ROCKY MOUNTAIN HYDROLOGIC RESEARCH CENTER

PROGRAM AND COMPILATION OF ABSTRACTS

51ST ANNUAL MEETING

SEPTEMBER 20-21, 1996

ESTES PARK, COLORADO

RMHRC PROGRAM
1996 ANNUAL MEETING

BOARD OF TRUSTEES MEETING 8:30 am - 10:00 am

REGISTRATION 9:45 am - 12:15 pm
1:15 pm - 5:30 pm

FRIDAY, SEPTEMBER 20

SESSION 1 10:15 am - 12:15 pm Four papers

HYDROLOGY

Julian, P.Y., Modeling of Flashfloods

Kim, Hung Soo and Jose D. Salas, Testing for Chaos in Tree-Ring Data

Shin, Hyun-Suk and Jose D. Salas, A Neural Model for Spatial Analysis of Hydrologic Data

Frevert, Donald K., Jose D. Salas and William L. Lane, Development of a New Stochastic Hydrology Computer Package

LUNCH BREAK 12:15 pm - 1:15 pm

SESSION 2 1:15 pm - 3:15 pm Four papers

HYDRAULICS AND SEDIMENTATION

Lane, Leonard J., Investigations of Runoff, Hydraulics and Sediment Transport in Streams in the Fort Carson, Colorado Area

Ryan, Sandra E. and C.A. Troendle, Bedload Transport Patterns in Coarse-Grained Channels under Varying Conditions of Flow, 1992-93

Thompson, Douglas, M., Hydraulics and Pool Geometry

Smelser, Mark G. and John C. Schmidt, Geomorphic Adjustability of Streams in the Uinta Mountains

AFTERNOON BREAK & REFRESHMENTS 3:15 pm - 3:30 pm

SESSION 3 3:30 pm - 5:30 pm Four papers

HYDRAULICS AND SEDIMENTATION

Fernald, Alexander, Hydraulic Roughness in Overland Flow through a Montane Riparian Zone

Milhous, Robert, Impact Analysis Using a Sediment Transport Capacity Index

Modeling of flashfloods

by

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Abstract

Recent advances in computer modeling enable the simulation of the surface runoff generated by flashfloods in steep mountains from GIS-based information on topography, soil type and land use. The surface runoff calculations stem from distributed rainfall precipitation in excess of the infiltration rate. Excess rainfall is routed with the two-dimensional model CASC2D for both overland and channel flows. The model has been calibrated in steep watersheds of the Reynolds Creek Experiment Station in Idaho. Rainfall precipitation can be defined at short time intervals from a network of raingages and the spatial distribution is calculated using the inverse square distance algorithm. The model has also be coupled with the polarized dual-Doppler CHILL radar located at Greeley. The model can simulate fast rising hydrographs for spatially distributed rainfall. Examples will be given with a spatial resolution as fine as 30m and a time resolution of 2 minutes. The simulated surface runoff can increase from near dry conditions to peak discharge in less than 30 minutes.

A NEURAL MODEL FOR SPATIAL ANALYSIS OF HYDROLOGIC DATA

by

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A general neural network model is developed for spatial analysis of hydrologic data. The model is nonlinear and nonparametric and provides estimates of local conditional probabilities for determining values at local points (interpolation) as well as areal values. Training is based on one-pass algorithm (unsupervised training). The applicability of the model is illustrated by estimating the mean annual precipitation over the upper basin of the Virgin River in Utah, their corresponding errors, and classifying the area into three classes, dry, normal, and wet. The potential of applying the method for network design and drought assessment will be discussed.

