

**HYDROCARPATH
INTERNATIONAL CONFERENCE
CATCHMENT PROCESSES IN
REGIONAL HYDROLOGY:
EXPERIMENTS, MODELING AND PREDICTIONS IN
CARPATHIAN DRAINAGE BASINS**

Abstracts of the Conference

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NEW SURVEYING METHODS OF LAKE FERTŐ, HUNGARY

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The Lake Fertő is a shallow continental steppe lake, with 321 km² area at the boundary line. In the 20th century the lake bed became heavily covered with reed, mostly because of the regulation works with the building of dams and the construction of channels. It is important for the future to measure and document the changes of the land cover at the lake and the water level-volume ratio.

The project GENESEE (New surveying of Lake Fertő and Hanság channel) started in 2011 with the cooperation of Hungary and Austria. The aim of the project is to create a uniform map database which will be a base for future researches and provide guidance for environmental protection, sustainable tourism and reed production. The project uses modern techniques (airborne laser scanning, ultrasonic surveys) for an accurate terrain model. Beside these techniques the traditional surveying methods are very important for the data collection. In this project we have made the field surveying of the lake bank and the cross-sections of the channels, which are unsolvable with the modern technics.

WATER BALANCE OF WOODS IN KISKUNSAG SANDRIDGE

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In this survey I would like to give a picture of the characteristic features of sand-land forests concerning their water balance, and in relation to forest hydrology, I would like to outline how to apply those features in the course of nature conservation treatment. I based my survey both on special literature and on exchanges of practical experience with experts.

More detailed investigation of the general hydrology of Duna-Tisza Sandridge started in the 1970s and expert opinions differ widely over the effects of crops on ground water level, that is, whether we can establish a connection between the growing afforestation in the area and the decrease in groundwater levels.

This study confirms that we need to broaden our knowledge about this special field during forestry and nature protection management, and to explore the water management of sand-land sites, which are characterized by dry growing features, even more in the future.

VARIOUS LAND COVER TYPES IMPACT ON WATER BALANCE IN ZALA COUNTY

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Water balance of Zala county was analyzed using remote-sensing based evapotranspiration (ET) 1-km spatial resolution maps by Szilágyi and Kovács over the 2000-2008 period [Szilágyi J., Kovács A., 2011: A calibration-free evapotranspiration mapping technique for spatially-distributed regional-scale hydrologic modeling. *J. Hydrol. Hydromech.*, 59, 2011, 2, 118–130.].

The ET maps were analyzed in the context of groundwater depth and land cover types (Corine Land Cover 2006). Runoff as the difference of precipitation and ET was also evaluated. These kind of analyzes were done not only ten years average but also in case of the driest and the wettest years.

The calibration parameter of Budyko-model was calculated by using spatially-distributed temperature data, precipitation and ET values. With the help of this parameter map, it is possible to examine the impact of climate change on ET and runoff, in spatially-distributed mode.

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Key words: evapotranspiration, runoff, Budyko-model, land cover

HYDROLOGY AND WATER RESOURCES DATA ANALYSIS WITH R

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R is a free software programming language and environment for statistical computing and graphics. The R language is widely used among statisticians and data miners for data analyse. Polls and surveys show that R's popularity has substantially increased in recent years. The free software environment for statistical computing and "R" graphics is maintained by statistical programmers, with the support of an increasing community of users from many different backgrounds, including hydrologists; it allows access to both well-established and experimental techniques in various areas.

The objective of this paper is to review, on the basis of available resources, some features and packages that make R a powerful environment for pre-processing and analyzing data from the hydrology and water resources management areas. A brief description of the R language is given at the beginning of the paper, and tools for data preparation tasks such as cleaning data, imputing missing data, and detecting outliers are presented. A description of the tools for both the descriptive and inferential statistics follows and is evaluated. For some tasks code snippets are also provided (e.g., for hydrologically-oriented descriptive statistics and for an extreme value analysis).

