

**HYDROCARPATH
INTERNATIONAL CONFERENCE
CATCHMENT PROCESSES IN
REGIONAL HYDROLOGY:
FROM EXPERIMENT TO MODELING IN
CARPATHIAN DRAINAGE BASINS**

Abstracts of the Conference

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THE CARPATHCC PROJECT: ASSESSMENTS OF VULNERABILITY OF ENVIRONMENTAL RESOURCES IN THE CARPATHIAN REGION

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The impacts of the climate change exert their influence well beyond borders and national levels. It is a must to coordinate efforts and build up geographically large – scale strategies to meet the challenges of these changes. Coordinated actions and their success require better exchange of information on each level of the society, politicians and citizens alike. The CarpathCC Consortium has been selected by the EU DG Environment as a contractual partner to cooperate in preparing in – depth assessments of vulnerability of environmental resources and ecosystem-based adaptation measures.

The Consortium has eight members and embraces more than 200 experts from the region and different European countries. The expert pool was collected so it covers the geographical boundaries and all of the languages of the region. Project implementation covers the following fields and tasks:

Module 1 – In- Depth Study on the key climate change threats and impacts on water resources addresses main impacts of climate change on the water resources in the Carpathians as a result of changes in temperature and precipitation patterns and a higher inter-annual variability climate change. Main objective of this study is to deliver the consistent knowledge about expected effect on flood and droughts, changes of snow conditions, water related vulnerability with some regulatory aspects in the Carpathian regions.

Module 2 – In- Depth Study on the impacts of climate change threats on ecosystems addresses climate change impacts on forests, grasslands and wetlands in the Carpathians, including options for adaptation, and vulnerability of mountain and subalpine regions. Main objective of this study is to deliver the consistent knowledge about expected effect of climate change on Carpathian ecosystems specifi-

cally for individual Carpathian regions, forest types and tree species, and pests and pathogens.

Module 3 – In- Depth study on the impact of climate change on ecosystem-based production, this in-depth study will deliver to and learn from the assessment in focal areas for in focal areas for selected ecosystems (Specific Request 6). The objective of this SR is translated in 3 tasks: To fine-tune the scope of the in-depth assessment in close relation with the Steering Committee and the CARPIVIA management. To examine the responses in ecosystem services to the changes described in relation to climate change and to provide a cost benefit analysis of the positive and negative trends in goods and services delivery, that would support decision-making in relation to adaptation actions by policymakers at all relevant levels. To carry on an assessment will be done of the vulnerability of the tourism sector to climate change.

Module 4 – In- Depth Study on adaptation measures. Main aim of the SR4 is to collect and evaluate the adaptation measures within and outside of the Carpathian region which could be beneficial in the Carpathian region for further use. The evaluation should highlight on the cost benefit quantification where possible. These results give the basis for recommendation to the European Commission for further support the region and develop the Common Agricultural Policy.

Module 5 – Supporting stakeholder interactions. The need of identifying stakeholders and interacting with them were expressed in the vulnerability assessment - related closely to CarpathCC - made by the Carpivia project as an organic continuation of the recent progresses. There will be a scientific and two stakeholder workshops held. The general objective of the workshops is to contribute to identifying the most feasible and most cost effective adaptation measures in selected focal areas and sectors.

Module 6 – Integral Vulnerability assessments in focal areas. Overall and selected project goals and aims are investigated in five focal areas: Tatra Mountains, including Zakopane; Rodnei and Maramureş; Târnava Marè Area; Iron Gates National Park and foothill and Bükk National Park.

THE ANALYSIS OF DAILY DISCHARGES AT THE SELECTED HYDROLOGICAL STATIONS ON THE DANUBE

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Flow variability is an inherent feature of streams, but high water levels are inherent extreme rainfall and extreme runoff conditions. The flow regime of a river stations that require continuous time series of water levels can be characterized in more detail. The processing of hydrology elements are widely used mode of the frequency curve and durability. The following paper deals with the analysis of the flow regime at the stations Devin, Medved'ov and Komárno. Hydrological data were provided by the VITUKI Environmental and Water Management Research Institute in Budapest. To assess differences in flow were used the average daily flow. Based on the calculation of the 1-6 daily flow differences were determined to frequency discharges in the selected interval and cumulative frequency curve.

