Analysis and occurrence of pharmaceuticals, estrogens, progestogens and polar pesticides in sewage treatment plant effluents, river water and drinking water in the Llobregat river basin (Barcelona, Spain)

Volume 358, Issues 1-2, August 2008, Pages 112-123

Kuster, M. | López de Alda, M.J. | Hernando, M.D. | Petrovic, M. | Martín-Alonso, J. | Barceló, D.

This work investigated the presence of 21 emerging contaminants of various chemical groups (7 estrogens, 3 progestogens, 6 pharmaceuticals and personal care products (PPCPs), and 5 acidic pesticides) in the Llobregat river basin (NE Spain). Waters from the outlet of various sewage treatment plants (STP) and waterworks located along the river basin, as well as water samples from the river or its tributaries upstream and downstream of these plants were analysed in two pilot monitoring studies. Chemical analyses were performed by means of on-line or off-line solid-phase extraction followed by liquid chromatography-electrospray-tandem mass spectrometry. Methods detection limits (in ng/L) were ≤0.85 for estrogens, ≤3.94 for progestogens, ≤30 for PPCPs, and ≤0.99 for pesticides. Of the estrogens and progestogens analysed, only estrone-3-sulfate, estrone, estriol and progesterone were found to be present in the low nanogram per liter range in some of the samples investigated. Except for atenolol, all PPCPs studied (ibuprofen, diclofenac, clofibric acid, salicylic acid, and triclosan) could be identified at levels usually lower than 250 ng/L and up to 1200 ng/l (diclofenac). Of the various pesticides investigated (2,4-D, bentazone; MCPA, mecoprop and propanil) MCPA and 2,4-D were the most ubiquitous and abundant and bentazone the only one not detected. Individual concentrations were most often below 100 ng/L and never surpassed the EU limits.

Ensemble flood forecasting: A review

Volume 375, Issues 3-4, September 2009, Pages 613-626

Cloke, H.L. | Pappenberger, F.

Operational medium range flood forecasting systems are increasingly moving towards the adoption of ensembles of numerical weather predictions (NWP), known as ensemble prediction systems (EPS), to drive their predictions. We review the scientific drivers of this shift towards such 'ensemble flood forecasting' and discuss several of the questions surrounding best practice in using EPS in flood forecasting systems. We also review the literature evidence of the 'added value' of flood forecasts based on EPS and point to remaining key challenges in using EPS successfully.

A comparison of performance of several artificial intelligence methods for forecasting monthly discharge time series

Volume 374, Issues 3-4, August 2009, Pages 294-306

Wang, W.-C. | Chau, K.-W. | Cheng, C.-T. | Qiu, L.

Developing a hydrological forecasting model based on past records is crucial to effective hydropower reservoir management and scheduling. Traditionally, time series analysis and modeling is used for building mathematical models to generate hydrologic records in hydrology and water resources. Artificial intelligence (AI), as a branch of computer science, is capable of analyzing long-series and large-scale hydrological data. In recent years, it is one of front issues to apply AI technology to the hydrological forecasting modeling. In this paper, autoregressive moving-average (ARMA) models, artificial neural networks (ANNs) approaches, adaptive neural-based fuzzy inference system (ANFIS) techniques, genetic programming (GP) models and support vector machine (SVM) method are examined using the long-term observations of monthly river flow discharges. The four quantitative standard statistical performance evaluation measures, the coefficient of correlation (R), Nash-Sutcliffe efficiency coefficient (E), root mean squared error (RMSE), mean absolute percentage error (MAPE), are employed to evaluate the performances of various models developed. Two case study river sites are also provided to illustrate their respective performances. The results indicate that the best performance can be obtained by ANFIS, GP and SVM, in terms of different evaluation criteria during the training and validation phases.

So just why would a modeller choose to be incoherent?

Volume 354, Issues 1-4, June 2008, Pages 15-32

Beven, K.J. | Smith, P.J. | Freer, J.E.

This article provides an extended response to the criticisms of the GLUE methodology by Mantovan and Todini [Mantovan, P., Todini, E., 2006. Hydrological forecasting uncertainty assessment: incoherence of the GLUE methodology. J. Hydrol. 330, 368-381]. It is shown that the formal Bayesian identification of models is a special case of GLUE that can be used where the modeller is prepared to make very strong assumptions about the nature of the modelling errors. Under such assumptions, GLUE can be coherent in the sense of Manotvan and Todini. In real applications, however, with multiple sources of uncertainty including model structural error, their strong definition of coherence is shown to be inapplicable to the extent that the choice of a formal likelihood function based on a simple error structure may be an incoherent choice. It is demonstrated by some relatively minor modifications of their hypothetical example that misspecification of the error model and the non-stationarities associated with the presence of input error and model structural error in the Bayes approach will then produce well-defined but incorrect parameter distributions. This empirical result is quite independent of GLUE, but the flexibility of the GLUE approach may then prove to be an advantage in providing more coherent and robust choices of model evaluation in these cases and, by analogy, in other non-ideal cases for real applications. At the current time it is difficult to make a reasoned choice between methods of uncertainty estimation for real applications because of a lack of understanding of the real information content of data in conditioning models.