Keywords: hydrology, statistics, modeling, R language

MODELING AND SPATIAL DATA ANALYSIS IN HYDROLOGY WITH R

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R is a free software programming language and environment for statistical computing and graphics. R is coupled with a large variety of easily available packages which allow access to both well-established and experimental statistical techniques and also to many specific methods from different fields. Although R was built originally for statistical tasks, its programming possibilities are not limited to them; it is a full-featured object-oriented programming language, which is suitable for a very broad class of tasks, including various tasks from hydrology and related fields.

The objective of this review paper is to present some features and packages that make R a suitable environment for hydrological modeling. There are various steps in hydrological modeling described in the paper together with the corresponding tools in R: data preprocessing, sensitivity analysis, calibration, the modeling itself using various types of models, and the validation of the model. Later in this article a description of the GIS and spatial data analysis possibilities of R are reviewed. This part mainly addresses two areas: moving spatial data into and out of R, and analyzing spatial data in R. Finally, some of the views of authors on the exploitation of R are discussed.

Keywords: hydrology, modeling, spatial data analysis and manipulation, R language

WHAT DID WE LEARN FROM THE TEN-YEARS-LONG SEDIMENT DATASET FROM THE RÁK BROOK?

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Based on ten-years-long dataset, spatial and temporal variability of suspended sediment concentration and its control factors have been analysed in two small forest catchments of the Sopron Hills. Difference in the sediment fluxes of the catchments can be explained by the geomorphology. Low flow temporal fluctuation at different time-scales may refer to the impact of forestry activities, sediment exhaustion–replenishment since the previous flood event and the freeze-thaw effect determining the in-channel fine material availability.

Three types of hysteresis loops have been identified during the flood events which indicate the intra-event variability of suspended sediment transport. Based on the observed data and the developed regression equations, total sediment load was 124.7 tons in the hydrological year 2008-2009.

The wide scatter in the data and the insignificant correlation coefficients point out that other stochastic factors influence the sediment load, besides the hydrological, hydro-meteorological and climate variables. Exhaustion of a sediment deposit behind log jam has been investigated in the Farkas Valley. Since the outwashed sediment deposit had 13% proportion (15.8 tons) to the total annual sediment yield, we can conclude that other processes contribute to the stream sediment sources as well.

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THE CHARACTERISTICS OF WATER SUPPLY IN RURAL SETTLEMENTS IN SW HUNGARY

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Characteristics of a water supply system from both the suppliers and consumers' sides are determined by the local environmental and socio-economic conditions. Significant differences are typically found between the rural and urban areas regarding the level of water supply, especially the parameters that considerably influence the magnitude of water consumption. Some of the main factors that may influence the water consumption of a given settlement, without striving completeness, include the type of residential homes, lifestyle (commuters, local residents, the number of gardens requiring regular irrigation and the number of residential pools), micro- and mesoclimate, as well as living and infrastructural standards. At settlement level, the number and proportion of communal facilities and joint ventures may also significantly influence water consumption. From the viewpoint of the water suppliers, consumption differences may also originate from legal and economical attributes of the area. In many occasions, financial and economic well-being of rural areas is considerably worse than that of the developed urban areas. The 26/2002 governmental act, based on the Environmental Directives of the European Union do not force and necessitate economic investments for the establishment of up-to-date sewerage systems in Hungarian settlements with less than 200 residents,

In the current study we analyzed the basic characteristics of the water supply and sewerage systems by studying a rural water supplier company (Transdanubian Regional Waterworks), and also investigated the consumers' behavior in SW Hungary. After the statistical analysis of the operational data of the Transdanubian Regional

Waterworks we conclude that despite the lower per capita water consumption, the rural settlements of SW Hungary have higher specific operational water supply and wastewater management costs than urban areas.

