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Water Quality Model for the Toxic Pollutant Transport Analysis in the Nakdong River

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A water quality model RIV-LAG1 for the toxic pollutant transport analysis is developed based on varied flow analysis and one-dimensional Lagrangian method. Applying to the prismatic channel, it shows accurate results compared with the analytical solutions. The model is applied to the Nakdong River to analyze the phenol spill accident, which occurred on March, 1991. The computed results have good agreements with the observed data. The travel times in the reach of Gumi to Mulkeum based on the monthly average and minimum flow are computed. The suggested model can be used to study the impact of the chemical spills and clean-up plans in the Nakdong River.

Estimation of evapotranspiration using NOAA-AVHRR data

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The purpose of this study is to estimate evapotranspiration and its spatial distribution using NOAA-AVHRR data. Evapotranspiration phenomena are exceedingly complex. But, factors which control evapotranspiration can be considered that these are reflected by conditions of the vegetation. To evaluate the vegetation condition as a fixed quantity, the NDVI (Normalized Difference Vegetation Index) calculated from NOAA data is utilized. In this study, land cover classification of the Korean peninsula using property of NDVI is performed. Also, from the relationship between evapotranspiration and NDVI histograms, evapotranspiration and its

distribuntion of the Han River basin are estimated.

Stochastic Multiple Input-Output Model for Extension and Prediction of Monthly Runoff Series

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This study attempts to develop a stochastic system model for extension and prediction of monthly runoff series in river basins where the observed runoff data are insufficient although there are long-term hydrometeorological records. For this purpose, univariate models of a seasonal ARIMA type are derived from the time series analysis of monthly runoff, monthly precipitation and monthly evaporation data with trend and periodicity. Also, a causual model of multiple input-single output relationship that take monthly precipitation and monthly evaporation as input variables - monthly runoff as output variable is built by the cross-correlation analysis of each series. The performance of the univariate model and the multiple input-output model were examined through comparisons between the historical and the generated monthly runoff series. The results reveals that the multiple input-output model leads to the improved accuracy and wide range of applicability when extension and prediction of monthly runoff series is required.

Rainfall Variations in the Nam River Dam Basin

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An investigation into the rainfall variability in time and space in the Nam River dam basin of Korea was made with use of the coefficient of variation and the correlation coefficient. The Nam River dam basin is a small mountainous watershed where the wind direction and orography are the dominant influences on the pattern and distribution of rainfall. It was found that the characteristics of rainfall distribution vary with elevation, position, and wind direction. And in the three directions considered, it was found that there is the related formulation dependent on the distance between two stations. The results of this study on the temporal and spatial characteristics of rainfall can be used in the design of raingauge networks, hydrological forecasting, and so on in the Nam River dam basin.

A Study on the Hydraulic Experiments of Modi Khola Hydroelectric in Nepal

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This study is concerned with the hydraulic experiments of Modi Khola Hydroelectric in Nepal. The experimental domain consists of the intake structure and the settling basin. The intake structure was made by the undistorted model with the scale of 1:20, the settling basin by the distorted model with the scale of 1:10 (vertical) and 1:15 (horizontal). Based on the movable bed model theory, the 'Anthracite' ($\rho_s=1.48$) is chosen as a model material. According to the model tests, the installation of the guide wall with proper height and the proper control of the flushing gate are required for the effective flushing in the intake structure. In the settling basin a more proper design of the inlet in order to constrain the turbulence flow is required for an efficient sedimentation and the installation of another flushing pipe near the maximum sedimental area is required. Since the trap efficiency is measured about 95%, it is concluded that the design of the settling basin is proper.

Development of Mathematical Model for the Cherepnov Water Lifter

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This paper presents a mathematical model which simulates the Cherepnov water lifter, that can lift water without the use of external energy such as electricity. A theoretical study was conducted to reveal the characteristics of the Cherepnov water lifter that was continuously operated with the aid of the siphon. The mathematical model was composed of the continuity equation and energy equation, and was coded using FORTRAN language. In this study, the govering flow equation of the lifter was derived and the computer programs of the equations were worked out. The accuracy of the theoretical equations and their solutions was checked by laboratory experimens. The mathematical model that simulate the Cherepnov water lifter appears to be good to predict the behavior of Cherepnov water lifter. Therefore, the mathematical model and the simulation method used in this study could be used in designing the Cherepnov water lifter.

Rainfall Estimation for Hydrologic Applications

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The subject of the paper is the selection of the number and location of raingauge stations

among existing ones, which will be part of real-time data collection system, for the computation of mean areal precipitation and for use as input of real-time flow forecasting models. The weighted average method developed by National Weather Service was used to compute MAP. Two different searching methods were used to find local optimal solutions as a function of the number of raingauges. An operational rainfall-runoff model was used to determine the optimal location and number of stations for flow prediction.

An Experimental Study on the Cherepnov Water Lifter Driven by the Potential Energy of the Water

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This paper presents an experimental study on the Cherepnov water lifter that can pump or lift water without the use of external energy such as electricity. The energy used by the lifter is derived from the potential energy of the water itself. The lifter consists of three interconnected tanks, one of which is open and two others are hermetically sealed. The water level and the pressure in each tank were measured to improve the undestanding of the behavior and the operational charateristics of the lifter. The effects of varying operating parameters such as the inflow rate, tank and pipe sizes, the relative positions of the tanks were anlyzed. As a result, factors that can maximize the efficiency, shorten the cycle time and increase the delivery rate were identified.