Decomposition of the mean squared error and NSE performance criteria: Implications for improving hydrological modelling

Volume 377, Issues 1-2, October 2009, Pages 80-91
Gupta, H.V. | Kling, H. | Yilmaz, K.K. | Martinez, G.F.

The mean squared error (MSE) and the related normalization, the Nash-Sutcliffe efficiency (NSE), are the two criteria most widely used for calibration and evaluation of hydrological models with observed data. Here, we present a diagnostically interesting decomposition of NSE (and hence MSE), which facilitates analysis of the relative importance of its different components in the context of hydrological modelling, and show how model calibration problems can arise due to interactions among these components. The analysis is illustrated by calibrating a simple conceptual precipitation-runoff model to daily data for a number of Austrian basins having a broad range of hydro-meteorological characteristics. Evaluation of the results clearly demonstrates the problems that can be associated with any calibration based on the NSE (or MSE) criterion. While we propose and test an alternative criterion that can help to reduce model calibration problems, the primary purpose of this study is not to present an improved measure of model performance. Instead, we seek to show that there are systematic problems inherent with any optimization based on formulations related to the MSE. The analysis and results have implications to the manner in which we calibrate and evaluate environmental models; we discuss these and suggest possible ways forward that may move us towards an improved and diagnostically meaningful approach to model performance evaluation and identification.

A review of drought concepts

Volume 391, Issues 1-2, September 2010, Pages 202-216
Mishra, A.K. | Singh, V.P.

Owing to the rise in water demand and looming climate change, recent years have witnessed much focus on global drought scenarios. As a natural hazard, drought is best characterized by multiple climatological and hydrological parameters. An understanding of the relationships between these two sets of parameters is necessary to develop measures for mitigating the impacts of droughts. Beginning with a discussion of drought definitions, this paper attempts to provide a review of fundamental concepts of drought, classification of droughts, drought indices, historical droughts using paleoclimatic studies, and the relation between droughts and large scale climate indices. Conclusions are drawn where gaps exist and more research needs to be focussed.

A compilation of data on European flash floods

Volume 367, Issues 1-2, March 2009, Pages 70-78
Gaume, E. | Bain, V. | Bernardara, P. | Newinger, O. | Barbuc, M. | Bateman, A. | Blaškovičová, L. | Blöschl, G. | Borga, M. | Dumitrescu, A. | Daliakopoulos, I. | Garcia, J. | Irimescu, A. | Kohnova, S. | Koutroulis, A. | Marchi, L. | Matreata, S. | Medina, V. | Preciso, E. | Sempere-Torres, D. | Stancalie, G. | Szolgay, J. | Tsanis, I. | Velasco, D. | Viglione, A.

Flash floods are one of the most significant natural hazards in Europe, causing serious risk to life and destruction of buildings and infrastructure. This type of flood, often affecting ungauged watersheds, remains nevertheless a poorly documented phenomenon. To address the gap in available information, and particularly to assess the possible ranges for peak discharges on watersheds with area smaller than 500 km 2 and to describe the geography of the hazard across Europe, an intensive data compilation has been carried out for seven European hydrometeorological regions. This inventory is the first step towards an atlas of extreme flash floods in Europe. It contains over 550 documented events. This paper aims at presenting the data compilation strategy, the content of the elaborated data base and some preliminary data analysis results. The initial observations show that the most extreme flash floods are greater in magnitude in the Mediterranean countries than in the inner continental countries and that there is a strong seasonality to flash flood occurrence revealing different climatic forcing mechanisms in each region.

Recent trends in the Central and Western Sahel rainfall regime (1990-2007)

Volume 375, Issues 1-2, August 2009, Pages 52-64

Lebel, T. | Ali, A.

