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RECENT TECHNICAL LITERATURE RELEVANT FOR THE HYDROLOGISTS OF THE COUNTRY

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CONTENTS

ABSTRACT

A sizable number of Journals in the field of hydrology and water resources are published. It is not a easy task to go through all of them by the scientists involved in different studies and projects. Also some hydrological institutes, NGO'S, regional centres cannot have all journals in their library. So it will be convenient to have a compilation of hydrology related research papers and data published in a set of journal for dissemination by the concerned hydrologist.

It has been decided to review five National Journals and five International Journals to identify the relevant information/research papers of topical interest for the last five years i.e., 1991-1995. The abstract of the papers have been collected. It can be a source of appropriate and useful source for ready reference for the present status of hydrological problems and their solutions in the emerging frontiers of hydrology relevant to the country.

Reviewed Journals are :

National	International
1. Mausam	6. Journal of Hydrology
2. Vayu Mandal	7. Nordic Hydrology
3. Indian J. of Soil-Conservation	8. Hydrological Sciences Journal (IAHS)
4. Hydrology Journal	9. International J. of Remote Sensing
5. Photonirvachak	10. Advances in Water Resources

Table 1: Referring Abstract Numbers of the Journals w.r.t their topics.
(Covered Journals are Journal of Hydrology, Int. J. of Remote Sensing and IAHS (Hydrological Sciences)

Topics/Journals	J.of Hydrology (Abstract Nos.)	Int.J.of Rem.Sensing. (Abstract Nos.)	IAHS(Hyd.Sci) (Abstract Nos.)
Surface Water Hydrology	1,2,3,4,5,6,7,8,9, 10,11,12,13,14,15, 16,17,18	58	74,75,76,77,78, 79,80,81,82,83, 84,85
Ground Water Hydrology	19,20,21,22,23,24, 25,26,27,28,29,30, 31,32,33,34,35	59,60,61,62,63	77,86,87,88,89, 90
Land/soil erosion	36,37		91
Drought Management	38,39	64	92
Sedimenta -tion in Reservoirs	40,41	65,66	93,94
Flood Hydrology	38,42,43,44	67	95,96,97,98
Recycling & reuse of water/ waterHarvesting			
Environmen -tal Hydrology.	45	68	
watershed management	46		
Forest Hydrology			99
Snow /Mountain Hydrology	47,48		100,101,102
Rem.sensing & data collection	3	58,60,61,62,63,65,66, 67,68,69,70,72	103
Lake pollution/ Hydrology	49,50	69,70	

Flash flood & Dam safety			
Hydrological data networks	51,52		104
Inter basin water transfer			
Reservoir routing			95,96,97,105
Potable water/ Water Quality	45,53		
Climatology	54		106,107,108
Hydrologic Modelling/ Instrumentation	4,10,15,17,18,30, 31,55,56	71	74,79,86,87,91, 93,109
Nuclear Hydrology	27,57		
Waterlogging/ soil salinity	33	72,73	

Table 2: Referring Abstract Numbers of the Journals w.r.t their topics. (Covered Journals are Nordic Hydrology, Adv. in water Resources, J. of soil conservation and Vayu Mandal.)

Topics/ Journals	Nordic Hydrology Abstract Nos.	Adv. in Water Resources Abstract No.	J.of Soil Conservation Abstract Nos.	Vayu Mandal Abstract Nos.
Surface Water Hydrology	110,111,112 113,114,115 116,117,118	139,140	155,156,164	
Ground Water Hydrology	119,120,121, 122,123	141,142,143 144,145,146 147,148,149, 150,151	157,158	183
Land/soil erosion	124		159,160,161, 162,163	
Drought Managem			164,165	
Sediment-ation				
Flood Hydrology	125,126	152		174
Recycling of water /water Harvestin			166,167,168	
Environm-ental Hydrology	127			
Watershd Hydrology			169,170,171	
Forest Hydrology				
Snow Hydrology	128,129,130, 131,132,133		155	
Rem.sens ing & data				

Lake Hydrology				
Flash flood & Dam Hyd				
Hydrologi-cal data networks				184
Interbasin water transfer				
Reservoir routing				
Potable water/W. Quality	127			
Climatolo-gical Hydrlogy	134,135	153,154		175,176,177, 178,179,180, 182 ,185
Hydrologi Modelling/ Instrumen -tation	110,117,132, 135,136, 137,138		172	181
Nuclear Hydrology				
Waterlogg ing & soil sailinity			173	

Table 3: Referring Abstract Numbers of the Journals w.r.t their topics. (Covered Journals are Hyd. J. of IAH (India), Photonirvachak and Mausam)

Topics/ Journals	Hyd. J. of IAH(India) Abstract Nos.	Photonirvachak Absrtract Nos.	Mausam Abstract Nos.
Surface Water Hydrology	186,187,188, 189	205,206,207, 208	
Ground Water Hydrology	190,191,192	207,209,210, 211,212	225,226
Land/soil erosion		213,214	
Drought Management			227
Sedimentation in reservoirs	193,194,195	215	
Flood Hydrology	196,197	216,217	228
Recycling of water/water Harvesting			
Environmental Hydrology	198,199	218	229
Watershed management			
Forest Hydrology		219	
Snow/Mountaio Hydrology	200	220	230,231
Rem.sensing & data collection	201	221,222	230,231
Lake pollution Hydrology			232
Flash flood & Dam safety			
Hydrologica -l data networks	202		

Inter basin water transfer			233
Reservoir routing			229
Potable water/Water quality	198,199		
Climatology	203		234,235,236, 237,238,239, 240,241,242
Hydrologic Modelling/ Instrumentation	186,187,195, 204		229,235,237
Nuclear Hydrology			
Waterlogging/ soil sailinity		223,224	

JOURNAL OF HYDROLOGY

1. Journal of Hydrology

SURFACE WATER HYDROLOGY:

1. Journal of Hydrology,122(1991)161-219

COMPARATIVE ANALYSIS OF SEVERAL CONCEPTUAL RAINFALL-RUNOFF MODELS

Marco Franchini and Michele Pacciani

The aim of the present study is to compare some of the most well-known conceptual rainfall runoff models. The study is not limited to verifying the ability of the various models to reproduce the measured flow rates, but also supplies a frame of reference for the structure and the connection between the conceptual blocks characteristic of each model, their influence in the overall representation of the effects on the closure section and the ease of calibration and estimation of the parameters, as well as their physical interpretation.
The analysis was carried out using data for the Sieve watershed (an affluent of the Arno river), for which precipitation, temperature, and hourly flow rate values were available for a four month period.

2. Journal of Hydrology, 130(1992)171-187

INFLUENCE OF SEASON AND BALANCE PERIOD ON THE CONSTRUCTION OF CATCHMENT WATER BALANCES

Charles I. Essery

Water balances have been constructed for three catchments using monthly data on rainfall (P),evapotranspiration (ET), stream discharge (Q) and groundwater levels.

Length of record on the three catchments is 12,8 and 6 years. Monthly, seasonal, and annual residuals (R) of the surface water balance equation R = P -Q - ET are used to infer changes in groundwater storage and are plotted against observed changes in groundwater storage (WTD). Linear regression analysis between R and WTD is used to examine the nature of the catchments storage characteristics, the watertightness of the catchments, and the possibility that systematic measurement errors accumulate as the balance period lengthens.

3. Journal of Hydrology, 135(1992)201-236

EVALUATION OF THE DEPTH-INTEGRATION METHOD OF MEASURING WATER DISCHARGE IN LARGE RIVERS

John A. Moody and Brent M. Troutman

The depth-integration method of measuring water discharge makes a continuous measurement of the water velocity from the water surface to the bottom at 20 to 40 locations or verticals across a river. It is especially practical for large rivers where river traffic makes it impractical to use boats attached to tag lines strung across the river or to use current meters suspended from bridges. This method has the additional advantage over the standard two and eight tenths method in that a discharge-weighted suspended-sediment sample can be collected at the same time. When this method is used in large rivers such as the Missouri, Mississippi and Ohio,a microwave navigation system is used to determine the ship's position at each vertical sampling location across the river, and to make accurate velocity corrections to compensate for ship drift. An essential feature is a hydraulic winch that can lower and raise the current meter at a constant transit velocity so that the velocities at all depths are measured for equal lengths of time.

Field calibration measurements show that: (1) the mean velocity measured on the upcast (bottom to surface) is within 1% of the standard mean velocity determined by 9.11 point measurements: (2) if the transit velocity is less than 25% of the mean velocity, then average error in the mean velocity is 4% or less.

The major source of bias error is a result of mounting the current meter above a sounding weight and sometimes above a suspended-sediment sampling bottle, which prevents measurement of the velocity all the way to the bottom. The measured mean velocity is slightly larger than the true mean velocity. This bias error in the discharge is largest in shallow water (approximately 8% for the Missouri River at Hermann, MO, where the mean depth was 4.3 m) and smallest in deeper water (approximately 3% for the Mississippi River at Vicksburg, MS, where the mean depth was 14.5m). The major source of random error in the discharge is the natural variability of river velocities, which we assumed to be independent and random at each vertical. The standard error of the estimated mean velocity, at an individual vertical sampling location, may be as large as 9%, for large sand-bed alluvial rivers. The computed discharge, however, is a weighted mean of these random velocities. Consequently the standard error of computed discharge is divided by the square root of the number of verticals, producing typical values between 1 and 2%.
The discharge measured by the depth-integrated method agreed within 5% of those measured simultaneously by the standard two and eight-tenths, six-tenth and moving boat methods.

4. Journal of Hydrology, 137(1992)1-31

RAINFALL FORECASTING IN SPACE AND TIME USING A NEURAL NETWORK

Mark N. French, Witold F. Krajewski and R bert R. Cuykendall

A neural network is developed to forecast rainfall intensity fields in space and time, it is a three-layer learning network with input, hidden, and output layers. Training is conducted using back propagation where the input and output rainfall fields are presented to the neural network as a series of learning sets. After training is complete, the neural network is used to forecast rainfall intensity fields with a lead time of 1 h using only the current field as input. Rainfall fields are model, and forecasted fields are compared with the perfectly known model-produced fields. Results indicate that a neural network is capable of learning the complex relationship describing the space-

time evolution of rainfall such as that inherent in a complex rainfall simulation model. One hour ahead forecasts are produced, and comparisons with true mean areal intensities and percent areal coverage indicate that in most cases the method performs well when applied to the events used in training. The neural network is used to forecast a series of events not included in the training data and is shown to perform well when a relatively large number of hidden nodes are utilized. Performance of the neural network is compared with two other methods of short-term forecasting, persistence and nowcasting.

5. Journal of Hydrology, 140 (1992) 1-23

APPLICATION OF THE SHE TO CATCHMENTS IN INDIA PART 1. GENERAL RESULTS

J.C. Refsgaard, S.M. Seth, J.C. Bathurst, M.Erlich, B. Storm,
G.H. Jorgensen and S. Chandra

The 'Systeme Hydrologique Europeen' (SHE) modelling system has been applied to six subcatchments totalling approximately 15000 km^2 of the Narmada Basin in Madhya Pradesh, central India. The study was carried out within the framework of an Indo-European cooperative project aimed at a transfer of the SHE technology to the National Institute of Hydrology, India. This paper presents the current status of the SHE, and then focuses on the experiences gained in applying it to basins of a size likely to be of practical interest, with a data availability characteristic of developing countries. Results from the largest of the six basins are presented and discussed along with summary results from all six basins. The procedures adopted and practical recommendations are given with regard to data collection, model preparation and parameter assessment, calibration approach and planning of field investigations. Finally, general conclusions regarding SHE applicability to Indian hydrological conditions are presented.

6. Journal of Hydrology, 140 (1992)25-47

APPLICATION OF THE SHE TO CATCHMENTS IN INDIA PART 2. FIELD EXPERIMENTS AND SIMULATION STUDIES WITH THE SHE ON THE KOLAR SUBCATCHMENT OF THE NARMADA RIVER

S.K.Jain, B.Storm, J.C.Bathurst, J.C.Refsgaard and R.D.Singh

The results of SHE modelling of the 820 km^2 Kolar catchment in Madhya Pradesh, Central India are presented. The data collection, the associated field investigations, the calibration and the modelling results are discussed along with the assessment of model parameters. Based on the experiences obtained in this study from modelling and field experiments, the necessity of fieldwork and the hydrological realism of the final model representation of the basin are discussed.

7. Journal of Hydrology, 143(1993) 429-454

ESTIMATION OF HYDROLOGICAL PARAMETERS AT UNGAUGED CATCHMENTS

Donald H. Burn and David B. Boorman

Estimates of hydrological parameters at ungauged sites have traditionally been obtained from regression equations. This study investigates alternative methods based on the classification of catchments into groups according to their flow regime, the assignment of ungauged catchments to a group based on physical characteristics of the catchment, and the use of similarity measures to transfer parameters from gauged to ungauged catchments. The paper considers the methods that can be adopted in this type of approach and the many variations that must be considered in their implementation. The methods are examined using a set of 99 catchments from the UK and are seen to be efficacious in estimating the unit hydrograph time to peak and standard percentage runoff, as defined by the UK Flood Studies Report.

8. Journal of Hydrology 144(1993)371-379

MONTHLY RUNOFF GENERATION USING THE LINEAR PERTURBATION MODEL

U.C. Kothyari, V.Aravamuthan and V.P. Singh

A linear perturbation model (LPM) was used for generation of monthly runoff. The model in its non-parametric (unconstrained) form was calibrated and verified using the data from the different countries. The response function given by the LPM was found to have a physically realizable shape. The model results were compared with those given by a non-linear model for one catchment.

9. Journal of Hydrology. 147(1993)1-36

COMPARISON OF SIX RAINFALL-RUNOFF MODELLING APPROACHES

F.H.S. Chiew. M.J. Stewardson. T.a. McMohan

Six rainfall runoff modelling approaches - simple polynomial equation. Simple process equation (tanh equation). simple time-series equation (Tsykin equation complex time series model (1HACRES).simple conceptual model (SFB) and complex conceptual model (MODHYDROLOG) - are compared in this paper with the models used to simulate daily. monthly and annual flows in eight unregulated catchments. The complex conceptual model gives. by far. the best simulation of daily high and low flows. and can estimate edequately daily flows for the wetter catchments. It can provide satisfactory estimates of monthly and annual catchment yields in almost all catchment. However. the time series approaches and the simple conceptual model can also provide adequate estimates of monthly and annual yields in the wetter catchments. As it is much easier to use these approaches than the complex; conceptual model, the simpler methods may be used to estimate monthly and annual runoff in the wetter catchments.

10. Journal of Hydrology, 153(1994), 383-416

APPLICATION OF THE DAILY RAINFALL-RUNOFF MODEL MODHYDROLOG TO 28 AUSTRALIAN CATCHMENTS

Francis Chiew, Tom McMahon

The daily rainfall-runoff model, MODHYDROLOG, has been used extensively in Australia to estimate runoff from rainfall and potential evapotranspiration data. This paper describes the application of MODHYDROLOG to 28 catchments throughout Australia with different climatic and physical characteristaics. Four simulations are carried out on each catchment, the simulations differing in the numbers of model parameters optimized in the model calibration. The study indicates that the use of nine (or fewer) model parameters is sufficient to give adequate estimates of streamflow, and the use of four or five parameters may be sufficient in temperate catchments and in applications where only approximate estimates of runoff are required. MODHYDROLOG is purported to be 'physically based' and this study also indicates that certain model parameters can be related to the catchment characteristics. However, it is difficult to estimate the values of some of the 'important' parameters, and for this reason, MODHYDROLOG must always be calibrated in all modelling applications. Based on the general results from this study, recommendations are given in the Appendix to guide model users in optimizing and determining parameter values in MODHYDROLOG.

11. Journal of Hydrology 158(1994)135-150

MULTILINEAR DISCRETE CASCADEMODEL FOR CHANNEL ROUTING

Muthiah Perumal

A method for flood routing in rigid bed channels using multilinear modelling based on a time distribution scheme is presented. The discrete cascade model with its

parameters related to channel and flow characteristics through a moment-matching technique is used as the linear submodel. The particular advantage of using this two-parameter submodel is that it simulates the outflow hydrograph in a realistic way unlike the Muskingum model which produces a 'dip' or 'reduced outflow' at the beginning of routing. The suitability of this method for routing floods in uniform rectangular channels is studied by routing a mathematically defined inflow hydrograph. The solutions obtained using this model are compared with the corresponding solutions of the St. Venant equations. The study reveals that the proposed multilinear model reproduces the St.Venant solutions closely when the rating curve corresponding to the inflow hydrograph is characterized by a narrow loop.

12. Journal of Hydrology, 158(1994)187-199

TWO-COMPONENT LOG-NORMAL DISTRIBUTION OF IRRIGATION-AFFECTED LOW FLOWS

N.T.Kottegoda, L.Natale

A new approach is used for determination of the theoretical distribution of low flows in a highly developed basin. As estimates of water diversions and return flows from irrigation may have errors, difficulties arise in transforming an observed series of river flows to a natural series, which is a prior requirement in a statistical analysis of this type. A priori reasoning suggests that the net diversions may be represented by linear, non-linear or truncated functions of river flows. A two-component log-normal distribution is proposed, in which the first component represents the natural low flows in the basin, unaffected by irrigation, and the second component models the effects of diversions, return flows and other regulations. The adopted diversion rule provides the link between the components. The maximum likelihood method is applied for parameter estimation, but simplified procedures based on the method of moments are investigated, and a sufficiently good fit result is obtained. The feasibility of relating the constants of the net diversion rules to physical parameters such as catchment area is investigated. The method is applied to the Po basin, the largest in Italy.

13. Journal of Hydrology 158(1994)381-404

SOIL MOISTURE AND RUNOFF SIMULATIONS USING FOUR CATCHMENT RAINFALL-RUNOFF MODELS

D.A. Hughes

Four deterministic rainfall-runoff models are briefly described and applied to a small (0.18 km^2) grassland catchment in the Eastern cape Province of South Africa. The models vary in complexity, from a variable time step model with two soil layers and incorporating Probability distribution principles for some of the parameters, through two daily time step models, to a relatively simple, but widely used, monthly time step model. The model parameters have largely been determined from measured physical characteristics (topography, soils, vegetation, etc.) of the catchment and not through calibration. As well as comparing the simulated runoff values, the model performances are compared using observed values of soil moisture measured over a period of some 29 months. Although the four models produce similar results, the variable time step model simulates the observed soil moisture variation most successfully and the monthly model least successfully. Most of the differences in the simulation results can be explained by either the differences in complexity of the modelling approach or the resolution of the input data.

14. Journal of Hydrology 161(1994)197-226

A REAPPRAISAL OF THE KALMAN FILTERING TECHNIQUE, AS APPLIED IN RIVER FLOW FORECASTING

Mainul Ahsan, Kieran M. O. Conner

Some applications of the Kalman filtering technique in river flow forecasting are critically reviewed. It is argued that when the flow forecasting model is assumed to be an autoregressive moving average (ARMA) model and the corresponding flow data

are considered to be free of measurement errors, the minimum mean-square error forecasts obtained by using the 'conventional' Box and Jenkins-type time series forecasting method are identical with those obtained by using the Kalman filtering technique. However, with the assumption of the presence of measurement errors in the river flow time series, the use of Kalman filtering technique assumes relevance, but this type of application results in reduced forecast efficiency as evaluated by the degree of matching attained, in the least-squares sense, of the forecasted flows with the measured flows. In the absence of measurement error, referred to as the pure prediction scenario, it is demonstrated that a simpler degenerate set of kalman filter equations results, in which the Kalman gain plays no part in the prediction, i.e. the application of the general Kalman filter becomes redundant.

15. Journal of Hydrology 161(1994)389-413

A METHODOLOGY FOR THE EVALUATION OF GLOBAL WARMING IMPACT ON SOIL MOISTURE AND RUNOFF

Juan B. Valdes, Rafael S. Seoane , Gerald R. North

This paper presents a numerical evaluation of the variability of soil moisture and direct surface runoff due to global warming. An analytical model of the soil moisture balance based on our previous work is used to evaluate the probability distribution of the soil moisture concentration and resulting surface runoff. The input of hydroclimatic values is based on the approach suggested by C.W. Richardson in 1981. Our results show that not only the mean of the distribution of both soil moisture and runoff change, as expected, but that the variability of the values around the means also changes. The results of our research have immediate applications on the planning of reservoir operation for irrigation demands and evaluation of the change in surface runoff expected due to global warming.

16. Journal of Hydrology 168(1995)127-157

UNIT HYDROGRAPH AND EFFECTAIVE PRECIPITATION IDENTIFICATION

I. Nalbantis , Ch. Obled, J.Y. Rodriguez

A recently proposed method for calibrating lumped rainfall-runoff models, called FDTFERUHDIT,is analysed and evaluated on synthetic data. Based on the Unit Hydrograph concept this method performs a simultaneous identification of the excess rainfall series and the transfer function or unit hydrograph through an alternating iterative procedure without presuming any runoff production model or applying any arbitrary baseflow removal. A general evaluation framework was built to allow for generation of realistic data both error-free and contaminated with controlled errors. The problems of the method's convergence and sensitivity to errors in the data and the model structure assumed are tackled. A rather exhaustive series of tests involve also evaluations of the effects of a priori choices of optimisation algorithms and their parameters, as well as assessments of sampling effects. Combinations of these facators are also tested. Finally, useful guidelines for practical use of the new identification approach are derived.

17. Journal of Hydrology 173 (1995)27-40

A CONCEPTUAL MODEL OF CATCHMENT WATER BALANCE: 1. FORMULATION AND CALIBRATION

V.M. Ponce , A.V. Shetty

A conceptual model of a catchment's annual water balance is developed. The model is based on the sequential separation of annual precipitation into surface runoff and wetting, and wetting into baseflow and vaporization. The separation is based on a proportional relation linking the three variables involved at each step. The generic form of the proportional relation is (X- \Z$^{\rho}$ -Y) / (1- \)Z$^{\rho}$ = Y/ (X-. \ Z$^{\rho}$), in which \ is an

independent variable, Y is a dependent variable, \ is the initial abstraction coefficient, and Z^p is the potential value of the difference Z = X - Y. Given a set of model parameters, the method can be used to separate annual precipitation into its three major components surface runoff, baseflow, and vaporization, Initial application of the method to literature catchment data provided encouraging results. The method can be used for estimates from past experience or calibrated using measured data.

18. Journal of Hydrology 173(1995)41-50

A CONCEPTUAL MODEL OF CATCHMENT WATER BALANCE: 2. APPLICATION TO RUNOFF AND BASEFLOW MODELLING

V.M. Ponce, A.V. Shetty

A conceptual model of catchment water balance developed in the companion paper (Ponce and Shetty, J. Hyd. 173:27-40,1995) is used to simulate changes in runoff and baseflow with annual precipitation. The model is based on the sequential separation of annual precipitation into surface runoff and wetting, and wetting into baseflow and vaporization. Runoff is the sum of surface runoff and baseflow. Runoff gain is defined as the derivative of runoff coefficient with respect to precipitation. Baseflow gain is defined as the derivative of baseflow coefficient with respect to precipitation. Catchment data show that runoff and baseflow gains are always positive. Runoff gain reaches a peak value at a threshold precipitation,p_{rt} , baseflow gain reaches a peak value at a threshold precipitation P_{bt}. Analysis of the runoff and baseflow function sheds additional light on the nature of the competition between runoff and vaporization, and baseflow and vaporization.

GROUND WATER HYDROLOGY

19. Journal of Hydrology, 123(1991)355-365

COMPUTATION OF AVERAGE SEASONAL GROUNDWATER FLOWS IN PHREATIAC AQUIFER-RIVER SYSTEM

A.K.Rastogi

A simplified approach to reduce a time-variant problem into a steady-state problem is considered by averaging the groundwater head over a seasonal period. This averaging is applicable to those areas (countries) where a year can be divided into three distinct monsoon, pre and post-monsoon periods and where the annual watertable variation is not large compared with the saturated aquifer thickness. This scheme is applied to solve a two-dimensional problem using a standard finite difference technique of solution. The phreatic aquifer system considered is bounded by two reservoirs and an impervious base. It also contains a partially penetrating river near the centre of the aquifer. Periodic contribution to the phreatic aquifer from the higher head reservoir, grounwater recharge from river seepage, net-free surface flux and the total groundwater flow towards lower head reservoir are worked out. These terms aid in estimating the net volume of ground water that is available from the aquifer system in a particular seasonal period.

20. Journal of Hydrology, 126(1991)315-326

WATER TABLE FLUCTUATION IN A SLOPING AQUIFER WITH TRANSIENT RECHARGE

R.N. Singh, S.N.Rai and D.V.Ramana

An analytical solution of the linearized Boussinesq equation with a complex transient recharge function is presented to describe the water table fluctuation in a sloping aquifer of finite width. The solution is obtained by using an eigenvalue-eigenfunction expansion method. Some previously known solutions for different recharge functions have been shown to be special cases of the present general solution. Applications of the solutions in prediction of the spatio-temporal distribution of the water table in a ditch drainage system are illustrated with the help of synthetic examples.

21. Journal of Hydrology, 135(1992)73-86

DETERMINING SOIL HYDROLOGIC PROPERTIES FROM RAIN SIMULATOR OR DOUBLE RING INFILTROMETER EXPERIMENTS: A COMPARISON

J. Touma and J. Albergel

Two infiltration experiments were conducted on two plots of $1m^2$,each equipped with a neutron meter access tube and tensiometers. One infiltration was performed with a constant head of water maintained at the soil surface, the other using a rain simulator. The order of experiments was reversed on the two plots, i.e. on the first plot, simulated rain preceeded infiltration under constant head, while on the second plot, ponded infiltration was performed prior to the simulated rain. For each plot, the water pressure and hydraulic conductivity relationships versus water content were determined from both experiments for the various horizons of the soil profile. It is shown that the range of data obtained from the double ring infiltrometer is much wider than that corresponding to the rain simulator. This is due probably to surface scaling during the latter experiment. Application of the Van Genuchten model (1980) to predict the hydraulic conductivity from the water retention curveshows good agreement for some horizons but is not satisfactory for others. It is concluded that when the soil surface is subject to crusting, the double ring infiltrometer is more suitable than the rain simulator for the determination of soil hydrologic properties.

22. Journal of Hydrology 136(1992)381-387

WATER TABLE FLUCTUATIONS IN AN AQUIFER SYSTEM OWING TO TIME-VARYING SURFACE INFILTRATION AND CANAL RECHARGE

S.N. Rai and R.N. Singh

A solution of the linearized Boussinesq equation for predicting the transient position of the water table in an unconfined aquifer system, which lies between two recharging

canal at different elevations above the aquifer's base and receives time-varying recharge from the overlying soils, is presented. The soulution for the constant rate of recharge is shown as a special case of the present solution. The effect of variation in the rate of recharge on the water table fluctuation is investigated with the help of an example.

23. Journal of Hydrology, 136(1992)177-192

PARAMETER ESTIMATION IN AN AQUIFER-WATER TABLE AQUITARD SYSTEM

M.Sekhar, M.s. Mohan Kumar and K. Sridharan

The weighted least squares approach is used for the estimation of parameters in an aquifer-water table aquitard system. Six parameters are to be evaluated, namely: the equivalent transmissivity, degree of anisotropy and storage coefficient of the aquifer, and the leakage coefficient, specific storage and specific yield of the aquitard. The coupled aquifer-aquitard equations are solved by an iterative numerical procedure and the optimisation problem is solved by the sensitivity analysis technique. This method is applied to one hypothetical problem and two field pumping tests of seven days duration.

24. Journal of Hydrology,136(1992)87-106

A MINI SLUG TEST METHOD FOR DETERMINATION OF A LOCAL HYDRAULIC CONDUCTIVITY OF AN UNCONFINED SANDY AQUIFER

Klaus Hinsby, Poul L. Bjerg, Lars J. Andersen, Bent Skov and Erik V. Clausen

A new and efficient mini slug test method for the determination of local hydraulic conductivities in unconfined sandy aquifers is developed. The slug test is performed in a small-diameter (1 inch) driven well with a 0.25 m screen just above the drive point. The screened drive point can be driven from level to level and thereby establish

vertical profiles of the hydraulic conductivity. The head data from the test well are recorded with a 10 mm pressure transducer, and the initial head difference required is established by a small vacuum pump. The method described has provided 274 spatially distributed measurements of a local hydraulic conductivity at a tracer test site at Vejen, Denmark. The mini slug test results calculated by a modified Dax slug test analysing method, applying the elastic storativity in the Dax equations instead of the specific yield, are in good accordance with the results from two natural gradient tracer experiments performed at the test site. The original Dax, the Bouwer and Rice, and the Chirlin analysing methods all led to an underestimation of the effective hydraulic conducativity by a facator of more than 2, when compared with the tracer tests. In contrast the spherical flow model of Karasaki et.al. overestimated the results of the tracer tests by approximately a factor 1.4. The Dax and the Cooper et.al. methods, assuming only radial flow to the partially screened well, yielded a better approximation of the horizontal hydraulic conductivity, than the Chirlin method, which also considers axial flow. This fact is suggested to be a result of aquifer anisotropy, as a significant higher horizontal than vertical hydraulic conductivity may supress the significance of the axial flow component.