Optimal Design of Detention System using Incremental Dynamic Programming

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The purpose of this study is to develop an efficient model for the least cost design of multi-site detention systems. The IDP (Incremental Dynamic Programming) model for optimal design is composed of two sub-models: hydrologic-hydraulic model and optimization model. The objective function of IDP is the sum of costs; acquisition cost of the land, construction cost of detention basin and pumping system. Model inputs include channel characteristics, hydrologic parameters, design storm, and cost function. The model is applied to the Jung-Rang Cheon basin in Seoul, a watershed with detention basins in multiple branching channels. The application results show that the detention system can be designed reasonably for various conditions and the model can be applied to multi-site detention system design.

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A Stochastic Model for the Prediction of Water Quality Variations in a River System

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A stochastic model "STO-RIV" for the prediction of water quality variation in a river system has been developed. Extended Streeter-Phelps equation and Monte Carlo simulation are used in the model. The model is applied to the reach of Waegwan to Mulkeum in the Nakdong River to compute the probability distribution of BOD and DO concentrations at Mulkeum site. As the strategies to attain the goal of the water quality, some alternatives considering the treatment effect of the Keumho river are discussed using the stochastic model. Application of stochastic analysis to water quality management is strongly recommended in this country.

An Extraction of Geometric Characteristics Parameters of Watershed by Using Geographic Information System

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A GIS is capable of extracting various hydrological factors from DEM (digital elevation model). One of important tasks for hydrological analysis is the division of watershed. It can be an essential factor among various geometric characteristics of watershed. In this study, watershed itself and other geometric factors of watershed are extracted from DEM by using GIS technique. The manual process of tasks to obtain geometric characteristics of watershed is automated by using the functions of ARC/INFO software as GIS package. Scanned data was used for this study and it is converted to DEM data. Various forms of representation of spatial data are handled in main module and GRID module of ARC/INFO. GRID module is used on a stream in order to define watershed boundary, so it would be possible to obtain the watersheds. Also, a flow direction, stream networks and orders are generated. The results show that GIS can aid watershed management and research and surveillance. Also the geometric characteristics parameters of watershed can be quantified with ease using GIS technique and the hardsome process can be automated.

Determination of State-Space Model for Parameter Estimation of Tank Model

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The propose of this study is improve the uncertainty of parameter choice of tank model by the trials and errors method. The real time prediction of parameter by using the Kalman filter is practiced to get the effective prediction algorithm of low flow runoff. Even though the total discharge of runoff through the orifice of each tank should be similar to the observed discharge, the tank model which can show the various basin characteristic is influenced by the runoff circumstances. As a result of the real-time estimation of the tank model parameter by the state-space type of Kalman filter, the variation of runoff circumstances is static when the convergence of observed value and estimated value keeps the fixed high point. The parameter of tank model which is estimated by Kalman filter shows good result for low flow and reasonable adaptability where flow change abruptly. The Kalman filter method is proved to give better result than automatic structure estimation method.

Quantitative Analysis for the Effects of Hydraulic Variables on the Formation of Freshwater-Saltwater Transition Zones in Aquifers

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The location and the shape of freshwater-saltwater transition zones in coastal aquifers are affected by many hydraulic variables. To date most work to determine the effects of these variables are limited to qualitative comparison of transition zones. In this work characteristics of transition zones (maximum intrusion length, thickness, and degree of stratification) are quantified, and effects of principal hydraulic variables(velocity and dispersivity) on these characteristics are studied using a numerical model. Dimensional analysis is used to assemble entire model results. Effects of velocity and dispersivity are seen clearly. From this study, increase in velocity is found to cause shrinkage of transition zones. This observation contradicts claims by some that, because dispersion is proportional to velocity, increase in velocity would cause expansion of transition zones.

Probability Distribution of Rainfall Events Series with Annual Maximum Continuous Rainfall Depths

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The various analyses of the historical rainfall data need to be utilized in a hydraulic engineering project. The probability distributions of the rainfall events according to annual maximum continuous rainfall depths are studied for the hydrologic frequency analysis. The bivariate normal distribution, the bivariate lognormal distribution, and the bivariate gamma distribution are applied to the rainfall events composed of rainfall depths and its durations at Kangnung, Seoul, Incheon, Chupungnyung, Teagu, Jeonju, Kwangju, and Busan. These rainfall events are fitted to the the bivariate normal distribution and the bivariate lognormal distribution, but not fitted to the bivariate gamma distribution. Frequency curves of probability rainfall events are suggested from the probability distribution selected by the goodness-of-fit test.

Friction Factor of Rectangular Open Channel Flow

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The present paper discusses the traditional empirical equations of friction factor or cross-sectional mean velocity of open channel flow and suggests the new form of friction factor equation. Dimensional analysis is conducted for the possible forms of traditional empirical equations in order to satisfy the dimensional equality, and new forms of empirical equations are presented with introducing equivalent roughness height. Considering the distribution of friction factor against Reynolds number which has a similar characteristics to that of smooth turbulent flow in circular pipe, the friction factor equation of rectangular open channel flow is developed by modifying the friction factor equation of circular pipe flow for the region of smooth turbulent flow. The equations including the dimensionally-corrected empirical equations are tested against Bazin's laboratory experiments.