One motivation for setting up the CATCH (Couplage de l'Atmosphère Tropicale et du Cycle Hydrologique) project at the end of the 1990s, was to contribute to documenting the Sahelian rainfall variability at the interannual scale and to provide a fine monitoring of possible long-term trends of the rainfall regime. This paper is a first attempt at characterising the Sahelian rainfall regime of the two last decades (1990-2007) by comparison to the rainfall regime of the previous decades, namely the 20-year wet period 1950-1969 and the 20-year dry period 1970-1989. While the rainfall deficit remained unabated in the Western Sahel (1990-2007 mean equal to the 1970-1989 mean, both being lower than the 1950-1969 mean), the Central Sahel progressively recorded wetter years from the end of the 1990s, but this recovery is limited (1990-2007 average larger by 10% than the 1970-1989 average, but still lower than the 1950-1989 average). There are also significant differences between the Western Sahel and the Central Sahel when looking at the interannual variability pattern and at the seasonal cycle. The low-frequency rainfall patterns are similar between the Western Sahel and the Central Sahel, but the interannual year-to-year variability is weakly related to each other. In the Central Sahel, the major modification of the seasonal cycle in the most recent decades was the disappearance of the well marked August peak observed during the wet period. In the Western Sahel the rainfall deficit is more or less evenly distributed all along the rainy season. The second part of the paper makes use of the CATCH-Niger recording rain gauge network in order to compare several ways of defining rainy events. The statistical properties of these various populations of rainy events are compared. It is shown that a simple CPP model allows for retrieving the statistical characteristics of point rainy events from daily rainfall series. It is also confirmed that in this area, the interannual rainfall variability is primarily linked to the year-to-year fluctuation of the number of large mesoscale rainfall events.

Trend detection in hydrologic data: The Mann-Kendall trend test under the scaling hypothesis

Volume 349, Issues 3-4, February 2008, Pages 350-363

Hamed, K.H.

The subject of trend detection in hydrologic data has received a great deal of attention lately, especially in connection with the anticipated changes in global climate. However, climatic variability, which is reflected in hydrologic data, can adversely affect trend test results. The scaling hypothesis has been recently proposed for modeling such variability in hydrologic data. In this paper, the Mann-Kendall test, which is widely used to detect trends in hydrologic data, is modified to account for the effect of scaling. Exact expressions for the mean and variance of the test statistic are derived under the scaling hypothesis, and the Normal distribution is shown to remain a reasonable approximation. A procedure for estimating the modified variance from observed data is also outlined. The modified test is applied to a group of 57 worldwide total annual river flow time series from the database of the Global Runoff Data Centre in Koblenz, Germany, that were shown in an earlier study to exhibit significant trends in annual maximum flow. The results show a considerable reduction in the number of stations with significant trends when the effect of scaling is taken into account. These results indicate that the evidence of real trends in hydrologic data is even weaker than suggested by earlier studies, although highly significant increasing trends seem to be more common than negative ones. It is also shown that admitting scaling in the modified test helps to avoid discrepancies found in some previous studies, such as the existence of significant opposite trends in neighboring stations, or in different segments of the same time series.

Uncertainty of the impact of climate change on the hydrology of a nordic watershed

Volume 358, Issues 1-2, August 2008, Pages 70-83

Minville, M. | Brissette, F. | Leconte, R.

The impact of climate change on the hydrology of the Chute-du-Diable watershed (Quebec, Canada) is studied by comparing statistics on current and projected future discharge resulting from a wide range of climate change scenarios. The use of 10 equally weighted climate projections from a combination of 5 general circulation models (GCMs) and 2 greenhouse gas emission scenarios (GHGES) allows for the definition of an uncertainty envelope of future hydrologic variables. GCM data is downscaled using the change factor approach for 30-year time slices centered around years 2020, 2050 and 2080. To estimate natural variability, synthetic time series are then computed for each horizon and for each climate change scenario, using a stochastic weather generator (30 series of 30 years), and are entered into a hydrology model. Future hydrological regimes are then compared to the control period (1961-1990) using the annual and seasonal mean discharge, peak discharge and timing of peak discharge criteria. Results indicate a 1-14 °C increase in seasonal temperature and a -9 to +55% change in seasonal precipitation. The largest increases in both temperature and precipitation are observed in the winter and spring seasons. The main hydrologic impact observed is a spring flood appearing 1-5 weeks earlier than usual and a modification of its amplitude from -40 to +25%. Most

scenarios suggest increases in the winter, spring and fall discharge, whereas summer is expected to see a decrease in discharge. While there is still a large scatter in projected values, the uncertainty analysis projects a better view of the most probable future hydrologic behaviour of the watershed. Of all sources of uncertainty considered in this study, the largest comes from the choice of a GCM. Accordingly, all impact studies based on results from only one GCM should be interpreted with caution.

Comparing uncertainty analysis techniques for a SWAT application to the Chaohe Basin in China

Volume 358, Issues 1-2, August 2008, Pages 1-23
Yang, J. | Reichert, P. | Abbaspour, K.C. | Xia, J. | Yang, H.