25. Journal of Hydrology, 138 (1992) 153-168

FEM MODELLING TO INVESTIGATE SEEPAGE LOSSES FROM THE LINED NADIAD BRANCH CANAL, INDIA

A.K.Rastogi and Baldev Prasad

Three secations of the lined Nadiad branch canal, involving a canal length of 8.6 km, were considered to investigate pre and post monsoon seepage losses. The hydraulic conductivity of the lined material was considered to be one-tenth that of the top soil, based on an earlier report which indicates a ten fold reduction in seepage losses as a result of lining of canals. A finite element program was developed to incorporate all the flow domain conditions of the canal-phreatic aquifer system. Sensitivity analysis showed that variation in the hydraulic conductivity of the canal liner or the topsoil layer

had less influence on seepage flux values compared with changes in canal supply depth or aquifer hydraulic conductivity.

26. Journal of Hydrology, 154(1994)245-254

A NEW METHOD FOR MEASURING NEAR-SURFACE MOISTURE BUDGETS IN HYDROLOGICAL SYSTEMS

W.E.Bardsley, D.I. Campbell

Preliminary results from a groundwater experiment set up near Matamata (New Zealand) reveal that confined aquifers can act as giant weighing lysimeters, with pore water pressures giving real-time measures of changes in amounts of surface and near-surface water. This opens the possibility of water balance studies at the scale of hectares using measurements from a single site. Given suitable confined aquifers, the technique has application in various environments for hydrological measurements as diverse as quantification of evapotransp;iration loss, areal precipitation measurement, monitoring the water content of an accumulating snowpack, and net lateral groundwater transfers in unconfined aquifers.

27. Journal of Hydrology 155(1994)73-91

ISOTOPIC DETERMINATION OF SNOW-WATER CONTRIBUTION TO SOIL WATER AND GROUNDWATER

C.P. Maule , D.S. Chanasyk, K. Muehlenbachs

The stable isotopes oxygen-18 and deuterium were used to determine the seasonal contributions of snow and rain to the soil and ground water system of a prairie agricultural site during the period, 1985-1987. Using measured isotope values and a temperature-isotope relationship the isotope values of precipitation during the period, 1985-1987. Using measured isotope values and a temperature-isotope relationship

the isotope values of precipitation during the previous 10 years at Edmonton, Canda, were determined. Winter precipitaion had average oxygen-18 and deuterium values of -25.6% and -194%, respectively; spring through autumn rains had weighted values of -16.2% and -125%, respectively. Soil samples taken in the top 4m indicated that mixing of infiltrating waters was generally complete by a depth of 30 cm. With algebraic manipulation of measured isotope concentrations of soil and precipitation waters with known physical processes, it was possible to estimate the seasonal composition of the waters in the top 4m. After correctionfor evaporation, both soil water (0-0.9m) and shallow groundwater (3-4m) had lower oxygen-18values(-18.7%; and -20.3%, respectively) than the weighted average annual precipitation concentration (-18.1%). These values are higher than the proportion of winter precipitation of total annual precipitation (21% with rains 5 mm day^{-1} excluded). The higher snow-water content of groundwater, along with the fact that the ground-water underwent less fractionation owing to evaporation than soil waters, could be the result of lateral flow from nearby small depressions where snowmelt runoff waters accumulated during spring. These findings emphasize the importance of the contribution of winter precipitation to groundwater recharge.

28. Journal of Hydrology 155(1994) 251-264

EFFECT OF DEPTH OF IMPERVIOUS LAYER AND ADSORPTION ON SOLUTE TRANSPORT IN TILE-DRAINED IRIGATED LANDS

S.K.Varma , Sita Ram Singh, K.V.G.K. Rao

A two-dimensional finite element model of solute transport in a tile-drained soil-aquifer system was applied to study the effect of the depth of impervious layer and adsorption on salt distribution in the soil and groundwater,and the salinity of drainage effluent. The model considers steady state water flow in the unsaturated and saturated zones, and includes the effect of convective transport, dispersion and linear adsorption. The results indicate that though the depth of the impervious layer has little effect on salt distribution in the unsaturated zone, it significantly influences the quality of the

drainage effluent. Further, it was found that during the initial years of reclamation of a highly saline soil with subsurface drainage, the effect of adsorption is more pronounced in the unsaturated zone than in the saturated zone and the movement of adsorbing solute species is retarded for a longer time in the groundwater than in the soil.

29. Journal of Hydrology 157(1994)349-366

APPLICABILITY OF LINEARIZED BOUSSINESQ EQUATION FOR MODELING BANK STORAGE UNDER UNCERTAIN AQUIFER PARAMETERS

Rao S. Govindaraju, James, K. Koelliker

Boussinesq's equation is frequently employed to study the influence of flood-stage hydrographs in streams on bank storage effects. This equation is nonlinear and no analytiacal solutions are available for arbitrarily shaped stage hydrographs. Analytical solutions are presented for the linearized form of the equation, and expressions for the flow rate from the stream to the aquifer are developed. Results indicate that these analytical solutions may not be very accurate (as much as 10% error) when compared with numerical solution of the nonlinear equation. These deterministic analytical solutions lead to analytical expression for the mean and variance of flux rates when the hydraulic properties of the aquifer are treated as random quantities. Monte-Carlo simulation results show that linearized analytical solutions are potentially useful for predicting mean flux rates when aquifer properties exhibit a large degree of variability.

30. Journal of Hydrology 159(1994)79-104

FORCED AND NATURAL GRADIENT TRACER TESTS IN A HIGHLY HETEROGENEOUS POROUS AQUIFER: INSTRUMENTATION AND MEASUREMENTS

T.Ptak , G. Teutsch

At the Horkheimer Insel experimental field site, several short to intermediatae distance forced and natural gradient tracer tests with depth-integrated and multilevel sampling were conducted to characterize the aquifer transport properties. Compared with other test sites, the aquifer at the Horkheimer Insel is highly heterogeneous and highly conductive. Hence, new tracer measurement techniques had to be developed. This paper presents some of the instrumentation developed together with measurements and their initial interpretation. The results demonstrate that for contaminant transport predictions in highly heterogeneous and highly conductive aquifers, investigation techniques with a high resolution in time and space are needed. The aquifer heterogeneity is evident from the spatial variability of peak concentration, transport velocity and longitudinal macrodispersivity values obtained from the tracer tests. Furthermore, the tracer test results indicate that at the observation scale investigated, a complex numerical flow and transport model is needed to describe adequately mass transport within the heterogeneous aquifer.

31. Journal of Hydrology 160 (1994) 1-20

ESTIMATING NEAR-SURFACE SOIL MOISTURE AVAILABILITY USING A METEOROLOGICALLY DRIVEN SOIL-WATER PROFILE MODEL

W.J. Capehart, T.N. Carlson

This paper presents a simple water budget model for determining the vertical profile of soil water content. The model is driven by conventional meteorological and land use data. The modeled solutions of soil water content become independent of their starting conditions after a few weeks to a few months into a simulation depending on rainfall and evapotranspiration. Once the model becomes free of its initial conditions (a state to which we refer as 'balance'), the model is driven almost completely by current environmental conditions. Two sets of data were used to validate the model which showed close agreement between simulations and measurements. This paper presents the details of the water budget model and verifications from two field experiments.

32. Journal of Hydrology 160(1994)123-135

A FORMULA FOR COMPUTATION OF TIME-VARYING RECHARAGE OF GROUNDWATER

Ninghu Su

This paper presents a formula for computation of time-varying recharge of groundwater. The formula is derived from the basic equation of groundwater flow on an inclined impervious base. This analytical expresion can also be used to compute evaporation rate if there is no recharge of groundwater. Readings from electronic data loggers show that recharge of groundwater is highly variable depending on the patterns of rainfall and antecedent conditions of the soil.

33. Journal of Hydrology 163(1994) 197-202

TRANSIENT WATER TABLE RISE WITH CANAL SEEPAGE AND RECHARGE

Sewa Ram, C.S. Jaiswal, H.S. Chauhan

An analytical solution to the problem of water table rise in a finite length phreatic aquifer based on appropriate transformations is obtained. The proposed solution is simpler than the available solution and for the selected illustrative numerical example gives fairly close results.

34. Journal of Hydrology 163(1994)373-391

PARAMETER ESTIMATION IN AN ANISOTROPIC LEAKY AQUIFER SYSTEM

M. Sekhar, M.S. Mohan Kumar, K.Sridharan

Parameter estimation is made for an anisotropic leaky aquifer system in which the

direction of principal axes is unknown. There is a declining water table in the aquitard. The seven governing parameters are the direction of principal axes, the degree of anisotropy, the equivalent transmissivity and storage coefficient of the aquifer, and the leakage coefficient, specific storage and specific yield of the unconfined aquitard. A modified parameter perturbation technique which is computationally efficient is used for the determination of sensitivity coefficients. The parameter estimation procedure is applied to three test problems including one field problem. Situations where the total number of wells is only three are handled with two pump tests by locating the pump in a different well in each test.

35. Journal of Hydrology 171(1995)23-47

THE TIPPING BUCKET EQUATIONS AS A MODEL FOR MACROPORE FLOW

Steven H. Emerman

The tipping bucket model, a computationally efficient scheme for simulating soil water transport which requires few input parameters, implicitly assumes that all water flow occurs through macropores. The model is limited in its elimination of both micropore flow and macropore flow with unsaturated micropores and its reliance on a fixed time step, normally taken to be daily. The reformulation of the tipping bucket model as a set of differential equations for macropore water and solute transport removes the above limitations. Previous work on simulation of water transport through oxiols using the Richards equation showed that an accurate fit to measured water contents could be obtained only by making the probably false assumption that the saturated water content is only 70% of the total porosity. Combining the tipping bucket equation for macropore water transport with the Richards equation for micropore water transport produces an equally good fit to measured water contents under the more reasonable assumption that saturated water content is equal to total porosity. A critical assumption in the producation of a good fit is that the saturated water content is scale-invariant i.e. the macropore and micropore domains have the same saturated water content. The tipping bucket equations introduce two parameters that are difficult to

estimate, the macropore drainage parameter and the mass transfer coefficient for drainage from macropores into micropores. However, for the particular data set studied in this paper, the above parameters are largely irrelevant as long as macropore water does not drain downwards through macro-pores faster than computes the surface runoff hydrograph at the cell outlet, relmicropore domains are not decoupled.

LAND/SOIL EROSION:

36. Journal of Hydrology, 123(1991)19-24

THE EFFECT OF SPARSE VEGETATIVE COVER ON EROSION AND SEDIMENT YIELD

R.D.Rogers and S.A. Schumm

An experimental study of the effects of changing vegetative cover from 43% to zero on a 10% slope demonstrates that sediment yield increases rapidly as vegetative cover decreases from 43 to 15% but with less than 15% vegetative cover the rate of increase of sediment yield is neither linear nor exponential, and these results indicate that less than 15% vegetative cover is ineffective in retarding erosion. Therefore, efforts to reduce erosion by slightly increasing vegetation density in the dry lands of the world will also be ineffective.

37. Journal of Hydrology, 127(1991) 279-305

MODELLING THE EROSION PROCESS OAVER STEEP SLOPES: APPROXIMATE ANALYTICAL SOLUTIONS

Rao S. Govindaraju and M. Levent Kavvas

Analytical expressions are developed for the rainfall-runoff-erosion process on steep

hillslopes subjected to time-varying rainfall events. The erosion equation is essentially represented as a first-order reaction with the reaction rate being represented by the soil erodibility. The analytical transient solutions are based upon the assumption that the flow and sediment discharge have a constant relationship as during steady-state conditions. The analytical solution for the sediment discharge performs well when compared with numerical and experimental results. The approximate analytical solution for the concentration profile is the asymptotic limit of the transient numerical solutions. An error analysis shows that the analytical solutions improve with increasing slope length and that the solution model presented here is applicable to a wide range of physical situtions.

DROUGHT MANAGEMENT:

38. Journal of Hydrology, 138(1992)487-501

REGIONAL FLOOD FREQUENCY ANALYSIS IN ARID AND SEMI-ARID AREAS

F.A.K. Farquharson , J.R. Meigh and J.V.Sutcliffe

Dimensionless regional flood frequency curves use a number of records from a reasonably homogeneous area to overcome the variability of site records. The problems posed by short individual records and the variability of estimates are particularly acute in arid areas. Regional flood frequency curves in a number of semi-arid and arid areas have been assembled to illustrate their extreme slope and skewness, and the mutual similarity of these curves.

Annual maxima from 162 stations with annual basin rainfall below 600mm are assembled from NW Africa, Iran, Jordan, Saudi Arabia, Botswana and South Africa, and compared with records from Australia, southwest USA and Russia. The general extreme value(GEV) curves from each region, fitted by probability weighted moments (PWM), are compared with the combined curve. Since floods in arid areas, if nowhere else, result from storm intensity exceeding soil infiltration, the similarity of regional flood curves may indicate similar storm characteristics in different regions.

The mean annual flood (MAF) for each catchment has been related to both basin area and mean annual rainfall by regression in an attempt to provide a preliminary means of estimating the scaling factor,MAF, for catchments with no flow data. Whilst in many of the regions studied, insufficient data are currently available to permit reliable estimation of the MAF by such an approach, it is hoped that the regression equations presented may permit estimation of the MAF for Iran, Saudi Arabia and Yemen, Queensland and more tentatively South Afric and Botswana. In addition, a combined regression equation for all semi-arid and arid regions is presented. This combination of estimated MAF and regional flood frequency curves permits flood magnitude with a known risk of exceedance to be derived within arid zones of the world even where local flow data are unavailable.

Specific problems associated with the analysis of flood records from arid include gauging problems and measurements, low or zero annual maxima in a number of years, and the suitability, or otherwise, of the mean annual flood as the appropriate scaling factor for the dimensionless curves. In some cases, the 5-year flood may be a more appropriate scaling factor.

39. Journal of Hydrology 173 (1995) 111-130

REGIONAL FREQUENCY ANALYSIS OF ANNUAL MAXIMUM STREAMFLOW DROUGHT

B.Clausen , C.P. Pearson

A regional frequency analysis of annual maximum streamflow drought was presented as a method for investigating the spatial and temporal variability of droughts. Three geographical regions in New Zealand with different climate and physical properties were used in the study. The annual maximum droughts in terms of severity (total deficit) were identified for 44 sites with at least 20 years of daily flow data using two truncation levels: the mean and 75% of the mean. For both approaches the mean of the standardised annual maximum severity was found to vary with physical and climatic catchment characteristics except for one region, where the severity was

almost constant because of very high annual rainfall. The best regional estimates of mean severity were found for the lower truncation level. The severities and the durations of the annual maximum droughts at each site were almost linearly related. L moment statistics showed that two of the three regions were homogeneous, and that the three-parameter lognormal distribution gave the best fit to both severities and durations. A baseflow index integrating the influence of various physical and climatic catchment characteristics on hydrographs was found to be useful in regionalising the mean annual maximum severity and the log-normal distribution, allowing estimation of extreme droughts and droughts in ungauged catchments.

SEDIMENTATION:

40. Journal of Hydrology. 139(1992) 197-210

SEDIMENT TRANSPORT IN THE CAUVERY RIVER BASIN: SEDIMENT CHARACTERISTICS AND CONTROLLING FACTORS

P. Vaithiyanathan, Al. Ramanathan and V.Subramanian

During the monsoon period, 75% of the annual rainfall, 73% of the annual water discharge and 85% of the annual sediment transport takes place in the Cauvery River. Basin geology and river water discharge are the major natural factors controlling the sediment transport. Sediment transport in the Cauvery River is greatly influenced by the presence of two major dams built across the river. An examination of the particle-size distribution of the suspended sediments shows that the less than 20micro metre fracation accounts for nearly 60% of the total sediment transported by the river. At dam sites, coarse sediments are selectively removed from the suspended load. The suspended mineralogy is dominated by quartz and feldpar, followed by clay minerals and carbonates. Clay minerals average about 30% and are dominated by the montoorillonite type. The results of our study also demonstrate the importance of such sediment characteristics as particle size and mineralogy in controlling the trace metal distribution in sediments.

41. Journal of Hydrology 159(1994)395-421

CHEMICAL FRACTIONATION OF LAKE SEDIMENTS TO DETERMINE THE EFFECTS OF LAND-USE CHANGE ON NUTRIENT LOADING

A.L. Heathwaite

Lake studies allow contemporary sediment and nutrient dynamics to be placed in a historical context in order that trends and rates of change in catchment inputs may be calculated. Here, a synthesis of the temporal information contained in catchment and lake sediment records is attempted. A chemical fractionation technique is used to isolate the different sediment sources contained in the lake core, and Pb dates provide an accurate record of changes in lake sediment sources over the past 100 years. The extent to which land-use records, collated from agricultural census returns, and process-based studies of sediment and nutrient export from different catchment land uses can be used to explain the trends observed in the lake sediments is examined. Sediment influx to the study lake has increased from less than 2mm year prior to the Second World War to over 10 mm year at present. The source of the sediment is largely unaltered and unweathered allochthonous material eroded from the catchment. Land-use records suggest that the intensification of agriculture, characterized by a shift towards arable land immediately postwar, followed by an increase in the area of temporary grass in the 1960s, may be the cause of accelerated catchment erosion; both land-use changes would have increased the area of ploughed land in the catchment. An increase in the number of cattle and sheep in the catchment from around 2000 and 6000, respectively, in the 1940s, to a peak of nearly 7000 cattle and over 15000 sheep in the 1980s, provides a further source of sediment and nutrients. Livestock are grazed on permanent grassland which is commonly located on steep hillslopes and in riparian zones where saturation-excess surface runoff may be an important hydrological pathway. Rainfall simulation experiments show that surface runoff from heavily grazed grassland has a high suspended sediment, ammonium-nitrogen and particulate phosphorus load. The combined effect of the long-term increase in the organic loading from livestock and the inorganic N and

P load from fertilizers, may be the source of nutrient enrichment in the lake.

FLOOD HYDROLOGY:

42. Journal of Hydrology, 131(1992)313-339

RAINFALL-BASED REAL-TIME FLOOD FORECASTING

Juan Carlos Bertoni, Carlos Eduardo Tucci and Robin Thomas Clarke

The use of conceptual rainfall-runoff models in real-time flood forecasting still presents problems, some of which relate to the updating of the mathematical model and to uncertainties associated with future rainfall. Both topics are approached in this study, in which a conceptual rainfall-runoff model (IPH-II) for real-time flood forecasting and a simplified stochastic model to determine the value of including quantitative rainfall forecasts were used. The methods were tested using data from a small watershed (the River Ray at Grendon Underwood,UK), for which 17 years of records were available. The results show that a simple method used to forecast rain falling during the next few hours, may help to improve real-time discharge estimates.

43. Journal of Hydrology, 135 (1992)371-381

THE XINANJIANG MODEL APPLIED IN CHINA

Zhao Ren-Jun

The Xinanjiang model is a rainfall-runoff, distributed, basin model for use in humid and semi-humid regions. The evapotranspiration component is represented by a model of three soil layers. Runoff production occurs on repletion of storage to capacity values which are assumed to be distributed throughout the basin. Prior to 1980, runoff was separated into surface and groundwater components using Horton's concept of infiltration. Subsequently, the concept of hillslope hydrology was introduced with an

additional component, interflow, being identified. Runoff concentration to the outflow of each sub-basin is represented by a unit hydrograph or by a lag and route technique. The damping or routing effects of the channel system connecting the sub-basins are represented by Muskingum routing. There are fifteen parameters in all, of which the model is particularly sensitive to six. Optimization of the parameters is achieved with different objective functions according to the nature of each parameter. The model has been widely used in China since 1980, mainly for flood forecasting, though more recently it is also being used for other purposes.

44. Journal of Hydrology 163(1994)95-106

VALUES FOR THE EXPONENT OF THE STORAGE-DISCHARGE EQUATION IN RUNOFF-ROUTING MODELS

B.L. Maheshwari

A storage-discharge equation: $S = kQ^m$ is often used in runoff-routing models. The prediction by the models is highly sensitive to the value of exponent m used. A discharge-depth equation: q $q= Ky^{\circ} S_c^{1/2}$ can be used to simulate overland and channel flows and the two equations considered here are shown to be similar and their parameters interrelated. Although the species of vegetative covers encountered in field data considered in the present study are probably not typical of those generally encountered on the catchments, their characteristics which influence overland and channel flows particularly on small catchments are of relevance here. The values of obtained from shallow overland flow and channel flow studies suggest that the exponent m in the storage-discharge equation should be varied between 0.33 and 1.00 depending upon the regime of flow and degree of turbulence in the flow. While the study provides a further understanding of the variation of exponent m, more research is needed particularly in quantifying the degree of turbulence in the flow and developing a practical method of varying m in the runoff-routing model to account for flow conditions present over the catchment.

45. Journal of Hydrology, 132(1992)263-281

MODELLING SURFACE RUNOFF CONTAMINATION BY SOIL CHEMICALS UNDER TRANSIENT WATER INFILTRATION

Rony Wallach and Rina Shabtai

A model was developed to predict the potential contamination of overland flow by chemicals removed from soil water by rainfall on sloping soil. The model accounts for transient water infiltration, overland flow and convective-dispersive solute transport in the soil. Solutes are assumed to be subjected to linear equilibrium sorption onto the soil's solid phase. Numerical simulations indicated that the value of the coefficient for soil chemical transfer to surface runoff does not affect the soil surface concentration when soil is initially dry, but is linearly related to the dissolved chemical flux to overland flow. This enables an approximate solution to the convective-dispersive equation for determining soil surface concentration, independent of its determination from rainfall-runoff relationships. Simulated dissolved chemical concentrations at the soil surface and in surface runoff were determined for different antecedent soil moisture and rainfall intensities. These concentrations were found to be lower when antecedent moisture was low, because ponding time for frier soils is longer and during this period soil solutes are therefore displaced downward by greater volumes of infiltrating water. For a specified initial soilwater content, higher rainfall rates cause higher dissolved chemical concentrations at the soil surface and in runoff water. The hydrological parameters (e.g. soil-surface slope, length and roughness) affecting the residence time of surface water on the field, greatly affect runoff concentration for a short time after the initiation of overland flow. The runoff concentration for longer periods is mainly affected by soil surface concentration, which is in turn controlled by the dispersion of the chemicals in the soil. The distribution coefficient between the liquid and solid phases of the soil controls the release of absorbed chemicals to the soil solution and therefore affects the runoff concentration.

WATERSHED MANAGEMENT:

46. Journal of Hydrology, 138(1992)97-117

A RAINFALL-RUNOFF MODEL FOR SMALL WATERSHEDS

Guang-Te Wang , V.P. Singh and F.X. Yu

A rainfall-runoff model was developed by combining the excess-rainfall process and the runoff-concentration process. The excess rainfall was modeled by using the two-parameter Green-Ampt infiltration approach. A six parameter linear-discrete model was used to model the runoff hydrograph. The infiltration parameters were estimated by using the simplex method, and the runoff parameters by least squares. The model was calibrated on ten watersheds and verified on seven. The model-simulated runoff hydrographs were in close agreement with observed runoff hydrographs.

SNOW/ MOUNTAIN HYDROLOGY:

47. Journal of Hydrology, 137(1992)73-97

INFLUENCE OF AVALANCHE SNOW TRANSPORT ON SNOWMELT RUNOFF

Fes A. de Scally

The influence of avalanche snow transport on snowmelt runoff is investigated in a large basin (2500 km^2) in the Punjab Himalaya, Pakistan. The results of modelling based on field measurements show that, of the two main changes occurring during avalanching which affect the subsequent generation of snowmelt runoff-concentration of the snow and an ambient temperature increase resulting from the avalanches fall to a lower elevation - the former is dominant on most avalanche paths. As a result, very high rates of surficial melting on avalanche snow are outweighed by the small surface area of the deposits, significantly decreasing the rate of meltwater production

and delaying the disappearance of avalanche snow compared with ;undisturbed snow. The lengh of the delay is difficult to estimate accurately but is of the order of two to three months on large avalanche paths. Calculations of the volume of avalanche snow in the basin indicate that, following a winter of maximum avalanche activity, such snow represents about 8 and 6% of the snowmelt runoff and annual runoff, repectively. In normal years these proportions are of the order of 1-2% and may still be exceptional for a basin of this size.

48. Journal of Hydrology, 151(1993) 19-34

CHEMICAL COMPOSITION OF SNOW AND ICE FROM CHHOTA SHIGRI GLACIER, CENTRAL HIMALAYA

V.N. Nijampurkar, M.M. Sarin, D.K. Rao

A systematic study of the chemical composition of snow, firn from a shallow core, surface ice and of meltwater samples collected from the Chhota Shigri glacier,Central Himalaya, is reported here. The average concentrations of Na and Cl in snow are 402 and 753 ugl^{-1}, respectively, whereas those in old surface ice are relatively low, 185 ugl^{-1} and 375 ugl^{-1} , relspecatively. The average Cl/Na weight ratio in these samples is equivalent to 1.9, quite similar to that in the sea salts suggesting that both C1 and na are predominantly of marine origin. The concentrations of other major ions such as K, Mg, Ca, NO and SO in snow and ice samples are generally less than 1 mgl^{-1} . The major ion concentrations, when normalized to Na, indicate that the abundances of K and Ca are dominated by terrestrial sources whereas Mg appears to have both marine and terrestrial sources. Based on the seasonal variations of Na and Cl concentration observed in the ice core samples, an approximate accumulation rate at the core site has been estimated to be 1.6 m year (640 kg m year).

LAKE HYDROLOGY:

49. Journal of Hydrology, 122(1991) 15-22

A COMPARISON OF SHORT-TERM MEASUREMENTS OF LAKE EVAPORATION

USING EDDY CORRELATION AND ENERGY BUDGET METHODS

David L. Stannard And Donald O. Rosenberry

Concurrent short-term measurements of evaporation from a shallow lake, using eddy correlation and energy budget methods, indicate the sensible and latent heat flux between lake and atmosphere, and energy storage in the lake, may vary considerably across the lake. Measuring net radiation with a net radiometer on the lake appeared to be more accurate than measuring incoming radiation nearby and modeling outgoing radiation. Short-term agreement between the two evaporation measurements was obtained by using an energy storage term that was weighted to account for the area-of-influence of the eddy correlation sensors. Relatively short bursts of evaporation were indicated by the eddy correlation sensors shortly after midnight on two of three occasions.

50. Journal of Hydrology, 127(1991)193-217

EVAPORATION FROM A TROPICAL LAKE: COMPARISON OF THEORY WITH DIRECT MEASUREMENTS

K.J.Sene, J.H.C. Gash and D.D.McNeil

Eddy correlation measurements of evaporation are reported for a large freshwater lake, Lake Toba, in Indonesia. Measured hourly values of bulk transfer coefficient. Bowen ratio and heat fluxes are presented, and the compared with data from Lakes at higher latitudes. A method is described whereby the measurements are used in conjunction with data from land-based meteorological stations to calibrate methods for estimating the long-term historical evaporation from the lake.

Hydrological data collection network:

51. Journal of Hydrology, 122(1991)71-91

AN APPROACH TO THE RATIONALIZATION OF STREAMELOW DATA COLLECTION NETWORKS

Donald H. Burn and Lan C. Goulter

A new procedure for rationalizing a streamflow data collection network is developed. The procedure is a two-phase approach in which in the first phase, a hierarchical clustering technique is used to identify groups of similar gauging stations. In the second phase, a single station from each identified group of gauging stations is selected to be retained in the rationalized network. The station selection phase is an inherently heuristic process that incorporates information about the characteristics of the indivisual stations in the network. The methodology allows the direct inclusion of user judgement into the station selection process in that it is possible to select more than one station from a gourp, if conditions warrant. The technique is demonstrated using streamflow gauging stations in and near the pembina River basin, southern Manitoba, Canada.

52. Journal of Hydrology 157(1994) 307-324

AN ENTROPY APPROACH TO DATA COLLECTION NETWORK DESIGN

Yujuin Yang , Donald H. Burn

A new methodology is developed for data collection network design. The approach employs a measure of the information flow between gauging flow measure is based on the entropy of gauging stations and pairs of gauging stations. Non-parametric estimation is used to approximate the multivariate probability density functions required in the entropy calculations. The potential application of the approach is illustrated using extreme flow data from a collection of gauging stations located in Southern manitoba, Canada.

WATER QUALITY:

53. Journal of Hydrology, 134(1992)95-102

A NEW TECHNIQUE FOR THE ANALYSIS OF CONTINUOUSLY MONITORED WATER-QUALITY DATA

David Hirst

A technique for analysing river data collected at frequent intervals over a long period is described. Summary measures, standardized for flow rate, are used to investigate long-term trends and to make xomparision between sites. The technique is applied to data from an acid rainf study, showing trends in pH and conductivity.

CLIMATOLOGY:

54. Journal of Hydrology, 128(1991)223-236

FACTORS CONTROLLING STABLE ISOTOPE COMPOSITION OF RAINFALL IN NEW DELHI, INDIA

P.S. Datta, S.K. Tyagi and H. Chandrasekharan

Temporal variations in the oxygen-18 and deuterium composition of New Delhi rainfall (1961-1983) have been analysed using statistical correlations. Although long-term values agree with the 'world meteoric line', short-term features can be seen following an evaporation line Rainfall in the monsoon months (June-September) seem to be undergoing evaporation and subsequent isotopic enrichment during the course of its fall. The isotopic composition of rainfall events of less than 30 mm show deviation from the meteoric line. The isotopic composition and deuterium excess values appear to be governed by the intensity and distribution of rainfall and the trajectory of the most air-mass movement. The long-trem mean temperature and mean rainfall

together account for about 80-95% of the long-term average variability of "O composition. Lack of correlation between monthly isotopic composition and rainfall reflects the possible impact of atmospheric circulation patterns on rainfall isotope contents. The necessity of isotope modelling of moist air-mass circulation is also discussed.

