir is a continuous process and it reduces the performance of the reservoir slowly in meeting the demands over the time during the life of the reservoir. Information on the capacity depletion during the life of a reservoir is required for the planning of conservation and flood control operation. The amount of sediment trapped in a reservoir is mainly based on the operating condition of the reservoir. In India, the water level in the reservoirs is kept always at higher level to meet the conservation demands and this contributes high sedimentation in the reservoir. The continuous submergence of water consolidates the sediment settled in the reservoir and thus reduces the porosity of the sediment and increases the life of the reservoir to some extent. The determination of consolidated sediment for future time horizon is important in assessing the life of the reservoir. This paper discusses the different methods to compute the consolidated sediment in Bhakra reservoir. The consolidated sediments for future have been computed by unit weights derived from particle size distribution, porosity of uniformly distributed sediment, hydrographic survey and frequency analysis. The sediment volumes for the data from 1987 to 2003 have been computed using the consolidated weight of the sediment by different methods and trap efficiency of the reservoir. The sediment volume computed using the consolidated unit weight of sediment computed from unit weight by hydrographic survey is very close to the observed sediment volume and the absolute percentage error is below 1 %. The comparison of results show that the sediment volume can be computed by consolidated unit weights of sediment by particle size distribution, porosity of uniformly distributed sediment and frequency analysis in the absence of data from hydrographic survey.

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ADOPTION OF KOSTIAKOV INFILTRATION MODEL TO DETERMINE THE SOIL INFILTRATION FOR EFFICIENT WATER RESOURCES MANAGEMENT

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ABSTRACT

The primary objective of this study is to assess the predictability of the Kostiakov model equation and to develop a simple technique in excel spreadsheet to find out the parameters of the model using least square technique. The objective was to develop a procedure to be used by the general farmers also. For determination of the parameters of Kostiakov model, a very simple user interactive module has been developed in excel-2007

Infiltration is considered as an important process in the management of water resources for crop production in both irrigated agriculture and dry-farming conditions. In irrigated agriculture, it is a fundamental prerequisite for designing, evaluating and managing irrigation systems. Likewise, under dry-farming conditions, knowledge of infiltration is needed to model, evaluate and design management technologies to conserve soil and water resources. Precise design for irrigation water is required for higher irrigation efficiency, efficient use of water and accurate prediction of the infiltration rate is of prime importance.

The infiltration process that is water entry into the soil affects the water budget in the watershed. Infiltration rates widely vary in different landuse and soil types under different hydroclimatic environments. Infiltration characteristic of an area is of great importance for hydrologic studies of the system. It is a basic parameter for water balance studies in an integrated crop, soil and water management plan. Infiltration affects the soil moisture status and is therefore amenable to vegetation manipulation. Determination of infiltration characteristics of a region is the basic necessity for its water management practices. Such results have also vital applications in agriculture and hydrological modeling.

Infiltration is an important parameter in the hydrologic cycle and one of the thrust area in hydrology, watershed management and irrigation water requirements. Infiltration is the only process by which precipitation enters the earth's surface and becomes potentially available to plant and animal life. Infiltration is one of the basic parameter for developing an integrated crop, soil and water management practices and also an integral part of the rainfall-runoff process whose modeling is required for planning and design of water resources systems.

It is very difficult to take large sample of observation in large watershed and agricultural command areas. The estimation in infiltration rates in such areas is required for the calculation of runoff for design purposes and also for assessing the effect of land use changes and management of irrigation water. Many

empirical and physically based models have been developed to express infiltrability as a function of time or of the total quantity of water infiltrated into the soil.

The empirical equations or models have been developed by applying the principles governing soil water movement for simplified boundary or initial conditions. They generally correlate infiltration as measured by one of the methods to some property or properties of the soil vegetative system. This involves evaluation of constants or parameters for a specific geographic location. The physically based models, on the other hand, are more complicated and apply the theory or continuity of mass and soil water movement with certain simplified assumptions. They normally employ numerical methods for the solution of governing differential equations and are extremely valuable in analyzing the effects of various factors on the infiltration process.

The use of a particular equation or model depends upon the intended purpose and the accuracy desired. A multitude of infiltration models used in applied hydrology and soil science exists. Some of these models are theoretically based (Phillip 1957, 1969; Green and Ampt 1911), while others are empirical (Kostiakov 1932; Horton 1938; Holtan 1961; Overton 1964). Some of the empirical models are quite popular and frequently used in various water resources applications. The reason for their popularity is that they are simple and yield satisfactory results in some cases. Since the empirical models are more or less based on experimental observations, they represent the overall infiltration process

Estimation of infiltration rate is a difficult task due to: (a) temporal and spatial variations caused by soil heterogeneity, difference in soil moisture content, compaction, surface crust and cracking depth, (b) difficulty in choosing most suitable technique to best duplicate field conditions while making accurate measurement, and (c) use of empirical infiltration models rather than physical based mathematical ones and the difficulty in the characterization of coefficients of the empirical relations.
Due to the importance of infiltration in agricultural field, several empirical and theoretical equations have been developed. From the result, it is found that goodness of fit of the Kostiakov model is very strong (around 99%) with cumulative observations. Cumulative infiltration is a vital requirement for efficient use of irrigation water requirements and management practices.