INVESTIGATIONS OF RUNOFF, HYDRAULICS, AND SEDIMENT TRANSPORT IN STREAMS IN THE FORT CARSON, COLORADO AREA

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ABSTRACT. Fort Carson is located south of Colorado Springs, CO primarily in El Paso and Pueblo Counties. Elevations range from about 1620 m above MSL on the southern boundary to over 2000 m on some of the mountains in the southern and eastern portions of the Military Reservation. Mean annual precipitation varies with elevation from approximately 300 mm/y at the lower elevations to over 400 mm/y at the higher elevations. The climate is classified as semiarid and the Reservation is classified as Great Plains Prairie and Pinon/Juniper ecosystems. The mission of Ft. Carson is to conduct training maneuvers with mechanized armament. To meet the mission the training sites must be sustainable under the training activities and, particularly, with respect to soil erosion and sedimentation and maintenance of stable landscapes. A critical step in assessing and maintaining landscape stability is to quantify runoff, streamflow hydraulics, sediment transport, and sediment yield under baseline and training uses on Ft. Carson. A major objective of these research investigations is to quantify water and sediment discharges in selected stream channels entering and leaving Ft. Carson. A total load sediment transport estimation method based on modifications of the Duboys bed load sediment transport equation and the Bagnold suspended sediment transport equation is parameterized using hydraulic and sediment transport data from the Niobrara River in Nebraska. The parameterized sediment transport equations are validated using hydraulic and sediment transport data from the North Loop River in Nebraska, the Rio Grande in New Mexico, and from the Walnut Gulch and Santa Rita Experimental Watersheds in southeastern Arizona. The sediment transport equations will be calibrated with data from US Geological Survey gaging stations in the Ft. Carson area and then applied to streams on Ft. Carson to develop sediment rating curves. Field investigations, in cooperation with the Directorate of Environmental Compliance and Management at Ft. Carson, are currently underway in the Ft. Carson area to measure stream channel properties and to sample stream bed and bank materials. These data are needed as input information for the hydraulic and sediment transport equations.

HYDRAULICS AND POOL GEOMETRY

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A flume located at Colorado State University's Engineering Research Center was used to determine geometric controls on hydraulics in pool systems. A 20.2 m long, 1.83 m wide and 0.60 m deep flume with a channel-bed slope of 0.0035 m/m was used to investigate the effect of four different geometric aspects of pool shape on pool hydraulics. Movable plywood sections were used to systematically vary the constriction width, the depth of the pool, the length of the pool and the gradient of the exit-slope each at two separate levels. The resulting four-way factorial design produced sixteen unique geometries with pool velocities serving as the response variable. The velocity data from the flume was used to calibrate a two-dimensional flow model. The on-going flow modeling allows manipulation of pool geometry and flow levels to help highlight flow responses of recirculating eddy-influenced pools to various hypothetical erosive and depositional events. Based on the flume experiment, consistent trends developed with constriction and depth effects dominating in the jet section of the flume, and pool length exhibiting an increasing effect within the recirculating-eddy system. At the downstream end of the pool, an upsloping section of the channel-bed, the pool exit-slope, appears to force flow reattachment effecting the rate of energy loss. The length of the pool also appears to control the rate and location of energy losses in recirculating eddy-influenced pools. The pool exit-slope and pool length variables may ultimately provide a feedback mechanism to control the flow velocities, energy losses and sediment transport rates in pools.

Abstract

Hydraulic Roughness in Overland Flow Through a Montane Riparian Zone

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Roughness coefficients in overland flow are important for modeling surface hydrology and pollutant transport. Often Manning's n (n) and Darcy-Weisbach friction factor (f) are back-calculated in surface runoff models, assuming constant flow depth across hillslopes and using roughness as a fitting parameter. This study addresses these shortfalls by using empirical data to calculate roughness coefficients for concentrated flow in very small channels. This work also provides roughness values for montane riparian zones where previous estimates have been lacking. The research was conducted in 1994 and 1995 at Sheep Creek in northern Colorado. Four 3 x 10 m plots were installed in each of grass, sedge, and mixed (grass and sedge) vegetation communities. On 10 cm grid cells covering each plot, measurements were taken of surface elevation, vegetation type (grass, sedge, reed, shrub, forb, moss) and vegetation density (bare, light, heavy). Basal area was measured for each vegetation type and density. Within GRASS, a raster-based geographic information system (GIS), elevation maps were constructed and a contributing area subroutine was used to define microchannel flow paths. Rainfall was applied to the plots with a rotating boom rainfall simulator and runoff was recorded at 1 min intervals. The resulting hydrographs were used to define equilibrium runoff periods where runoff reached a near steady state. Flow depths and microchannel cross sections were measured during equilibrium runoff and flow velocity was measured with both tracers and a micro velocity meter. Manning's n was calculated by two methods. In the first, Darcy-Weisbach f for the microchannel network on each plot was distributed into bed, soil, and vegetation components according to field measured data. Flow was assumed to be fully turbulent, allowing calculation of Manning's n from f and flow depth in the channels. By the second method, n was calculated from flow depth and measured velocity. For both techniques, n was estimated using flow only in microchannels then compared with estimates of n using flow depth averaged across the plots. Final Manning's n in microchannels was lower than that derived with plot averaged flow depth. This suggests that n may be overestimated when flow is assumed to be of constant depth across the hillslope. Estimates of Manning's n for the grass community were lower than published values for a similar Kentucky Bluegrass community, highlighting the need for additional field measurements of hydraulic roughness in diverse environments.