HYDROLOGIC MODELLING:

55. Journal of Hydrology, 142(1993)47-69

A COMPREHENSIVE SURFACE-GROUNDWATER FLOW MODEL

Jeffirey G. Arnold , Peter M. Allen and Gilbert Bernhardt

In this study, a simple groundwater flow and height model was added to an custing basin-scale surface water model. The linked model is (1) watershed scale, allowing the basin to be subdivided, (2) designed to accept readily available inputs to allow general use over large regions (3) continuous in time to allow simulation of land management, including such facators as climatic and vegetation changes, pond and reservoir management, groundwater withdrawals and strem and reservoir withdrawals. The model is described, an is validated on a 47 km^2 watershed near Waco. Texas. This linked model should provide a comprehensive tool for water resource managers in development and planning.

56. Journal of Hydrology 157(1994)61-85

CELMODS - A SEMI-DISTRIBUTED CELL MODEL FOR CONVERSION OF RAINFALL INTO RUNOFF IN SEMI-ARID WATERSHEDS

Amon M. Kamieli , Mordechai H. Diskin, Leonard J. Lane

This paper intoroduces the general outline of CELMOD5, a parametric, semi-

distributed, quasi-linear model, for conversion of rainfall into surface runoff. The model considers the waterhsed as a series of interconnected cell units, each representing a specific portion of the area of the watershed. In contrast to grid models using a large number of rectangular elements or cells, the number of cells in CELMOD is relatively small and their boundaries are chosen according to the watershed topography. For each cell, the program computes the surface runoff hydrograph at the cell outlet, related to a specified record of total rainfall data at a number of rain gages. If measured surface runoff data are available for some locations in the watershed, the program can compare these data with computed values of surface runoff at the corresponding points of cell model. Detailed descriptions are provided for the main model procedures -computation of rainfall excess, conversion of rainfall excess into surface outflow, routing the channel inflow and subtraction of channel losses. Special attention is given in this model to the specific conditions of arid or semi-arid watersheds.

This paper is also concerned with a technique for calibrating and testing a forecasting model of storm hydrographs with emphasis on two objective functions-runoff volume and peak discharge. A method for evaluation procedure is presented based on the following five steps: trial and error calibration; sensitivity analysis bilinear interpolation optimization; testing the model on different storm events testing the model on a different watershed. Results are presented for all the larger storm events with reliable data during 12 years in two sub-watersheds of the Walnut Gulch Experimental Watershed in southeastern Arizona. The evaluation procedure is demonstrated for one particular rainfall-runoff event.

NUCLEAR HYDROLOGY:

57. Journal of hydrology, 139(1992)49-62

STABLE ISOTOPE STUDY OF THE GANGA(GANGES) RIVER SYSTEM

R.Ramesh and M.M. Sarin

Stable hydrogen ($D) and oxygen (^{18}O) isotope ratios of the Ganga river system are reported for the first time. High-altitude streams (Ganga headwaters) show a $D -^{18}O relationship close to that of the global meteoric water line. Samples from the lowland regions show a significant effect of evaporation, indicated by a reduced slope (of approximately six) in the $D - ^{18}O plot. There is a progressive enrichment of the values downstream in the Ganga. The $ values of the Ganga headwaters show a change of -0.19% (^{18}O) and- 1.6% ($D) per 100 m increase in altitude (the 'altitude effect'), which is shown by a simple theoretical calculation to be half that in the local precipitation.

INTERNATIONAL JOURNAL OF REMOTE SENSING

SURFACE WATER HYDROLOGY/REMOTE SENSING:

58. Int. J. Remote Sensing, 1991, Vol. 12, No. 12, 2597-2609.

REMOTE SENSING AND RIVER MIGRATION IN WESTERN INDIA

S.M. Ramasamy, P.C. Bakliwal and R.P. Verma

The art of remote sensing has opened up many vistas in the study of river migration as satellite photographs, both in their normal and digitally enhanced modes, vividly show the rivers and their migratory signatures. The rivers migrate of various reasons amongst which tectonic movement is one of the main causes. In the present study an attempt has been made to exhibit the paleochannel network of the rivers of Western India and integrate them with lineament fabric, so as to understand the Quaternary tectonics of the region. The study has shown that Western India shows considerable signs of Quaternary tectonics.

GROUND WATER HYDROLOGY/REMOTE SENSING:

59. Int. J. Remote Sensing, 1992,Vol.13,No.10,1891-1901

EVOLUTION OF KOSI RIVER FAN, INDIA: STRUCTURAL IMPLICATIONS AND GEOMORPHIC SIGNIFICANCE

R.P. Agarwal and R.Bhoj

The Kosi river fan located in the northern part of India is one of the largest alluvial

cones built by any river in the world. This 180 km long and 150 km wide alluvial cone shows evidence of lateral shift exceeding 140km during the past 250 years. The Kosi alluvial cone and its adjoining area has been studied in detail by remote sensing techniques. The data have been integrated with the available geological and geophysical information to decipher the causes responsible for the lateral shift of such a high magnitude fan.

The satellite image better defines the old palaco-channels of the Kosi river and its confluence with the Mahananda river north of Lava prior to 1731. The dominant structural contro!, in shifting the river towards the west from one fault zone to another, is also discernible. Integrated study reveals the occurrence of dominant NNW-SSE and NNE-SSW trending faults/lineaments colinear with the pre-existing basement weak zones and their reactivation to date. The recent Himalayan relief, the thrusting of Siwaliks over the Gangetic alluvium, the development of inclined. Holocene terrace in the piedmont zone and ocurrence of recent earthquakes amply demonstrates the continued neotectonic movements in the recent past. The structure contour map at the basement and Neogene. Quaternary level suggests a regional tilt from east to west along the Malda Kishanganj fault, which got accentuated in the recent past due to reactivation along the faults/lineaments resulting in westward migration of the river. Thus neotectonic movements result in rapid uplift in the catchment area and a gradual regional westward tilt responsible for building up this gigantic alluvial cone.

60. Int. J. Remote Sensing, 1992, Vol. 13,No. 15, 2925-2942

APPLICATION OF DIGITAL ENHANCEMENT TECHNIQUES FOR GROUNDWATER EXPLORATION IN A HARD-ROCK TERRAIN

J. Krishnamurthy, P. Manavalan, & V. Saivasan

Geomorphological and geologaical features, namely landforms, rock units and geological structures have a definite relationship with the occurrence and movement of groundwater in hard-rock crystalline formations. Exploration and exploitation of this sub-surface resource depend upon the understanding of expected subsurface

hydrological conditions through surface expressions. The different types of digital enhancement techniques using remotely sensed data help in the extraction of specific features that act as groundwater indicators and ultimately lead to the preparation of maps indicating groundwater prospective zones. In this study, different enhancement techniques, such as linear stretching, band combination, filtering and edge enhancement, have been employed for deriving groundwater-controlling features in typical hard-rock crystalline formations of parts of the Raichur district, Karnataka, India. The qualitative evaluation of each enhanced output for its feature exhibitance has narrowed down the optimum operations to be performed for extracting all the groundwater-related features. The linear-stretched band data and specific false colour composite (FCC) have brought out the details on geology and geomorphology, while the various landforms have been highlighted by the FCC of principal-composite analysis. The geological structures have been highlighted by filtering techniques. Band subtraction has brought out the vegetation along valley fills and moisture-laden lineaments. Based on the results achieved, a package has been suggested that can be used on an operational basis for groundwater targeting in typical hard-rock crystalline formations. It should be further used in conjunction with knowledge of local field conditions to aid the investigations made by remote sensing techniques.

61. Int. J. Remote Sensing, 1993, Vol. 14 No. 17, 3221-3229

LANDFORM ANALYSIS AND GROUND WATER POTENTIAL IN THE BIST DOAB AREA, PUNJAB, INDIA

Rajiv Chopra and P.K. Sharma

In the Bist Doab tract of the Punjab, occurrence of ground water is controlled by geological and geomorphological features. In this study an attempt has been made to analyse different landforms and geomorphological features and to evaluate their ground water potential. The geomorphological units identified include linear ridge, structural hills, alluvial fans, piedmont plain, alluvial plain, sand dunes, flood plain, seasonal rivulets and braided river channels. The palaeochannels, ox-bows and

meander scars have prominent shallow aquifers of good quality with excellent yield. The low lying alluvial plain is cropped extensively due to more moisture and or shallow aquifers. Flood plains are potential sites for artificial recharge. Tapping off the flood plain for ground water can be easy and cheap. The run-off and recharge zones have been identified from satellite data.

62. Int. J. Remote Sensing, 1993, Vol. 14,No. 17, 3231-3237

IDENTIFICATION OF OVERDEVELOPED ZONES OF GROUND WATER AND THE LOCATION OF RAINWATER HARVESTING STRUCTURES USING AN INTEGRATED REMOTE SENSING BASED APPROACH-A CASE STUDY IN PART OF THE ANANTAPUR DISTRICT, ANDHRA PRADESH, INDIA

R.S. Rao, M. Venkataswamy, C. Mastan Rao, & G.V.A. Rama Krishna

The Kuderu macro watershed has in the middle reaches of Pennar river basin in Anantapur district,Andhra Pradesh, India. There is great need and demand for ground water for irrigation and drinking purposes, due to frequent failure of monsoons and recurring drought. The majority of the irrigated wells are dried up and the ground water is extracted from the deeper aquifers, to meet the acute shortagae of water. In this article, an attempt has been made to make a quantitative estimate of ground water resource at the micro level using conventional techniques, hydrogeomorphological and hydrogeological mapping using remotely-sensed data. Multi-spectral and multi-date satellite data from IRS LISS-I and Landsat-TM were utilised to assess the hydrogeological characteristics as well as ground water irrigated areas. The rainwater harvesting structures are recommended in the ground water overdeveloped villages to recharge the irrigated wells for further utilisation and management.

GROUND WATER HYD./REMOTE SENSING & DATA COLLECTION:

63. Int. J. Remote Sensing, 1995, Vol.16 No.13, 2393-2401

SYNERGETIC USE OF ACTIVE AND PASSIVE REMOTELY-SENSED AND MAP DATA IN THE DELINEATION OF PART OF GODAVARI PALAEOCOURSE

R. Nagarajan, R. Vinod Kumar and A. Roy

Map information for (1937-38 and 1965-66). Indian Remote Sensing Satellite (IRS) data of October 1988 and 1990. Landsat-TM data of 1987 and airborne SAR data (1988) were used in the identification of river course, geomorphological features and palaeo channels over part of the Godavari river, India. The change in river course and growth and erosion of the island/sand bar were measured. The palaeocourse of the river at test sites has been reconstructed. The measured cut-off ratio indicates that the chute cut-off of the river course near Gannavaram is very high. Flood affected areas in the regions could be assessed by this method.

DROUGHT MANAGEMENT/REMOTE SENSING:

64. Int. J. Remote Sensing, 1993, Vol.14.No. 17, 3201-3208

AN INTEGRATED PC ENVIRONMENT FOR ASSESSMENT OF DROUGHT

S. Thiruvengadachari and H.R. Gopalkrishna

The design of a versatile software environment to support routine activities of a satellite based operational drought monitoring system is presented in this article. In addition, software provides the asistance to analyse and interpret drought conditions based on satellite derived normalised difference vegetation index (NDVI) statistics and

ground information pertaining to a give area. The environment currently under development deals with district-wise drought assessment for nine states, taluk-wise for Karnataka State and operates on a standard PC with EGA graphics.

SEDIMENTATION IN RESERVOIRS / REMOTE SENSING:

65. Int. J. Remote Sensing, 1992, Vol. 13, No. 8, 1473-1486

ESTIMATION OF SUSPENDED SOLIDS USING INDIAN REMOTE SENSING SATELLITE- 1A DATA: A CASE STUDY FROM CENTRAL INDIA

V.K. Choubey and V. Subramanian

The objective of this study was to use Indian Remote Sensing Satellite-1A(IRS-1A) Linear Imaging Self Scanning-1(LISS-1) digital data in combination with field measurement for the estimation of suspended solids concentration in an inland water body (reservoir). For this purpose, a small reservoir (Tawa), on the Tawa river of the Narmada basin in Central India, was studied. The Tawa reservoir water samples were collected on 28 September and 20 October 1988, concurrent with IRS-1A overpass. Reservoir water samples have been analysed to determine grain size analysis and mineralogy.

IRS-1a, LISS-I computer compatible tapes (CCTs) have been obtained from N.R.S.A. Hyderabad. The relation between 20 October 1988 LISS-1 digital data and measured values of suspended solids concentration were quantified using simple linear and multiple regression equations. An optimum equation was chosen based on higher coefficient of determination, lowest standard error and F value (four times greater than F critical) (Whitlock et.al. 1982). For the verification of equations and obtained results, these equations were applied to LISS-I digital data of 28 September 1988, for 21 sampling sites to estimate the concentration of suspended solids.

The results indicate that in the concentration range 10-50 ppm, functional relations exist between suspended solids concentration and visible wavelength Bands 1,2 and

3(0-45 and 0.68 micro m.). As the concentration of suspended solids increases, the spectral response also increases in the range 10-50ppm. Visible wavelength bands (0.45 and 0.68 micro m.) are more useful than the near Infrared Band 4 (0.77- 0.89 micro m.). Band 3 (0.62-0.68 micro m.) especially has proved to be best for the quantification of suspended solids concentration.

IRS-1A LISS-1 digital data can be used successfully to quantify suspended solids concentrations. Based on the results of this study, it appears that the regression technique has a strong potential for the application of IRS-1A data in this area and possibly to other reservoirs in India.

66. Int. J. Remote Sensing, 1992, Vol. 13.No. 11.2151-2159

CUMULATIVE EFFECTS OF SALINITY AND SEDIMENT CONCENTRATION ON REFLECTANCE MEASUREMENTS

D.S. Bhargava and D.W.Mariam

The cumulative effects of salinity and sediment concentration variation on the spectral reflectance measurement from a sediment-laden saline water was studied in the laboratory using a spectroradiometer. Reflectance is observed to be dependent on salinity concentration in addition to sediment type and concentration. It is also observed that, in general, the spectral response (i.e. per cent reflectance at different wavelengths) has a negative correlation with salinity, but a positive correlation with sediment concentration. A model for predicting the suspended sediment concentration from reflectance measurements with due involvement of the salinity variation is developed. The predicted and observed values of the sediment concentration by the presented model show good agreement.

FLOOD HYDROLOGY/REMOTE SENSING:

67. Int. J. Remote Sensing, 1993, Vol. 14, No.7, 1297-1303

IDENTIFICATION OF FLOOD PRONE REGIONS OF RAPTI RIVER USING TEMPORAL REMOTELY-SENSED DATA

R. Nagarajan, G.T. Marathe & W.G. Collins

Remotely-sensed data in the form of satellite images and aerial photographs were used in conjunction with ancillary data to study flood related features of River Rapti in the state of Uttar Pradesh India. The morphological characteristics and sedimentation patterns were used to reconstruct the flood history of the region. The flood history was utilised to forecast dynamics of river channel migration. This information will lead to timely selection of appropriate measures to mitigate flood related damages.

ENVIRONMENT HYDROLOGY / WATER QUALITY/REMOTE SENSING:

68. Int. J. Remote Sensing 1993, Vol. 14, No. 11, 2215-2221

REMOTE SENSING FOR MAPPING OF SUSPENDED SEDIMENTS IN KRISHNA BAY ESTUARY, ANDHRA PRADESH, INDIA

M. Anji Reddy

The objective of this study was to use Landsat-MSS digital data converted for the mapping of suspended sediments (SS) in the Krishan Bay Estuary. The relation between Landsat-MSS radiance values for all four bands and measured values of suspended solid concentrations were quantified using simple linear and multiple regression equations. An optimum and best fitted equation was chosen based on the percentage error of estimation, Chi^2 values and simplicity of the model. This calibrated regression model was then applied to map the SS(mg l^{-1}) concentration

for the entire study area. It is shown that Landsat-MSS data can be used successfully to quantify suspended sediment concentrations in this geographical area and possibly in other areas which have similar environmental and climatic conditions, if the regression equation is tested using an independent data set.

LAKE HYDROLOGY/REMOTE SENSING:

69. Int. J. Remote Sensing, 1993, Vol. 14, No.15, 2747-2758

DETECTING AND EVALUATING THE INFLUENCE OF WATER DEPTH, VOLUME AND ALTITUDE ON THE VARIATIONS IN THE SURFACE TEMPERATURE OF LAKES USING LANDSAT IMAGERY

Serwan M.J. Baban

The Landsat thermal band has been used to map the thermal pattern in three lakes of the English Lake District, Cumbria. The patterns are clearly associated with the variations in the depth. The cause of the formation of this pattern is thought to be solar warming of water. The influence of water volume and altitude and the surface temperature and the relation among them were formalised in an equation involving 16 lakes.

70. Int. J. Remote Sensing, 1995, Vol. 16, No. 2, 365-368

RANKING OF LAKES: LOGISTIC MODELS

B.S. DAYA SAGAR and B.S. PRAKASA RAO

One of the simplest systems a limnologist can study is the periodical variations in areal extent of lakes. This system may be represented in a single difference equation $X_{t+1} = [(\text{lambda}). X_t (1-X_t)]$. Based on this equation, logistic maps have been constructed

to predict the size of changing areal extent of water and marsh in the Chilka lake.

HYDROLOGIC INSTRUMENTATION:

71. Int. J. Remote Sensing, 1992, Vol. 13, No. 14, 2727-2733

TANK DEPTH DETERMINATION FOR WATER RADIOMETRIC MEASUREMENTS

J.E. Mantovani and A.P. Cabral

To determine the optimum tank depth for the assessment of spectral reflectance from suspended inorganic matter (SIM), a 1.10m x 0.90m x0.67m black-coated tank was used. A plate with the same coating was constructed to simulate various depths. Different concentrations of bentonite and red silt suspensions were produced and radiometric measurements were performed in the 400-900 mm spectral range. The results showed close relationships between optimum depth and suspension characteristics. e.g. at 5mg/1 of bentonic the optimum depth was around 0.63 m and at 140 mg/1 it was 0.41 m too. Before each experiment the optimum tank depth must be assessed to produce spectral reflectance of SIM.

WATER QUALITY AND SOIL SALINITY/ REMOTE SENSING:

72. Int. J. Remote Sensing, 1993, Vol., No. 10, 1919-1929

MAPPING OF SALT-AFFECTED LAND IN SAURASHTRA COAST USING LANDSAT SATELLITE DATA

M.D. Joshi And B. Sahai

Coastal salt-affected land is subject to variation in area as well as magnitude with time because of influence of coastal processes. In order to take corrective and protective measures, it is essential to have accurate information about such an area in the form

of maps. Using conventional ground methods, mapping of such an inhospitable area is not only difficult and time-consuming but also expensive, laborious, and associated with vagaries of weather. Hence an attempt has been made to use remote sensing techniques for the purpose of preparing a map of one of the coastal areas of Gujarat state, providing information about the extent and magnitude of salt-affected land.

73. Int. J. Remote Sensing, 1994, Vol. 15, No. 9, 1901-1914

REMOTE SENSING TECHNIQUE FOR MAPPING SALT AFFECTED SOILS

K.S. Verma. R.K. Saxena, A.K. Barthwal & S.N. Deshmukh

The salt affected soils of Etah, Aligarh, Mainpuri and Mathura districts have been mapped into SI: <10 percent of the area covered by salts, S2: 10-30 per cent. S3:30-50 percent, S4:50-75 percent and S5: >75 percent using an integrated approach of image interpretation. The dull white tone of salt affected and sandy soils have posed problems in their discrimination, on TM false colour composite, however, the problem of spectral similarity was solved through integration of interpretation of thermal data (10.4-12.5 micro m.) with TM FCC (bands 2,3,4) interpretation. The discrimination of salt affected soils was significantly better on data between March and first week of April because of maximum contrast. Out of 1.75m ha of the total geographical area, the salt affected soils account for 11.8 per cent. Another 16.2 per cent is likely to be affected with this problem if similar degraded conditions prevail there. The values of pH:8.7 and ECe: 1.3 dsm^{-1} of SI soils group them into non saline and mildly alkali calss. Similarly iow ECe: 44 dSm^{-1} and high pH: 9.8 for S3 soils and high ECe: 24.0 dsm^{-1} and very high pH: 10.7 of S4/S5 soils, placed the soils into alkali and sodic classes respectively. The gypsum requirement based on pH values varies from 1 to 15 tha^{-1}

HYDROLOGICAL SCIENCES JOURNAL (IAHS)

SURFACE WATER HYDROLOGY/SNOW HYD./HYD.MODELLING:

74. Hydrological Sciences-Journal-des Sciences Hydrologiques, 36,2,April,1991

DYNAMIC-STOCHASTIC MODELS OF RAINFALL AND SNOWMELT RUNOFF FORMATION

L.S. Kuchment & A.N. Gelfan

Possibilities for the development of dynamic-stochastic models of runoff formation with random inputs are discussed. Two models are described: the first allows the calculation of the satistical distribution of the maximum discharges of rainfall floods, and the second the statistical distribution of snowmelt flood volumes. Meteorological inputs are generated by the Monte Carlo method. Physically-based models are used for the transformation of input data into runoff. The various models are applied to observation data from two watersheds.

SURFACE WATER HYDROLOGY:

75. Hydrological Sciences-Journal-des Sciences Hydrologiques, 36,5, Oct.1991

INTERCOMPARISON OF EVAPOTRANSPIRATION ESTIMATES

S.Mohan

Five methods of computing reference evapotranspiration from a reference crop (Penman, radiation, Blaney-Criddle, Hargreaves and pan evaporation) have been

studied for their applicability under different climatic conditions. The Penman method was taken as the standard and the other four methods were compared against this method. Good correlation was obtained between the values estimated by the four methods and the Penman method although differences in magnitude were found. Regression equations were developed to correct those differences in magnitude. The method suitable for the estimation of reference evapotranspiration for each climatic condition is also suggested.

76. Hydrological Sciences Journal des Sciences Hydrologiques,37,1,Feb. 1992

RUNOFF ESTIMATION USING LANDSAT THEMATIC MAPPER DATA AND SCS MODEL.

K.D. Sharma & Surendra Singh

Landform, drainage pattern, slope, soil, vegetation and land use/land cover, all of which control surface runoff and peak flow, can be evaluated and mapped reliably and reasonably through Landsat Thematic Mapper (TM) false colour composites of the post-monsoon season. Runoff curve numbers (CN) determined from those data predicted the runoff depth and peak flow with a coefficient of determination of 0.970 and 0.863 respectively; thereby iridicating that, in terms of accuracy, speed and cost, the Landsat TM data are of great significance for estimating surface runoff via the SCS model in the arid environment of northwest India.

SURFACE WATER HYD./GROUND WATER HYD.:

77. Hydrologial Sciences-Journal-des Sciences Hydrologiques, 37,4, 8/1992

DETERMINATION OF THE EFFECT OF SURFACE WATER IRRIGATION ON THE GROUNDWATER CHEMISTRY OF A HARD ROCK TERRAIN IN CENTRAL INDIA

L.P. Chourasia & John H. Tellam

The Bundelkhand area of central India consists of weathered granitic bedrock. The aim of the present study was to identify the effects of surface water irrigation on groundwater quality in shallow aquifers used for domestic supply. A set of 37, 58 and 17 samples were collected, respectively, from the non-irrigated area, the irrigated area and surface waters. Concentrations of major ions (including NO), PO and Fe were determined. A statistical comparison of the data groups was carried out assuming that the only difference between the two areas was in agricultural practice. It was discovered that, despite the better quality of the surface waters, the irrigated area groundwaters were higher in concentration than those of the non-irrigated area. The main causes for that appear to be evaporation/transpiration and fertilizer application, modified by calcite precipitation and ion exchange. The proposed approach is simple enough to be used routinely in monitoring.

SURFACE WATER HYDROLOGY:

78. Hydrological Sciences-Journal des Sciences Hydrologiques,37,5,10/1992

UNIT HYDROGRAPH ESTIMATION WITH MULTIPLE EVENTS AND PRIOR INFORMATION: I. THEORY AND A COMPUTER PROGRAM

M. Bruen & J.C. I. Dooge

The method of regularization for estimating unit hydrographs is expanded to allow the inclusion of prior information about the unit hydrograph shape. This may give smooth estimates without any loss in volume. The method is illustrated with prior information from a regression on catchment characteristics and with catchment lag determined from the data. A computer program to implement the method is given together with a sample calculation.

SURFACE WATER HYD./HYDROLOGICAL MODELLING:

79. Hydrological Sciences-Journal des Sciences Hydrologiques,38,5, October, 1993

CALIBRATION OF CONCEPTUAL MODELS FOR RAINFALL-RUNOFF SIMULATION

S.K. Jain

Conceptual mathematical models are a useful tool for rainfall runoff modelling of a basin. The calibration of such models has attracted the attention of a number of hydrologists since unique and optimal parameters are difficult to obtain. The calibration of a conceptual model is discussed through a simple conceptual model whose parametrs are determined using a search technique. It is shown that the optimization algorithm converges to a global optimum even when the errors in the initial parameters are quite significant and the input environment is noisy.

SURFACE WATER HYDROLOGY:

80. Hydrological Sciences-Journal-des Sciences Hydrologiques, 39,2,April 1994

MESO-SCALE MODELLING OF RUNOFF AND WATER BALANCES USING REMOTE SENSING AND OTHER GIS DATA

G.A. Schultz

For about two decades remote sensing (RS) data in the form of multi-spectral air photography, ground based weather radar as well as geostationary and polar orbiting satellite data have been available for use in hydrology. It is the intention of this paper to advocate the use of RS data in the field of hydrological modelling. It is shown that the main field of application of RS data in hydrological modelling lies in the mesoscale. The potential of RS in the framework of GIS is shown along with three examples. The first example shows the use of RS data for rainfall/runoff modelling in the lower meso-scale. A model was developed which used the high spatial resolution of Landsat polar orbiting satellites (30m X 30 m) for model parameter estimation. The second example

shows the use of geostationary satellite data for the computation of long time series of monthly runoff values in the upper meso-scale. It was applied in West Africa for the purpose of water resources planning. In the third example, a water balance model in the upper meso-scale is presented which computes daily values for all the variables in the water balance equation along with an example of the model's application in the international Mosel River basin. Here also the detection of land use changes by multi-temporal satellite imagery and their impact on hydrological parameters is discussed. In this example, emphasis is put on the combination of RS data with other information, such as digital elevation models or digitized mapes, all within the framework of GIS. In conclusion, not only the potential but also the limitations of the use of RS in hydrological modelling are discussed.

81. Hydrological Sciences Journal des Sciences Hydrologiques, 39,4,August 1994

EVAPOTRANSPIRATION ESTIMATION USING A NORMALIZED DIFFERENCE VEGETATION INDEX TRANSFORMATION OF SATELLITE DATA

P.M. Seevers & R.W. Ottman

Evapotranspiration of irrigated crops on two irrigation service areas along the lower Colorado River was estimated using a normalized difference vegetation index of satellite data. A procedure was developed which equated the index to crop coefficients. Evapotranspiration estimates for fields for three dates of thematic mapper data were highly correlated with ground estimates. Service area estimates using thematic mapper and Advanced Very High Resolution Radiometer data aagreed well with estimates based on US Geological Survey gauging station data.

82. Hydrological Sciences Journal des Sciences Hydrologiques,39,5,October 1994

A COMPUTER BASED SYSTEM FOR MODELLING THE STAGE-DISCHARGE RELATIONSHIPS IN STEADY STATE CONDITIONS

In order to support the effort of Environment Canada directed to the automation of surface water quantity data management, an Intelligent Decision Support System (IDSS), to be used to create,develop and maintain stage-discharge (S-D) rating curves, is in the final stage of development. Environment Canada is the agency responsible for establishing gauging stations and monitoring streamflow in Canada. Hydraulic data such as stage and discharge are measured at these stations and used for the development of S-D rating curves. These in turn are corss-referenced with continuous water level recordings to generate daily stream discharges. The current procedure for establishing S.D curves used by Environment Canada is subjective, due to the manual labour involved in the plotting of measurements, analysing of data points and decision making to alter or update an existing curve. The IDSS computer system is based on the concept of representing rating curves with mathematical models or equations. The paper describes the main characteristics of the modelling module of the IDSS. Linear regression is the modelling technique used within the IDSS together with power and Box-Cox transformations introduced to achieve linearity of the data. Within the module presented in the paper, the generation of multiple S-D curves is combined with comprehensive statistical and multi-objectiave analyses in order to select an optimal mathematical model or equation.