Distributed watershed models are increasingly being used to support decisions about alternative management strategies in the areas of land use change, climate change, water allocation, and pollution control. For this reason it is important that these models pass through a careful calibration and uncertainty analysis. To fulfil this demand, in recent years, scientists have come up with various uncertainty analysis techniques for watershed models. To determine the differences and similarities of these techniques we compared five uncertainty analysis procedures: Generalized Likelihood Uncertainty Estimation (GLUE), Parameter Solution (ParaSol), Sequential Uncertainty FItting algorithm (SUFI-2), and a Bayesian framework implemented using Markov chain Monte Carlo (MCMC) and Importance Sampling (IS) techniques. As these techniques are different in their philosophies and leave the user some freedom in formulating the generalized likelihood measure, objective function, or likelihood function, a literal comparison between these techniques is not possible. As there is a small spectrum of different applications in hydrology for the first three techniques, we made this choice according to their typical use in hydrology. For Bayesian inference, we used a recently developed likelihood function that does not obviously violate the statistical assumptions, namely a continuous-time autoregressive error model. We implemented all these techniques for the soil and water assessment tool (SWAT) and applied them to the Chaohe Basin in China. We compared the results with respect to the posterior parameter distributions, performances of their best estimates, prediction uncertainty, conceptual bases, computational efficiency, and difficulty of implementation. The comparison results for these categories are listed and the advantages and disadvantages are analyzed. From the point of view of the authors, if computationally feasible, Bayesian-based approaches are most recommendable because of their solid conceptual basis, but construction and test of the likelihood function requires critical attention. © 2008 Elsevier B.V. All rights reserved.

Spatial and temporal variability of precipitation maxima during 1960-2005 in the Yangtze River basin and possible association with large-scale circulation

Volume 353, Issues 3-4, May 2008, Pages 215-227
Zhang, Q. | Xu, C.-Y. | Zhang, Z. | Chen, Y.D. | Liu, C.-l. | Lin, H.

This study investigated spatial and temporal patterns of trends of the precipitation maxima (defined as the annual/seasonal maximum precipitation) in the Yangtze River basin for 1960-2005 using Mann-Kendall trend test, and explored association of changing patterns of the precipitation maxima with large-scale circulation using NCEP/NCAR reanalysis data. The research results indicate changes of precipitation maxima from relative stable patterns to the significant increasing/decreasing trend in the middle 1970s. With respect to annual variability, the rainy days are decreasing and precipitation intensity is increasing, and significant increasing trend of precipitation intensity was detected in the middle and lower Yangtze River basin. Number of rain days with daily precipitation exceeding 95th and 99th percentiles and related precipitation intensities are in increasing tendency in summer. Large-scale atmospheric circulation analysis indicates decreasing strength of East Asian summer monsoon during 1975-2005 as compared to that during 1961-1974 and increasing geopotential height in the north China, South China Sea and west Pacific regions, all of which combine to negatively impact the northward propagation of the vapor flux. This circulation pattern will be beneficial for the longer stay of the Meiyu front in the Yangtze River basin, leading to more precipitation in the middle and lower Yangtze River basin in summer months. The significant increasing summer precipitation intensity and changing frequency in the rain/no-rain days in the middle and lower Yangtze River basin have potential to result in higher occurrence probability of flood and drought hazards in the region. © 2007.

Frequency, electrical conductivity and temperature analysis of a low-cost capacitance soil moisture sensor

Volume 352, Issues 3-4, May 2008, Pages 367-378

Kizito, F. | Campbell, C.S. | Campbell, G.S. | Cobos, D.R. | Teare, B.L. | Carter, B. | Hopmans, J.W.

This study evaluated the family of ECH2O sensors (EC-5 and ECH2O-TE) for measurement of soil moisture content (θ), bulk electrical conductivity (ECb) and temperature for a range of soils, across a range of measurement frequencies between 5 and 150 MHz. Measurement frequency is one of the primary factors affecting the sensitivity of capacitance sensor measurements to soil variables such as soil texture, electrical conductivity, and temperature. Measurements in both soil and solution demonstrated that the ECH2O EC and TE measurements were accurate. Using a measurement frequency of 70 MHz, a single calibration curve was determined for a range of mineral soils, independent of soil salinity, suggesting there might be no need for a soil specific calibration. When combining all data for each soil type, the R2 values remained high (R2 = 0.98) with little probe to probe variability. After laboratory calibration, the error for θ was about 2%, independent of soil ECb, up to a soil solution EC of about 12 dS/m. Our results showed that a single calibration curve could be used for all tested mineral soils, independent of soil salinity. The bulk soil ECb - water content data were excellently described by a polynomial expression. Measurements of temperature sensitivity to soil water content and ECb were sufficiently small. For example, for a temperature change of 10 °C, measurements of θ and ECb were affected by about 0.02 cm3 cm-3 and 0.02 dS/m, respectively. Limited sensor calibration requirements are important, when large networks of soil moisture sensors

are being deployed. It is concluded that an accurate, cost-effective soil moisture sensor is available that operates at a measurement frequency of 70 MHz, with a low sensitivity to confounding soil environmental factors.