Stochastic Optimization Approach for Parallel Expansion of the Existing Water Distribution Systems

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The cost of a looped pipe network is affected by a set of loop flows. The mathematical model for optimizing the looped pipe network is expressed in the optimal set of loop flows to apply to a stochastic optimization method. Because the feasible region of the looped pipe network problem is nonconvex with multiple local optima, the Modified Stochastic Probing Method is suggested to efficiently search the feasible region. The method consists of two phase: i) a global search phase (the stochastic probing method) and ii) a local search phase(the nearest neighbor method). While the global search sequentially improves a local minimum, the local search es-

capes out of a local minimum trapped in the global search phase and also refines a final solution. In order to test the method, a standard test problem from the literature is considered for the optimal design of the parallel expansion of an existing network. The optimal solutions thus found have significantly smaller costs than the ones reported previously by other researchers.

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Hydraulic Flood Routing for Natural Channels

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A nonlinear wave routing model is suggested for the routing of floods in the natural open channel networks. For the optimization of parameter of the proposed routing model, parameter adjustment is executed through the proposed objective function. The model treats backwater effect form upstream and downstream ends. Solution of formulated model is made possible on computer by adopting a nonlinear finite-difference scheme for the numerical analysis based on a combination of Lax-Wendroff scheme and Burstein-Lapidus modification. Comparison of the results of the proposed model to those of actual hydrograph and dynamic wave routing model denotes that the proposed model is as accurate as actual runoff hydrograph and faster the computer time than the dynamic wave routing model.

Development of Flow Forecasting System in Large Drainage Basin

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The subject research attempts to develop a hydrologic-hydraulic forecasting system suitable for use in large river basins. A conceptual hydrologic rainfall-runoff model is used to produce streamflow from meteorological and hydrologic input data over each subbasin, while a hydraulic model is used to route the catchment outflows in the stream network. For operational flow prediction, an efficient state estimator has been designed for the real-time updating of model states from newly recorded data. The real-time application of the forecasting system indicates that this model produces reliable short-term predicted results.

The Influence of Lake Position on Groundwater Fluxes

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The purpose of this study is to investigate the influence of the position of lake upon groundwater fluxes on a lake watershed, and to provide the guidance for the monitoring network design to survey the exchange relations between groundwater and lake water. Three kinds of hypothetical flow through lakes, which are located at the upper, middle, and lower portion of a watershed were considered. And groundwater flow for each case was numerically simulated under three dimensional steady state conditions. As a result, it can be shown that: (1) The exchange between lake and groundwater in the case where a lake is located at lower portion on watershed shows more active than that for a lake located at upper portion. (2) The amounts of inflow from groundwater to a lake are less than the amounts of discharge to groundwater in a target lake watershed. (3) The rate of inflow and outflow of groundwater to a lake is increased as the lake is located at upper portion of a watershed. (4) The horizontal flux of groundwater occurred on the lake bed is more significantly active than the vertical flux.

Precipitation Change in Korea due to Atmospheric CO_2 Increase

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A precipitation change in Korea due to atmospheric CO_2 doubling has been estimated with a mixed method (Robinson and Finkelstein, 1991) to represent regional precipitation distribution from the simulated precipitation data by three GCM(general circulation model) (CCC, UI, and GFDL GCM) experiments. As a result of this analysis, the precipitation change by atmospheric CO_2 doubling can be summarized as follows: The precipitation increases as much as 25㎜/yr during spring season and more than 50㎜/yr during summer and autumn. However, it decreases as much as 13㎜/yr during winter. In terms of percentage with respect to current precipitation climatology, we may have more rain as much as 10%, 13% and 24%, respectively, for spring, summer and autumn than current precipitation. However, we may have less winter precipitation than current climatological average.

A Study on the Hydrologic Design of Detention Storage Ponds in Urbanized Area

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This study is to develop the suitable hydrologic models for determination of the size and location of detention storage facilities to restrain stormwater runoff in urban areas. Fictitious areas of two levels are considered to seize the hydrologic response characteristics. A one-square-kilometer area is selected for the catchment level, and a 10-square-kilometer area consisting of 10 catchments is adapted at the watershed level as representative of urban drainage area. In this analysis, different rainfall frequencies, land uses, drainage patterns, basin shapes and detention storage policies are considered. Flow reduction effect of detention storage facilities is deduced from storage ratio and detention basin factor. A substantial saving in detention storage volumes is achieved when the detention storage is planned at the watershed level than the catchment level. For the application of real watersheds, two watersheds in Seoul metropolitan area-Jamshil 2, Seongnae 1-are selected on the basis of hydrologic response characteristics. Through the regression analysis between dimensionless detention storage volume, dimensionless upstream area ratio and reduction rate of storage ratio, the regression equations to determine the size and location of detention storage facilities are presented.