83. Hydrological Sciences Journal des Sciences Hydrologiques, 40,2, April 1995

MULTIVARIATE MODELLING OF WATER RESOURCES TIME SERIES USING ARTIFICIAL NEURAL NETWORKS

H. Raman & N. Sunil Kumar

The artificial neural network(ANN) approach described in this paper for the synthesis of reservoir inflow series differs from the traditional approaches in synthetic hydrology in the sense that it belongs to a class of data-driven approaches as opposed to traditional model driven approaches. Most of the time series modelling procedures fall

within the framework of multivariate autoregressive moving average (ARMA) models. Formal statistical modelling procedures suggest a fourstage iterative process, namely, model selection, model order identification, parameter estimation and diagnostic checks. Although a number of statistical tools are already available to follow such a modelling process, it is not an easy task, especially if higher order vector ARMA models are used. This paper investigates the use of artificial neural networks in the field of synthetic inflow generation. The various steps involved in the development of a neural network and a multivariate autoregressive model for synthesis are presented. The application of both types of model for synthesizing monthly inflow records for two reservoir sites is explained. The performance of the neural network is compared with the statistical method of synthetic inflow generation.

84. Hydrologaical Sciences-Journal des Sciences Hydrological,40,3, June, 1995

MODELS FOR EXTENDING STREAMFLOW DATA: A CASE STUDY

H.Raman, S. Mohan & P. Padalinathan

Models are proposed to extend the monthly streamflow data a site where the available historic rainfall and streamflow data are too short for adequate systems study, subject to the condition that there are no gauging sites in the basin or adjacent basins with a longer period of streamflow data. Hence rainfall data of a nearby raingauge station are used. Five regression models, namely, runoff coefficient model, single linear regression, monthly linear regression with stochastic description for residuals, and a double regressed model are used. The results show that the monthly linear regression model with stochastic description for the residuals is best suited for the purpose when applied to a case study.

85. Hydrological Sciences Journal des Sciences Hydrologiques,40,4, August 1995

ESTIMATION OF MONTHLY RUNOFF FROM SMALL CATCHMENTS IN INDIA

Data from 31 non-snowfed catchments in India having catchment areas less than 1515 km have been analysed to develop a simple method for the estimation of monthly runoff for the monsoon months of June to October. One of the parameters of this method was found to vary with the catchment area, the percentage of forest cover in the catchment and the monthly average temperature. The value of another parameter of the proposed method was found to be constant during any one month in a hydrologically homogeneous region. The method proposed herein is useful for estimating the monthly runoff during the monsoon period from catchments having scarce data.

GROUND WATER HYD./HYDROLOGICAL MODELLING:

86. Hydrological Sciences Journal-des. Sciences Hydrologiques, 36,1, 2/1991

LOGIC PROGRAMMING IN GROUNDWATER RESOURCES MANAGEMENT

F. Tangorra & M. Vurro

Artificial intelligence techniques can be used to solve problems using a heuristic approach. This paper deals with a model able to verify whether there is groundwater in a given place, the quantity available and its quality. The system has been implemented in the logic programming language Prolog and runs on a personal computer under MS-DOS. The knowledge base has been constructed using degrees of certainty and other factors. The model has been applied to a region in Southern Italy, where data are available. The first results are encouraging and further questions about groundwater quantity and quality are being examined.

GROUND WATER HYD./HYDROLOGICAL MODELLING:

87. Hydrological Sciences-Journal-des Sciences Hydrologiques, 36,2,4/1991.

DYNAMIC SIMULATION MODEL OF VERTICAL INFILTRATION OF WATER IN SOIL

VALERU YURIEVICH GRIGORJEV & LASZLO IRITZ

One of the most important problems of hydrological forecasting is to obtain a reliable estimation of effective rain. Infiltration is one of the variables which greatly influences the partitioning of rainfall into surface runoff and subsurface flow. This paper presents an infiltration model which describes the unsaturated zone as a multi-layer system. For this purpose a relationship developed by Denisov (1978) for total hydraulic potential versus soil moisture content has been used. The model contains a system of ordinary differential equations for describing soil moisture movement and it can be interpreted as an aggregated simulation model with lumped parameters. Some basic equations and results of simulation runs are presented.

GROUND WATER HYDROLOGY:

88. Hydrological Sciences-Journal des Sciences Hydrologiques,27,4,8/1992

OVER-EXPLOITATION OF AN ALLUVIAL AQUIFER IN GUJARAT, INDIA

N.B. Kavalanekar, S. C. Sharma & K.R. Rushton

Over-exploitation of an alluvial aquifer in India has occurred since tubewells were drilled into deeper aquifers. Field information concerning the fall in both the water table and the piezometric head in the deeper aquifers has been examined and the piezometric heads in the deeper aquifers has been examined and a numerical model has been developed to represent a heavily exploited area. Predictions using the model suggest that the annual declines in the water table and the piezometeric heads are accelerating as the water table moves into a zone having a lower specific yield. Careful monitoring of the movement of the water table is proposed.

89. Hydrological Sci.-Journal des Sciences Hydrologiques, 38,1,2/1993

KARAST SPRINGS HYDROGRAPHS AS INDICATORS OF KARST AQUIFERS

Ognjen Bonacci

By analysing the hydrographs of karst springs it is possible to identify aquifer characateristics and, accordingly, the main features of a karst rock-fissure massif. Consequently, relevant data can be obtained by analysing hydrograph recession curves. This paper presents a detailed analysis and explanation of numerous cases of break points on recession curves via various values of the recession coefficient in Maillet's (1905) equation. The paper also identifies the relationship between and a linear reservoir coefficient by employing groundwater hydrograph methods. It is shown that the linear reservoir coefficient changes with time in accordance with changes of the flow conditions in the karst massif.

90. Hydrological Sciences-Journal-des Sciences Hydrologiques, 40,3, June 1995.

ANALYSING THE LONG TERM REDUCTION IN GROUNDWATER TEMPERATURE DUE TO PUMPING

Mankoto Taniguchi

A heat transport model that incorporates the effect of decreases in hydraulic head due to pumping ofgroundwater has been developed to explain the decrease in groundwater temperature during the last three decades in the Nara basin, Japan. Vertical two dimensional temperature analyses have been made based on a theory of simultaneous transfer of heat and water in porous media. The calculated relationships between the depth and the groundwater temperature in the discharge area agree well with the observed temperature-depth relationships. The model used suggests that the decrease in groundwater temperature is caused by the decrease in the hydraulic head due to pumping.

SOIL EROSION/HYDROLOGICAL MODELLING:

91. Hydrological Sciences Journal des Sciences Hydrologiques,40,2, April 1995

SATELLITE REMOTE SENSING FOR SOIL EROSION MODELLING USING THE ANSWERS MODEL

K.D. Sharma & Surendra Singh

The distributed parameter model ANSWERS was used to predict runoff and soil loss from three agricultural watersheds in the arid zone of India. Model input parameters such as landform, drainage, soil and land use/land cover were derived from Landsat Thematic Mapper false colour composites and limited ground truth. The model predicted hydrographs and sediment graphs within acceptable limits. ANSWERS underpredicted the total soil loss by factors of 2.6 to 3.6. Reasons for these results are discussed.

DROUGHT MANAGEMENT:

92. Hydrological Sciences-Journal- des Sciences Hydrologiques, 36,1,2/1991

A MODIFIED METHOD FOR DROUGHT IDENTIFICATION

S.Mohan & N.C.V. Rangacharya

Water management under drought conditions is a challenging task to irrigation and agricultural engineers. The parameters of interest in identifying drught include onset, termination and severity. In this paper, a methodology to identify those parameters from the available historic data on streamflow and rainfall having seasonal pattern is proposed. The methodology follows and modifies a procedure by Herbst et.al. (1966) suggested for the analysis of drought. This modified methodology is applied to the streamflow series of the Bhadra river and the mean areal rainfall series for the

catchment of the Bhadra reservoir in Karnataka State, India. The droughts identified by the proposed methodology are concurrent with the historically realized droughts, thus proving the viability and applicability of the methodology in the identification of drought conditions.

SEDIMENTATION/HYDROLOGIC MODELLING:

93. Hydrological Sciences Journal des. Sciences Hydrologiques, 37,5,1992

MODELLING SUSPENDED SEDIMENT FLOW IN ARID UPLAND BASINS

K.D. Sharma, R.P. Dhir & J. S.R. Murthy

A conceptual basin model of the instantaneous unit sediment graph was developed for sediment graph prediction from arid upland basins by routing mobilized sediments through a series of linear reservoirs. The sediment graphs generated by convolution of the instantaneous unit sediment graph compared reasonably well with the observed ones for four representative and upland sub-basins in the Luni basin, India. The mobilized sediment during a storm was related to effective precipitation and the parameters of the model were estimated from observed events. The model can be applied to ungauged flow events through parameterization.

SEDIMENTATION IN RESERVOIR:

94. Hydrological Sciences-Journal des Sciences Hydrologiques, 40,2, April 1995

TECHNICAL NOTE : METHODS FOR ASSESSING SEDIMENT DELIVERY IN RIVER SYSTEMS

Edmund Atkinson

A key component of a sediment yield prediction is an estimate of the sediment deposition between erosion sources and a drainage basin outlet. This technical note presents methods requiring a minimum of data which can be used to assess the importance of sediment deposition within the river system of a basin. The methods were applied to a 4123 km^2 basin in the Philippines. Results indicated that sediment deposition within this river system had no significant effects on the overall sediment yield.

FLOOD HYD. & RESERVOIR ROUTING:

95. Hydrological Sciences Journal des. Sciences Hydrologiques, 37,4 5/1992

THE CAUSE OF NEGATIVE INITIAL OUTFLOW WITH THE MUSKINGUM METHOD

Muthiah Perumal

The cause of negative or reduced outflow formation at the beginning of a Muskingum solution is examined in two steps. The first step involves a physical interpretation of the Muskingum weighted discharge and the storage equation, using theory based on an extension of the Kalinin-Milyukov method. The second step involves the derivation of an analytical solution for the weighted discharge based on linear systems analysis theory, and then subsequently the Muskingum solution from that analytical solution using the assumption of linear variation of discharge within the reach. It is proved that this assumption causes the formation of negative or reduced outflow at the beginning of a Muskingum solution.

96. Hydrological Sciences-Journal des. Sciences Hydrologiques, 39.5,October,1994

HYDRODYNAMIC DERIVATION OF A VARIABLE PARAMETER MUSKINGUM METHOD: 1. THEORY AND SOLUTION PROCEDURE

Muthiah Perumal

An approach is presented for directly deriving a variable parameter Muskingum method from the St.Venant equations for routing floods in channels having any shape of prismatic cross-section and flow following either Manning's or Chezy's friction law. The approach also allows the simultaneous computation of the stage hydrograph corresponding to a given inflow or the routed hydrograph. This first paper also describes the solution procedure for routing the discharge hydrograph. A second paper (Perumal, 1994b)presents a verification of the methodology.

97. Hydrological Sciences Journal des Sciences Hydrologiques,39,5,October 1994

HYDRODYNAMIC DERIVATION OF A VARIABLE PARAMETER MUSKINGUM METHOD: 2. VERIFICATION

Muthiah Perumal

The hydrodynamic derivation of a variable parameter Muskingum method and its solution procedure for estimating a routed hydrograph were presented in Part I of this series (Perumal, 1994a). In this paper, the limitations of the method, the criterion for its applicability and its accuracy are discussed based on the assumptions used. The method is verified by routing a given hypothetical inflow hydrograph through uniform rectangular cross-section channels and comparing the results with the corresponding numerical solutions of the St.Venant equations. The stage hydrographs as computed by the method are also compared with the corresponding St.Venant solutions. It is demonstrated that the method closely reproduces the St. Venant solutions for the discharge and stage hydrographs subject to the compliance of the assumptions of the method by the routing process.

FLOOD HYDROLOGY:

98. Hydrological Sciences-Journal des Sciences Hydrologiques,40,6,December 1995

EXPERT SYSTEM FOR THE SELECTION OF METHODS TO CALCULATE DESIGN

Eduardo A. Varas & Marcelo Von Chrismar

This paper presents an expert system to help select the best method to estimate design flood flows for civil engineering works based upon the procedures available, the nature and characteristics of the basin and existing hydrological records. The system presents the user with a list of possible methods ranked in descending grade order and optionally presents explanations which support the selected choices. Ordering is achieved using the knowledge base provided by the expert. The system recommends procedures for both preliminary estimates and final designs. The system also constitutes a valuable aid for junior engineers and experienced hydrologists in the selection of methods. Its conceptual structure can be easily generalized to treat other problems of a similar nature in the field of hydrology and water resources.

FOREST HYDROLOGY:

99. Hydrological Sciences-Journal des Sciences Hydrologiques, 39,6, December 1994

IMPACTS OF FOREST DRAINAGE ON FLOODS

Laszlo Iritz, Barbro Johansson & Lars Lundin

Forest drainage networks are open ditches excavated for lowering the groundwater level in wetland areas to improve growing conditions for the trees. This procedure creates longer discharge surfaces for input to groundwater and shorter pathways for groundwater and overland flow to the channel system, which in turn, changes the basic runoff processes in the catchment. The hydrological effects of forest drainage have been the subject of studies for many years but the conclusions reached are conflicting because of the diversity of conditions as well as the constraints of data availability and the limited accuracy of the methods applied. This study applied three techniques (the control basin method, as well as conceptual and distributed models)

for examining whether or not forest drainage increased peak flows. Small basins were investigated, and estimated parameters were transferred to a larger basin. This paper briefly presents the case study areas, the research concept and the methods applied. The computations showed that the peak flows decreased in general after drainage works. According to all three methods, the effect on the peak flows was larger after dry periods. Event simulations made by the Systeme Hydrologique Europeen (SHE) model suggested that the highest peak flows could be increased by drainage in cases of intensive rainstorms in catchments with already high (close to the soil surface) groundwater level. The general tendency of the drainage effects was that a lowered groundwater level had greater influence on peak flow formation than the increased channel conveyance capacity in the drained catchments.

SNOW /MOUNTAIN HYDROLOGY:

100. Hydrological Sciences-Journal-des Sciences Hydrologiques, 39,5, October 1994.

IMPACTS OF SPATIALLY AND TEMPORALLY VARYING SNOWMELT ON SUBSURFACE FLOW IN A MOUNTAINOUS WATERSHED: 1. SNOWMELT SIMULATION

G.N. Flerchinger & K.R. Cooley & Y. Deng

The dominant source of streamflow in many mountainous watersheds is snowmelt recharge through shallow groundwater systems. The hydrological response of these watersheds is controlled by basin structure and spatially distributed snowmelt. The purpose of this series of two papers is to simulate spatially varying snowmelt and groundwater response in a small mountainous watershed. This paper examines the spatially and temporally variable snowmelt to be used as input to the groundwater flow modelling described in the second paper. Snowmelt simulation by the Simultaneous Heat and Water (SHAW) model (a detailed process model of the interrelated heat, water and solute movement through vegetative cover, snow, residue and soil) was validated by applying the model to two years of data at three sites ranging from

shallow transient snow cover on a west-facing slope. The simulated energy balances for several melt periods are presented. Snow depth, density, and the magnitude and timing of snow cover outflow were simulated well for all sites.

101. Hydrological Sciences-Journal-des. Sciences Hydrologiques, 39,5,1994.

IMPACTS OF SPATIALLY AND TEMPORALLY VARYING SNOWMELT ON SUBSURFACE FLOW IN MOUNTAINOUS WATERSHED: SUBSURFACE PROCESSES

Y. Deng, G.N. Flerchinger & K.R. Cooley

The impacts of spatial and temporal variations of snowmelt recharge on subsurface flow in a small mountainous watershed were investigated using field measurements and numerical simulations. A two-dimensional, variably saturated flow model (VAM2D) was used to characaterize the hillslope aquifer and to delineate hillslope transect described in the preceding paper were used as input for the subsurface flow analyses. Simulations indicated that the heterogeneous hillslope aquifer provides hydrogeological conditions for confined and unconfined groundwater flow depending on the extent of snowmelt recharge. The spatial and temporal distribution and amount of snowmelt recharge play important roles in determining when flow is governed by confined and unconfined flow. Results showed that the VAM2D model was able to simulate piezometric measurements reasonably using calibrated hydraulic parameters. Sensitiavity analyses showed that the flow regime was considerably different when the spatial variation of snowmelt was not considered.

102. Hydrological Sciences-Journal-des. Sciences Hydrologiques,40,2,April 1995

HYDROLOGICAL CHARACTERISTICS OF THE DOKRIANI GLACIER IN THE GARHWAL HIMALAYAS

Pratap Singh, K.S. Ramasastri, U.K. Singh, J.T. Gergan & D.P. Dobhal

Observations of discharge, temperature and suspended sediment made at a gauging site established near the snout of the Dokriani glacier in the western Himalayan region are presented. These observations were made during a scientific expedition to this glacier over 21 days (23.8.1992 - 12.9.1992). Because of harsh weather conditions, observations could not be made for a longer period. The minimum streamflow in the glacier melt stream was observed at 0700 h whereas the maximum was observed at 1800h. The ratio of maximum to minimum flow was computed to be 1.81 from the continuous hourly observations. Based on an analysis of the recession of the hydrograph, it was found that the meltwater time lag from the accumulation zone of the glacier was more than seven times higher than that from the ablation zone. No specific relationship was observed between suspended sediment and discharge. The average values of the suspended sediment and discharge. The average values of the suspended sediment concentration and load were found to be 350 ppm and 180 t day^{1}, respectively, for the study period. Weathering processes in different zones of the glacier were also studied to find out the source of the sediment transported by the meltwater into the melt stream. A high correlation coefficient (r = 0.89) was found between the glacier specific runoff and the air temperature at the gauging site. It showed that temperature alone can represent the melting of the glacier and may be considered for the hydrological modelling of glacier melt runoff. Based on observations over three days under clear weather conditons for isolated snow blocks, the average snowmelt factor was computed to be 5.4 mm (C.6h).

REMOTE SENSING:

103. Hydrological Sciences-Journal des. Sciences Hydrologidques, 19,4 August 1994

APPLICATION OF REMOTE SENSING METHODS TO HYDROLOGY AND WATER RESOURCES

A. Rango

A brief review of research in remote sensing of water resources indicates that there

are many prositive results, and some techniques have been applied operationally. Currently, remote sensing data are being used operationally in precipitation estimates, soil moisture measurements for irrigation scheduling, snow water equivalent and snow cover extent assessments, seasonal and short term snowmelt runoff forecasts, and surface water inventories. In the next decade other operational applications are likely using remote measurements of land cover, sediment loads, erosion, groundwater, and areal inputs to hydrological models. Many research challenges remain, and significant progress is expected in areas like albedo measurements, energy budgets and evapotranspiration estimation. The research in remote sensing and water resources also has much relevance for related studies of climate change and global habitability.

HYDROLOGICAL DATA NETWORK:

104. Hydrological Sciences-Journal-des Sciences Hydrologiques, 36, 3, 6/1991

AN INTERCOMPARISON OF HYDROLOGICAL NETWORK-DESIGN TECHNOLOGIES

Marshall E. Moss & Gary D. Tasker

Two network-design technologies are compared by random sub-sampling of actual streamflow data. The technologies, Network Analysis for Regional Information (NARI) and Network Analysis Using Generalized Least Squares (NAUGLS), have a common objective, viz. to maximize regional information within a limited budget and time horizon. The data used for intercomparison are from a network of 146 streamgauges in the central part of the United States. In general, the results for the illustrative example indicate that the NAUGLS method conveys more information than the NARI method to the network designer interested in maximizing regional information about mean annual flows with a limited budget.

RESERVOIR ROUTING:

105. Hydrological Sciences-Journal des. Sciences Hydrologiques,37,3,6/1992

RESERVOIR ROUTING

John D. Fenton

This paper asserts that the traditional method for reservoir routing is unnecessarily complicated. It requires the solution of a transcendental equation at each time step. Reservoir routing is actually simply the numerical solution of a differential equation. Any standard method can be used, an all are simpler than the traditional method. The paper also shows that the alternative form of the governing equation in terms of the reservoir surface elevation has some advantages over the usual form involving storage volume. The presentation incorporates the case where reservoir outflow may be varied by control of valves or spillway gates. Numerical methods for reservoir routing are examined and compared, and it is concluded that simple standard methods for solving differential equations are to be preferred to the traditional method for flood routing, and should replace it.

CLIMATOLOGY:

106. Hydrological Sciences-Journal-des Sciences Hydrologiques, 36,4,8/1991

CLIMATE AND WATER - A CALL FOR INTERNATIONAL ACTION

A.J.Askew

The work undertaken by climatologists and atmospheric physicists during the 1980s has led to far more consistent and precise predictions of future climate change being made at the close of the decade than had been made at its start. Governments have responded by calling for more information and in some cases, have taken steps to mitigate the effects of such a change. The hydrological community has not been idle and many projects have been launched to study the interaction between climate

change, the hydrological regime and water resources. However, the move towards larger scale international projects with major hydrological components will make new and extensive demands on the hydrological community, to which it must respond.

107. Hydrological Sciences-Journal-des Sciences Hydrologiques, 40.2,April 1995

CLIMATE CHANGAE AND HYDROLOGY WITH EMPHASIS ON THE INDIAN SUBCONTINENT

Divya & R. Mehrotra

On a regional scale, some of the most profound impacts of climate change due to increases in greenhouse gases would probably be major changes in the hydrological cycle, in water availability, in agricultural producation and in the use of energy. This paper gives a brief overview of studies carried out on climate change and possible impacts on hydrology and water resources in India, covering also the agricultural aspect. The need is emphasized for carrying out further studies in this important subject area at the national level, keeping in view the data and computing facilities available.

108. Hydrological Sciences-Journal des. Sciences Hydrologiques, 40,5, Oct., 1995

THE EFFECTS OF CLIMATE CHANGES ON AQUIFER STORAGE AND RIVER BASEFLOW

D.M. Cooper, W.B. Wilkinson & N.W. Arnell

The effects of changes in climate on aquifer storage and groundwater flow to rivers have been investigated using an idealized representation of the aquifer/river system. The generalized aquifer/river model can incorporate spatial variability in aquifer transmissivity and is applied with parameters characteristic of Chalk and Triassic

sandstone aquifers in the United Kindgom, and is also applicable to other aquifers elsewhere. The model is run using historical time series of recharge, estimated from observed rainfall and potential evaporation data, and with climate inputs perturbed according to a number of climate change scenarios. Simulations of baseflow suggest large proportional reductions at low flows from Chalk under high evaporation change scenarios. Simulated baseflow from the slower responding Triassic sandstone aquifer shows more uniform and less severe reductions. The change in hydrological regime is less extreme for the low evaporation change scenario, but remains significant for the Chalk aquifer.

HYDROLOGIC MODELLING:

109. Hydrological Sciences-Journal des. Sciences, Hydrologiques, 38.5,October 1993

A MODIFIED TWO-LEVEL ESTIMATOR FOR REAL TIME FORECASTING

Krashnendra Singh & Mandakinee Majumdar

A modified two-level estimator is proposed and implemented for real time flood forecasting for a hydrological system plagued by a high order of uncertainties because of ungauged tributaries and scanty nonrepresentative rainfall information. A finite set of time varying models running in parallel constitutes a coarse estimator for the proposed two-level estimator. The results of this coarse estimator are combined on the basis of a posterior probability distribution the weighted model thus obtained is fine tuned by a Restricted Exponential Forgetting (REF) algorithm based on a fine estimator. In addition to the usual link between the coarse estimator and the fine estimator, a backward fine-to-coarse estimator link is also suggested. This not only helps in the crucial task of compilation of the finite model set of the coarse estimator but also materially affects the performance of the other components of the estimator. The estimator is shown to yield improved results.

NORDIC HYDROLOGY

IV. Nordic Hydrology:

SURFACE WATER HYD./HYDROL.MODELLING:

110. Nordic Hydrology, 21, 1990, 165-184

RAIN-RUNOFF PARAMETERS FOR SIX SMALL GAUGED URBAN CATCHMENTS

Mogens Jensen

The interpretation of rain-runoff measurements from 6 small (less than 17 ha) urban catchments is described. The recording period covers mostly 1979-1983. Relations between rain- and runoff depths were developed using the traditional linear regression model as well as a new continuous model. Both models compute runoff from impervious surfaces in the same way. Calculation of runoff from semipervious surfaces accounts for infiltration through cracks, percolation from a sublayer and evaporation during dry weather. These phenomena are related to water content of the sublayer. The 10 parameters in the continuous model are calibrated and show values in good agreement with data from the literature. The continuous model fits the measured runoff depths somewhat better for the largest runoff events. For more frequent events, however, the two models are equally good.

Rain intensity - duration - frequency curves have been computed. Variations of up to 20 percentage, for return periods 1/5 and 1/2 yr., are seen for catchments with distances approximately 5 km from each other. Peak flow statistics are compared with rain intensity. The peak runoff coefficient (cf. rational method) is mostly constant or slightly increasing with the return period.

SURFACE WATER HYDROLGY:

111. Nordic Hydrology, 22, 1991, 109-122

TRANSPOSITION OF MONTHLY STREAMFLOW DATA TO UNGAUGED CATCHMENTS

K.C. Gan, T. A. McMahon and J.C. O'Neill

Various forms of the regressional relationship between the concurrent monthly discharges of neighbouring catchments are explored, with a view to generalising the relationship for a region. This enables monthly streamflow data to be transposed from a gauged catchment to an ungauged catchment, provided that certain transfer coefficients can be estimated from the physical catchment and rainfall characteristics. Most of the methods are based on a linear relationship between the concurrent monthly discharges of a pair of catchments with only one transfer coefficient. This may be estimated in a number of ways for a pair of gauged-ungauged catchments, however, errors in the individual transposed flows are high.

112. Nordic Hydrology, 22, 1991, 149-160

AN IMPROVED RATIONAL METHOD FOR URBAN RUNOFF APPLICATION

Seven Lyngfelt

In the initial stages of drainage systems planning and for independent tests of advanced runoff model performance there is a need for a simple point flow model. In these cases a method is proposed which is an improved version of the traditional Rational Method. The method, usually regarded as empirical, has a certain relationship with the kinematic wave theory. It is then discussed from both a theoretical and practical point of view based on comparisons with the performance of an advanced continuous model.

113. Nordic Hydrology, 23, 1992, 121-136

THE IMPORTANCE OF RAINFALL DISTRIBUTION IN URBAN DRAINAGE OPERATION

Fons Nelen and Annemarieke Mooijman & Per Jacobsen

A control simulation model, called LOCUS, is used to investigate the effects of spatially distributed rain and the possibilities to benefit from this phenomenon by means of real time control. The study is undertaken for a catchment in Copenhagen, where rainfall is measured with a network of 8 rain gauges. Simulation of a single rain event, which is assumed to be homogeneous, i.e. using one rain gauge for the whole catchment, leads to large over- and underestimates of the systems output variables. Therefore, when analysing a single event the highest possible degree of rainfall information may be desired. Timeseries simulations are performed for both an uncontrolled and a controlled system. It is shown that from a statistical point of view, rainfall distribution is NOT significant concerning the probability of occurrence of an overflow. The main contributing factor to the potential of real time control, concerning minimizing overflows, is to be found in the system itself, i.e. the distribution of available storage and discharge capacity. When other operational objectives are involved, e.g., to minimize peak flows to the treatment plant, rainfall distribution may be an important factor.

114. Nordic Hydrology, 24, 1993, 359-364

POTENTIAL EVAPORATION -A MATTER OF DEFINITION A COMMENT ON "IMPROVEMENTS OF RUNOFF MODELS -WHAT WAY TO GO?"

Anders Lindroth

The aim of this paper is to discuss the concept of potential evaporation and its. use in runoff models. The potential evaporation for forest is defined on basis of estimated minimum canopy resistances for a well-watered spruce forest. The difference between the Penman open water evaporation, commonly used as "potential" evaporation, and a more realistic estimate of the potential evaporation from a dry forest showed a large scatter and a systematic seasonal deviation. Part of the differences were explaincd by differences in vapour pressure deficit. It was also shown that the evaporation rate of a completely wet forest was typically four times higher than the rate predicted by the

Penman equation. The conclusion was that Penman open water evaporation did not give a good representation of forest conditions.

115. Nordic Hydrology, 25, 1994. 213-232

ON CURRENTS AND VERTICAL MIXING IN LAKE ONTARIO DURING SUMMER STRATIFICATION

A. Omstedt & C. R. Murthy

Currents and vertical mixing characteristics were investigated on the basis of time series of current meter and temperature data from a summer-stratified period in Lake Ontario. The experimental set up consisted of seven current meters distributed in one vertical line from 12 meter below the surface to 1 m above the lake botttom at a total depth of 143 m. The period considered for the analysis was from June to September 1991.
The currents showed pronounced oscillations with two significant kinetic energy peaks, one at about 17 hours due to inertial motions, and one at 10 days, probably due to meteorological forcing. The current shear in the hypolimnion was strong enough to overcome stability and generate turbulence (Richardson numbers below 0.25) and there was probably turbulence enough available to keep the matter (almost neutral buoyant particles) in the Whole Nepheloid bottom layer in suspension. In the thermocline region the turbulence was mainly damped (Richardson numbers above 1), but some events with lower Richardson numbers were also calculated indicating increased mixing during these events. By analysing filtered and unfilicred current meter data it was found that the shear-generated turbulence in the hypolimnion was mainly due to the meteorologically forced currents. In the thermocline region, how-ever, the vertical shear associated with the inertial oscillation had a greater impact on the mixing.