Transport and delivery of suspended solids, nitrogen and phosphorus from various sources to freshwaters in the UK

Volume 350, Issues 3-4, February 2008, Pages 144-153
Edwards, A.C. | Withers, P.J.A.

Sources of nutrients and suspended solids (SS) are diverse in origin and dynamic with respect to their transport pathways and delivery to surface and groundwaters. Three broad source groups can be identified based on their hydrological and compositional characteristics. Consented discharges from point sources are generally continuous and highly concentrated relative to receiving waters while non-point (diffuse) sources are generally more dilute with SS and phosphorus in particular tending to have a high transport dependence upon hydrological (storm) events. A third group with properties that are intermediate include overflows from septic systems, seepages from farmyards or road/track runoff. This grouping automatically introduces a strong temporal and spatial variability in the relative contribution individual group sources make to the total quantity of nutrients and SS delivered to freshwaters. This spatial or temporal variability in either effluent volumes or composition is generally not considered when predicting impacts, which can be highly significant in headwater streams. Complete compositional data for individual sources (especially the intermediary group) are also often lacking when apportioning source contributions in catchments, being simply lumped into average export coefficients. Better definition of intermediary sources would help to more accurately define the relative contribution of different sources and enable cost-effective river basin management planning as required under the Water Framework Directive.

Spatial and temporal variability of annual precipitation during 1961-2006 in Yellow River Basin, China

Volume 361, Issues 3-4, November 2008, Pages 330-338
Liu, Q. | Yang, Z. | Cui, B.

The Shannon Entropy method, Mann-Kendall method (M-K method) and linear fitted model were applied in this study to investigate the spatial and temporal patterns of trends of the precipitation in the Yellow River Basin (YRB) during 1960-2006. Results indicated that the precipitation possessed longitude zonality and had no clearly linear relationship with the latitude, it showed a decreasing trend in most of the precipitation stations, only two meteorological stations displayed upward trend in the YRB. The abrupt changes revealed by the M-K method mainly occurred to the south of 38 °N in the middle-lower reaches of the YRB. Furthermore, the abrupt changes occurred in the period ranged from 1963 to 1998 and the abrupt changes in the lower reaches appeared earlier than those in the middle and upper reaches of the YRB.

Assessing the ability of potential evaporation formulations to capture the dynamics in evaporative demand within a changing climate

Volume 386, Issues 1-4, May 2010, Pages 186-197
Donohue, R.J. | McVicar, T.R. | Roderick, M.L.

Rates of evaporative demand can be modelled using one of numerous formulations of potential evaporation. Physically, evaporative demand is driven by four key variables - net radiation, vapour pressure, wind speed, and air temperature - each of which have been changing across the globe over the past few decades. In this research we examine five formulations of potential evaporation, testing for how well each captures the dynamics in evaporative demand. We generated daily potential evaporation datasets for Australia, spanning 1981-2006, using the: (i) Penman; (ii) Priestley-Taylor; (iii) Morton point; (iv) Morton areal; and (v) Thornthwaite formulations. These represent a range in how many of the key driving variables are incorporated within modelling. The testing of these formulations was done by analysing the annual and seasonal trends in each against changes in precipitation (a proxy for actual evaporation), assuming that they should vary in an approximately inverse manner. The four-variable Penman formulation produced the most reasonable estimation of potential evaporation dynamics. An attribution analysis was performed using the Penman formulation to quantify the contribution of each input variable to overall trends in potential evaporation. Whilst changes in air temperature were found to produce a large increase in Penman potential evaporation rates, changes in the other key variables each reduced rates, resulting in an overall negative trend in Penman potential evaporation. This study highlights the need for spatially and temporally dynamic data describing all drivers of evaporative demand, especially projections of each driving variable when estimating the possible affects of climatic changes on evaporative demand. Crown Copyright © 2010.

Hydrologic and pollutant removal performance of stormwater biofiltration systems at the field scale

Volume 365, Issues 3-4, February 2009, Pages 310-321
Hatt, B.E. | Fletcher, T.D. | Deletic, A.

Biofiltration systems are a recommended and increasingly popular technology for stormwater management; however there is a general lack of performance data for these systems, particularly at the field scale. The objective of this study was to investigate the hydrologic and pollutant removal performance of three field-scale biofiltration systems in two different climates. Biofilters were shown to effectively attenuate peak runoff flow rates by at least 80%. Performance assessment of a lined biofilter demonstrated that retention of inflow volumes by the filter media, for subsequent loss via evapotranspiration, reduced runoff volumes by 33% on average. Retention of water was found to be most influenced by inflow volumes, although only small to medium storms could be assessed. Vegetation was shown to be important for maintaining hydraulic capacity, because root growth and senescence countered compaction and clogging. Suspended solids and heavy metals were effectively removed, irrespective of the design configuration, with load reductions generally in excess of 90%. In

contrast, nutrient retention was variable, and ranged from consistent leaching to effective and reliable removal, depending on the design. To ensure effective removal of phosphorus, a filter medium with a low phosphorus content should be selected. Nitrogen is more difficult to remove because it is highly soluble and strongly influenced by the variable wetting and drying regime that is inherent in biofilter operation. The results of this research suggest that reconfiguration of biofilter design to manage the deleterious effects of drying on biological activity is necessary to ensure long term nitrogen removal.