IDENTIFICATION OF INTENSE RAINFALL EVENTS BASED ON HIGH RESOLUTION METEOROLOGICAL DATA IN SWITZERLAND

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The study deals with the identification of precipitation events with a convective character based on high resolution records (10-min time step) of precipitation, temperature and lightning strikes, which are available from the SwissMetNet network of MeteoSwiss. We provide an analysis for the Aigle station (SW of Switzerland).

First, we deal with the issue of the identification of independent storm events, which is governed by the inter-arrival time, i.e., the length of the dry period between two rainfall records. Then, the entire set of the independent precipitation events is confined to those with liquid precipitation (rainfall). For each storm event, the key storm characteristics (total rainfall depth, storm duration, average rainfall intensity and peak 10-min intensity) are derived, and the number of lightning strikes is assigned in case the event was accompanied by lightning activity.

Rainfall events with a convective character are sought on the basis of the hypothesis that thunderstorms with strong convective lifting are commonly associated with lightning strikes. We define a threshold of peak intensity I^* that differentiates between events with and without lightning with an acceptably small probability of misclassification. This allows us to identify intense convective events as those where the peak intensity exceeds I^* regardless of their duration or total rainfall depth.

Keywords: rainfall events, inter-arrival time, rainfall intensity, lightning, convective rainfall, intensity threshold, Switzerland

DECISION SUPPORT SYSTEM FOR CLIMATE CHANGE ADAPTATION – APPLICATION OF CLIMATE DATA FOR HYDROLOGICAL IMPACT ANALYSES

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Rainfed sectors of agriculture are threatened by projected climate change especially in low-elevation regions in Southeast Europe, where precipitation is the limiting factor of production and ecosystem stability. To initiate preparation for frequency increase of extreme events, disasters and economic losses, a Decision Support System is under development, which provides GIS-supported information about the most important regional and local risks and mitigation options regarding climate change impacts. The *Climate* part of the Decision Support System contains daily time series for precipitation and temperature means and extremes. For the time period 1961-2010, gridded station data from the EU-project CARPATCLIM (www.carpatclim-eu.org) as well as from the FORESEE database (Barcza et al. 2013) are used. Until 2100, results of 14 regional climate models are included (www.ensembles-eu.org). In our presentation, the application of the climate database will be introduced (calculating indices, plotting figures, etc.). Based on case studies it will be shown, how the data can be used for climate impact analyses (e.g. land cover changes, potential production, water and carbon cycle, potential pests and diseases, tolerance limits, mortality etc.) with special focus on the hydrological aspects.

Keywords: climate data, regional climate modelling, climate change, hydrological impact analysis

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GROUNDWATER UPTAKE OF A POPLAR, AN OAK FOREST AND A PASTURE

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Water uptake of forests from groundwater can be significant in shallow groundwater areas of Hungarian Great Plain especially in drought periods. So forests can cause water table depression and subsurface salt accumulation above saline water table in areas with negative water balance.

The impact of forests is examined by a systematic study in Hungarian Great Plain. Under the frame of this research factors are analyzed like climatic water balance, water table depth and salinity, three species, subsoil layering and stand age. At the stand scale from 18 intensively monitored forested and accompanying non forested plots, a poplar, an oak forest and a pasture groundwater uptake were compared. Under the forests the water table levels were lower, and the groundwater uptake was significantly larger as under the pasture. Larger forest groundwater use is not parallel with salt uptake, therefore salt accumulates in soil and also in groundwater as can be measured of the representative monitoring sites as well. This process can result the decline of biological production or even the dry out of some part of the forest. Greater groundwater uptake and salt accumulation effect can be especially true under pronounced drought conditions of global climate change.