Characteristics of Runoff and Groundwater Quality from a Pasture and Field

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Characteristics of runoff and groundwater qualities from a pasture and field were investigated. Flumes and monitoring wells were installed and water qualities of NO_3-N, TP and TKN were monitored from Aug. 1993 to Aug. 1994. Runoff from the pasture which was a sandy soil with cobbles mostly formed with seeping water at the bottom of it. But once overland flow occurred because of heavy rainfall, runoff increased sharply. NO_3-N concentration in pasture runoff was relatively stable ranging between 0.241-3.962㎎/ℓ. TP and TKN concentrations were stable but sharply increased once overland flow occurred. NO_3-N concentration in pasture groundwater was relatively stable regardless of depth of monitoring wells but TP and TKN concentrations were smaller in deeper wells. Runoff from the field which was flat and covered well with Sudan grass and surface residue was relatively small and NO_3-N, TP and TKN concentrations in runoff were stable and seemed unaffected by flow rate. NO_3-N concentration in field groundwater increased at the rate of 2.2㎎/ℓ per 100 m during a growing season as groundwater flows through the field. No significant differences in TP and TKN concentrations between the upper and lower areas in field groundwater were detected.

Hydrological Stability Analysis of the Existing Soyanggang Multi-Purpose Dam

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This study aims at suggesting an alternative to improve current capacity of flood control for the existing Soyanggang multi-purpose dam which was constructed 20 years ago as a largest dam in Korea. The newly estimated value of the probable maximum precipitation(PMP) is 760. 0 mm which is based on the hydro-meteorological method. The peak inflow of 1000 years return period at the time of construction was 13,500 m^3/s. However, the newly estimated peak inflow of the PMF is 18,100m^3/s which is 1.34 times bigger than the original one. In order to adopt the newly estimated PMF as a design flood, following four alternatives were compared; (1) allocation of more flood control space by lowering the normal high water level, (2) construction of a new spillway in addition to the existing one, (3) raising the existing dam crest, (4) construction of a new dam which has relevant flood control storage at the upstream of the Soyanggang multi-purpose dam. The preliminary evaluation of these alternatives resulted in that the second alternative is most economical and feasible. So as to stably cope with the newly estimated PMF by meeting all the current functions of the multi-purpose dam, a detailed study of an additional spillway tunnel has to be followed.

Experimental Study on the Depth-Variations of Confluence Area in Small Urban Channel

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The runoff from an urban catchment is increased because of the gravitation of the population towards cities. For this reason, water level increment in confluence area makes it impossible to drain internal water and thus produces flood out in upstream areas. In this study, flow variations of main channel are measured which is caused by combining storm sewer into main channel in small watershed. Depth increment in main stream is analyzed due to flowrate and slope in main channel and flowrate, slope and degree of confluence in tributary channel. For main channel slope, as a result, the depth ratio increases as the channel slope is getting steeper, and also due to low flowrate in main stream and high flowrate in tributary channel. For the degree of confluence, depth ratio decreases when the degree is getting small. As mentioned above, main factors influencing the depth ratio increment of confluence channel are in the order of the degree of confluence, and the flowrate of tributary channel and main channel.

Analysis of Longitudinal Dispersion Coefficient : Part I. Comparative Study of Existing Equations for Dispersion Coefficient

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Existing equations for dispersion coefficient are analyzed in depth to select proper dispersion coefficient which can represent dispersion characteristics of natural streams. Several equations are tested with measured data which were collected in 26 streams in the United States. Findings of this study are as follows. Elder's equation should not be used to estimate dispersion coefficient of the one-dimensional dispersion model because it underestimates significantly. McQuivey and Keefer's equation is overestimating, whereas Magazine et al.'s equation is underestimating. However, Iwasa and Aya's equation predicts relatively well. Fischer's equation is generally overestimating. Liu's equation predicts quite well. The performance of Liu's equation is the best of all especially in terms of accuracy. However, Liu's equation is generally overestimating in case of large river because the square of channel width is included in the equation. Therefore, it is recommended not to use Liu's equation in case of large rivers, especially rivers of which channel width is larger than 200m.

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Comparison of the Results of Finite Difference Method in One-Dimensional Advection-Dispersion Equation

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ELM, a characteristic line based method, was applied to advection-dispersion equation, and the results obtained were compared with those of Eulerian schemes (Stone-Brian and QUICKEST). The calculation methods consisted of Lagrangian interpolation scheme and cubic spline interpolation scheme for the advection calculation, and the Crank-Nicholson scheme for the dispersion calculation. The results of numerical methods were as follows: (1) for Gaussian hill: ELM, using Lagrangian interpolation scheme, gave the most accurate computational result. ELM, using cubic spline interpolation scheme, and QUICKEST scheme gave numerical damping for Peclet number 50. Stone-Brian scheme gave phase shift introduced in the numerical solution for Peclet number 10 and 50. (2) for advanced front: All schemes gave accurate computational results for Peclet number 1 and 4. ELM, Lagrangian interpolation scheme, and Stone-Brian scheme gave dissipation error and ELM, using cubic spline interpolation scheme, and QUICK-

EST scheme gave numerical oscilation for Peclet number 50.