116. Nordic Hydrology, 26, 1995, 191-204

DISCHARGE DATA COLLECTION AND ANALYSIS STRATEGIES IN LOW FLOW STUDIES

The objectives of this paper is to determine the most appropriate data collection strategy and analysis techniques which should be used to assess the low flow regime of a catchment. The data used were: a) synchronous dishargc measurements during low flow periods, and b) continuous daily flow, records. Thw analyses based on both types of data were able to distinguish different low flow regimes within a 1 1 4 kM2 Danish catchment. Despite the limited spatial variation in climate and geomorphology there was a high spatial Variability in low flows caused by differences in the lithology of sediments. This demonstrates the difficulties in using simple indices of catchment ecology in regional low flow estimation. The results highlight the benefits of using synchronous discharge measurements, both for estimating low flows at ungaugcd sites. and for understanding groundwater flow paths. Analyses of daily flow records from six gauging stations in the catchment showed that a baseflow index was more useful than the flow duration curve for classifying low flow regimes when only short records were available. The paper illustrates the importance of estimating the uncertainty of discharge measurements when interpreting low flow data.

117. Nordic hydrology, 26, 1995. 297-312

SOME REMARKS ON THE USE OF GIUH IN THE HYDROLOGICAL PRACTICE

C. Corradini, F. Melone & V. P. Singh

The geomorphologic instantaneous unit hydrograph (GIUH) as a component of rainfall-runoff models directcd to the determination of design hydrographs in ungaged basins is investigated. Specifically, we first performed a sensitivity analysis of the GIUH to errors in the basin lag estimated by commonly used empirical relationships involving basin area. Then, the details required in representing the geomorphologic features in thc GIUH estimate for fixed basin lag, L_L were examined. Real basins located in Central Italy were selected they range in area from 12 km sq. to 4,147 km.sq. and are characterized by a significant variability in the drainage channel density,D. It was found that given L a

minimum detail was necessary in representing basin geomorphology. Further, the estimate of L through basin area led to large errors in computing design hydrographs for a few small basins. An explicit consideration of D is suggested in order to eliminate this shortcoming.

118. Nordic hydrology, 26, 1995. 331-358

SPRING CIRCULATION ASSOCIATED WITH THE THERMAL BAR IN LARGE TEMPERATE LAKES

Joakim Malm

The overall circulation pattern in spring is rather specific as density-induced currents may be of significance. The density-driven circulation perpendicular to the shore can be described as consisting of two circulation cells, with a zone of convergence, referred to as thermal bar. in between. The thermal bar, which coincides with the 4°C isotherm (the temperature of maximum density). inhibits horizontal water exchange. implying its practical importance. In this paper, a hydrodynamic numerical model is used to study the relative influence of wind and density-driven currents in a large temperate lake during spring. The study shows that the general density-driven circulation is strongly dependent on the bottom topography, with a more pronounced circulation and considerable descending motions in the thermal bar zone in lakes with steep sloping bottoms. In shallow lakes, the wind-driven circulation dominates, and the effect of density-induced currents is marginal, cxcept at locations with a drastic change in bottom depth.

GROUND WATER HYDROLOGY:

119. Nordic Hydrology, 21, 1990, 1-12

UNSTEADY FLOW TO A NON-PENETRATING LARGE DIAMETER WELL IN EXTENSIVE AQUIFERS

Zekal Sen

Non-equilibrium groundwater movement equations are written explicitly for the continuity and flow laws in the case of a non-penetrating large diameter well discharging from extensively thick confined porous medium aquifers. The equations representing these laws are combined together with the Boltzmann transformation which leads to the specific discharge equation within the aquifer. Type curve expressions are obtained with convenient definitions of the well function and dimensionless time factor for a non-penetrating well. The forms of these curves on double logarithmic paper appear identical to the fully penetrating large diameter well type curves but with differences in the variables as well as the aquifer parameters. In the non-penetrating well case the significant aquifer parameters are the hydraulic conductivity and specific storage coefficient which are intact of the aquifer saturated thickness. The methodology developed herein is applied to the time-drawdown data from a non-penetrating well in Saudi Arabia. Aquifer parameter determinations can be obtained through a similar procedure to the Theis type curve usage.

120. Nordic Hydrology, 21, 1990, 81-94

TILL GENESIS AND HYDROGEOLOGICAL PROPERATIES

Sylvi Haldorsen & Johannes Kruger

Hydrogeological properties of tills are highly dependent upon factors as grainsize distribution, compaction, orientation of particles, presence of fractures and occurrence of sorted sediments. These factors are again dependent upon the till forming processes. Lodgement tills formed under active, temperate sliding glaciers are usually compact, rather homogeneous and in many cases they are fractured. Melt-out tills deposited in connection with stagnant ice are in most cases less dense, have a lower content of fine-grained particles and a higher abundance of sorted sediment lenses. Flow tills which are mainly formed by a secondary flow of supraglacoal debris are commonly very variable, they may have a low content of fine-grained components, a low degree of compaction

and they are often closely connected with sorted glaciofluvial sediments. Till genesis is in many cases difficult to interpret, and an objective description of all main characteristics of the till is important in hydrogeological studies. The lodgement till has a lower effective porosity than the melt-out and flow tills due to its finer grain-sizes and higher compactness. The saturated hydraulic conductivity is lower, and dependent upon the fracture pattern. In melt-out tills and flow tills the occurrence of well sorted sediments will in many cases control the hydraulic conductivity. In all till types the structural properties are most important for the saturated water flow.

121. Nordic Hydrology, 22, 1991, 253-264

DRAWDOWN DISTRIBUTION DURING RECOVERY AROUND A LARGE DIAMETER WELL

Zekdien

An analytical solution is presented for the drawdown distribution in a large diameter well during recovery. It takes into consideration the well storage. A set of type curves are given to determine the transmissivity and storage coefficient of the aquifer. The basis of the methodology is to solve simultaneous differential equations of the water balance and Darcy laws. The application of developed methodology has been given for recovery data from India and Saudi Arabia.

122. Nordic Hydrology, 25, 1994, 345-358

CUMULATIVE SEMIVARIOGRAM MODELS OF TRACE ELEMENTS FROM SPRINGS IN SAUDI ARABIA

Abdulghaffar S. A. Bazuhair & Zekai $en

Trace elements are rarely distributed in earth's crust and they are invariably in low concentrations. Due to this low concentration they are not analysed by conventional

hydrochcmical methods but by rather special techniques with great care. The trace elements are especially usefull in detecting the origin of the groundwater in an area. Their regional distribution helps to obtain significant clues on the groundwater movement and mixture processes. It is proposed, herein to assess the trace element concentration available at far distant points by employing the cumulative semivariogram models. These models furnish further systematic interpretation about trace element areal extends, concentration directions, groundwater movement and its continuity.

123. Nordic Hydrology, 26, 1995, 111-124

ESTIMATION OF AQUIFER PARAMETERS BY LEAST-SQUARES METHOD UNDER LINEAR FLOW CONDITIONS ILL FRACTURED ROCKS

M.L. Jat, M.S. Acharya and J.Singh

Pumping and rccovery, test data in phyllite formations were analysed under linear flow conditions by incorporationg modification in the method proposed by Sen (1986). Although the Sen (1986) method is developed for analysis of borewell test data, this method has been used for large-diameter well-test data by taking average inflow rate in the well. The results obtained compared with Sen's graphical method. Lower values of root mean-square error were obtained by least-squares method. The estimated values of transmissivity and storage coefficient were acceptable at 1 per cent level of significance. An advantage of the least-squares method is the automizition, which is lacking in the graphical method utilising curve-matching technique.

SOIL EROSION:

124. Nordic Hydrology, 22, 1991, 227-242

EFFECT OF TEXTURE, RAINFALL AND SLOPE ON RAINFALL LNTERRILL SEDIMENT TRANSPORT

Experiments were conducted with rainfall intensities of 45.0 and 140.0 mm/hr at slopes of 2, 9 and 20 per cent to separate the dominant effect of rainfall intensity on sediment transport capacity. The effect of sediment size on rain intensity contribution to unit sediment transport capacity was also investigated. Regression models for rain-intensity contribution to unit sediment transport capacity Y were developed including median particle diameter X of sediment as an additional independent variable. The constants of power relationships of the form Y = a Xb were found to vary with the median particle diameter of the soil.

FLOOD HYDROLOGY:

125. Nordic Hydrology, 22, 1991, 265-274

CONCEPTUAL MODELLING OF WATER LOSS ON FLOOD PLAINS AND ITS APPLICATION TO RIVER YAMUNA UPSTREAM OF DELHI

S. Asger Nielsen and J.C. Refsgaard & V. K. Mathur

A water loss module for the river modelling system MIKE 11 has been developed to account for water losses due to retention and infiltration on flood plains. MIKE 11 including the water loss module has been calibrated and tested on data from the Yamuna river, India. The inclusion of the water loss module has improved the water level forecasts at Delhi to a large extent.

126. Nordic Hydrology, 26. 1995. 73-90

REGIONAL FLOOD RELATIONSHIPS BY NONPARAMETRIC REGRESSION

D. Gringras, M. Alvo and K. Adamowski

Since some theoretical asssumtions needed in linear regression are not always fulfilled in practical applications,nonparmetric regression was investigated as an alternative method in regional flood relationship development. Simulation studies were developed to compare the bias, the variance and the root-mean-square-errors of nonparametric and parametric regressions. It was concluded that when an appropriate parametric model can be determined. parametric regression is preferred over nonparametric regression. However, where an appropriate model cannot be determined, nonparametric regression is preferred. It was found that both linear regression and nonparametric regression gave very similar regional relationships for annual maximum floods from New Brunswick, Canada. It was also found that nonpar-armetric regression can be useful as a screening tool able to detect data deficient relationships.

ENVIRONMENTAL HYD. & WATER QUALITY:

127. Nordic Hydrology 25,1994,193-212

METAL TRANSPORT IN GROUNDWATER CONTAMINATED BY ACID MINE DRAINAGE

Roger B. Herbert Jr.

Acid mine dranage from a rock dump at an abandoned mine,in Dalarna. Sweden, has contaminated the gorundwater and created a leachate plume characaterized by low pH and high concentrations of Fe. So and heavy metals. Groundwater samples have been collected in order to explain the observed spatial variation in groundwater chemistry. The minerology of soil samples collected at the.water table has been identified by X-ray diffraction analysis. In order to determine which processes may be controlling the evolution of the leachate plume, the geochemical mass-transfer model PHREEQE is used to evaluate a possible reaction pathway controlling the reaction of the leachate plume with uncontaminated groundwater and the till aquifer. The results suggest that silicate weathering and goethite precipitation are the processes primarily controlling observed pH. pe and Fe concentrations in groundwater direct down-gradient of the rock dump.

Increases in K, Na, and Al concentrations along the flow path can be attributed to the feldspar weathering, while Al and SO concentrations further down-gradient can be controlled by the precipitation of $AlOHSO_4$. The attenuation of heavy metal concentrations may be the result of adsortion and coprecipitation with goethite and other Fe oxides.

SNOW/MOUNTAIN HYDROLOGY:

128. Nordic Hydrology, 21, 1990, 317-340

A REVIEW OF TECHNIQUES USED BY CANADA AND OTHER NORTHERN COUNTRIES FOR MEASUREMENT AND COMPUTATION OF STREAMFLOW UNDER ICE CONDITIONS

Patrice M. Pelletier The SNC Group Inc., Montreal, Quebec, Canada

In Canada, Water Survey of Canada, a division of the Water Resources Branch of Environment Canada, is responsible for the collection and processing of data from more than 3,300 active streamflow, water level and sediment data gauging stations. Because of the climatic conditions prevalent in Canada, an important part of the monitoring program is conducted under winter ice conditions. The determination of daily streamflow records during the winter period is important for several practical purposes, in particular for water power development. Essential to the computation of daily discharge records, are reliable streamflow measurements. However, discharge measurements under ice conditions are generally difficult to obtain because of severe weather conditions, hazardous field conditions, and ill-adapted field measurement techniques.

In this paper, the field methods and instruments, and computational methods used by Water Survey of Canada for streamflow measurement and computation under ice conditions are reviewed. Factors affecting the age measurements performed under ice conditions are discussed. Newly developed instruments for use under ice conditions are described and their advantages discussed. A comparison between techniques used by Canada and other northern countries is also given. Areas of research and investigations

for improvement in the overall quality of data

129. Nordic Hydrology, 22, 1991, 193-210

SNOW COVER MAPPING USING MICROCOMPUTER IMAGE PROCESSING SYSTEMS

M. F. Baumgartner & A. Rango

For many years, digital snow cover mapping using satellite data had to be carried out on large and expensive image processing systems. Recently, small computer systems (microcomputers) have been developed for image processing. Snowmelt runoff forecasting models have also been developed to run on microcomputers. Digital snow mapping procedures were surveyed, and a general snow mapping approach was developed that allows use in various snowpack regions. Tests were conducted to determine if satellite snow cover mapping could be carried out effectively on the microcomputers and which combination of software and hardware provided optimum performance. A range of computer facilities was tested and recommended capabilities for snow cover image processing were established. It was discovered that adequate microcomputer image processing systems were already on the market, and that the Snowmelt Runoff Model (SRM) could easily be run on the same microcomputer system. Further improvements will result as the 40486 microcomputers image processing systems become widely available. The microcomputer approach, as opposed to operation on larger, more expensive, and non dedicated systems, has much appeal for hydroelectric power companies and other small users who need economical, yet powerful, processing systems where both snow mapping and snowmelt runoff forecasting can be conducted.

130. Nordic Hydrology, 23, 1992, 155-172

WORLDWIDE TESTING THE THE SNOWMELT RUNOFF MODEL WITH APPLICATIONS FOR PREDICTING THE EFFECTS OF CLIMATE CHANGE

A. Rango

The Snowmelt-Runoff Model (SRM), a simple degree-day model, has been applied to over 50 basins in 15 countries around the world. Where results have been reported, the average R has been 0.84 and the average seasonal volume difference, DV, has been 3.8 %. The testing of SRM has taken place on basins in different climatic regions, thus setting the stage for using SRM in evaluations of the hydrological effects of climate change. A method for using SRM in evaluations of climate change has been established and tested on several basins. Initial results show some potentially serious problems involving water supply, flooding, and drought. More testing in a variety of climatic regions is necessary along with improved specification of the changes in temperature and precipitation by region.

131. Nordic Hydrology, 23, 1992, 183-192

LINEAR OR NONLINEAR COVARIANCE OF SEASONAL SNOWMELT AND SNOW COVER IN WESTERN HIMALAYAS

B. Dey and V. K. Sharma & A. Rango

Log-linear, exponential and fractional relations for estimating seasonal snowmelt from early-spring snow accumulation in the Indus and Kabul river basins in the western Himalayas are developed with a view to improve the prediction given by bivariate linear regression models earlier developed by the senior author in collaboration with others. This study shows that although the transformed data may improve the above prediction, they fail to satisfy the condition of nonlinearity, a property that must be borne in mind before recommending any nonlinear regression model. Any further improvement in the prediction of seasonal flow volume from basin snow cover area, therefore, has to come from within the domain of linear regression models only or from improvements in the original input data.

132. Nordic Hydrology, 25, 1994, 101-112

INTEGRATION OF FIELD DATA INTO OPERATIONAL SNOWMELT-RUNOFF MODELS

M. Brandt and S. Bergstrom

Conceptual runoff models have become standard tools for operational hydrological forecasting in Scandinaya. These models are normally based on observations from the national climatological networks, but in mountainous areas the stations are few and sometimes not representative. Due to the great economic importance of good hydrological forecasts for the hydropower industry attempts have been made to improve the model simulations by, support from field observations of the snowpack. The snow pact has been mapped by several methods; airborne gamma-spectrometry, airborne georadars,satellites and by conventional snow courses. The studies cover more than ten years of work in Sweden. The conclusion is that field observations of the snow cover have a potential for improvement of the forecasts of inflow, to the reservoirs in the mountainous part of the country. Where the climatological data coverages is poor. This is pronounced during years with unusuals snow distribution. The potential for model improvement is smaller in the climatologically more homogeneous forested lowlands, where the climatological network is denser. The costs of introduction of airborne observations into the modelling procedure are high and can only be justified in areas of great hydropower potential.

133. Nordic HydrOlogy, 26. 1995. 359-368

RELEASE OF MAJOR IONS AND HYDROGEN PEROXIDE FROM HOMOGENEOUS, MELTING SNOW

Reimer Herrmann and Jutta Kranz

We undertook two laboratory experiments to study the change of concentrations and the preferential elution of Major ions and hydrogen Peroxide during melting of a homogeneous snowpack .The elution sequence was as follows: alkali metals,alkaline-earth metals and protons > anions > NH_4+ > H_2O_2. We explain the late elution of Cl,

NH_4+ and H_2O_2 by high ice\water partition coefficients and a more even distribution of the two ions as well as of H202 within the ice crystal due to formation processes of snow particles in the atmosphere.

CLIMATOLOGY:

134. Nordic HydrOlogy, 24, 1993, 225 242

RAIN DISTRIBUTION IN A MOUNTAINOUS WATERSHED

A. Loukas and M.C. Quick

The Orographic and temporal gradients of rainfall in a mountainous watershed in southwestern British Columbia have been analyzed and Streamflow has been estimated using a watershed model. The study watershed is the Jamieson Creck watershed located approximately 30 km north of Vancouver in the Caostal Mountains. The p urpose of the study was tc determine whether rainfall follows a definable pattern in this mountainous watershed. Regression analysis has been performed for the total rainfall depth per event and hourly intensity for the period 1972-1995. Data is taken from the rainfall season of June to mid November in order to avoid complications of combined rain and snow events. In this analysis, the rainfall data from a gauge at the lower elevation was used as the set of independent variables and the data from the other four gauges in the watershed as dependent variables. The results showed that the rainfall depth per event increased up to the mid-elevation of the watershed, and then decreased at the upper elevations. On the other hand, the hourly rainfall intensity was found to decrease with increase of elevation in the watershed, so that longer duration of rainfall events occurs at the middle and upper watershed. The regression equations, developed from the analysis of the distribution of the hourly intensity, was used for the prediction of rainfall events of the year 1976-1977. The agreement between the predicted and the observed rain was statistically good. Also, the simulation of the watershed streamflow using the predicted rainfall gave good results. Consequently because the rainfall follows a definable distribution as a function of elevation, it is possible to use data from one

station located at the lower elevation in combination with the developed predictor equations to accurately describe the rainfall over the watershed.

CLIMATOLOGY/HYDROLOGICAL MODELLING:

135. Nordic Hydrology, 25, 1994. 279-300

PDS-MODELLING AND REGIONAL BAYESIAN ESTIMATION OF EXTREME RAINFALLS

H. Madsen and D. Rosbjerg & P. Harrem.oas

Since 1979 a country-wide system of raingauges has been operated in Denmark in order to obtain a better basis for design and analysis of urban drainage systems. As an alternative to the traditional non-parametric approach the Partial Duration Series method is employed in the modelling of extreme rainfalls. The method is applied to two variables: the total precipitation depth and the maximum 10-minute rain intensity of individual storms. On the, basis of the at-site modelling a regional analysis is carried out. It is shown that the previous assumption of spatial homogeneity of extreme rainfalls in Denmark cannot be justified. In order to obtain an estimation procedure at non-monitored sites and to imporve at-site estimates a regional Bayesian approach is adopted. The empirical regional distributions of the parameters in the Partial Duration Series model are used as prior information. The application of the Bayesian approach is derived in case of both exponential and generalized Pareto distributed exceedances. Finally, the aspect of including economic perspectives in the estimation of the design events is briefly discussed.

CLIMATOLOGY:

136. Nordic Hydrology, 26, 1995. 259-284

TOPOGRAPHICAL INFLUENCE ON PRECIPITATION DISTRIBUTION IN DIFFERENT RANGES OF WESTERN HIMALAYAS

Seasonal and annual distribution of rainfall and snowfall with elevation has been studied for outer, middle and greater Himalayan ranges of Chenab basin in the western Himalayas. Rainfall and snowfall exhibited different trends with elevation on the windward and leeward slopes of the three ranges of Himalayas. Seasonal characteristics of rainfall have shown a spill over effect on leeward side during winter, pre-monsoon, and post-monsoon seasons in the outer Himalayas. The role of orography in the middle Himalayas was found to be more pronounced for both rainfall and snowfall in comparison to other ranges of Himalayas. Variation of snowfall with elevation was more prominent in comparison to variation of rainfall. In the greater Himalayan range it is found that rainfall descreases exponentially with elevation and snowfall increases linearly. Rainfall becomes negligible at elevations beyond 4,000 m on the windward side of the greater Himalayan range. Efforts have also been made to explain whether variation in precipitation is due to changes in precipitation intensity or number of precipitation days or a combination of both.

HYDROLOGICAL MODELLING:

137. Nordic Hydrology, 22, 1991, 123-136

PRINCIPLES AND CONFIDENCE IN HYDROLOGICAL MODELLING

Sten Bergstron

General principles in development and application of hydrological models are discussed and related to the confidence in the results. The presentation is mainly based,on the experience from the work with the HBV and PULSE models at the Swedish Meteorological and hydrological Institute between 1971 and 1990 but has also been influenced by other modelling work. It covers a discussion on the optimal complexity of models, use of observations, calibration, control and sensitivity analysis. Special attention is given to the uncertainties encountered when using hydrological models for the

simulation of extreme floods and long-term scenario simulations. Finally a few ethical problems in modelling are mentioned.

138. Nordic Hydrology, 24, 1993,309-322

ADAPTING THE CREAMS FOR FINNISH CONDITIONS

SEPPO Rekolainen and Maximilian Posch

The CREAMS model, a management model for predicting field-scale runoff and erosion, has been modified and adapted for Finnish conditions: The most important changes are the implementation of a new snow accumulation and snow melt model, a simple soil frost model, the use of an adustable albedo for evapotransporation calculations, the implementation of a plant growth model for calculating leaf area index and soil loss ratio, and allowing for a variation in the rainfall erosivity parameters. The modeified model has been compared to the original model and observed data from an experimental field in southwestern Finland. In most cases the modified model predicted surface runoff and soil loss better than the original model. Although there remain discrepancies between model simulations and observations, the modified model seems to perform better and allows an easier comparison of management practices.

ADVANCES IN WATER RESOURCES

V. Advances in Water Resources:

SURFACE WATER HYDROLOGY:

139. Advances in Water Resources 15(1992) 133-141.

A SIMPLIFIED MODEL FOR TWO-DIMENSIONAL OVERLAND FLOWS

Rao. S. Govindaraju, M.Levent Kawas & G. Tayfur

Numerical models of two dimensional overland flow equations are often prohibitively expensive due to the highly nonlinear nature of the flow equations and the dense mesh required for accurate solutions. These models are frequently under utilized due to lack of sufficiently detailed data at the grid scale. Observed results of the outflow hydrographs show fluctuations due to variability in the surface topography and precision limitations in the measuring instruments. A new solution methodology is presented in this paper using an eigenfunction expansion which is then combined with the kinematiac wave approximation. The computational effort required by this new method is negligible when compared to the usual numerical methods. The results from the method are compared with the more expensive numerical results and expenmentally observed results. These comparisions suggested that the semi-analytical solution methodology is an attractive modeling tool for practical two-dimensional overland flow computations.

140. Advances in Water Resources 17(1994)3-18

THE EVOLUTION OF MODERN HYDROLOGY (FROM WATERSHED TO CONTINENT IN 30 YEARS)

Peter S. Eagleson

The purpose of this paper is to describe hydrology to a scientifically-literate audience of non-hydrologists and to highlight its evolution over the last 30 years from a field focused

on engineering problems at the scale of the small watershed to one dealing with global-scale issues which demand a geophysical perspective. The Ralph M. Parsons Laboratory at MIT has been one of the leaders of this evolution, and the illustrations presented to things that (some) hydrologists do are drawn primarily from recent work done there. These include introduction of the concept of hydrologic scale along with its definition, significance and estimation; the sub-grid scale parametrization of precipitation and vegetation in atmospheric GCMs; precipitation recycling: and completion of the land surface-atmosphere feedback loop for moisture at climatic time scales.

GROUND WATER HYDROLOGY:

141. Adv. Water Resources. 1991, Vol. 14, No.4

DEVELOPMENT AND APPLICATION OF A HOILLSLOPE HYDROLOGIC MODEL

C.A. Blain & P.C.D. Milly

A vertically integrated two dimensional lateral flow model of soil moisture has been developed. Derivation of the governing equation is based on a physical interpretation of hillslope processes. The lateral subsurface-flow model permits variability of precipitation and evapotranspiration and allows arbitrary specification of soil-moisture retention properties. Variable slope, soil thickness, and saturation are all accommodated. The numerical solution method, a Crank-Nicolson, finite-difference, upstream-weighted scheme, is simple and robust. A small catchment in northeastern Kansas is the subject of an application of the lateral subsurface-flow model. Calibration of the model using observed discharge provides estimates of the active porosity (0.1 cm /cm) and of the saturated horizontal hydraulic conductivity (40 cm/hr). The latter figure is at least an order of magnitude greater than the vertaical hydraulic conductivity associated with the silty clayloam soil matrix. The large value of hydraulic conductivity derived from the calibration is suggestive of macropore-dominated hillslope drainage. The corresponding value of active porosity agrees well with a published average value of the difference between total porosity and field capacity for a silty clay loam.

142. Adv. Water Resources, 1991, Vol. 14, No.5

APPLICATION OF THE PILOT POINT METHOD TO THE IDENTIFICATION OF AQUIFER TRANSMISSIVITIES

Catherine Certes & Ghislain de Marsily

A method is presented to estimate smoothly varying (as opposed to zoned) hydraulic parameters, transmissivity in particular, appearing in a time-dependent flow equation. A finite difference model based on a nested grid discretization reduces the computational effort while allowing local refinement. Structuring of the unknown parameter field, use of a priori information, and parametrization of the inverse problem are geostatistically based. Calibration is carried out by minimizing a quadratic objective function depending on head data. Aprimal-adjoint discretegradient method is used, where the unknowns are parameter values at a number of user-defined points, the 'pilot points'. The key feature of this method consists of kriging together the pilot point values and the measured values, if any, in order to generate the parameter field needed at each iteration to solve the primal and adjoint systems. Minimization is performed by a BFGS algorithm. Two numerical examples are considered, where transmissivity is the unknown. The first one is adapted from Carrera and Neuman's synthetic problem. The purpose is to compare kriged and zoned results obtained from different types of observation data sets e.g., stationary vs. transient head or drawdown. The second example is a case study of the Dijon (France) aquifer. Pilot point-based identification is applied to the same model (domain, equations, grid), which was manually calibrated in 1985. Only the measured data were made availabe. The raesults from amnual calibration were kept unknown until the end of the inversion trials. Sensible ;use of pilot points and of a priori information appears to play a key role in yielding plausible resutls.

143. Adv. Water Resources, 1991, Vol. 14, No.6

FLOW RATE DETERMINATION FOR ONE-DIMENSIONAL GROUNDWATER

P.Tolikas, A. Damaskinidou and C. Fotiadis

The nonsteady one dimensional flow from an unconfined aquifer to an adjacent stream is studied. The flow results from a sudden decrease of the water level in the stream. The Boussinesq equation describing the problem is transformed to an ordinary differential equation with flux as the dependent variable and hydraulic head as the independent. The slope of the water profile at the origin and consequently the flow rate, are expressed in the form of a rapidly converging series, allowing calculation to the desired accuracy. The results are utilized in a number of other physical problems governed by the same equations.

144. Advances in Water Resources 15(1992) 75-83

GROUND-WATER MODELS CANNOT BE VALIDATED

Leonard F. Konikow

Ground-water models are embodiments of scientific hypotheses. As such, the models cannot be proven or validated, but only tested and invalidated. However, model testing and the evaluation of predictive errors lead to improved models and a better understanding of the problem at hand. In applying ground water models to field problems, errors arise from conceptual deficiencies, numerical errors, and inadequate parameter estimation. Case histories of model applications to the Dakota Aquifer, South Dakota, to bedded salts in New Mexico, and to the upper Coachella Valley, California, illustrate that calibration produces a nonunique solution and that validation, per se, is a futile objective. Although models are definitely valuable tools for analyzing groundwater systes, their predictive accuracy is limited. The terms validation and verification are misleading and their use in ground-water science should be abandoned in favour of more meaningful model assessment descriptors.

145. Advances in Water Resource 0309-1708/92/505.00

NUMERICAL MODELLING OF FREE-DRAINAGE WATER SAMPLERS IN THE SHALLOW VADOSE ZONE

R. Zhang , A.W. Warrick & J.F. Artiola

A finite element model was used to simulate the performance of a free-drainage sampler. This device may be used to collect soil water by free drainage in the shallow vadose zone. A unique feature of this sampling device is that it serves as a barrier to flow and creates a locally saturated region in an otherwise unsaturated system. Steady and unsteady flows were modeled assuming the hydraulic functions of van Genuchten and Gardner. Results include flux into the sampler and distribution of hydraulic head as functions of soil hydraulic properties, background soil flux and sampler size.