Integrated Hydrometeorological Decision Support Systems in the Bureau of Reclamation

Abstract

by

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Accurate and timely hydrometeorological information is essential for reservoir operations and river basin management conducted at the Bureau of Reclamation's (Reclamation) facilities. Reclamation serves over 31 million Americans in 17 Western States, providing over 9.3 trillion gallons of water and 45 billion kilowatt hours of electricity each year. River basin managers must have timely data from remote areas that are often inaccessible in winter and have a means of quickly analyzing the impacts of precipitation and snowmelt on streamflow for routine river system management and emergency responses to extreme events. Consequently, Reclamation uses a variety of hydrometeorological observing systems that it maintains and cooperates with other agencies in collection of other data. This paper briefly describes Reclamation's hydrometeorological and early warning observing systems (Fisher), decision support tools, and interactions with other cooperating agencies including NOAA, US Geological Survey, NRCS, ARS and NASA who collect, transmit and analyze hydrometeorological information. Other remotely sensed information from NOAA's National Operational Hydrologic Remote Sensing Center, NEXRAD, and inputs from the National Resources Conservation Service SNOTEL and US Geological Survey streamgage observations will be discussed in the context of integrated application of these data to solving practical water resource management challenges. This paper presents an overview of current and planned applications of hydrometeorological data for water resources management in Reclamation.

The Watershed and River System Management Program sponsored by Reclamation's Science and Technology Program integrates hydrometeorological data with advanced technologies for decision support. This program provides an excellent example of an integrated water resources management decision support system. The hydrologic data base provides a central source of information that drives physically based process models that compute streamflow from precipitation runoff. This data base is linked to observing systems through data collection platforms that transmit to base stations and GOES satellites and radio relay links. Internet and other Reclamation communication networks bring data into the Hydrologic Data Base from Reclamation and other agencies. Models such as the Modular Modeling System developed by Leavesley simulate snowpack evolution and runoff and resulting streamflow from the hydrometeorologic data. This streamflow data then drives the Power and Reservoir Systems Model (Zagona, Fulp, Vickers) that is used by river operations managers to control irrigation deliveries and hydropower dispatches and maintain an equitable and sustainable use of vital water resources. Efficient and effective management of the river basin resources within the "law of the river" requires careful and accurate decisions that balance limited water supplies with ever

Measuring Precipitation and Snowfall -- We're Still Struggling

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Abstract

Hydrologic researchers know that there are many uncertainties in their field. Surprisingly few, however, realize that even the basic measurement of precipitation is difficult, and much of our precipitation data used in hydrologic studies are inaccurate to some extent. Even the best long-term monitoring networks such as those operated by the National Weather Service and the Natural Resources Conservation Service are plagued by instrument biases, exposure problems and other inaccuracies that can produce precipitation measurement errors of 50% or more. Measurements of snowfall and water content of snow on the ground also have problems many of which have been known (but not solved) by data collection experts for more than 100 years.

Several examples of precipitation and snowfall data collection problems will be presented including exposure-related gauge undercatch, time-of-observation biases, biases introduced by particular gauge types, human errors, and automation problems. In conclusion, comments will be given on the accuracy of remotely-sensed precipitation estimates from the new National Weather Service WSR-88D radar.

Submitted to 51st Annual Meeting of the Rocky Mountain Hydrologic Research Center, YMCA Camp of the Rockies, Estes Park, Colorado, September 20-21, 1996.

Arne L. Sjodin (M.A., Biology)

Nitrogen Processing in a Large Plains River

Nitrogen concentrations in many rivers are often elevated above natural ranges as a result of sewage discharges and agricultural runoff. High nitrate concentrations are of concern, due to possible ecological and public health effects. Processes affecting nitrate concentrations are therefore of interest. Particularly, a greater understanding of processes that remove nitrogen from the river, such as denitrification, is warranted.