T-N and T-P Simulations in the Downstream of the Han River

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QUAL2E model is applied to predict T-N and T-P concentrations in the downstream of the Han River. Sensitivity analysis shows that the pertinent parameters for T-N and T-P have small effects on the computed concentrations. The computed concentration profiles of T-N and T-P show good agreements with recently measured data. The future tributary loads of T-N and T-P have been estimated to simulate concentrations. The modeling result has been presented under the mean and low flow condition after wastewater treatment in the future.

Experimental Study on Downstream Local Scour of Free-Falling Jet

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Scour characteristics of noncohesive bed materials at the downstream of free-falling jet were analyzed through hydraulic experiments. It was assumed that the downstream had no special energy dissipators. Flow characteristics of free falling jet from rectangular section were studied, and scour characteristics with and without mounds, which were generated at the downstream of the scour hole, were comparatively analyzed for various bed materials, discharges and tailwater depths. Not only the equilibrium scour depth but also the height of mound could be expressed as a function of densimetric Froude number. Densimetric Froude number had closer relationship with the equilibrium dimensionless scour depth than other dimensionless parameters. It was suggested that the mound effects should be considered at the design stage of bed protection works.

Hydrologic Analysis for Determining the Lag Times of GIUH

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Three types of methods are used to determine the lag time which is an important parameter in estimating the geomorpholbgical instantaneous unit hydrograph (GIUH) and their results are analyzed hydrologically in this study. The first method uses only the average velocity and second one uses the combination of the stream length and the average velocity. The third method employs the relationship between watershed area and lag time obtained from the empirical coefficients of Boyd and Singh. To verify the applicabilities of such methods to the actual river basin, the obtained lag times were tested by using the observed data. The results showed that the first method was applicable to small watershed area but not to larger area. The several other hydrologic characteristics beside the watershed area should be considered for the third method because the accuracy of the lag time was not good. Finally, the second method gave the most similar simulation results and the best agreements to the observed runoff data than any other method.

Applications of Snyder's Unit Hydrograph to the Cheat River Basin for Flood Control Analysis

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The Snyder's Unit Hydrograph Method is applied to simulate the November 1985 Flood of the Cheat River Basin, which is located in the North-East region of West Virginia in United States. The entire basin is divided into many subareas according to the hydrologic and geologic characteristics. The overland flows are computed on each subarea and combined together along the streams. The flows are also routed by the Normal Depth Storage and Outflow Method in Modified Pulse option. The several structural flood control alternatives are examined. The study shows the OPTION Ⅲ which has the three moderately sized dam is ultimately suitable to control the flood. The HEC-1 computer model is used to analyze the flood.

Hydrologic Response Analysis Considering the Scale Problem:Part 1. Derivation of the Model

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The objective of this study is to explore scale problem and to analyze the relations between scale and geomorphologic parameters of the rainfall-runoff model. Generally, measurement and calculation of geomorphologic parameters rely on and are sensitive to the resolution of source information available. Therefore, rainfall-runoff models using geomorphologic parameters should

take account of the effects of the map scale used in their development. The derived rainfall-runoff model considering scale problem in this research is the GIUH type model, that is a basin IUH consisting of the channel network response and hillslope response. The channel network response is computed by means of the diffusion analogy transformed from linearized St. Venant equation and hillslope response is calculated by 2-parameter gamma distribution function. Representing geomorphologic structure of the channel network and initial distribution of its response is width function. This width function is derived by fractal theory and Melton's law to consider scale problems and is weighted by the source location function (SLF) proposed in this research to increase the applicability.

Analysis of Longitudinal Dispersion Coefficient: Part Ⅱ. Development of New Dispersion Coefficient Equation

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New dispersion coefficient equation which can be used to estimate dispersion coefficient by using only hydraulic data easily obtained in natural streams has been developed. Dimensional analysis was performed to select physically meaningful parameters. One-Step Huber method, which is one of the nonlinear multi-regression method, was applied to derive a regression equation of dispersion coefficient. 59 measured hydraulic data which were collected in 26 streams in the United States and were analyzed in the Part Ⅰ of this study, were used in developing new dispersion coefficient equation. Among 59 measured data sets, 35 data sets were used in deriving regression equation, and 24 data sets are used for verification. The new dispersion coefficient equation, which has been developed in this study was proven to be superior in explaining dispersion characteristics of natural streams more precisely compared to existing dispersion coefficient equations.

A Study on Riprap Size in Meandering Channels by Hydraulic Model Test

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Flow in meandering channel is a great concern to civil engineers and may further be characterized as one of the key problems in river morphology. It is difficult to state generalized criteria for channel improvement applicable to any particular river. But it is important to provide some principles and guidelines for the design engineer. The objective of this experimental study is to suggest riprap size, principles and guidelines for the design engineer by the hydraulic model test. For the sake of effective uses for the bank stabilization, hydraulic model tests

about riprap weight and size are performed and examined thoroughly. Riprap weight for the upstream of the curvature appex can be computed by U.S.B.R. and Brahms' equation, and the size by Mavis and Laushey's equation. Those for the downstream can be computed using Brahms' and Steinberg's equations, respectively.