146. Advances in Water Resources 0309-1708/92/505.00

PARAMETER IDENTIFICATION OF NONSTEADY GROUNDWATER FLOW SYSTEMS

Jiannan Xiang & Derek Elsworth

This paper presents several methods which are based on multiple data sets to reduce the errors caused by the noise in the measured data. The comparisons show that the accuracy of inverse solution depends both on the noise level and on the number of consecutive observations. For low noise levels, both average and least squares methods perform well. When the noise level is high, integration methods based on the trapezoidal rule yield better accuracy. However, when noise dominates the record, all methods may yield an unacceptable error. To reduce noise levels, a Butterworth filter is used. Using filtered data, the accuracy of the estimated parameters is improved. A computed example shows that the errors in transmissivity and storage coefficient are different because they have different derivatives. Application of the inverse methods are demonstrated in a two-dimensional problem.

147. Advances in Water Resources 15(1992)311-324

A KINEMATIC MODEL OF INFILTRATION AND RUNOFF GENERATION IN LAYERED AND SLOPED SOILS

Mariza C. Cabral, Luis Garrote, Rafael L. Bras & Dara Entekhabi

A model of infiltration, subsurface lateral flow and surface runoff generation that considers the effects of anisotropy and vertical heterogeneity is developed. The flow relations are based on the kinematic approximation and account for the influence of terrain slope. The model consists of equations for the evolution of the wetting front, the growth of the perched saturation zone, and the rate of unsaturated and saturated lateral subsurface flow.

148. Advances in Water Resources 17(1994)25-34

SCALING, SOIL MOISTURE AND EVAPOTRANSPIRATION IN RUNOFF MODELS

Eric F. Wood

The effects of small-scale heterogeneity in land surface characteristics on the large-scale fluxes of water and energy in the land-atmosphere system has become a central focus of many of the climatology research experiments. The acquisition of high resolution land surface data through remote sensing and intensive land-climatology field experiments (like HAPEX and FIFE) has provided data to investigate the interactions between microscale land-atmosphere interactions and macroscale models. One essential research question is how to account for the small scale heterogeneities and whether 'effective' parameters can be used in the macroscale models. To address this question of scaling, the probability distribution for evaporation is derived which illustrates the conditions for which scaling should work. A correction algorithm that may be appropriate for the land parametrization of a GCM is derived using a second order linearization scheme. The performance of the algorithm is evaluated.

149. Advances in Water Resources, Vol. 18, No.4, pp 203-215,1995

A NON-LINEAR THEORY OF HIGH-CONCENTRATION-GRADIENT DISPERSION IN POROUS MEDIA

S.Majid Hassanizadeh & Anton Leijnse

The application of Fick's law to describe hydrodynamic dispersion in porous media is based on the assumption of a linear dependance of a solute dispersive mass flux on its concentration gradient. Both theoretical and experimental studies have shown that the Fickian description of dispersion is not valid when large concentration variations in the porous medium are encountered. However, an appropriate alternative is still lacking. In this work, based on a theoretical derivation of the Fickian dispersion equation, a non-linear theory of dispersion is suggested. In the non-linear theory, in addition to the longitudinal and transversal dispersivities, a new parameter is introduced. Miscible displacement experiments are carried out in order to investigate the effects of large variations in salt mass fraction and to assess the validity of the new theory. Low-concentration liquid is displaced upwards in a vertical column by a high-concentration liquid. Thus, only hydrodynamically stable flow regimes are considered.

150. Advances in Water Resources, Vol. 18, No.4, pp 237-251

1-,2- AND 3- DIMENSIONAL MODELING OF WATER MOVEMENT IN THE UNSATURATED SOIL MATRIX USING A FUZZY APPROACH

A. Bardossy, A. Bronstert & B. Merz

Modeling water movement in the unsaturated soil matrix is usually based on the numerical solution of the Richards equation. This approach requires much computational effort, therefore practical 2 - or 3-dimendional applications are extremely rare. The purpose of this paper is to describe a computationally efficient and simple method. It is based on a transformation of the unsaturated Darcy law to a fuzzy rule system. The rule

system is combined with the continuity equation yielding a fuzzy rule-based model for simulating the unsaturated flow. Basic definitions of fuzzy logic are given and the concept of the unsaturated flow model is outlined. The presented model performs well compared with a semi-analytica model and a 2-dimensional, numerical model. Furthermore the model has been incorporated into a physically-based and distributed, hydrological model. Model simulations for different types of hydrological situations show that the fuzzy rule based approach is especially suitable for eal-time applications.

151. Advances in Water Resources Vol. 18, No.5,pp. 295-313,1995

AN ASYMPTOTIC METHOD FOR PREDICTING THE CONTAMINATION OF A PUMPING WELL

Jaco J. A. van Kooten

A method is presented for predicting the advective-dispersive transport of a contaminant towards a well in a confined aquifer. Due to (macro-) dispersion, particles carry out random walks through the porous formation. Using perturbation techniques analytical approximations are derived for the fraction of the particles that reach the well and for the mean and variance of the arrival time. In particular, approximations for the break through curve at the well are provided. The asymptotic approximations are shown to be in good agreement with results of random-walk simulations. The method may be applied to any 2D-flow pattern.

FLOOD HYDROLGY:

152. Adv. Water Resources, 1991,Vol. 14,No.1 31

COMPUTATION OF TWO-DIMENSIONAL DAM-BREAK-INDUCED FLOWS

C.V. Bellos, J.V. Soulis and J.G.Sakkas

Two-dimensional flood waves resulting from the instantaneous break of dams are numerically examined. The governing system of differential equiations is transformed into an equivalent system applied over a square-grid network in order to overcome the difficulties and inaccurates associated with the determination of few measurements near the flow boundaries. The McCormack two-step, predictor-correcator, scheme is used for the solution of the transformed system of equations. Comparisons between computed and experimental data show a satisfacatory agreement.

CLIMATOLOGY:

153. Adv. in Water Resources 17(1994)79.91

A SIMPLE MODEL OF THE HYDROLOGIC CYCLE AND CLIMATE: 1. MODEL CONSTRUCT AND SENSITIVITY TO THE LAND SURFACE BOUNDARY

Dara Entekhabi

In current General Circulation models (GCMs) and their proposed improvements, the fluxes of heat and moisture from soil storage and plant canopies are represented by a large number of parameters. Sensitivity testing of the candidate parametrizations is thus an important step in model development. Repeated simulations with the full GCM is burdened by both cost and the burial of sensitivity information in large volumes of generated data. Here we propose the use of a simple climate model with a full hyhrologic cycle to perform some of the basic sensitivity experiments and thereby reduce the number of experiments for the three-dimensional GCM. The simple climate model is thus used to screen the multitude of possible parameter-sensitivity experiments. This model is derived from the column model of Koster and Eagleson (J.Climate, 3(6) (1990) 593-606) and it contains the important one-dimensional physical processes of GCMs.The large-scale convergence of heat and moisture for the atmosphere is parametrized; atmospheric dynamics are therefore neglected in that momentum equations are not solved in this simple climate model.

In a series of sensitivity experiments, the influence of some land boundary parameters

on the partitioning of the atmospheric precipitation and relative forcing at the land surface are determined. The role of soil texture, soil column discretization and percolation boundary condition at the bottom of the soil column on surface water and energy balance components are investigated using the simple climatic model.

154. Adv. in Water Res. 17(1994)93-10

A SIMPLE MODEL OF THE HYDROLOGIC CYCLE AND CLIMATE: 2.OBSERVATIONAL EVIDENCE FOR THE PARAMETRIZATION OF ATMOSPHERIC HEAT AND MOISTURE DIVERGENCE

K.L. Brubaker, D. Entekhabi & P.S. Eagleson

Entekhabi (Adv. Water Resour. 17(1&2)(1994)79-91) extended the simple climate model of Koster and Eagleson (J. Climate, 3(6) (1990)593-606) to include a closed-system hydrologic cycle. Because the screening model does not simulate three-dimensional dynamics, it uses a simple linear reservoir transfer scheme to parametrize the lateral convergence of heat and moisture from the atmospheric column overlying the ocean to the column overlying the landsurface. Observations of wind and humidity profiles in the tropical Atlantic and South America are used to estimate the dependence of the net convergence of moisture oaver the continent on the precipitable water over land and ocean. In this manner, comparisons may be made between the parametrization of sensible heat and moisture convergence assumed in the screening model and measured quantities. The observed results indicate a similar pattern of sensitivity between the net convergence and the linear reservoir coefficient that form the basis of the parametrization.

J. OF SOIL CONSERVATION

VI. J. Of Soil Conservation:

SURFACE WATER HYDROLOGY:

155. Indian J. Soil Conservation, Vol.21, No.1, pp 22-28, 1993

Monthly runoff estimation from rainfall data

R.C. Srivastava and Y.P. Rao

Reliable information on the runoff both total and its distribution over time is essential for the design of the water harvesting system. In the absence of the long duration records of the observed runoff data, the runoff is often predicted. However; this prediction: generally lacks statistical backing. This paper presents estimation of the probable runoff both in quantity and distribution over time for mid-hills of uttar pradesh.

156. Indian J. Soil Conservation, Vol.21,No.2, pp 29-35, 1993

Selection of best fit probability density function for the Annual runoff events of eastern red soil region watersheds

Virendra Kumar

Although there is little agreement among the hydrologists as to which probability density function (pdf) be used, an effort is made in this study to select out the most representative " pdf for the annual runoff time series data obtained from the watersheds of the eastern red soil region of India. Seven theoretical probability functions which are commonly used in hydrologic frequency analysis have been tried for this purpose. Chi-square goodness of fit test has been applied to find out the best fit. Method of moments has been used to estimate the distributon parameters. The two parameter lognormal

distribution has resulted in the best description of the datasets for point frequency analysis.

GROUND WATER HYDROLOGY:

157. Indian J. Soil Conservation, Vol. 20 No. 3. pp. 32-38, 1992

Effect of soil conditioner on moisture retention, Infiltration and swelling properties of soil.

M.G. Shinde and G.B. Bangal

The effect of 'Jalshakti'-a soil conditioner, on soil moisture retention after application of water infiltration rate and swelling Of soil was studied for three different soils, i.e. day loam,silty loam and loamy sand. Experiment was conducted in the laboratory Jalshakti application by weight. The application of jalshakti to the soil helped in retaining more moisture in the soil, decreased infiltration rate and induced swelling of the soil mass. Soil moisture retained after application of water increased with increasing doses of Jalshakti. Moisture content, eight days after irrigation in siltyloam soil treated with 0.5 percent Jalshakti was almost the same as that of untreated clay loam soil. Addition' of 0.5 per cent Jalshakti to the soil decreased initial infiltration rate by about 51, 50, and 25.5 per cent in clay loam, silty loam and loamysand respectively. Addition of same quantity of Jalshakti to clayloam, silty loam and loamy sand increased their volumes by 64, 30 and 24 percent, respectively.

158. Indian J soil Conservation, Vol. 22, NO 3. pP 20-28. 1994

Infiltration characteristics and modelling for Kutch main land soils

Ravender Singh, G.P.Bhargava and C.B.Tiwari

Studies were conducted to evaluate infiltration characteristics of Kutch main land soils. On the basis of soil texture the Kutch main land soils can be divided into three major

classes i.e. coarse medium and fine textured. In coarse textured soils the highest initial and steady state infiltration rates were found 6.5E-5 and 3.86E-5m's respectively in Ustalfic Haplargids. In medium textured soil the highest initial and steady state rate was high in Ustertic camborthids (5.53 E-6 m/s). Among all the soil groups the highest initial (104 E.4 m/s) and steady state (3 86 E.5 m/s) infiltration rates were observed in Ustalfic Haplargids and lowest initial (12E.5 m/s) and steady state (1.15E-6 m/s) rates were found in Typic Salorthids (medium textured soil). This indicates that apart from soil texture other inherent soil properties also affect the soil infiltration characteristics. The modal 1 = + B for cumulative infiltration and = for infiltration rate based on empirical parameters were found to satisfactorily predict cumulative infiltration and infiltration rate for Kutch main land soils.

LAND/SOIL EROSION:

159. Indian J. soil conservation, Vol. 21, No.2, pp-6-10, 1993

Soil erosion map of West Bengal

Pratap Narain, Ram Babu and M.S. Rama Mohan Rao, and J.L. Sehgal, R.K. Batta, D.Sarkar and C.J. Thampi

Soil erosion induced by water is major cause of land degradation in India as well as in parts of the state of West Bengal. Soil loss was estimated, from 800 points at IO km^2 grid distributed over entire state of West Bengal, using Universal Soil Loss Equation. The information on soil properties, landuse, slope, vegetation and irrigation etc. were drawn from soil survey reports. Sediment data from small and medium watersheds and reservoirs was also made use of estimated and observed data points were transferred on to 1,250,000 scale map and erosion rates were processed using SPANS-GIS System reclassifying the map in six suitable soil loss classes.

The soil erosion rates in West Bengal ranged from less than 5 t/ha/yr in deltaic and dense forest regions to more than 40 t/ha/yr in western parts of Chhotanagpur plateau and hilly regions having open forest in Darjeeling, Jalpaiguri and Kooch Bihar. About 10

percent of the area of the state revealed severe erosion (> 20 t/ha/yr) needing immediate attention to treat the area with soil conservation measures on priority. The areas under moderately severe (15-20 t/ha/yr) and moderate erosion classes (10- 15 t/ha/yr) are about 6 and 13 per cent respectively. About 70 percent area of West Bengal lies under slight to moderate erosion classes depicting (<10 t/ha/yr.) The map will prove a handy tool for identifying priority areas for developing landuse plans and devising conservation strategies for effective resource management.

160. Indian J of soil conservation, Vol. 22.NO.1-2. pp.94-101.1994

Problem of soil erosion and conservation strategies in the southern hill region with particular reference to the Nilgiris

K.P. Tripathi and P.Samraj

The Nilgiri district of Tamil Nadu is situated in western ghat. The change of land use in the form of extensive agriculture after 1820 AD has not only resulted in the washing of top soil thus resulting in development of unfertile land and silting of various multipurpose reservoirs but has also resulted in the change of hydrological behaviour of the region which is also a responsible factor for the landslide events now occuring with greater frequency. Several soil and water conservation measures have been developed keeping in view only soil loss and surface runoff. But in a hilly region of higher rainfall the change of hydrological behaviour and its possible adverse effect is also very important, which needs further study on a optimum plot size (area) which would facilitate the monitoring of base flow.

161. Indian J. Soil Conservation, Vol.22, No. 1-2. pp. 102-111.1994

Soil erosion and its control in semi-arid region of south-eastern Rajasthan

S.N.Prasad and Ratan Singh

Semi-arid south-eastern Rajesthan is characterised with hilly/rocky terrain and almost flat alluvial planins. The rainfall pattern is highly erratic as more than 90% of annual rainfall(792mm) is recovered during June to September. Soils are pedominently black of alluvial origin and belong to order vertisol. The river Chambal and its tributaries drain the region. Sheet, rill and gully erosion are prevent on rainfed arable lands due to excessive runoff. Nearly 79% of total ravine lands in Rajasthan (4.52 lac ha) are situated along the river chambal and its tributaries whivh provide constant threat to adjoining fertile arable lands.

Graded bunds, gully control structures, minor land levelling in inter bunded area, contour cultivation, intercropping, use of legumes in rotation, other improved package of practices etc. have been found every successful in the region to minimise erosion hazards and maximise production on rainfed arable lands. For halting the growth of ever-extending ravines in the region, In-situ rainfall conservation in watersheds and safe disposal of excess runoff through peripheral bunds and drop spillwaysin to the selected ravine beds have been found successful. Shallow ravines should be reclaimedfor agriculture while medium and deep ravines must be utilized for the production of fodder and fuel with a provision of closure against biotic interferences.

162. Indian J Soil Conservation, Vol. 22, No.1-2,pp-290-296, 1994

Soil conservation programmes and policies in india

D.K. Singh and T.K.Sarkar

Land and soil mass is basic support system for all kind of biomass production. Causes of land degradation may be classified as biotic and abiotic. In this paper, various forms of biotic causes (Population pressure, land holding and ownership policies, economic, social and cultural) of land degradation are discussed and appropriate conservation policies have been suggested.

163. Indian J Soil Consorvation, Vol 22. No 3. pp 1-9, 1994

Estimation of runoff, soil loss and usle parameters for Doon valley

Pratap Narain. M.L,Khybri. H.P,S,Tomar and N.S.Sindhwal

A study on runoff. soil loss and USLE- parameters was conducted (1986-91) at Central soil ans water conservation Research and Training institute, Dehradun on 1.86mx22.13m runoff plots at 8% slope having multi slot diviser and cisterns to measure runoff and soil loss. Methodology to estimate USLE - parameters is described. The average rainfall erosion index(R) for Dehradun is 10.48 and soil -erodibility factor (k) is 124 kg/ha/unit of R cowpea cover effectively reduced runoff and soil loss by providing cover near the land surface and at early stage of crop growth. Similarly Mandua and Jhingora, the native hill region crops, are efficient in respect of soil and water conservation. The crop management factor 'C' for cowpea was 0.31 and for Mandua and Jhingora was 0.17 and 0.18 respectively. Which is close to the 'C' factor for grass species. The canopy of different crops and their combination is presented to support the results.

DROUGHT MANAGEMENT:

164. Indian J. Soil Conservation, Vol. 21. No. 3, pp. 71-76, 1993

Probability models for prediction of annual maximum rainfall

M. Dalabehera, J. Sahoo and M.K. Bala

The maximum daily rainfall data for a period of 23 years (1967 to 1989) of Regional Research Station, Bhawanipatna in Kalahandi district of Orissa have been analysed using three different theoretical distributions, viz log-Pearson type III, log normal and Gumbel distributions. The theoretical frequency values are found to be in close agreement with observed data for all the three distributions. For the data analysed in this paper, the log-normal or Gumbel distribution seems to provide the closest fit to the observed data.

165. Indian J.Soil Conservation, Vol. 22, No.1-2, pp. 177-183,1994

Forest and its influence on environmental protection

D.N. Tewari

The growing awareness of the environmental concerns and the newly emerging critical role that forests play in maintaining the health and stability of the environment of the 'Planet Earth' has been increasingly realised by the world community. There have been global debates on the ecological, biological, climatic, socio-cultural, economic and environmental roles that forests play in different communities, nations and the globe. The United Nations Conference on Environment and Development (UNCED) held at Rio de Janeiro, Brazil in June 1992 reached to following agreements.

.Agenda 21- an action plan to the year 2000 and beyond.

.Convention on climatic change.

.Convention on biodiversity conservation.

.Non-legally-binding authoritative statement of principles for global consensus on the management, conservation and sustainable development of all types of florests (in short called as "Forest Principles")

.Forests play an important role in combating desertification and drought, preventing soil erosion problems and other protective functions hence a "Convention to Combat Desertification" is under negotiation. To monitor the progress of agreements, the Commission on Sustainable Development (CSD) was established.

Forests were recognised to protect following aspects of environment:

.Protection of the atmosphere (Sequestration of carbon).

.Combating degradation of land and water.

.Protecting fragile ecosystems.

.Combating desertification and drought.

.Conservation of biological diversity.

166. Indian J. Soil Conservation, Vol. 20 No. 3. pp. 39-47 1 9

Earthern embankment reservoir planning for water harvesting - a case study of vagpura watershed.

Vinay K. Pandy and K.S.Hiran

Water is the critical determinant to accomplish the challenging task of enhancing the productivity. Harvesting local rain water and reusing it for a life-saving irrigitlion is not a new concept in India. Reservoirs were constructed at many locations in cental and south India for storing rain water and irrigating the crops. The developmemt of major and medium irrigation projects in the recent decades and consequential negligence of reservoir construction activities have pushed earthen embankent reservoirs to relative insignificance. Uneven and erratic distribution of rainfall caused the use of earthen embankent reservoir traditionally as a mean of irrigation. Since a considerable amount is invested for the development of reservoir irrigation system, appropriate dimensioning requires most attention. The benefit cost ratio of earthen embankment reservoir was 1.38 : 1. Hence. it can economically be taken up with the govemment assistance development.

167.Indian J, Soil Conservatioon Vol., 21, No,2. 40-45,1993

Catchment area- pond size relationship for water harvesting and re-use of runoff water in doon valley

G.Sastry and Gurmei Singh

Water harvesting storage and recycling studies conducted at Dehra Dun show that of the total monsoon rainfall 16.9 per cent can be harvested from treated agricultural watershed into farm pond. Major sources of water loss comprise storage and

overflow from pond which account for nearly 118 and 40 mm. respectively. Properly designed reservoir capacity and suitable lining would minimize the losses. The catchment area-pond size relationship works out to 1.0 ha.m capacity for every 6 and 9 ha of catchment area for lined and unlined farm ponds, respectively in Doon Valley. Supplemental imgation of 5cm at pre sowning and CRI stage and 5cm each (total 10 cm) at presowing and CRI stage to wheat could be effected to 80,50 and 25 per cent of catchment area resulting in grain yield of 3 14, 2 61 and 2 45t ha. respectively compared to control yield of 1.9th ha. Presowing stage is found to be the most favourable stage for supplemental irrigation for wheat in Doon Valley.

WATERSHED MANAGEMENT:

169. Indian J. Soil Conservation, Vol 22. No.1 -2,pp. 84.93,1994

Water harvesting and recycling in northern hilly regions

V.N. Sharda and S.S. Shrimali

Due to erratic and uneven distribution of rainfall, water harvesting which is normally recommended in arid and semi-arid region, has also become essential in the humid and sub-humid climates. Northern hilly region, though recleves sufficient average annual rainfall, its temporal and spatial variation frequently results in moisture stress conditions during critical stages of plant growth. This paper briefly reviews the water harvesting techniques being adopted under different situations in the Northern Hilly regions with special emphasis on their design criteria, rainfall-runoff relationships, catchment area-storage capacity ratios and methods to contain storage losses. Studies have revealed that properly designed dugout-cum-embakement type ponds/reservoirs when used for providing supplemental irrigations, can help in boosting the crop yields two to three folds.

170. Soil Characteristics Under Different Landuse in Fakot Watershed of Western Himalayas (U.P.)

Soil characteristics under different land uses viz. forest, agriculture and wasteland were studied in Fakot watershed of District TehriGarhwal (U.P.) to evaluate influence of landuses on soil properties at varying elevations ranging from 650 to 2015 m above msl. Amongst the forest covers, solils under deciduous mixed forest (Terminalia alata-Mallotus phillippensis community) at vukkage Ghursera (700 m above msl) had maximum amount of organic matter (3.32 per cent), total nitrogen (0.216 per cent), avalilable P_2O_5 (140 kg./ha.) DTPA extractable Zn (7.52 ppm) and Cu (0.62 ppm) in surface layers. The lowest nutrient levels (2.27 per cent organic matter, 0.148 per cent total nitrogen, 37.9 kg.ha. available P_2O_5, 4.86 ppm DTPA extractable Zn and 0.38 ppm Cu) were observed in soils under Opuntia papyntera community at village Kathkore (1900 m above msl). The soils supporting other tree species like Quercus in cana at an elevation 900-1800 m above msl has moderate values in respect of these characteristics. Available K_2O, Mn , Fe and water holding capacity did not vary significantly with variations of tree species and altitude in the watershed.

The grain yield of irrigated paddy (Oryza sabvaL) was positively correlated with total nitrogen plus available phosphorus($r=^{+}$- 0.89) and with available phosphorus alone (y=0.98). The soils of irrigated paddy fields had more amount of organic matter, total nitrogen, available P_2O_5 and K_2O, DTPA extractable Zn, Cu and Fe than the soils of rainfed paddy, Grain yield of rainfed paddy increased with increase in soil depth, water holding capacity and available nutrients. Wastelands were either barren rocks with shale and slate at an altitude 2000 m above msl of were coarse loamy soils with coarse fragments > 35 per cent at an altitude 1200 m above msl indicating lowest values of organic matter, total nitrogen, available k_2O, DTPA - extractable Zn and Mn. Comparison of average values of soil characteristics under different landuses indicated highest amount or organic matter, total nitrogen, DTPA-extractable Zn and Mn in forest soils and lowest in wastelands. DTPA-extractable Cu and Fe in forest soils were more than agriculture soil but did not show marked difference with wastelands. Rainfed agricultural lands were poorer in organic matter and macro and micro-nutrients than irrigated agricultural lands.

171. Indian J. Soil Conservation, Vol. 22,No.1-2,pp.271-278, 1994

People's participation in micro watershed management- a case study of an NGO in Gujarat

Katar Singh

People's participation in watershed development and management programmes is crucial for their successful and cost-effective implementation. This is so because the watershed management approach requires that every field/parcel of land located in a watershed be treated with appropriate soil and water conservation measures and used according to its physical capability. For this to happen, it is necessary that every farmer having land in the watershed accepts and implements the recommended watershed development plan. In the watershed management approach, a watershed is used as the basic unit for planning and management of land, water, and other resources. The approach is holistic, multidisciplinary and a practicable approximation of the systems approach. It enables the planners and managers to consider together various physical, biological, socio-cultural,economic and institutional factors operating with in a watershed and its surrounding environment and formulate a comprehensive and development plan to achieve specific social objectives. In a watershed, natural and human resources are all inter-dependent and interact with one another. This means that nothing short of a systems approach can realise full potential synergistic benefits from the use of a watershed's resources. The watershed approach is also justified on the ground that it internalises various environmental externalities such as soil erosion, siltation, and pollution of water involved in the use of land and water resources and thereby narrows the hiatus between individual and social interests. In view of all these considerations, the watershed seems to be an ideal unit for natural resource and environment management. Like most other agricultural and rural development programmes in India, watershed development programmes also have suffered due to inadequate people's participation. It is, therefore, necessary for successful implementation of watershed development programmes that the process of people's participation is documented systematically and factors affecting it indentified and necessary measures for securing the needed

participation are adopted.

HYDROLOGIC MODELLING/MOUNTAIN HYD.:

172. India J. Soil Conservation, Vol,21,NO. 3.PP. 53-59. 1992,

Determination of peak runoff rates from a himalayan watershed

P.S. Kumbhare' and R.A. Rastogi

A two parameter conceptual model of rainfall runoff transformation based on the cascade of linear reservoirs theory has been applied to a mountainous watershed to develop a peak runoff rate formula. The hydrologic sequences data of the Gagas watershed comprising an area of 506 km^2,of the Ramganga reservoir catchment for 1972 through 1982 were analysed to determine the model parameters. The estimated peak runoff rates compared favourably well with the observed peak runoff rates.

WATER LOGGING & SOIL SALINITY:

173. Indian J, Soil Conservation, Vol 22.No.1.2. pp.112-124.1994

Conservation of soils against waterlogging And salinization

N.T.Singh, J.C.Dagar and G.Singh

Waterlogging and soil salinity have emerged in menacing proportions in the canal command and non-command areas threatening the productivity of a sizeable area in the country. The estimates regarding the extent of such areas vary a great deal, but estimates claim 8.53 m.ha area under waterlogging. 5.50 m ha. as saline (including coastal sandy areas), and 3.58 m ha as alkaline. Ground water tables are rising at an average rate of 0.8 to 1.0m per annum in many canal command areas where conjunctive

use of ground water is not possible due to their poor quality. Efficient water delivery, field management of water, skimmingot fresh water from saline aquifers and its conjunctive use with canal water, efficient open, sub-surface, vertical, and biodrainage measures and use of amendments are recommended. Saline agriculture may be preferred in coastal areas only and saline irrigation must be practiced very cautiously and it should not be permitted where ground waters are scare. Suitable trees of economic value may play a vital role as bio-pumps in waterlogged areas and a tool in reclamation of saline and sodic soils. These may be blended with salt tolerant herbaceous specios of lodder or industrial value as agroforesly crops.

VAYU MANDAL

VII. Vayu Mandal:

FLOOD HYDROLOGY:

174. Vayu Mamdal, JULY-DEC.,1993

Worst flood-prone rivers and sites of india

O.N. Dhar and Miss Shobha Nandargi

Examination and flood data of 10-year period from 1983-1992 has shown that only four rivers, viz. Ghagra, Katakhal, Manas and Sankosh experienced floods in each year of this period. Flood data at each site was also examined for the 6-year period (1987-1992) and it was found that the worst flood hit sites are Dibrugarh (on Brahmaputra) and Road Bridge (over Beki river) which experienced more than 75 floods in this period. It was also seen that Dibrugarh experienced 19 floods in 1990 flood season which is the highest for any site in India during this period.

CLIMATOLOGY:

175. Vayu Mandal, July-Dec.,1991

Trends and periodicities in the rainfall of Delhi

Bhukan Lal and Dharampal Gupta

Trends and periodicities in the annual, seasonal and monthly rainfall of Delhi based on data of 90 years (1901-90) have been examined by various techniques like Mann-Kendall rank method, Student's-test, low-pass filter and power spectrum analysis. It is seen that out of 17 rainfall series the frequency distribution of only 4 series is normally distributed for their frequencies. The Coefficient of Variation (C.V.) is lowest (34%) for annual

rainfall and highest (343%) for November rainfall. Delhi receives 594.2 mm mean monsoon rainfall which is 84% of the annual rainfall. There is significantly high (95%) positive correlation between annual and monsoon rainfall.

The spectral analysis reveals the presence of significant cycle of range 6 to 12 years in some rainfall series. However, detailed examination indicates that these cycles exist during the last 30 or 60 years of the data period. QBO is also observed in some data series.