The South Platte River in Northeastern Colorado serves as an ideal site to study denitrification and nitrogen concentrations in a river from a mass balance approach. In this area, nitrogen inputs into the system are primarily from nonpoint fertilizer inflows and groundwater seepage. Processes affecting nitrogen concentrations in a 65 mile study reach were modeled using a mass balance approach. Physical inflows and outflows to the river were taken from existing records or estimated from residual analysis of long-term flow records. Rates of biological processes were then estimated by mass balance modeling of ammonium and nitrate concentrations measured during selected synoptic samplings during a two year period.

Under low flow (< 1000 cfs) conditions, the South Platte is a gaining stream due to groundwater seepage. However, the river loses water to bank storage during periods of high flow (greater than 1000 cfs), which are typically associated with spring runoff. Additionally, the seepage rates exhibited a seasonality associated with irrigation.

After hydrologic inputs and outputs were estimated, mass balance of nitrogen in the river could proceed. Due to the small amount of biological growth on the river bottom, net biological assimilation of nitrogen was considered negligible. Thus, the main processes affecting nitrogen were assumed to be nitrification (conversion of ammonia to nitrate) and denitrification (conversion of nitrate to dinitrogen gas). Both ammonia and nitrate concentrations decreased downstream and the nitrification and denitrification processes were best described with first order kinetics. Modeled denitrification rates were significant, and ranged from 2 to 52 mg-N/m^2-h. These whole-channel derived rates are comparable to published denitrification rates using chamber-type approaches. Overall, denitrification removes a large portion of the instream nitrogen load.

WATER QUALITY PROBLEMS IN THE UPPER SAN MIGUEL RIVER, TELLURIDE, COLORADO

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ABSTRACT

During the spring and summer of 1995, a study was conducted of the water chemistry of the San Miguel River in and near the mountain town of Telluride, Colorado. The purpose of the study was to determine the effects on water quality of a nearby mine and the town itself. Water samples were collected from five river sites selected to indicate town and mine inputs as well as background watershed chemistry. Samples of groundwater pumped into the river from the town were also collected. All samples were analyzed for major anions and cations, pH, conductivity, ANC, and silica.

Nitrate levels for all sites started at 15-18 ueq/L and decreased during the growing season although they remained above zero. These values were higher than expected for a forested catchment. For sitess affected by the mine, sulfate levels were in the range of 600 to over 1700 ueq/L. At other river sites the sulfate levels were 150 to 350 ueq/L, which indicates other basin souces of sulfur. Total phosphorus was available only for the late season samples and was less than one umole/L. ANC values were above 300 ueq/L, which was expected due to an abundance of sedimentary rock, and so acidification is not a potential problem. The values for pH were in the neutral range.

During runoff there was no noticeable effect on water chemistry from the town. When water levels decreased, however, the effect of the town became evident. Nitrate levels below town increased by a factor of 2 to 5 from above town values. There were similar increases in other ions. Since the groundwater inputs to the river had high levels of nitrate and other ions, the town is clearly one source of the increase. The sources of nitrate above town are not clear. The mine and the ski area are possibilities.

The study of water chemistry is being continued during the spring and summer of 1996. Several sites for water sample collection have been added, particularly at higher elevations. Nutrient amendment experiments are being conducted to determine limiting nutrients and possible sources of algae blooms observed in the late winter. Wet deposition is also being collected.

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Abstract

This study examines the potential for sulfate retention in a subalpine wetland in Loch Vale Watershed (LVWS) in Rocky Mountain National Park. The study is one component of a larger study with the National Biological Service (NBS) and the United States Geological Survey (USGS). The broad objective of these groups is to examine the pathways and processes that affect the flux of chemical species through watersheds. More specifically, this study aims to examine the influence of a subalpine wetland on where atmospherically deposited sulfur is retained, how much sulfur is retained, and for how long it is retained within the wetland. Sulfur isotope measurements on aqueous sulfate in conjunction with surface water chemistry data will address the following hypotheses: 1. Sulfate does not behave conservatively as it moves through a subalpine wetland, and is retained via dissimilatory sulfate reduction. 2. Sulfate retained by dissimilatory sulfate reduction resides in a subalpine wetland less than one year. Changes in the relative abundance of stable isotopes of sulfur will elucidate biogeochemical processes that occur along the flow path of sulfur. Cosmogenic S-35 will be used to examine the rates of sulfur migration and sequestration as well as verify uptake of sulfur along its flowpath.