Experimental Study on Hysteresis Phenomena in Porous Media

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The water retention function which has the hysteresis phenomena is required to analyze the Richards equation which is a governing equation of the unsaturated flow, and its hysteresis phenomena has influence upon the characteristics of the unsaturated flow. The accuracy of the published hysteresis models is compared by using experimental data of the water retention function. The apparatus to experiment the hysteresis phenomena on the soil is developed, and experimental data for the main wetting process and the main drying process of the water retention function are obtained. The parameters of the van Genuchten equation are calibrated by using experimentally obtained data. As a result of the comparison of the selected hysteresis models which simulate the main drying curve from the main wetting curve, the Model I-1 (Mualem) overestimates and the Model II-1(Mualem) underestimates but the Model III-2(Park and Sonu) similarly estimates the experimental data of the main drying curve.

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Hydrologic Response Analysis Considering the Scale Problem:Part 2. Application and Analysis

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The application and analysis for the scale considering GIUH model proposed by the authors in this issue have been performed for the Ieemokjung sub-basin in the Pyungchang basin one of IHP representative basin in Korea. Scales of topographic maps for model application and fractal analysis are 1:25,000, 1:50,000 and 1:100,000. The ratio between successive scales is therefore con-

stant. Link lengths were measured using a curvimeter with the resolution of 1mm. Richardson's method was employed to have fractal dimension of streams. Apparent alternations of parameters were found in accordance with variations of map scale. And this tendency could mislead physical meanings of parameters because model parameters had to preserve their own value in spite of map scale change. It was found that uses of fractal transform and Melton's law could help to control the scale problem effectively. This methodology also could emphasize the relationship between network and basin to the model. To verify the applicability of GIUH proposed in this research, the model was compared with the exponential GIUH model. It is proven that proposed 2-parameter gamma GIUH model can better simulate the corresponding runoff from any given flood events than exponential GIUH model. The result showed that 2-parameter gamma GIUH model and fractal theory could be used for deriving scale considered IUH of the basin.

Surface Saturation Area-Subsurface Outflow-Soil Moisture Storage Relationships: I. Steady-State Analysis

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In this study we derived steady-state relationships between surface saturation area and subsurface outflow, and between surface saturation area and soil moisture storage through numerical experiments with Richards equation on a hillslope. Numerical experiments analyzed the sensitivity of topographic and soil hydraulic properties on steady-state relationships between surface saturation area and subsurface outflow. And the power law for the extent of surface saturation area was determined as a function of subsurface outflow or soil moisture storage.

An Analysis of Attenuation Effect of Pressure Head Using an Air Chamber

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An air chamber is designed to keep the pressure from exceeding a predetermined value, or to prevent low pressures and column separation. Therefore, it can be used to protect against rapid transients in a pipe system following abrupt pump stoppage. In this research, an air chamber was applied to a hypothetical pipe system to analyze attenuation effect of pressure head for different air volumes, locations, chamber areas, coefficients of orifice loss and

polytropic exponents. With an increase of air volume, the maximum pressure head at pump site is decreased and the minimum pressure head is increased. For different locations and areas of the chamber, the attenuation effects do not show much difference. Also, as the orifice loss coefficient increases, the maximum pressure head is decreased. For different polytropic exponents, isothermal process shows lower maximum pressure head than that of the adiabatic process.

Numerical Investigation of Transverse Dispersion in Natural Channels

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A two-dimensional stream tube dispersion model is developed to simulate accurately transverse dispersion processes of pollutants in natural channels. Two distinct features of the stream tube dispersion model derived herein are that it employs the transverse cumulative discharge as an independent variable replacing the transverse distance and that it is developed in a natural coordinate system which follows the general direction of the channel flow. In the model studied, Eulerian-Lagrangian method is used to solve the stream tube dispersion equation. The stream tube dispersion equation is decoupled into two components by the operator-splitting approach; one is governing advection and the other is governing dispersion. The advection equation has been solved using the method of characteristics and the results are interpolated onto Eulerian grid on which the dispersion equation is solved by centered difference method. In solving the advection equation, cubic spline interpolating polynomials is used. In the present study, the results of the application of this model to a natural channel are compared with a steady-state flow measurements. Simulation results are in good accordance with measured data.

Floodwave Modeling in Inundated Area Resulting from Levee-Break

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A diffusion hydrodynamic model named "DFLOW-2" for the floodwave analysis from levee-break in protected lowland has been developed. The model has been applied to Ilsan levee-break, which occurred on September 12-13, 1990 in the downstream of the Han River. An unsteady flow analysis has been made in the reach from Indokyo to Junryu. Overflow through broken levee has been treated as internal boundary condition in the channel. A post-processor has been also developed to demonstrate the simulation results. The velocity distributions and inundated depths have been presented. The computed results have good agreements with ob-

served data in terms of inundation depth, flood arrival time and flooded areas.

Basic Equations for Explicit Design of Uniformly Rough Pipe

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Pipe design normally requires pump power, discharge rate or pipe diameter for each condition given. Due to several investigators the pipe friction factor can now be estimated by explicit way when the flow condition is provided. In various problems of pipe design, however, the flow condition cannot be pre-determined even for the uniformly rough pipe. In these cases a lot of iterations are often required to have an accurate solution with ordinary approach. This paper presents the explicit way of estimating the discharge rate and pipe diameter without any iteration process being related to non-dimensional physical numbers, power-diameter number, power-discharge number, and discharge-slope number, which enable to develop explicit forms of equations.