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Keywords: evapotranspiration, groundwater, diurnal fluctuation, forest, pasture

SOIL MOISTURE CHARACTERISTICS OF WETLANDS WITH SHALLOW GROUNDWATER

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Water use of plants is manifested in diurnal signal of soil moisture and water table in shallow water table environments. This diurnal signal in soil moisture shows significant changes along the growing season and also has a different shape along the vertical profile of the soil column. A new technique was elaborated on the basis of diurnally curve of soil moisture dynamic taking into account diurnally changing replenishment rate. Using this new technique a significantly different water uptake can be calculated comparing to the traditional methods. New technique was tested on the soil moisture dataset of a riparian alder forest in Hidegvíz Valley experimental catchment.

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Keywords: soil moisture, diurnal signal, evapotranspiration, forested wetlands

URBAN WATER QUALITY ON THE RÁK STREAM IN SOPRON

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The urban areas has a special hydrologycal-cycle changing effect. In addition the climate changing, plus that special urban circumstances result in water quality modifications onto the streams. In the article I am going to do describe our measuring (volumetric flow, physico-chemical parameters) results and the evaluations of the laboratory (ion-contents) for Rák-stream water quality in Sopron, Hungary. Plus calculate mass loads, and mass loads for the part-catchments of Rák-stream. In addition I compared to two low-water period days average with a day of high-water period.

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METHODOLOGIES OF CALCULATING THE ECOLOGICAL STABILITY IN SLOVAKIA

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The determination of a landscape's ecological stability is based on the identification and evaluation of landscape elements and their categorization into predefined categories. A complete categorization of all landscape elements is done during the completion of land consolidation (LC). LC is used for mapping and planning all the features in a defined area. To determine the ecological stability coefficient value various mathematical methods are used. The latest methods feature a large range of methodological tools for evaluating the ecological stability of a landscape. The latest coefficient calculating of ecological stability was created by Muchová et al. (2009), an older methodology was presented in Reháčková – Pauditšová (2007). Both methodologies were designed to be used in LS and the Territorial System of Ecological Stability (TSES). This paper deals with a comparison of these well-known methodologies and the possibilities of creating a new methodology for the calculating the value of an ecological stability coefficient. The idea was based on methodologies already known and published in Slovakia and The Czech Republic. A possible application for the proposed methodology is in the land consolidation projects implemented in Slovakia.

Keywords: Land consolidation (LC), Territorial System of Ecological Stability (TSES), ecological stability, coefficient of ecological stability

TRENDS IN DETECTION OF ANNUAL MAXIMUM DISCHARGES IN THE VAH RIVER BASIN

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A number of floods have been observed in the Slovak Republic in recent years, thereby raising awareness of and concern about flood risks. The paper focuses on an analysis of the trend in the annual maximum discharge series in the Vah river catchment located in Slovak Republic. Calculations were performed on data obtained from 59 gauging stations with minimum lengths of the observations from 40 years to 109 years. The Mann-Kendall trend test and its correction for autocorrelated data by Hamed and Rao (1998) were used to detect the significance of changes in the behaviour of discharges detected by linear regression. The series were analysed at lengths of 40, 50, 60 years or longer periods and visualised in GIS. The results suggest that the length of observations has an impact on detecting trends in annual maximum discharge series.

Keywords: trend analysis, maximum discharge series

INVENTORY AND MONITORING OF DANUBE FLOODPLAIN FORESTS BY INNOVATIVE REMOTE SENSING TECHNOLOGY – FIRST RESULTS FROM INMEIN PROJECT

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A methodological overview on Airborne Laser Scanning- (ALS) or LiDAR-based inventory of forests is given. The airborne survey of the Szigetköz / Csallóköz area between the dikes on the Hungarian side and the channel in the Slovakian side has been carried out recently in the frame of a Hungary-Slovakia Cross-border Co-operation Programme 2007–2013, called INMEIN, Innovative methods for monitoring and inventory of Danube floodplain forests based on 3D technologies of remote sensing (HUSK/1101/1.2.1/0141). Our first results on forests investigation are shown on these inundation area determined by the Danube and its tributaries.