176. Vayu Mandal, Jan.-June,1992

Southwest monsoon rainfall features over Karnataka

V.S. Ramachandran and N.M. Murali

The chief synoptic features of the southwest monsoon seasonal rainfall distribution pattern in Karnataka State are studied sub-division-wise for the past two decades (1969-88). Some of the spatial and temporal precipitation characteristics of the southwest monsoon are examined for the past 80-90 years. The study revealed that the highest percentage frequency of number of days of various categories of rainfall patterns during the southwest monsoon season are noticed in South Interior Karnataka compared to the other two sub-divisions namely North interior Karnataka and Coastal Karnataka.

177. Vayu Mandal, July-Dec.,1992.

Rainspell characteristics over Sriharikota

T.R. Sivaramakrishan and K. Prakasam

Rainfall data collected at Sriharikota rocket launching centre since 1975 have been critically analysed and the results are presented. Nature of rainspell, duration and intensity as well as the preferred period of occurrence of rain have been discussed. The synoptic situations causing rain over this place have been identified. The rain occurrence

over this place is simultaneous with rain occurrence at Madras, the nearest Class 1 Meteorological Observatory and metropolis, on 70% of occasions.

178. Vayu Mandal, JAN.-JUNE, 1993

Trends and periodicities of winter, monsoon and annual rainfall Of districts of hills of west uttar pradesh

Bhukanlal, B. Lakshmanaswamy and I R Meena

The trends and periodicities in the winter(December- February), monsoon (June-September) and annual rainfall series of 6 districts of hills of West Uttar Pradesh based on fixed number of raingauge stations(28) has been made for 82-year period(1901-1982) in order to search for trends and periodicities in the rainfall. It is seen that winter, monsoon and annual rainfall has a similar variability and is least where rainfalls is maximum. It is also observed that frequency distribution of winter rainfall is not normal in all the districts. Mann-Kendall as well as Student's t-test indicate negative trend in the monsoon rainfall of Pithoragarh and winter rainfall of Garhwal district.

179. Vayu Mandal, JULY-DEC.,1993

Distribution of rainy days, rainfall and associated synoptic features in the river catchments of Bihar

M.C.Prasad & G.Prasad

Economic operation of multipurpose dams providing irrigation, power generation and navigation requires accurate quantitative precipitation forecasts to regulate its inflow and outflow. The nature and distribution of rainfall in a catchment indicates its ground water potential, the extent of its water wealth and the nature of flooding in the catchment. Flood Meteorological Office (FMO) Patna issues quantitative precipitation forecasts in prescribed ranges of rainfall. The forecasts are verified with the actual areal precipitation

of the catchments next day. This paper, based on monsoon rainfall from 15 June to 15 Oct. for years 1977 to 1989 gives the distribution of rainy days and rainfall in the river catchments of Bihar under synoptic conditions of monsoon months. Significance of synoptic features causing the rainfall of various ranges have also been discussed.

180. Vayu Mandal, JAN.-JUNE, 1994

Some rainfall features of North-East India

Umesh Kumar Singh

Average (annual & seasonal) rainfall over different meteorological sub-divisions of north-east India has been discussed along with the heavy rainfall stations and district normals of rainfall and it is concluded that the rainfall features over different meteorological sub-divisions of north-east India are different due to influence of local topography of the region and synopltic systems responsible for heavy precipitation.

HYD. INSTRUMENTATION:

181. Vayu Mandal, JAN.-JUNE,1992

Fabrication, testing and evaluation of nozzle type rainfall simulator

R.N. Adhikari and M.S.R. Rao

The development of rainfall simulator was taken up with the objective of obtaining rainfall-runoff-soil loss relationship under simulated condition for varying slopes, soil type and rainfall intensities under various cultural operations. There are two types of rainfall simulators available, Sprinkler type and Nozzle type. In the Sprinkler type rainfall simulator, there was variation in distribution of rainfall over the soil tray. The other (nozzle type) rainfall simulator brings fairly good uniformity in the distribution of rainfall. The model described here is locally fabricated and tested. Some observations were

collected for rainfall and runoff and are presented in this paper.

CLIMATOLOGY:

182. Vayu Mandal, Jan.-June 1991

A study of exceptionally heavy rainspell of September, 1988 over northwest india

O.N. Dhar and Shobha Nandargi

In this study the severe rainstorm which occurred over northwest India in September, 1988 has been analysed by depth-area-duration (DAD) method. The areal rainfepths thus obtained have been compared with another severemost rainstorm of this region which occurred in October, 1955. This study has shown that both these severe rainstorms yeilded, more or less, areal raindepths of the same magnitude. However, the areal extent of the Sept. 1988 rainstrom was larger and extended even beyond the Pir-Panjal range of the Himalayas causing heaviest raindepths in the Chenab basin.

GROUND WATER HYDROLOGY:

183. Vayu Mandal, Jan.-June 1995

Transient flow response of a porous medium under rapid Changes in periodic boundary condition

M. Banerjee

An analysis of he water movement process under fairly extreme intermittent conditions in semi-infinite profiles of a sand has been studied for four different surface flux patterns and the numerical results are presented for changes of water content (B). Soil water pressure (h) and soil water flux (q) with time. The significance of the average flux rate has been discussed with respect to the attenuation of the amplitude of the transient soil

water flux variation with depth.

HYDROLOGICAL DATA NETWORK:

184. Vayu Mandal July-Dec. 1994

Global data monitoring software developed at rth, New delhi

T.K. Ray, A.K. De, and M.C. Rastogi

Non-real-time annual global monitoring helps in finding out the deficiencies in the GTS as well as identifying data sparse regions. This paper describes the software developed, by RTH, New Delhi for providing the statistics in the new format, introduced by WMO in 1991, on electronic media.

CLIMATOLOGY:

185. Vayu Mandal Jan.-June,1995

Is shimla getting warmer?

Bhukan Lal, H.R. Gola and K.I. Kapoor

An attempt has been made in this paper to determine whether Shimla is getting warmer. For this purpose seasonal and annual, maximum, minimum and mean temperature series of 102 year (1981-1992) were subjected to sophisticated statistical analysis. The analysis revealed that mean as well as minimum temperature of winter and minimum of monsoon is not normally distributed. Rest of the temperature series are normally distributed for their frequencies. Markov linear-type persistence is found in some of the temperature series. Mann-Kendall test suggests significant warming (increasing trend) in maximum temperatures of seasonal as well as annual. This is confirmed by low-pass filter analysis also. Further both the Mann-Kendall test and low-pass filter analysis reveals the

inceasing trend in annual and winter mean temperature series. Spectrum analysis indicates a significant cycle of 6.8 years in minimum temperature of winter and quasi biennial oscillation (QBO) in mean temperature series of monsoon, post-monsoon and annual.

HYDROLOGICAL J. OF IAH (INDIA)

Viii. Hydrological J. of IAH(India):

SURFACE WATER HYD./HYD. MODELLING:

186. Hyd. J. of IAH. Vol. XV, No 1&2, 1992

A case study of rainfall runoff modeling using a conceptual model

S.K. Jain

Rainfall-runoff modelling of a catchment is an important part of many hydrological studies. The conceptual mathematical models are best suited for this task. A new lumped conceptual model structure for rainfall-runoff modelling is described in this paper. It has a small number of parameters which can be easily calibrated using a trial and error procedure. The model is applied to several subbasins located in central India. The basin size varies from about a thousand sq.km. to several thousand sq.km. and they have wide variations in hydrologic regime. The results show that this model can be successfully used for rainfall-runoff modelling of a basin.

187. Hyd. J of IAH, Vol. XVI, No. 1 & 2, 1993

Improved SCS Models for Computing Runoff Volume

S.J. Chen and V.P. Singh

The SCS runoff models were developed for semi-arid and humid regions. These models alleviate the problems existing in the current SCS model.

SURFACE WATER HYDROLOGY:

188. Hyd. J. of IAH, Vol. XVI, Nos. 1 & 2, 1993

Surface water minor irrigation project-hydrological Investigations and design

R.S. Saksena

All individual irrigation projects upto 2000 hectares of culturable command are classified as Minor Irrigation Schemes and there comprise diversions, lift Canals, cheek dams, weir and tanks. The present assessment indicate that irrigation potential which can be developed from surface water minor irrigation schemes, is 17 million hectares. By end of VII plan (1992-97), it is proposed to develop an irrigation potential of about 13 m. ha. from these schemes. However, these schemes have not received due attention. The investigations particularly hydrological planning and design are mostly on adhoc basis and empirical. This paper describes the deficiencies on the hydrological investigation, planning and design of these schemes and lists the remedial measures needed.

189. Hyd. J. of IAH, Vol, XVIII, No. 1 & 2, 1995

Simulation of Daily Runoff for the Catchments of the Hard Rock Region - A Case Study

Venkatesh B. and B.K. Purandara

An attempt was made to simulate the daily runoff using the tank model for the catchments lying in the hard rock region (Malaprabha and Ghataprabha) for the years 1990 and 1991. The validity of the tank model for the hard rock region is checked by comparing the observed and simulated runoff.

GROUND WATER HYDROLOGY:

190. Hydrology J. of IAH, Vol. XIV, No. 1, 1991

Development of springs - the hydrological aspects

A.K. Bhar

A spring is a natural outlet through which groundwater emanates at the ground surface as concentrated discharge from an aquifer. There are many springs in the Himalayas, in the Western Ghats and in other places in the country. Springs provide a viable and ready source of clean water for the rural community especially in a hilly area where there is logistic difficulty in creating storage of water. Spring discharge can also be made use for irrigation, power generation, and recreation purposes. The importance of hydrological study of spring for providing a dependable and sustainable source of water is stressed upon in this paper. An attempt has been made to interlink the development of springflow with the development of land resource and to suggest a procedure to monitor the effect of development on each other.

The solution of available linear unsteady one dimensional hydrological models of springflow can be used to interpet the straight line plot of springflow discharge and time on a semilog graph paper. The slope of the straight line is a measure of depletion time of the spring. The depletion time is a parameter of the spring and is the time required to empty the live reserve of the spring at the present flow rate. The change of slope of the plot of springflow with time (effect) is the manifestation of various desired and undesired activities (causes) in the recharge area of the spring. Effect of various developmental activities in the recharge area of the spring on the springflow are also highlighted.

The simple methodology which has been focussed in the paper using this cause and effect relationship may be used as a monitoring tool for both diagonistic and ameliorative purposes to develop the natural resources in the hilly area.

191. Hyd. J. of IAH, Vol. XIV, No. 4, Oct.to Dec. 1991

Specific capaciaty of large diameter wells in the crystalline rocks of visaakhapatnam region,Andhra pradesh, India.

N. Subba Rao, S. Ravi Prakash and G. Krishna Rao

Specific capacity of wells in the crystalline rocks of Visakhapatnam region ranges from 94 to 357 lpm/m of drawdown in khondalites, 8 to 142 lpm/m of drawdown in leptynites, and 28 to 53 lpm/m of drawdown in charanackites. The yeild of wells in the rocks varies from 3 to 86m /h. It is found that specific capacity increases with an increase in cross-sectional area of wells and the relation of unit area specific capacity with depth to static water level indicates that the permeability decreases with increase of depth.

192. Hyd. J. of IAH, Vol. XVII, No. 1 & 2 1994

Integrated Approach to Watershed Developmednt for Water Conservation and Artifica Recharge to Groundwater - A Case Study of Pune District Maharashtra State

Dr. K.G. Welekar, M.S. Vaidya and , S.B. Khandale

Large scale destrucation of forest, excessive utilisation of groundwater and heavy application of surface water has damaging effect on the eco-system. The situation becomes more critical in the central part of Maharashtra, which receives scanty rainfall ranging from 400 mm. to 750mm and which have high rates of potential evaporation ranging from 300 mm. to 350 mm per year. Major part to Pune district falls in the rain-shadow zone of Sahyadri ranges resulting in partial saturation of the aquifer and drinking water shortage.

Pune district is divided into 66-watersheds and out of which 10-watersheds fall in critical category and 15 watersheds fall in the category of deep post monsoon water level. The total area covered is about 3200 sq.km. The critical conditions of the natural resources and deeper groundwater level has laid to the formulation of watershed development projecat to conserve surface water and augment the groundwater resources by implementing various projects of afforestation, soil and water conservation. The present paper deals with the various aspects of watershed development by evaluating the total water resources available, utilised and balance left or further development.

SEDIMENTATION:

193. Hyd. J. of IAH, Vol. XIV, No. 2,1991

A mathematical model for sediment and chemical transport in agricultural watersheds

V.P. Singh, S.N. Prasad and K.T. Valsaraj

The study aims at developing a physically-based model for determining the fate and transport of chemical constitutents in agricultural watersheds. Migration of chemicals is considered as a physical-chemical process. Dynamic interactions prevailing between the processes of surface runoff, erosion and sediment transport, and adsorption/desorption processes of the various chemical substituents form the basis of the proposed model. The surface runoff is modeled using the kinematic wave theory. The sediment model includes erosion and sediment wash off in overland areas and sediment transport in streams and channels. The sediment washoff consists of dilution, advection and dispersion. The effect of raindrop impact is determined by solving the momentum balance equations for fluid-sediment mixture with rainfall rate as a source term. Transport of sediment in streams and channels is treated as a turbulent two-phase mixture in a continuum. Transport of chemicals by water and sediment is also modeled using the continuum approach. Modeliing of chemical transport by water is due in a manner similar to that for surface flow streams and channels. Chemical transport associated with sediment in suspension and in bed is modeled by accounting for adsorption/desorption processes.

194. Hyd. J. of IAH, Vol. XIV No.3, 1991

Hydrology Based Model for Prediction of Runoff and Sediment Yield With Limited Data for Agricultural Watershed

R.N. Adhikari

The observed rainfall depth, resultant runoff volume and quantity of soil held behind a storage structure from a red soil treated agricultural watershed (area 120 ha) under different cropping system for the year 1985 and 1986 was used as basic input data for preparation of this paper. The wataershed is in a semi-arid zone of Karnataka (India). Runoff prediction was made based on rainfall-runoff modelling with A.P.I. as an additional factor. Sediment yield was predicted based on the sediment model developed by (Williams and Berndt 1977), which is known as Modified Universal Soil Loss Equation. Since the catchment is practically undisturbed since 1981, the soil loss, runoff volume & other hydrological parameters from 1981 to 1984 were estimated by using the above mentioned models.

The analysis of soil loss, runoff volume, runoff curve number, peak rate of runoff were made in probabilitic terms. From the daily rainfall record of 15 ;years, different year return periods of maximum rainfall occurrence was also estimated and is presented in this paper.

SEDIMENTATION IN RESERVOIRS/HYDR. MODELLING:

195. Hyd. J. of IAH, Vol. XVI, No. 1 & 2 , 1993

A distributed model of runoff and sediment processes in dryland environments

Vicente L. Lopes and Peter F. Ffolliott

A process-based model for simulating the spatial and temporal variations of runoff and sediment processes on small watersheds in dryland environments is presented. Stormflow hydrographs are generated from computations of rainfall excess rates, and overland and channel flow routing equations. Sediment entrainment, transport, and deposition on broad shallow and concentrated flow areas are described by the concept of simulataneous sediment exchange. Non-equilibrium sediment continuity equations are solved numerically. Parameter identification and model evaluation were performed using information from rainfall simulator plots and small watersheds in the southwest of the United States. Model testing results confirmed that the governing equations, initial and

upper boundary conditions, and structural framework satisfactorily described the physical processes controlling surface runoff and sediment processes.

FLOOD HYDROLOGY:

196. Hyd. J. of IAH, Vol. XVII, No. 1 & 2, 1994

Assessment of extreme floods in indian tropical region

Dr. P.R. Rao

Storm transposition and moisture maximisation techniques have serious limitations in their application to catchments of Indian Tropical Region. Methods appropriate to Indian Tropics are to be devised to arrive at design storm depth and flood estimates and adopted after due process of testing and validation. Attempts to achieve standardisation are presented, with an illustrative case study, bringing out the issues that need to be debated and resolved.

197. Hyd. J. of IAH, Vol. XVIII, No. 1 & 2, 1995

Flood forecasting models based on watershed storage

S.J. Chen and V.P. Singh

This paper develops linear and nonlinear models for flood forecasting based on the state of watershed storage. The linear model is suitable for big watersheds and the nonlinear model for either middle-sized or small watersheds. The models are also suitable for flood forecasting in ungaged watersheds as well as for flood forecasting in river reaches.

198. Hydrology J. of IAH, Vol. XIV, No.4, Oct. to Dec. 1991

Study of water quality for agricultural use in Hemavathy river (Karnataka)

T.S.Suresh. C.Naganna and G.Srinivas

The investigation deals with the quality of water for agricultural practices in Hemavathy basin. The river Hemavathy is a tributary of Cauvery, with an areal extent of 5410 Sq.kms. It lies between Lat. 12^0 30 to 13^0 30' and Long. 75^0 25' to 76^0 45 . The basin is a part of hardrock terrain of karnataka made up of Granite, Gneisses and Schists. The soil types of the basin are red soils, mixed red and black soils and alluvium.
The paper presents the results of chemical analyses of 190 water samples of both dug and tube wells. The quality of water from the point of view of agricultural pracatises has been studied. The data has been tested for possible hazards due to total dissolved solids, sodium, bicarbonate, chloride and sulphate. From the above analyses it is seen that the water quality is suitable for agricultural practises in the study basin.

199. Hyd.J. of IAH, Vol. XVI, No.1&2, 1993

Sediment Control & Water Resource Conservation in a Mined Watershed in The U.P. Himalaya

V.S. Katiyar, G.P. Juyal, K.S. Dadhwal and P. Joshie

Mining and other development activities like road construction have seriously disturbed the sensitive eco-system of the Himalayas. Mining activity on these fragile slopes has resulted in drying of water sources, siltation and pollution of streams and rivers, landslides etc. A small abandoned lime stone quarry watershed near Sahastradhara (Dehradun) was selected for the study of environmental impact of mining activity and its rehabilitation. Different types of engineering measures adopted to retain the depris in the

watershed and reduce the channel slope include, gabion check dams and cross barriers, silt detention basins, spurs, toe wills etc. Biological measures like planting of suitable species of trees, shrubs and grasses were carried out. Geo-jute matting was used in stabilizing landslide areas.

Different conservation measures adopted in the watershed have resulted in reduction of monsoon runoff and have increased the flow during lean period making the channels perennial. The water quality has also improved rendering it potable now.

SNOW/MOUNTAIN HYDROLOGY:

200. Hyd. J. of IAH, Vol. XIV, No.3 1991

A temperature lapse rate study in Western Himalayas

Partap Singh

The temperature lapse rate (TLR) is considered one of the important derived parameter in most of the snowmelt models. The distribution of temperature based on TLR has a major influence on snowmelt run-off computation and on the determination of the form of precipitation. To improve the understanding of distribution of temperature and how best to incorporate its effect in the snowmelt models, a study of TLR in Satluj catchment has been carried out. It is found that TLR values for the two sets of stations which are in the sakme region vary drastically. The results show a decrease of TLR with elevation at different elevation. The use of derived values of TLR is suggested at least on the monthly basis for the snowmelt season. Separate values of TLR for maximum, minimum and mean temperatures are recommended for temperature extrapolation/intrapolation for snowmelt computation.

REMOTE SENSING:

201. Hyd. J. of IAH, Vol. XVII, No. 3 & 4, 1994

A Proposal Plan for Rural Drinking Water-Supply for 111 Villages by Suggesting Tube Well Sites Through Remote Sensing Technique - A Case Study in Parts of Jhansi District

A.K. Agarwal and S.N. Chandu

The villages around Mauranipur, Garauta and Torifatehpur towns of Jhansi district meet their drinking water requirement through a combination of pipeline water supply scheme through surface reservoirs, hand pumps and dug wells. While the quantity of the water from the dug wells and hand pumps is inadequate to fulfill the drinking water requirement, the existing pipeline water supply which is through Kamala Sagar reservoir has severely been affected because of lowering of water level in it. On the basis of the present investigation, it is suggested to make supply of drinking water through subsurface source instead of the surface source. For this, the hydrogeomorphological map of the study area on 1:50 000 scale has been prepared using Landsat TM data. It shows various hydrogeomorphological and structural features like deep buried pediplain, moderately buried pediplain, linear ridges, ravinous land and lineaments. Based on the remote sensing, a total number of 58 sites have been geophysically surveyed. Out of this, a total number of 10 sites have been recommended for drilling. The entire rural drinking water scheme is to be rejuvenated to meet the drinking water requirement of 111 villages. The correlation of three drilled sites have also been made to analyse the hydrological behaviour of the aquifers in the area. A tentative proporal has also been suggested for laying the new pipeline and overhead tanks.

HYDROLOGICAL DATA NETWORK:

202. Hyd. J. of IAH, Vol. XVIII No. 3 & 4, 1995

Comparison of various precipitation network design methods In a typical basin

A.K. Lohani , M. Arora

Hydrological and meteorological data are collected mainly to provide information for

proper development, assessment and management of Water resources. The aim of raingauge network is to provide the number and location of raingauge stations in a region such that by interpolation between data sets at differnet stations, it should be possible to determine with sufficient accuracy, the rainfall depths in the region. In the present study adequacy of existing network of raingauges using World Meteorological Organisation (WMO) standard, simple well known formula $N = (Cv/P)^2$ the kiagan's technique involving the interstation correlation and, Hall's rational method for determining the key station network has been determined. Further in order to select best method for network design the results obtained by different methods have been compared.

CLIMATOLOGY :

203. Hydrology Journal of IAH, Vol.XVIII, No. 1 & 2, 1995

Weekly rainfall probability by gamma distribution model over West Bengal

B.C. Biswas and Jayanta Sarkar

Weekly rainfall amount at different probabilty levels (30,40,50,60 and 70%), called assured rainfall, has been computed by fitting incomplete Gamma Distribution Model during the monsoon season for 76 stations spread over the entire West Bengal state. Based on the Accumulated Assured Rainfall (AAR) at 70% probability level the entire state has been divided into four homogeneous rainfall zones. The analysis reveal that maximum amount of AAR is received in the north eastern part of Jalpaiguri district and minimum is over a zone comprising of central parts of Burdwan, southeast part of Birbhum and northeast part of Bankura district and also over a small portion of the southern part of Nadia district. Buxa in Jalpaiguri and Mangalkote in Burdwan district receives the highest and the lowest amount of assured rainfall respectively at all the probability levels. During the monsoon season subdued rainfall activity is observed in 33rd and 34th mateorological week, especially in zone D. This investigation could be very useful for developing water resources for hydrological purposes, land use planning, irrigation scheduling and many other purposes, such as determining drainage

requirements and setting up industries.

HYDROLOGICAL MODELLING:

204. Hyd. J. of IAH, Vol. XVI, No. 3 & 4, 1993

A geomorphic time-variant unit hydrograph model

S.J. Chen , V.P. Singh

A geomorphic cascade model of the unit hydrograph with gvariable storage (GUHVS) coefficient is proposed. The model does not involve rainfall-excess for analysis of the unit hydrograph, thus overcoming the problem of determining the rainfall abstracation. The relationship between the varying runoff area between isochrones and the geomorphological unit hydrograph is established. This model is suitable for hydrologic design and flow forecasting on different kinds of basins, especially in ungaged and data-deficient regions.

PHOTONIRVACHAK

IX. Photonirvachak:

SURFACE WATER HYDROLOGY:

205. Photonirvachak - J. of the Indian Society of RemoteSensing,Vol.19,No.4,1991

Establishing SCS Runoff Curve Number from IRS Digital Data Base

Pramod Kumar , K.N. Tiwari and D.K. Pal

USDA Soil Conservation Service (SCS) Runoff Curve Number (CN) is a quantitative descriptor of the land use/land cover/soil complex characteristics of a watershed and is commonly assigned values based on information acquired from field surveys and/or interpretation of aerial photographs. However, these techniques are prohibitively expensive and time consuming for large watersheds. In this study an attempt has been made to establish the SCS runoff curve number from an IRS-1A LISS II digital data base for the Kaliaghai river basin situated in the Midnapore district of West Bengal. Land use/land cover map with hydrologically significant classes (cultivated, forest, fallow, waste land, impervious surface) was developed with the help of IRS digital data. SCS model modified for Indian conditions was used for establishing the curve number for Kaliaghai river basin.

206. Photonirvachak - J. of the Indian Society of RemoteSensing,Vol.21,No.1,1993

Migration behaviour of river Ganga between Allahabad and Buxar using remotely sensed data

S. K. Jain and Tanvear Ahmad

Channel migration includes any change of river channel geometry within the context of the cross-section, pattern or network in a drainage basin. To study the dynamic behaviour of a river, measurements taken with conventional ground-based instruments

are time-consuming and expensive. Remote sensing techniques are capable of providing a measure of surface variability including dynamic behaviour of channels, reasonably quickly due to availability of the repetitive remotely-sensed data. These data are well suited for the assessment and monitoring of dynamic changes on the surface of the earth.

In the present study Landsat MSS and TM data of winter season in the form of false colour composites (FCC) of years 1982 and 1987 were used for the delineation of river Ganga course lying between Allahabad and Buxar. The interpretation of satellite data was carried out using visual interpretation technique for the assessment of channel migration. The shift in river banks delineated from satellite data were measured with respect to river banks identified from topographical base map. The maximum shift observed in mid channel is 4.55 km while maximum left and right banks shifts are 4.6 and 4.8 km, respectively.

SURFACE WATER HYDROLOGY / GROUND WATER HYDROLOGY

207. Photonirvachak - J. of the Indian Society of RemoteSensing,Vol. 22, No.4,1994

Morphometric Analysis of A Drainage Basin Using Aerial Photographs ; A Case Study of Khairkuli Basin, District Dehradun, U.P.

M.D. Nautiyal

Remote sensing techniques using satellite images and aerial photographs are convenient tools in morphometric analysis of a drainage basin. In the present study morphometric parameters of Khairkuli drainage basin, district Dehradun, are worked out using aerial photographs. The parameters worked out include bifurcation ratio, stream length, form factor, circulatory ratio, elongation ratio, drainage density, constant of channel maintenance and stream frequency. Hypsometric relations of drainage basin are also presented. Relation between cumulative stream length and the stream order establishes that the ratio between cumulative stream length

$\Sigma_1^u . \Sigma_1^{n \cdot u} Lu$

and the stream order u is constant throughout the successive orders of a drainage basin suggesting that geometrical similarity is preserved in the basins of increasing order. The morphometric parameters computed suggest that the area is covered by resistant permeable rocks (with fracture and karstic porosities) and vegetative cover, the drainage network is affected by tectonic disturbances. The peak flows generated from the basin are likely to be moderately high and of short duration.

208. Photonirvachak - J. of the Indian Society of RemoteSensing,Vol.23, No.4,1995

Study of Drainage Pattern of Raniganj Coalfield (Burdwan District) as observed on Landsat-TM/IRS LISS II Imagery

V. K. Srivastava and D. Mitra

Drainage pattern of Raniganj Coalfield basin has been mapped as observed on false colour composites of Landsat TM and IRS-LISS II imagery and their characteristics have been interpreted in terms of basin morphology, surface materials and underlying rock types. The drainage system of the region is composed of 3 perennial rivers with 15 ephemeral nalas and jhors which as a whole flows on recent peneplain basin. A lthough, on an average, nalas and jhors of the area have smaller stream length and with smaller basinal area but they hold sufficient amount of water during monsoon and therefore by effectiave planning and management, surface water resources could be enhanced in the region.

GROUND WATER HYDROLOGY:

209. Photonirvachak- J. of the İndian Society of RemoteSensing,Vol. 20, No.2 &3,1992

Evaluation of Ground Water Potential in The Environs Of Jhansi City, Uttar Pradesh Using Hydrogeomorphological Assessment By Satellite Remote Sensing Technique

A. K. Agarwal and D. Mishra

An attempt has been made to delineate different hydrogeomorphological units in and around the immediate environs of Jhansi city with a view to attempt a correlation between the well yields and hydrogeomorphic units using satellite remote sensing technique. In general, a positive correlation is observed between the geomorphic units and the borewell yields with overlapping yields at the margin. The pediment residual hill complex is observed to provide wells with discharges ranging from 100 gallons per hour (gph) to 5000 gph, while the wells drilled in shallow weathered, buried pediplain has yields in the range of 2000 to 10000 gph moderately weathered, buried pediplain has discharges in the range of 8000 to 12000 gph, and deeply weathered, buried pediplain has discharges in excess of 12000 gph.

210. Photonirvachak- J. of the Indian Society of RemoteSensing Vol.20, No.2 & 3, 1992

Delineation of Shallow Deccan Basaltic Aquifers From Maharashtra using Aerial Photointerpretation

Himanshu Kulkarni

The Deccan basaltic lava flows shallow unconfined aquifers tapped for irrigation by large diameter dugwells. Aerial photographs form an important utility in the hydrogeological mapping of these shallow basaltic aquifers. Aerial photographs provide extensive information regarding the agricultural landuse in the agricultural sector from the Deccan basaltic terrain of Maharashtra. A zonation based on the cultivation patterns brings out, quite clearly, the relathionship between the agriculture in the area and the irrigation potential of the aquifer(s). This relationship itself points to the inherent heterogencity of the Deccan basaltic aquifers. Cultivation patterns/signatures that emerge through aerial photointerpretation can form the basis for a systematic hydrogeological mapping leading to aquifer characterisation of Deccan baslats, especially in regions where rock surfaces are not directly exposed (such as is evident in many agricultural belts of Maharashtra state).