Conversion of Flood Level and Flood Frequency Analysis for Goan Station in Han River

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In this study, the past flood levels of Goan station, which is one of major gaging stations and located at downstream of Paldang dam, were converted based on the 1994's cross section and the flood quantiles were estimated from flood frequency analysis. The recently established rating curve was used to convert flood levels. And the parameters of the several probability distributions commonly used in hydrologic analysis were estimated based on the method of probability weighted moments and the goodness of fit tests were applied to those distributions. As a result, the gamma-2 and gamma-3 distributions were selected as the appropriate models. The flood levels and quantiles for selected return periods were calculated based on those distributions. Furthermore, frequency analysis using historical flood information was performed to overcome the misleading caused by missing data.

A Study on the Application of Time Distribution Model for Design Storms

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The historical data from 3,550 event storms during 11 years in Wi-stream basin have been used to investigate the statistical parameter of the time distribution for design storms by the method of Yen-Chow, Huff, Pilgrim-Cordery and Mononobe. The dimensionless value of triangular hyetograph, a^0, ranges from 0.44 to 0.50 and trapezoidal hyetograph, h^0, value increases as the duration time is getting longer in Yen-Chow method. In the Huff, the second-quartile storms occurred most frequently and third-quartile storms occurred most infrequently. In the Pilgrim-Cordery, the shapes for shorter than 6-hour durations are advanced tendency. However, for longer than 6-hour durations show delayed tendency. In the Mononobe, every one hour rainfall occured Centered Type. The application of these method for each duration time was tested by using the observed rainfall-runoff data of Wi-stream basin. As a result, the reappearance of hydrographs of triangular hyetograph by Yen-Chow method showed promising, and it was approved to be used for prediction of the ungaged basins.

Rainfall Prediction of Seoul Area by the State-Vector Model

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A non-stationary multivariate model is selected in which the mean and variance of rainfall are not temporally or spatially constant. And the rainfall prediction system is constructed which uses the recursive estimation algorithm, Kalman filter, to estimate system states and parameters of rainfall model simultaneously. The on-line, real-time, multivariate short-term, rainfall prediction for multi-stations and lead-times is carried out through the estimation of non-stationary mean and variance by the storm counter method, the normalized residual covariance and rainfall speed. The results of rainfall prediction system model agree with those generated by non-stationary multivariate model. The longer the lead time is, the larger the root mean square error becomes and the further the model efficiency decreases from 1. Thus, the accuracy of the rainfall prediction decreases as the lead time gets longer. Also it shows that the mean obtained by storm counter method constitutes the most significant part of the rainfall structure.

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Investigation of Dispersion and Storage Processes of Pollutants in Natural Streams

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Mathematical models have been developed in which storage-release processes of pollutants are modeled to explain storage effect of variations of flow and channel geometry on mixing and transport of polluted releases in natural channels including low flow conditions. The models were tested by using the laboratory dispersion data. Comparisons between concentration-time curves predicted by using the proposed model incorporating two different submodels show that Storage-Diffusion Model seems to be superior in explaining physical processes inside the storage zone to the Storage-Exchange Model even though accuracies of simulation results by two models are about the same. The proposed model shows significant improvement over the conventional one-dimensional dispersion model in predicting natural mixing processes in open channels.

Two-Dimensional Model for the Prediction of Inundation Area in Urbanized Rivers

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Two-dimensional diffusion and kinematic hydrodynamic models have been studied for preparing the flood inundation map. The models have been tested by applying to one-dimensional dam-break problem. The results have good agreements compared with those of dynamic wave model. The diffusion wave model produces the mass conservation error close to zero. Floodwave analyses for two-dimensional floodplain with obstruction and channel-floodplain show both stable and efficient results. The model presented in this study can be used for flood inundation map and flood warning system.

Estimation of Channel Roughness Coefficients in the Han River Using Unsteady Flow Model

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Manning's roughness coefficient for the Han River (from Paldang dam to Indo Bridge) is estimated by one-dimensional unsteady flow model, NETWORK. The entire river is divided into two regions, one region of Paldang dam to Kwangjang, and another region of Jamsu Bridge to Indo Bridge, and changes of the roughness coefficient according to changes in discharge are estimated using data of the past flood events. Estimated roughness coefficients are compared

with previous results. Finally, the stage variation according to the variation of channel roughness is presented.

A Study on the Variation of Daily Urban Water Demand Based on the Weather Condition

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The purpose of this study is to establish a method of estimating the daily urban water demand using statistical model. This method will be used for the development of the efficient management and operation of the water supply facilities. The data used were the daily urban water use, the population, the year lapse and the weather conditions such as temperature, precipitation, relative humidity, etc. Kwangju city was selected for the case study area. The raw data used in this study were rearranged either by month or by season for the purpose of analysis, and the statistical analysis was applied to the data to obtain the regression model. As a result, the multiple linear regression model was developed to estimate the daily urban water use based on the weather condition. The regression constant and the model coefficients were determined for each month of a year. The accuracy of the model was within 3% of average error and within 10% of maximum error. The developed model was found to be useful to the practical operation and management of the water supply facilities.