REGIONAL DESIGN FLOOD ESTIMATION IN SLOVAKIA

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During recent decades extreme floods in Central Europe have resulted in the raising scientific and societal concerns about the reliability of flood frequency estimates in the region. As a consequence, currently-used flood frequency estimation methods are being re-visited. The use of more complex climate-soil-vegetation controls in regional frequency analysis for estimating floods on a regional scale instead of the traditional regional regression formulae between flood quantiles and basin area or mean basin altitude is being considered as a solution for computing design discharges in ungauged basins. In this study a regional flood frequency approach was applied to annual maximum floods using flood data from 197 mid sized basins in Slovakia. Several physiographic catchment characteristics representing climate-soil-vegetation controls were used to pool catchments into homogeneous pooling groups by cluster analysis. Regional flood frequency distributions were derived for the annual maximum summer floods using L-moment statistics. A regional formula for the computation of index flood was derived by multiple regression methods using physiographic and climatic catchment characteristics. A comparison of flood quantiles computed by the regional approach was performed with statistical reference values. The applicability of the methods compared for design purposes was discussed.

Keywords: regional flood frequency, annual maximum flood, pooling scheme, L moments

HEAT WAVES IN SLOVAKIA

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An analysis of the long-term changes and the incidence of the temporal variability of heat waves in Slovakia from 1951-2010 is the aim of this paper.

There is a presumption that climate change could, over the next few decades, lead to a higher frequency and a larger spatial extent of extreme heat waves in Central Europe. Heat waves can cause severe thermal environmental stress, leading to higher hospital admission rates, health complications, and increased mortality. Heat waves bring about higher temperatures, increased solar overheating of buildings, inhibited ventilation, and a larger number of consecutive warm days and nights.

This paper is focused on an analysis of long-term changes in heat waves at selected meteorological stations in Slovakia. As a heat wave can only be quantitatively evaluated using its maximum temperature, as well as its duration, it is necessary to analyze the characteristics of both together using available statistical methods.

Keywords: heat waves, extremes of air temperature, climate change, temporal variability of heat waves incidence, Slovakia.

ESTIMATION OF CHANGES IN SNOW STORAGE IN MOUNTAINOUS BASINS IN SLOVAKIA

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Snow storage represents an important part of the hydrological balance in Slovakia, especially in its mountainous regions. An evaluation of changes in the snow cover in mountainous basins in Slovakia during recent decades is provided in this paper. The upper Hron River basin, which has 6 climate stations with measured data of snow the depth and snow water equivalent from the period 1961-2010 available was selected as the pilot basin. An analysis of the changes in snow cover was given by evaluating changes in the snow depth, the duration of snow cover, and the simulated snow water equivalent. The snow water equivalent was simulated in a daily time step using a conceptual hydrological rainfall-runoff model with lumped parameters. Several sets of calibrated model parameters were tested with the aim of achieving the best simulated values of the snow water equivalent. The simulated values of the snow water equivalent were compared with the available measured data at climate stations in the basin. The changes in the snow cover and the simulated snow water equivalent in the basin were estimated by trend analysis, and the significance of the trends was tested using the Mann-Kendall test. From the results, it is possible to see a decrease in the snow depth and the snow water equivalent on the upper Hron River basin in the period of 1961-2010 in all months of the winter season, and significant decreasing trends were indicated in the months of December, January and February.

Keywords: snow depth, snow water equivalent, trend analysis, the upper Hron River basin

HYDROLOGICAL ANALYSIS OF THE SPRINGS OF TATA

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The Transdanubian Midmountains – and in the narrow sense the city of Tata – serves excellent pilot area to study the recharging processes of the karstic water reservoirs. This interesting process has many harmful effects such as appearing water in basements or overloading of the rainwater's drainage system. For the solution of these problems it is necessary to know well the soil-stratification under the city of Tata and define which areas are endangered by the rising water level nowadays and which can be potential hazard in the future.