Calibration of a distributed hydrological model based on satellite evapotranspiration

Volume 349, Issues 3-4, February 2008, Pages 411-424
Immerzeel, W.W. | Droogers, P.

Calibrating spatially distributed hydrological models is complex due to the lack of reliable data, uncertainty in representing the physical features of a river catchment, and the implementation of hydrological processes in a simulation model. In this paper, an innovative approach is presented which incorporates remote sensing derived evapotranspiration in the calibration of the Soil and Water Assessment Tool (SWAT) in a catchment of the Krishna basin in southern India. The Gauss-Marquardt-Levenberg algorithm is implemented to optimise different combination of land use, soil, groundwater, and meteorological model parameters. In the best performing optimisation, the r2 between monthly sub-basin simulated and measured actual evapotranspiration (ETact) was increased from 0.40 to 0.81. ETact was more sensitive to the groundwater and meteorological parameters than the soil and land use parameters. Traditional calibration on a limited number of discharge stations lumps all hydrological processes together and chances on the equifinality problem are larger. In this study we have shown this problem can be constrained by using spatially distributed observations with a monthly temporal resolution. At a spatial resolution below the sub-basin level further study is required to fine-tune the calibration procedure.

Annual and seasonal streamflow responses to climate and land-cover changes in the Poyang Lake basin, China

Volume 355, Issues 1-4, June 2008, Pages 106-122
Guo, H. | Hu, Q. | Jiang, T.

Repeated severe floods and damages in the Poyang Lake basin in China during the 1990s have raised the concern of how the floods have been affected by regional climate variations and by human induced changes in landscape (e.g., draining wetlands around the lake) and land-use in the basin. To address this concern and related issues it is important to know how the climate, land-use and land-cover changes in the region affect the annual and seasonal variations of basin hydrology and streamflow. This knowledge is essential for long-term planning for land-use to protect water resources and to effectively manage floods in the Poyang Lake basin as well as the lower reaches of the Yangtze River. It also has important ecological and socioeconomic implications for the region. This

study used the SWAT model to examine the climate and land-use and land-cover effects on hydrology and streamflow in the Xinjiang River basin of the Poyang Lake. A major finding of this study is that the climate effect is dominant in annual streamflow. While land-cover change may have a moderate impact on annual streamflow it strongly influences seasonal streamflow and alters the annual hydrograph of the basin. Because of the vegetation and associated seasonal variations of its impact on evapotranspiration, increase of forest cover after returning agricultural lands to forest reduces wet season streamflow and raises it in dry season, thus reducing flood potentials in the wet season and drought severity in the dry season. On the other hand, losing forests increases flood potential and also enhances drought impacts. Results of this study improve our understanding of hydrological consequences of land-use and climate changes, and provide needed knowledge for effectively developing and managing land-use for sustainability and productivity in the Poyang Lake basin.

Do cytotoxic chemotherapy drugs discharged into rivers pose a risk to the environment and human health? An overview and UK case study

Volume 348, Issues 1-2, January 2008, Pages 167-175

Johnson, A.C. | Jürgens, M.D. | Williams, R.J. | Kümmerer, K. | Kortenkamp, A. | Sumpter, J.P.

This opinion paper assesses for the UK, whether the current use of cytotoxic drugs, one of the most toxic pharmaceuticals in common use, could pose a risk to aquatic organisms and to humans through water recycling. A water quality model was set up for one of these drugs, 5-fluorouracil, in the Aire and Calder catchment in Northern UK. The study predicts 5-50 ng/L concentrations for long stretches of this catchment under low flow conditions. Due to their mode of action, practically all eukaryotic organisms are vulnerable to damage, with teratogenicity being the greatest concern at such levels. However, it is unclear to what extent the predicted low concentrations would affect flora and fauna in receiving waters but there may be an additive effect of a mixture of cytotoxic drugs which should be taken into account. The exposure of the pregnant mother, or more specifically her foetus, to these drugs via drinking water should be minimised. Current drinking water purification technology gives grounds for optimism on removal of these compounds, but no appropriate data exist yet.

Flash flood warning based on rainfall thresholds and soil moisture conditions: An assessment for gauged and ungauged basins

Volume 362, Issues 3-4, December 2008, Pages 274-290

Norbiato, D. | Borga, M. | Degli Esposti, S. | Gaume, E. | Anquetin, S.