Run-up and Evolution of Solitary Waves on Steep Slopes

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The run-up and the evolution of solitary waves on steep beaches are investigated by using a two-dimensional boundary integral equation model. The model is first used to compute the run-up heights of solitary waves on a relatively mild slope. The model is verified by comparing the computed numerical solutions with available experimental data, other numerical solutions and approximated analytical solutions. The agreement between the present numerical solutions and the other data is found to be excellent. The model is then applied to the calculation of run-up heights on very steep slopes. As far as the maximum run-up of solitary waves is concerned, the boundary integral equation model provides reasonable and reliable solutions. Finally, the evolution on steep beaches is also examined and the obtained wave heights are compared with those calculated from the Green's law.

The Rating Curve of Goan Station for Calibration of Discharge of Paldang Dam

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No correction has been made for the rating curve of Goan Station since 1986 even though there has been a severe bed degradation until now. Furthermore, it was informed to Han River Flood Control Center that there was a difference between ı e discharge released from Paldang dam and the discharge observed at Goan station during 1990 flood. By considering such river bed changes, hydraulic model experiment with 1/100 scale was performed for the range of 2.2 km, which covers from Paldang dam to the downstream of Goan station. From this experiment, the rating curve was obtained by considering the discharges from Paldang dam and the corresponding water levels at Goan station. Also, the exsiting and the proposed rating curves were compared with those by computational method of RMA-2V.

Velocity Measurement of Stream Water Surface Using Microwave

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Applying microwave, a velocity measurement system has been developed in order to measure the velocity of stream water surface. It's main purpose is the measurement for high velocity of flood water. It is under the developing stage of experimental measurement system. The microwave surface velocity meter uses Doppler effects of microwave. It consists of a radio frequency (RF) part and that of signal processing. The RF part has the function of microwave oscillation, reception of reflected wave, and determination of Doppler frequency, etc. Signal processing designates amplification, fast Fourier transform, etc. Various measuring experiments were performed at bridges and a spillway of Taechong re-regulation dam with the microwave velocity meter. Verification test was also made through water tank of ship model test at Research Institute of Ships and Ocean Engineering. It shows 4% error inherent in A/D converter and additional several percentage errors from measurement circumstance. The measuring ranges are from 0.5 to 3.5 m/s. The result shows good linear relationship between carriage velocity and measured velocity, thus proves usefulness as a measuring instrument for flood water velocity. The instrument requires overall re-engineering procedure and number of data should be accumulated and analyzed to treat wind effects and random fluctuations of water surface.

Runoff Analysis on the Physically-Based Conceptual Time-Continuous Runoff Model

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The subjective research attempts to apply a rainfall-runoff model capable of considering time-variation of soil water contents which are highly correlated to the river flows on the Pyungchang river basin and to evaluate its performance for flow forecasting. The model used in this study is a physically-based conceptual time-continuous model, which is composed of the Sacramento soil moisture accounting model and the nonlinear multiple conceptual reservoirs model. The daily precipitation and evaporation data for 7 years and for 3 years were used for the parameter estimation and the model verification, respectively. As a result, the flows including a significant flood event were well simulated, and the cross-correlation coefficient between observed flows and computed flows for the verification periods was 0.87, but in general computed flows were underestimated for the low-flow periods. Also, the effects of precipitation and soil water content to the river flows were analysed for the flood and the drought.

A Study on the Development of the Operation Models for Storm Water Pumps in Detention Pond

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Operation models for storm water pumps in detention pond were developed in order to reduce the damage by inundation in urbanized area. The return periods (10, 20, 30 years) of rainfall were selected to estimate inflow discharge to detention ponds. Inflow hydrographs of detention ponds were derived by using the SWMM, and Petri net diagrams were selected to analyze the pump actions. Safety and efficiency of pumps and detention ponds were estimated by penalty index. In order to verify the models, the models were applied to three selected detention ponds in Seoul area. In numerical experimental results, the developed model 3 is more effective in inland flooding prevention than the existing one, and may be used to design and evaluate detention ponds with real time data of rainfall.

Reservoir Operation by Variable Restricted Water Level during Flood Period

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For optimal reservoir operation during flood period, a general and systematic policy is suggested to make balance of the conflicting purposes between water conservation and flood control. The purpose of this study is to decide the restricted water level of the reservoir during flood period specially to meet water demand in non-flood period. The optimal policy is derived by reallocation of storage capacity through the application of variable restricted water level(VRWL) and minimum required water level(MRWL) for shorter intervals. This study also suggests water level conditions to secure conservation storage capacity at the end of the flood period estimated by reservoir operation study. This paper illustrates an application of the methodology through the simulation of multipurpose reservoirs at the DaeCheong Dam and the Chungju Dam respectively during flood and the results are reviewed.

A Study on the Improvement of Heavy Rainfall Model Based on the Ground Surface Data and Cloud Physics

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The physically based heavy rainfall model developed by Ceon (1994) for storm events is modified in this study. The main parts of this paper are composed of modeling saturation vapor pressure, cloud thickness, cloud top pressure. In a different way from the previous model, cloud top temperature and albedo measured by satellite are used as input data to the model. In this paper, the defect of saturation vapor pressure equation in the previous model was improved. Furthermore, the parameters for temperature and pressure on cloud top are eliminated as well as the time of calculation in the model is decreased. Also, the results show that there are very small gab between the hourly calculated.