During our work first we explored the stratification of soil from data on geotechnical drillings. We produced 29 pieces of borehole section and 7 pieces of stratification section. Then we collected the springs of downtown of Tata, and we presented details in connection with springs too. We defined a contour-map on the present karstic water levels, and we created one for the future with estimated values. By the help of these maps endangerment maps were created.

Keywords: Tata, karstic water, borehole section, stratification section, endangerment map

CHARACTERISTICS OF SOFTWOOD FLOODPLAIN FORESTS FORMED AFTER CONSTRUCTION OF GABČÍKOVO WATERWORKS

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This paper is focused on the phytocoenological characteristics and production analysis of the herbaceous layer biomass of softwood floodplain forests (*Salici-Populetum* (R. Tx. 1931) Meijer Drees 1936 association). The area of study represents new softwood forest stands formed after the construction of the Gabčíkovo Waterworks construction in 1992. After the decrease in the water level in the old Danube riverbed, new bare stands have appeared. Within a few years, young softwood floodplain forests formed there by the process of primary succession. These stands are the subject of the study presented in this paper. We estimated the herb layer biomass using indirect sampling modified for non-repeated field measurements (Kubíček, Brechtel, 1970). The total biomass of the herbaceous layer was estimated to be 5577 kg/ha; the aboveground biomass was 4065 kg/ha, while the belowground biomass was 1512 kg/ha. The results were compared with the data by Kubíček et al. (2009) and Kollár et al. (2010). Some attention was also paid to their phytocoenologic characteristics. Considering this, it seems that they represent a full-value soft-wood floodplain forest of the *Salici-Populetum* association, despite a slightly higher occurrence of some synanthropic species. To determine their next succession, we also established a monitoring site with a detailed study of its floristic composition.

Keywords: herb layer biomass, phytocoenology, *Salici-Populetum*, Danube, Gabčíkovo Waterworks

CLIMATE CHANGE AND CHANGES IN SOIL WATER STORAGE IN THE LOCALITY OF POIPLIE

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Climate change, which is currently one of the most recent and biggest threats to the contemporary world, has its part in changes that occur in wetlands. Due to the increasing air temperature, the uneven distribution of rainfall during the year, and the alternation of dry periods without rainfall with periods of intense torrential rainfall, the global water regime of the wetlands is changing, which in extreme cases can lead to the degradation or disappearance of wetland ecosystems. Therefore, an examination of the climatic conditions and water regime of wetlands is justified, especially in the context of ongoing climate change.

This contribution is dedicated to the consequences of climate change on the development of soil water storage in selected wetlands within the Poiplie Ramsar site. To simulate the climate change, CGCM3.1 global model (A2 pessimistic scenario and B1 optimistic scenario) and the KNMI and MPI regional models were selected as the most appropriate. A simulation of soil water storage was carried out using a GLOBAL model. For the 20-year reference period the years 1977-1996 were chosen, which is within the evaluation compared with the 20-year time horizons of 2020, 2050 and 2080.

Keywords: climate change, soil water storage, wetland

APPLICATION OF DIFFERENT APPROACHES TO SIMULATE THE RUNOFF OF THE ARAGVI RIVER BASIN IN GEORGIA

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The subject of this article is a comparison of flow forecasts using a physically-based and data-driven model in the Aragvi river basin in Georgia. The forecast is based on daily data from the gauging station in Magharoskari, Georgia, the data from seven precipitation stations in the river basin and air temperatures from three climate stations. The WetSpa model developed for the simulation and forecasting of water and energy transfers between soil, plants and the atmosphere on a regional scale and a river basin scale was used as the physically-based model. A Support Vector Machine (SVM) model with a high degree of effectiveness with regard to regression tasks as certified in the scientific literature was used for this work. The regression tasks also include flow prediction, which is the subject of this paper. The article includes an evaluation of the reliability and application domain of the various above-stated approaches with regard to flow modeling with a result which indicates their mutual complementarity.