The main objective of this paper is to evaluate a threshold-based flash flood warning method, by considering a wide range of climatic and physiographic conditions, and by focusing on ungauged basins. The method is derived from the flash flood guidance (FFG, hereafter) approach. The FFG is the depth of rain of a given duration, taken as uniform in space and time on a certain basin, necessary

to cause minor flooding at the outlet of the considered basin. This rainfall depth, which is computed based on a hydrological model, is compared to either real-time-observed or forecasted rainfall of the same duration and on the same basin. If the nowcasted or forecasted rainfall depth is greater than the FFG, then flooding in the basin is considered likely. The study provides an assessment of this technique based on operational quality data from 11 mountainous basins (six nested included in five larger parent basins) located in north-eastern Italy and central France. The model used in this study is a semi-distributed conceptual rainfall-runoff model, following the structure of the PDM (probability distributed moisture) model. Two general questions are addressed: (1) How does the efficiency of the method evolve when the simulation parameters can not be calibrated but must be transposed from parent gauged basins to ungauged basins? (2) How sensitive are the results to the method used to estimate the initial soil moisture status? System performances are evaluated by means of categorical statistics, such as the critical success index (CSI). Results show that overall CSI is equal to 0.43 for the parent basins, where the hydrological model has been calibrated. CSI reduces to 0.28 for the interior basins, when model parameters are transposed from parent basins, and to 0.21, when both model parameters and soil moisture status is transposed from parent basins. Performance differences between FFG and use of time-constant soil moisture status are very high for the parent basins and decrease with decreasing the system accuracy. The percent difference amounts to 53% for the parent basins, to 25% for interior basins with parameter transposition, and to 19% for interior basins with parameter and soil moisture status transposition. These results improve our understanding of the applicability and reliability of this method at various scales and under various scenarios of data availability.

Analysis of impacts of climate variability and human activity on streamflow for a river basin in arid region of northwest China

Volume 352, Issues 3-4, May 2008, Pages 239-249

Ma, Z. | Kang, S. | Zhang, L. | Tong, L. | Su, X.

In this study data from 8 catchments in the Shiyang river basin in the arid region of northwest China were analysed to investigate changes in annual streamflow over the past 50 years. The non-parametric Kendall test and the Pettitt test were used to identify trends and change points in the annual streamflow. It was found that 5 out of the 8 catchments had significant downward trends in annual streamflow. Change points in annual streamflow were identified in 4 catchments, which occurred in the year around 1961. A simple method was employed to evaluate the impacts of climate variability and human activities on mean annual streamflow based on precipitation and potential evapotranspiration. It was estimated that the climate variability accounted for over 64% of the reduction in mean annual streamflow mainly due to decreased precipitation. It was also shown that streamflow in the Shiyang river basin is more sensitive to changes in precipitation than potential evapotranspiration.

Declining summer flows of Rocky Mountain rivers: Changing seasonal hydrology and probable impacts on floodplain forests

Volume 349, Issues 3-4, February 2008, Pages 397-410

Rood, S.B. | Pan, J. | Gill, K.M. | Franks, C.G. | Samuelson, G.M. | Shepherd, A.

In analyzing hydrologic consequences of climate change, we previously found declining annual discharges of rivers that drain the hydrographic apex of North America, the Rocky Mountain headwaters region for adjacent streams flowing to the Arctic, Atlantic and Pacific oceans. In this study we investigated historic changes in seasonal patterns of streamflows, by comparing mean monthly flows and analyzing cumulative hydrographs over the periods of record of about a century. We tested predictions of change due to winter and spring warming that would increase the proportion of rain versus snow, and alter snow accumulation and melt. We analyzed records from 14 free-flowing, snow-melt dominated rivers that drained relatively pristine parks and protected areas, thus avoiding the effects of river damming, flow regulation, or watershed development. The collective results indicated that: (1) winter flows (especially March) were often slightly increased, (2) spring run-off and (3) peak flows occurred earlier, and most substantially, (4) summer and early autumn flows (July-October) were considerably reduced. The greatest changes were observed for the rivers draining the east-slope of the Rocky Mountains toward the northern prairies and Hudson Bay, with late summer flow decline rates of about 0.2%/year. This would have considerable ecological impact since this is the warm and dry period when evaporative demand is maximal and reduced instream flows would reduce riparian groundwater recharge, imposing drought stress on floodplain forests. In combination with the decline in annual discharge, earlier peaks and reduced summer flows would provide chronic stress on riparian cottonwoods and willows and especially restrict seedling recruitment. We predict a loss of floodplain forests along some river reaches, the narrowing of forest bands along other reaches, and increased vulnerability of these ecosystems to other impacts including livestock grazing, encroachment of upland vegetation, and weed invasion.