211. Photonirvachak - J. of the Indian Society of RemoteSensing,Vol. 21, No.1, 1993

Lineament Identification for Groundwater Drilling in a Hard-rock Terrain of Sirohi District, Western Rajasthan

O. N. Tiwari

In hard-rock terrain under semi-arid climatic zone of western Rajasthan, prospective groundwater zones are poorly defined. The area of Sirohi district studied is regarded as a critical zone for tubewell siting. The present study involves delineation of lineaments on spaceborne and airborne data and their identification in field. Lineaments are identified with surface and subsurface geological features for selection of drilling sites. The study has resulted in 100 percent high-yielding exploratory wells in the area. Identical results obtained in their respective observation wells reaffirm utility of the approach adopted.

212. Photonirvachak - J. of the Indian Society of RemoteSensing,Vol.21, No.3, 1993

Remote Sensing for Analysis of Ground Water Availability in an Area with Long Unplanned Mining History

Jharia coalfield, the chief storehouse of prime coking coal in India, has lost the original controls of ground water conditions. Here, ground water level is dependent mainly upon the presently existing topography, geomorphic features such as abandoned channels, confluence of channels, losing streams etc. and human-induced recharge conditions. These features are reflected by the soil moisture content and presence of vegetative cover. The ground water map of Jharia coalfield has been prepared from the aerial photographs using the grey tone and vegetation cover as the criteria. The observations are supported with field checks. The ground water map prepared will be very much useful to the society because some parts of the coalfied suffer from severe drought during summer.

LAND/SOIL EROSION:

213. Photonirvachak - J. of the Indian Society of RemoteSensing,Vol.19, No.2,1991

Soil Erosion Assessment and Mapping of the Aglar River Watershed (Uttar Pradesh) Using Remote Sensing Technique

S.K. Saha and B.M. Singh

This study was undertaken to prepare an inventory on soil erosion of a hilly river watershed-the Aglar watershed, part of Tehri Garhwal and Dehradun districts (U.P.), using terrain physiography and soil survey data obtained from interpretation and analysis of Landsat TM FCC (1:62,500 scale)and limited ground investigations.
The watershed is divided into four broad physiographic units viz. higher Himalayas (2000m elevation); lower Himalayas (2000m elevation); river terraces and flood plains. Each physiographic unit has been further divided into subunits on the basis of aspecats and landuse. Three major orders of soils viz. Inceptisols, Mollisols and Entisols were found in different physiographic units. Soil, and land properties of soilscape unit viz. soil depth, texture, structure, slope, landuse and soil temperature regime were evaluated for soil-erosion hazard. The results indicate that in the whole watershed 19.13%, 45.68%, 26.51% and 7.92% areas have been found to be under none to slight, moderate, severe and very severe soil erosion hazard categories, respectively.

214. Photonirvachak - J. of the Indian Society of RemoteSensing,Vol.22, No.3, 1994

Assessment of Soil Degradation Hazards in Jalor and Ahor Tehsil of Jalor Districat (Western Rajasthan) by Remote Sensing

Pramila Raina

In the present study efforts have been made to identify and map areas affecated by various land degradation processes with the aid of Landsat TM imagery data of 1988 and

ground truth verification. The kind, extent and degree of land degradation have been mapped. In an area of over 4,124 sq. km. 51% was affected by water erosion and 30% area by wind erosion. Nearly 1.14% area is affected by salinity. Degradation due to combined effect of water and wind erosion and water erosion and salinization has affecated 8.20% of the study area. 1.53% area is free from any hazard. Remaining 7.85% area comes under hills and rivers. Nearly 44 percent of the affecated area is subjected to moderate and severe degradation which can easily be combatted by techniques referred.

SEDIMENTATION IN RESERVOIRS:

215. Photonirvachak - J. of the Indian Society of RemoteSensing,Vol. 22, No.2, 1994

Assessment of Sediment Distribution Pattern in the Tungabhadra Reservoir Using Satellite Imagery

V.K. Choubey

In order to understand the dynamic aspects of suspended sediments in an inland water body, Tungabhadra reservoir on the Tungabhadra river in the Krishna basin was studied. The study has been carried out using Landsat MSS and IRS-1A LISS-II images. Visual interpretation techniques have been used to obtain information on the location and extent of sediment distribution pattern in the water-spread area of the reservoir. It has been possible to monitor the seasonal fluctuations in the reservoir water-spread, measure corresponding fluctuation in the volume of water in the reservoir, and study seasonal changes in the suspended sediment distribution pattern in the reservoir. An attempt has also been made to prepare area capacity curve for the reservoir. Semi-quantitative assessment of sediment deposits between reservoir levels were made considering water spread area from the satellite images (May 1986, April 1987, Jan. 1988, Jan. 1989 and March 1989) and sedimentation survey report of KERS 1985, (Karnataka Engineering Research Station). The results indicated that the high oncentration of sediments is at the western confluence of the Tungabhadra river. On the basis of tonal variation as

observed, the reservoir could be divided into four major zones, viz. very high and high at the river confluence, moderate at the periphery and low at the dam site.

FLOOD HYDROLOGY:

216. Photonirvachak - J. of the Indian Society of RemoteSensing,Vol.21.No.2, 1993

Flash Flood Damage Mapping in Arid Environment Using Satellite Remote Sensing- A Case Study of Pali Region

N. Singh, N. S. Vangani and J. R. Sharma

In the Bali and Pali tehsils of Pali district of western Rajasthan, which were affected by floods during the period August 6-10, 1990, using IRS-1A LISS-1 data of post-flood and ground truth, seven flood damage categories viz. (1) loss of bund and slight sheet erosion (2) loss of bunds, severe sheet and rill erosion and few gullies (3) deep gullies (4) water inundated area (5) moderate scouring and sand casting (6) severe scouring and sand casting and (7) river widening and bank cutting have been mapped. Out of seven, four categories could be mapped visually on the raw FCC (post-flood) and remaining three categories could be separated out from the digitally generated FCC. The PC was found to contain maximum information on soil erosion/deposition and inundated areas. Density-slicing of band-ratioed output gave maximum information on newly formed channels, water bodies and flow direction. The damage caused to be human beings, animals, agricultural lands, engineering structure by different type of flood hazards under various geomorphic clood zone and comparison between pre-flood and post-flood product has been highlighted.

217. Photonirvachak - J. of the Indian Society of RemoteSensing,Vol.23, No.3, 1995.

Mapping and Management of Flood-Affected Areas Through Remote Sensing - A Case Study of Sirsa District, Haryana

The flood-affected areas in Sirsa district, Haryana, was mapped during 1993 using IRS-1A LISS-II data. Two categories of flood-affected areas viz. (i) standing water, and (ii) wet areas were identified. The flood water was standing in an area of 19676.25 ha, while wet areas covered 16773.75 ha. Silting of Ottu reservoir, mismanagement of river banks and bunds and lack of drainage system were identified as major causes of floods. Three management practices including (i) desilting of Ottu reservoir, (ii) proper management of river banks and bunds, and (iii) constructions of drains to flush out flood water have been suggested to contain the fury of floods. This study will be useful to the planners and administrators in the planning of flood-affected areas.

ENVIRONMENTAL HYDROLOGY:

218. Photonirvachak - J. of the Indian Society of RemoteSensing,Vol.23, No.3, 1995

Geoenvironmental Impact Analysis of G.B. Pant Sagar Reservoir (Rihand Reservoir), U.P. and M.P.

A comparison of aerial photointerpreted data around G.B. Pant Sagar (Rihand Reservoir) for pre-dam (1944) and post-dam (1967) periods and satellite imagery of 1988 shows that slope stability of the hills surrounding the reservoir has not been affected adversely as a result of impounding of the reservoir as no landslides are observed in the area in post-dam period. However, significant changes in the landuse of the area surrounding the reservoir are noticed in the post-dam aerial photographs and satellite imagery. Large areas show decrease in vegetation density as a result of deforestation while the areas bordering the reservoir show increase in vegetation density. The area under cultivation has decreased on the western side due to development of a number of coal fields in post-dam period. Improper management of coal ash disposal from a number of thermal power plants located around the reservoir is causing siltation of the reservoir.

FOREST HYDROLOGY:

219. Photonirvachak - J. of the Indian Society of RemoteSensing,Vol.22, No.1, 1994

Stratification Approach for Forest Cover Type and Landuse Mapping Using IRS-1A LISS-II Data - A Case Study

S.Sudhakar, R.K. Das, D.Chakraborty, B.K. Bardhan Roy, A.K. Raha and P. Shukla

Indian Remote Sensing Satellite-1A (IRS-1A) LISS-II data of 24th Nov., 1988 was analysed digitally to differentiate three density classes viz. dense/closed forest, open forest and degraded forest within each vegetation type in the district, Jalpaiguri, West Bengal, Stratification approach was used to classify seperately forest cover into pure sal forests, mixed forests, riveine forests along with man-made sal/teak plantations. In this approach the forested and non-forested areas were classified separately through supervised classification techniques using maximum likelihood algorithm using VAX 11/780 based VIPS-32 Image Processing software. Later the two classified outputs were composited to provide entire area of the district. The forest cover of the district was 1420.89 sq.km, (22.82 percent). Other broad landuse/landcover dominant in the district include agriculatural areas(45.20 percent) and tea gardens (10.49 percent). The accuracy of the classified output was estimated to be 90 percent for forested areas and 85 percent in case of other landuse/landcover classes.

SNOW / MOUNTAIN HYDROLOGY:

220. J. of the Indian Society of Remote Sensing, Vol.19,No.3,1991

Glacier Inventory in Himachal Pradesh Using Satellite Images

Anil V. Kulkarni

A total of 125 glaciers covering an area of 1896 sq.km. were mapped on 1:250,000 scale

in Himachal Pradesh using satellite images. The areal extent obtained from satellite images was found to be comparable with that from field estimates for eight glaciers for which data are available. This suggests that remote sensing can provide glacial area extent similar to ground-based methods. Depth of an individual glacier was inferred indirectly by using its relationship with areal extent and geomorphological characteristics, as suggested by Muller (1970). These charcteristics were estimated by using satellite images. The analysis suggests that the water equivalent of the glaciers in Himachal Pradesh is about 165 cu km. It is seventeen times more than the storage capacity of the Govind Sagar. This estimate will get revised when other snow/ice features as permanent snow field, ice apron, hanging glaciers and rocky glaciers are mapped. Mapping on larger scale, say 1:50,000, will lead to a further revision as many smaller glaciers and other features will get mapped.

REMOTE SENSING AND DATA COLLECTION:

221. Photonirvachak - J. of the Indian Society of RemoteSensing,Vol. 21, No.1, 1993

Geoenvironmental Characateristics and Identification of Hydropotential Zones in Tansa and Bhatsai Reservoir Catchments

A. D. Mangrulkar, V. K. Kondawar and Y. V. N. Krishnamurthy

In the present paper efforts have been made to establish basline information on the landuse/landcover,hydrogeomorphology, physiography, drainage pattern, settlements, erosion and soils with the aid of satellite imagery by visually interpreting the enhanced colour composites. The resulting information base has been integrated for evaluating the potentialities of the mapping units. The area statistics of the different theme files are also generated.

222. Photonirvachak - J. of the Indian Society of RemoteSensing,Vol. 21, No.2, 1993

An Integrated Approach for Resource Development Using Remote Sensing - A Case

Study Specific to Hill Areas

A.K. Gupta, P.P. Nageswara Rao, K. Ganesha Raj, C.B.S.. Dutt and M. G. Chandrasekhar

Hill areas form one of the most fragile ecosystems vulnerable to all kind of human influences. Low productivity of hill lands and rampant poverty among the hill population call for adequate attention to be given towards sustainable development of land and water resources of the hill areas. Remote sensing offers one of the most viable technological solutions for generating data on natural resources of an area. The Geographical Information System technology offers an appropriate method for integrating the land and water resources information and for identifying agroclimatically coherent zones for suggesting locale specific prescriptions and treatment packages. In the present study using capabilities offered by the satellite remote sensing and geographical information system technology an attempt has been made to develop and suggest sustainable development plan for the hill areas of Sakaleshpur and Alur taluks of Hassan district (approx. 1466 sq.km. area) of the Karnataka state. integrated analysis of factors such as topography, rainfall pattern, landuse practices, status of natural resources (wastelands, soils, forest, water resources, etc.), land capability and environmental factors concerning the area has been carried out to suggest development plan for the study area. A set of 11 thematic maps (on 1:50,000 scale) have been prepared using remote sensing data and topomaps and compiled in the form of an atlas. Landuse statistics obtained from remote sensing data has been compared with the conventional landuse statistics reported by the State Department of Economics and Statistics and both are found to be in good agreement with each other (within = 7 percent).

WATER LOGGING AND SALINITY:

223. Photonirvachak - J. of the Indian Society of RemoteSensing,Vol.19, No.4,1991

Characteristics, Distribution and Genesis of Salt-Affected Soils in Punjab

P. S. Sidhu, P. K. Sharma and M. S. Bajwa

The extent of salt-affected soils in Punjab based on the 1984 Landsat-MSS data (FCC) has been investigated. The area of salt-affected soils has decreased from 0.699 million ha in 1972 to 0.488 million ha in 1984. The 1972 extent of salt-affected soils is based on the available maps and interpretation of ERTS pictures. The morphological, physical, chemical and minerological characateristics of salt-affected soils in Punjab are described. These soils are characterised by high pH, ESP and EC but lack columnar or prismatic structure. The highest salt accumulation is observed at the surface and decreases with depth. The only sodium containing silicate mineral identified in these soils is albite. The development of salt-affected soils in Punjab is intimately connected with fluctuation of ground water. These soils have been formed by a combination of topographic, climatic, hydrological and geochemical conditions conductive for the accumulation of brackish waters at or near soil surface.

224. Photonirvachak - J. of the Indian Society of RemoteSensing,Vol. 22, No.3,1994

Specatral Reflecatance Characteristics of Salt-Affecated Arid Soils of Rajasthan

N. K. Kalra and D. C. Joshi

The spectral reflectance characteristics of different types of natural and authropogenic salt-affected soils have been studied under field conditions. The spectral reflectance value for non-saline and all types of salt-affected soils was maximum in near infra red region (800-1000nm). The natural salt-affecated soils having surface salt encrustation showed highest reflectance value followed by the sodic soils (formed due to high residual sodium carbonate water irrigation) natural saline soils and saline soils due to saline water irrigatin. Soil texture, pH, CaCo and organic matter together accounted for 29.6% variation in the maximum reflectance percentage value out of which only pH accounted for more than half (14.2% variation).

MAUSAM

X. Mausam:

GROUND WATER HYDROLOGY:

225. Mausam, (1991),42,1,65-70

Moisture availability and its application in Evaluating agriculture potential in semi-arid region

S.S. Mondal

The states of Punjab and Haryana generally belong to part of arid and semi-arid regions of India. An index known as Moisture Availability Index (MAI) has been used to demarcate it into different agroclimatic zones. The four zones identitied were named Very Low Potential (VLP), Low Potential (LP), Moderate Potential (MP) and High Potential (HP) zones.
The zone VLP had the lowest crop potential area where crops are possible in only 20-30% of the years. A short duration rainfed crop of 10-20 weeks duration may be grown from zone LP while in area MP the crop growing potitial is slightly more. From agricultural point of view area HP appears best suited with minimum risk. Crop prospects at one station in each zone at various risk levels have been discussed.

226. Mausam, (1995), 46, 2, 141-148

Estimation of potential evapotranspiration using a single weather element- the evaporation

S.G. Bhandari and S.K. Shaha

Knowledge of potential evapotranspiration is a basic requirement in any study related to crop water management. Observing the conceptual simmilarity between potential evapotranspiration and evaporation an attempt has been made to establish a linear

relationship between the two.

Using 10 year's potential evapotranspiration and evaporation data, linear regression analysis was carried out. Three stations namely, Bangalore, Pune and Hissar in different latitude belts were selected for the present study. It was observed that partitioning of the annual period into dry and wet periods give better results. Analysis of 10 years data for dry as well as wet period shows that correlation coefficient is more than 0.95 and variance of residual is very small for each data set.

Using the linear regression equation, potential evapotranspiration values were predicted for independent data set. It was found that correlation coefficient between estimated and observed potential evapotranspiration exceeds 0.90, implying that more than 80% of the variation in potential evapotranspiration can be explained by this simple method. Error analysis and also Chi-square test show that predicted values are quite close to observed values.

Drought Management:

227. Mausam, (1993), 44,2, 147-152

Analysis of rainfall data for water management Dry land zone of Karnataka

R.N. Adhikari, M.S. Rama Mohan Rao and P.Bhaskar Rao

Bellary region is characterised as one of the semi-arid zones of Karnataka, having only 508 mm of annual rainfall distributed over 35 rainy days.

The ill-distribution of rainfall creates at least 5 drought years in every decade. The average rainfall distribution shows that there is a total failure in Kharif season. However, some assured rainfall is recieved during September and October a better prospect which assumes for rabi season. This problem can be overcome to certain extent by scientific management of crops and water. This calls for detailed analysis of any important water resources issues. Keeping this in mind, an attempt is made in this paper to analyse short and long period rainfall data. The probability analysis of rainfall for shorter periods for identification ofsuitable periods for sowing, return period analysis for designing of soil and

water conservation structures and determining the size of storage structures, the identification of number of various rainfall events for designing water harvesting system for crop and water management are carried out and presented in this paper.
The results of this study will help to plan the watershed management project in this and similar agroclimatic regions of Karnataka.

FLOOD HYDROLOGY:

228. Mausam, (1995), 46,2,149-154

Semi-quantitative precipitation forecasts for river punpun by synoptic analogue method

K.M. Singh, M.C. Prasad and G. Prasad

An attempt has been made to issue semi-quantitative precipitation forecasts for river Pun Pun by synoptic analogue method. Based upon twelve years data (1982-93) the study reveals that it is possible to issue semi-quantitative precipitation forecasts with confidence. The severe floods in the river Pun Pun pose problems to Patna town due to blocking effect of Ganga.

ENVIRONMENTAL HYD./WATER QWALITY/HYD.MODELLING.:

229. Mausam, (1994), 45,1, 1-6

The modelling study of flow in vasishta godavari estuary

A.D. Rao, S. Chamarthi and P.C. Sinha

The Vasishta branch of the Godavari estuary opens into the bay of Bengal at Antarvedi, Conditions in the estuary are characterized by a seasonally varying fresh water discharge and salt water intrusion from the Bay resulting from the flow associated with the semi-diurnal tide. A numerical model is applied to simulate the flow and salinity

structures which have also been documented in the literature. The observations during monsoon and post-monsoon seasons are used in a comparison with the theoretical results which are derived from a model in which turbulence closure scheme is used.

SNOW/MOUNTAIN HYDROLOGY:

230. Mausam, (1991), 42,2, 187-194

Use of satellite based information in snowmelt run-off studies

D.S. Upadhyay, D.K. Mishra, A.P. Johri, D.K. Mishra and A.K. Srivastava

This paper aims at evolving a conceptual technique for the computation of water yield from the basin snow cover. it may serve as a useful information to compute the snowmelt driven run-off particularly in the lean summer season. For this purpose, the measurement of snow cover area in catchment of Satluj river, using very high resolution imagery received from the meteorological satellite NOAA-9 was undertaken on selected dates during the periods, (i) October 1985 to May 1986, and (iii) January to June 1987. The computed snowmelt water yield have been compared with the available actual run-off data.

The study shows that the satellite derived snow cover data are potentially useful in predicting the snowmelt run-off The importance of the technique is further enhanced for the large watersheds over Himalayas where ground based measurements are too scanty.

231. Mausam, (1994), 45,2, 129-138

Snowmelt processes and applications

D.S. Upadhyay

Snow is a dynamic material which changes its texure and properties almost continuously. Besides this challenging aspecat, we are also concerned with its role in water supply,

recreation, maintenance of environmental standard, modifying atmospheric circulation and also in destructive forces like avalanche and slides. Present paper deals with following 3 aspects of this subject.

i) Presentation of specific data and information illustrating properties of snow related phenomena. These informations have been collected from various literature and other materials including field observations collected by the author.

ii)Presentation of methodology and results of the following studies:

a) deduction of thermal structure of snowpack using equation of heat transfer.

b) density variations in time and space, and c) snowmelt processes.

iii) Identification of some problems and outlining the proposal for further studies.

LAKE HYDROLOGY:

232. Mausam, (1995), 46,2, 193-198

Behaviour of rainfall over lakes around Bombay

Surender Kumar and S.C. Bhan

Analysis of monthly rainfall brings out two districtly different areas of rainfall affinity-one comprising of the lakes situated in Greater Bombay and the other in Thane districts. Rainfall of different sub-periods/months was found to be independent of the rainfall of proceding sub-periods/months. Multiple regression equations between lake levels and monthly rainfall have been computed to predict the anticipated lake levels at the end of different months.

RESERVOIR ROUTING:

233. Mausam, (1992), 43,3, 315-320

Monsoon onset and reservoir build up - a case study for Hirakud

Onset of monsoon for each year of the period from 1961 to 1986 the Upper Mahanadi basin has been studied taking into consideration the sharp increase in water levels of the Hirakud reservoir. This study has shown that there are positive and negative time-lags in the arrival of monsoon run off into the reservoir. It has been seen that positive time lags are due to antecedent conditions of the basin before the onset of monsoon while negative time-lag appears to be due to pre-monsoon thunderstorm activity which causes reservoir levels to increase before the onset of monsoon. Attempt has been made to discuss all these cases briefly. It has been seen that on a majority of occasions monsoon runoff has reached the reservoir with a time-lag of 1 to 4 days.

CLIMATOLOGY :

234. Mausam, (1991),42,1, 57-64

Some studies on rainfall climatology Of the Zagpur region

S.r. Ghadekar and k.k. Thakare

Characaterisation of rainfall of the Nagpur region for crop production and cropping patterns is studied. Percentile index based on five parameters to show adequacy of rainfall for crop production is developed and found to describe monsoon performance satisfactority. These studies have revealed that the mean rainfall of kharif season is 861.5 mm (CV 20.8%) with 52.3 (CV 17.3%) rainy days. Cropping season of 13 weeks (25-37 MW) with dependable rainfall at 75,80,85,90% probubility levels was found to be most assured and risk-free. The cropping period at 75% and 50% probability levels can be extended ;up to 18 weeks (23-40MW) with marginal risk. In rabi and summer growing seasons, there was no rainfall at all at any feasible, dependable level and this situation asked for irrigation. Strategy for stabilizing rainfall crop yields included the adaptation of short to medium duration crops (16-18 weeks) with water requirements 500-900 mm, viz., groundnut, soybean, sunflower, maize, sorghum. Long duration crops like cetton and rice

with high water requirements can be adapted with certain risk.

CLIMATOLOGY/HYDROLOGICAL MODELLING:

235. Mausam, (1991), 42,2, 125-130

A power regression model for long range forecast of southwest monsoon rainfall over India

Vasant Gowariker, V. Thapliyal, S.M. Kulshrestha, G.S. Mandal, N. Sen Roy and D.R. Sikka

A detailed analysis of southwest monsoon (June to September) rainfall over India of several decades vis-a-vis the regional and global antecedent signals in numerous permutations and combinations has led the authors to conclude that a long range forecast based on one, two three or four parameters as attempted by several workers in the past, cannot be reliable on all occasions as indeed has proved to be the case. The parametric and power regression models utilizing 16 parameters, described in the present paper, suggest that it is a tapestry of several parameters and interactiave nature of the regional and global climatic forcings that govern the quality and quantity of the monsoon. A detailed analysis of non-linear interactions among the antecedent climatic conditions and the monsoon has led the authors to introduce the concept of proportionate weightage to the signals of different parameters. This has led to the development of a power regression model which is able to quantify the effect of each parameter. Details of the model are presented. Based on the model, the India Meteorological Department has been issuing the operational long range forecast of monsoon rainfall over India as a whole during the past 3 years, 1988 to 1990, and these forecasts have proved to be correct.

236. Mausam, (1991), 42, 4, 333-338

Climate changes and trends over India

Based on the instrumental observations of over a century available in India, attempt is made to study if there is a clear-cut evidence of any climate change or trend over India with particular reference to rainfall, surface temperature, atmospheric pressure and total ozone. The study concludes that while there are year to year random fluctuations in these atmospheric variables and there are certain epochal increases and decreases in respect of rainfall and surface temperature, there appears to be no systematic climate change or trend over India. There is also no evidence of ozone depletion over India.

237. Mausam, (1992), 43,3,239-248

Recent models for long range forecasting of southwest monsoon rainfall in India

V.Thapliyal and S.M. Kulshrestha

India has a long tradition of scientific work on long range forecasting of the southwest monsoon ever since the times of Blandford and Walker in the early parts of this country. The recent decades have witnessed increased research in regard to the development of new long range forecast models in the India Meteorological Department which have given correct long range (seasonal) forecasts of southwest monsoon rainfall, over the country as a whole, during the successive four years, 1988 to 1991. Presently, four models namely, Parametric, Power Regression, Dynamic Stochastic Transfer and Improved Multiple Regression models are being used for formulating the seasonal forecast of monsoon rainfall over the country as a whole. The forecast is issued in two stages. In the first stage, a tentative inference which is qualitative in nature, is issued before the middle of April based mainly on the Parametric model which utilizes signals from 16 regional and global parameters that are related to land, ocean and atmospheric forcings and show physical linkages with monsoon. In the second stage, a firm quantitative forecast is issued towards the end of the May and is based on the remaining three models, mentioned above, although higher weightage is given to the Power Regression

Model which has shown encouraging performance during the last four years. In this paper, these recently developed models and the scientific basis underlying these are discussed. Data on validation of these operational models, used for the long range forecast during the past four years (1988-91) are also presented.

CLIMATOLOGY :

238. Mausam, (1992), 43, 3, 273-282

Objective determination of northeast monsoon onset dates over coastal Tamil Nadu for the period 1901-90

Y.E.A. Raj

The onset dates of northeast monsoon over coastal Tamil Nadu have been determined by adopting an objective method for the years 1901-90. The various statistical parameters associated with onset dates have been computed and interpreted. Relation between onset dates of easterlies and northeast monsoon over Tamil Nadu has been examined. The normal data obtained has been shown to be by the large consistent with the characateristics of normal daily rainfall of coastal Tamil Nadu. The superposed epoch method has been used to compute the mean rainfall with reference to onset data and the abrupt increase in rainfall at onset has been clearly brought out. The spatial distribution and intensity of rainfall at the time of onset have also been discussed. Daily rainfall has been graphically presented for some years with spectacular onset at well as for some years with subdued onset.

239. Mausam, (1993), 44,1,53-60

Agroclimatic classification in India

A.Chowdhury, H. P. Das and S.S. Singh

In the present study, principal component analysis has been applied to agroclimatic variables for delineating India into homogeneous agroclimatic zones for Kharif crops. The variates chosen were soil moisture, water need of the crops, number of rainy days and radiation. Spatial variability of some of these factors has been discussed. Vector 1 and vector 2 were obtained for each of the three seperate sets of the variates and plotted to obtain grid maps. Through a process of successive superimposition of these maps, agroclimatic zones have been obtained.

The study revealed that India could be divided into 15 agroclimatic zones. Implication of each zone from cropn potential point of view has been discussed. Crop variety and duration appropriate for each zone have been indicated.

240. Mausam, (1993), 44,2, 199-204

Dispersion climatology for Patna and Gaya

Bijendra Rai and B. Padmanabhamurty

The present study aims at seasonal and diurnal pollution potential around Patna, the capital region of Bihar and Gaya. To assess the pollution potential, meteorological data of two stations. viz., Patna and the neighbouring station Gaya for five year period (1984-88) have been analysed. The analysis has been done for four representative seasonal months, viz., winter (January), pre-monsoon (April), monsoon (August) and post-monsoon (October).

The analysis shows no stable conditions in the day time and no unstable condition in the night time in each month. April shows higher frequency and January the lowest frequencies of unstable conditions. April has the highest mixing height and ventilation coefficient. From the results it has been concluded that day time is suitable for good dispersion in all the months. In the case of existing industries, emission must be lessened during night time and particularly in the winter months. These results also suggest that pollutants are well dispersed in April and August. January and August may be regarded as the worst months for vertical diffusion of contaminants. As the predominant surface winds are easterly, any new industrial set up should be in the west

of the city in order to minimise the effects of pollutants.

241. Mausam, (1993), 44,3, 249-254

Probale maximum precipitation over TamilNadu - a generalised approach

P.R. Rakhecha and B.D. Kulkarni

In this paper to estimate areal probable maximum precipitation (PMP) for 1000,5000 and 10,000 km for 1-day duration over Tamil Nadu, three generalised charts depicting variation of areal PMP for these three areas have been prepared. The study showed that the areal PMP estimates for 100, 5000 and 10,000 km over Tamil Nadu seems to vary between 48.32, 38-26 and 32-22 cm respectively for 1-day duration.

242. Mausam, (1993), 44,4,353-358

Variability of southwest monsson rainfall over West Bengal

B.Biswas and K. Gupta

Monthly and seasonal variations of southwest monsoon rainfall over the districts of Gangetic and Sub-Himalayan West Bengal are presented and their differences discussed. Latitudinal variations of monsoon rainfall are brought out. Decadal means of seasonal rainfall over plains are compared with those at higher elevations and northern latitudes. An attempt is made to study long term rainfall trends.

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