Keywords: WetSpa model, Support Vector Machine (SVM), flow forecasts, Aragvi River Basin

INVESTIGATION OF THE CURVE NUMBER METHOD'S PROPERTIES

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The SCS-CN (Soil Conservation Service – Curve Number) Method is a method used to calculate direct runoff. The Curve Number is a function of the soil group, land use, and surface conditions of a catchment. Due to its simplicity, the method is applied in different geographical areas around the world. The catchments investigated in this article are located in Slovakia and Poland. The objective was to characterize the samples and analyze their empirical distributions, the theoretical distribution of two parameters of the SCS-CN method (Curve Number (CN) and maximum potential retention parameter (S)), and to apply the asymptotic approach method to some selected catchments. Empirical distributions of CN are usually negatively skewed or symmetric and are positively skewed of S. The Generalized Extreme Value distribution was determined to be the most accurate distribution. The asymptotical approach confirmed the adequacy of the SCS-CN model in selected watersheds.

Keywords: SCS-CN method, maximum potential retention parameter S, theoretical distribution, asymptotical behaviour of CN

HYDROLOGICAL MODEL ANALYSES ON THE WATERSHED OF BÜKKÖS CREEK

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The exploration of runoff processes in small catchments located on mountainous terrain has become relevant in order to predict floods and runoff volumes.

This study purposes to describe the basin (36 km²) of Bükkös Creek through hydrological model simulations. Firstly a one-dimensional hydrodynamic model of the main creek was set up to determine the accurate rating curve at the outlet of the watershed obtaining reliable discharge time series from the water level measurements.

The lumped model of HEC-HMS was clarified with the catchment's digital elevation model and successfully calibrated and validated.

The conception of the spatially semi-distributed TOPMODEL has been also implemented on the watershed, achieving better results throughout calibration and validation. Sensitivity analyse of parameters made the performed calibration of TOPMODEL precise. Effects of resolution of the digital terrain model and the complexity of hydrological model were analysed. The results were quantified with well-known indices of goodness of fit.

Keywords: hydrologic modelling, semi-distributed TOPMODEL, HEC-HMS, sensitivity analysis

EFFECTS OF RIVER REGULATION OF RÁK-STREAM ON THE MACROINVERTEBRATE COMMUNITIES

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The regulation of the Rák Stream had a lot of different impacts on the water regime, the water quality and the surroundings of the streambed. This intervention started in autumn of 2011 and ended in summer of 2012. This project targets firstly to protect Sopron from the flood waves of the Rák Stream. As a result of river regulation works significantly changed the shape of the streambed and decreased the size of wetted area in the concerned part of the Rák Stream. These effects were modified also the habitat of macroinvertebrates.

Samplings were taken two times before stream regulation, and five times after. "Kick and sweep" method was used for sampling. The collected macroinvertebrates have been classified with stereo microscope, determined on family level. The number of discovered taxa is significantly decreased after river regulation, but the recolonization process was started rather quickly after completed the works. For the analysis the Hungarian Macrozoobenton Family Point System were used. Overall it can be stated that the regulation project was successful and the contractors took into account not only technical but also human, aesthetic and ecological aspects in case of the regulation works.

Research has been supported by funds: TÁMOP-4.2.2.A-11/1/KONV-2012-0013 project.

Keywords: macroinvertebrates, stream regulation, recolonization, biological water quality

FACTORS AFFECTING VERTICAL MOVEMENTS OF GROUNDWATER AND SOLUTE ACCUMULATION UNDER FORESTED PLOTS

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A systematic study is being carried out in order to characterize the influence of environmental factors on the solute accumulation under forested plots in the north-eastern part of the Great Hungarian Plain.