Multivariate statistical analysis of geochemical data as indicative of the hydrogeochemical evolution of groundwater in a sedimentary rock aquifer system

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The study of groundwater hydrogeochemistry of the Paleozoic Basses-Laurentides sedimentary rock aquifer system in Québec produced a large geochemical dataset. Groundwater samples were collected at 153 sites over a 1500 km 2 study area and analyzed for major and minor ions. The large number of data can lead to difficulties in the integration, interpretation and representation of the results. Two multivariate statistical methods, hierarchical cluster analysis (HCA) and principal components analysis (PCA), were applied to a subgroup of the dataset to evaluate their usefulness to classify the groundwater samples, and to identify geochemical processes controlling groundwater geochemistry. This subgroup consisted of 144 samples and 14 parameters (Ca 2+, Mg 2+, Na +, K +,

HCO 3 -, Cl -, SO 4 2 -, Fe 2+, Mn 2+, Br -, Sr 2+, F -, Ba 2+, HS -). Seven geochemically distinct clusters, C1-C7, resulted from the HCA. Samples from clusters C3, C4, C6 and C7 are mostly located in preferential recharge areas. The majority of these samples have Ca-Mg-HCO 3 recharge groundwater (C3, C6, C7) and Na-HCO 3 evolved groundwater (C4). Samples from the other three clusters (C1, C2, C5) are characteristic of an aquifer system under confined conditions. The majority of these samples have Na-HCO 3 evolved groundwater (C1, C5) and Na-Cl ancient groundwater that exhibits elevated concentrations in Br - (C2). In addition to recognizing the importance of hydrogeological conditions on groundwater geochemistry, the distribution of clusters also showed the importance of the geological formations on minor and trace elements, such as Fe 2+, Mn 2+, Sr 2+, F - and Ba 2+. The first five components of the PCA account for 78.3% of the total variance in the dataset. Component 1 is defined by highly positive loadings in Na +, Cl - and Br - and is related to groundwater mixing with Champlain Sea water and solute diffusion from the marine clay aquitard. The high positive loadings in Ca 2+ and Mg 2+ of component 2 suggest the importance of dissolution of carbonate rocks in this aquifer system. From their characteristic loadings, the first two components are defined as the "salinity" and "hardness" components, respectively. Components 3-5 are related to more local and geological effects. The integration of the HCA and the PCA, with conventional classification of groundwater types, as well as with the hydrogeological and geological contexts, allowed the division of the region into four main geochemical areas, providing an improved regional picture of the aquifer system dynamics and hydrogeochemical evolution of groundwater. The following factors were recognized as influencing the evolution of groundwater identified in every geochemical area: (1) geological characteristics including sedimentary rock type and till mineralogy; (2) hydrogeological characteristics represented by the level of confinement and the hydraulic gradient; and (3) the geological history including the latest glaciation and the Champlain Sea invasion. With its integrated approach, this hydrogeochemical study contributes to the characterization and understanding of complex groundwater flow systems, and provides an example of the long-term geochemical evolution of hydrogeological systems after a major perturbation, in this case seawater invasion.

Flood generation and sediment transport in experimental catchments affected by land use changes in the central Pyrenees

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Three small catchments (<2.5 km2 in size) were monitored in the Central Spanish Pyrenees to analyse the hydrological and geomorphological consequences of different land covers under the same climate scenario: (i) the San Salvador catchment represents a dense, undisturbed forest environment; (ii) the Arnás catchment corresponds to an old, abandoned cultivated area subjected to colonisation by plants; and (iii) the Araguás catchment consists in part of active badlands. The obtained results

demonstrate that plant cover is a key factor, influencing (i) the seasonality and intensity of floods, (ii) the annual volume of discharge, and (iii) the suspended sediment concentration, total sediment yield and proportions of different types of sediment. The forested catchment tends to generate floods in late winter and spring, when the water table is close to the surface, and flood hydrographs are generally gentle, with solutes largely prevailing over suspended sediment. The old agricultural catchment produces in average twice the number of floods as that recorded in the forested catchment, with the highest floods recorded in autumn and spring; this catchment behaves as a complex mosaic, with a large spatial and temporal variability in terms of both sediment- and runoff-contributing areas; in addition, suspended sediment is equal to solutes, and bedload reaches a relatively high importance. Finally, the badland catchment reacts to all rainstorm events throughout the year, with a high suspended-sediment load. Sediment outputs from the Araguás catchment are two orders of magnitude higher than in the Arnás and San Salvador catchments. Suspended sediment concentrations exceed 300 g l-1 in the Araguás catchment, whereas they rarely exceed 20 g l-1 in the Arnás and rarely 1.5 g l-1 in the San Salvador catchment.