Data of two sites (pairs of control vs. forested plots) showed the importance of both biotic and abiotic factors. In a dominantly sandy area with shallow water table (2.1-2.5 m), a transect was established according to elevation and forest types (108 m ASL - *Quercus robur* –Mikepércs; 156 m ASL - *Populus x. euramericana* –Nyírbogát). On each site, temporal change of groundwater level was observed to get information about groundwater fluctuation/water table depression under forestations of different type and age. Chemical parameters (EC, pH, pNa, pCl) of groundwater and soil was analysed and compared to the control plots (arable land or grassland) to observe accumulation processes under plantations.

The factors modifying clearly hypothetical results are assumed to be regional recharge/discharge systems and contrasting stand age of recently established *P. x. euramericana* stand versus more than 140 years old oak site.

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Keywords: water table level, forestation, solute accumulation, land use change

CALIBRATION OF A RAINFALL-RUNOFF MODEL ON A SERIES OF ANNUAL MAXIMUM FLOWS

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In flood frequency analysis (FFA) the first decades of the new millenium has been dedicated to the searching for new ways how to improve traditional techniques of estimating design floods and assessing their probabilities of occurrence even on places without observation. One of the tools which are currently used in the FFA are rainfall-runoff models. However, their use in the FFA often faces a problem of how to correctly calibrate the model on extreme floods. Since the FFA deals only with the extreme flows, traditional calibration techniques using simple objective functions such as Nash-Sutcliffe model efficiency criterion are not sufficient. In this paper we have focused on the improvement of traditionally used calibration techniques in order to enhance the description of extreme flows. As a rainfall-runoff model we have selected a conceptual, lumped model HRON. We have suggested two improvements: 1) using of a new optimization function comparing only values higher than 95th percentile of observed flows and 2) using two sets of parameters to separately simulate medium and high flows. Each of these improvements have enhanced the simulation of extreme flows which has been demonstrated on an empirical cumulative distribution function (ECDF) calculated for simulated and observed annual maximum series (AMS) of flows. The biggest improvement has been achieved by combining both of these improvements when the ECDF curves of observed and simulated AMS series were almost identical.

Keywords: rainfall-runoff model HRON, calibration, annual maximum series of flows, flood frequency analysis

ECORIVER: AN INTEGRATED DYNAMIC SIMULATION MODEL – THE SCHWECHAT CASE STUDY

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In recent years the knowledge acquired in the field of hydrodynamics and vegetation modeling has allowed for the formulation and implementation of countless simulation models. However, most of these solutions consider only one aspect of the whole ecosystem, either vegetation or hydrodynamics. Little effort has been so far devoted to the modelization of the active feedbacks existing between these two ecosystem components. The effects of hydrodynamics on vegetation are given by the morphodynamic disturbance exerted by floods and their duration. Conversely, vegetation affects flow properties by altering the roughness properties of a channel bottom. Hydrodynamic effects on vegetation were simulated using the mean water elevation as a key input in the simulation of a recruitment; shear stress and stream power were used instead and tested as indicators of morphodynamic disturbances. The results here present the preliminary outcomes of the Ecoriver project (performed by Environmental Consulting Ltd, Klagenfurt), which encompass a case study along the Schwechat River (Austria) and focus on a comparison between the alternative usage of stream power or shear stress as morphodynamic disturbance indicators.

Keywords: floodplain vegetation, vegetation modelling, Casimir vegetation

DEVELOPMENT OF FOREST LITTER INTERCEPTION MODEL FOR A SESSILE OAK FOREST

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Models that describe nature running processes in forest can help to estimate assessment of the consequences of forestry intervention, or the climate change. The present work shows a developed model for estimation of the forest litter interception in case of a middle-aged sessile oak (*Quercus petraea*) stand. This model uses the antecedent water content and the storage capacity of the forest litter as parameter. The antecedent water content of the litter was estimated in the model with the daily precipitation and temperature data. This study represents the result of a three years long (2006-2008) measurement in Hidegvíz Valley near Sopron. The measurements were done by own developed instrument, where the forest litter are enclosed in frames measured the litter in every time step on stationary place.

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