THE APPLICATION OF DATA MINING METHODS IN HYDROLOGY – A CASE STUDY OF THE KYSUCA RIVER

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Data mining is the intersection between statistics and computer science. At this point artificial intelligence, machine learning, statistics, and database systems meet. Using data mining in hydrology is a logical step, because large volumes of data are continually being collected, processed and evaluated in this field of science and engineering. This article deals with an application of data mining methods while solving a selected hydrology task (a short-term flow prediction). The authors demonstrate various steps in the data mining process, which are formalised in the so-called CRISP-DM process and demonstrate selected methods for data pre-processing and two modelling approaches (classification and regression). The paper describes river flow predictions in the Kysuca River watershed. Classification tries to predict if the expected flows will fall into the potential flood-danger category. Regression is used to predict the values of the flow in cubic metres per second. The results from both methods are compared with the hydrological data about the flows observed in the watershed studied. An evaluation of these methods shows the usability of data mining in this field.

SEDIMENT YIELD VARIABILITY IN THE HEADWATER CATCHMENT OF RÁK STREAM

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Sediment in water bodies has different environmental and economical significance. Suspended sediment can directly damage physical, chemical, and biological water quality. Suspended sediment form may also refer to the erosion processes in the catchment. Suspended sediment concentrations (SSC) have been measured in the headwater catchment of Rák Stream (Sopron Hills, Hungary) since more than one decade. Time series represent significant fluctuation of the SSC in different time scales, such as inter and intra-annual, seasonal, monthly, inter-event and within-event variations. The authors have analysed which factors have significant correlation with the mean SSC values. The assessment had special regard to the discharge, rainfall erosivity index and rainfall depth. The results of basic statistical analyses help to describe the sediment dynamics in forested catchments and make possible to reveal the impacts of forest management activities on sediment transport processes in the future.

LAND COVER IMPACTS ON MESOSCALE PRECIPITATION FORECASTS

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The MM5 non-hydrostatic dynamic model was used to further evaluate the meteorological effects of Hungarian land cover changes. The lower boundary conditions for this mesoscale model were generated for two selected time periods (for 1900 and 2000) based on reconstructed maps. The dynamic model has been run with the same detailed meteorological conditions of selected days from 2006 and 2007, but with modified lower boundary conditions. The set of the 26 selected initial conditions represents the whole set of the macrosynoptic situations for Hungary. In this way, 2×26 “forecasts” were made with 48 hours of integration. The computed results show that although the land cover change does not have a significant effect on the average precipitation nation-wide, the impact on the regional distribution of precipitation is considerable, especially under unstable weather conditions.

USING HYDROLOGICAL CATCHMENT MODEL IN FLOOD FORECAST SYSTEM

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The extreme precipitations and the floods originating from them in the recent years highlighted that the adequate flood forecast on the upper catchment of the rivers can be implemented successfully only with connection of the hydrodynamic and the hydrological models. This kind of forecasting system were made for catchment of two Hungarian rivers (the Rába and the Mura) in 2011 developed by DHI a.s.; where the most of the frame conditions of hydrodynamic models are provided by an algorithm, called NAM; that is using a complex parameter kit. The NAM is an algorithm developed by DHI; which is based on water change processes between aquifers connected in series (e.g.: snow, surface, root zone, groundwater). Charging and overflow of the different aquifers were counted on the base of the parameters featuring the competent aquifer. The input data of the NAM model is the meteorological forecast and the output is the appearing discharge in the watercourse. The model runs hourly, therefore it uses the results of previous running so it continues counting with the stored water quantity of the aquifers. The catchments ending in gauge stations were calibrated by 5 year data series (snow, precipitation, temperature, humidity); calibration of other catchments was done by analogy. The forecast system recently is operating in test mode. On the base of our experiences the meteorological forecasts influence operation and punctuality of the forecast system significantly. Furthermore in case of not adequate calibration the stored water quantity can reach unreal quantity in the aquifers due to lack of feedback (mainly in case of snow).

HYDROLOGIC EFFECTS OF LAND COVER CHANGE: REGIONAL-SCALE CASE STUDIES FOR EUROPE

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Regional-scale sensitivity studies have been carried out to assess the climatic effects of a potential land cover change in Europe. For the end of the 21st century (2071-2090) the projected temperature and precipitation have been analysed applying the regional climate model REMO. It has been investigated, whether the assumed forest cover increase would reduce the effects of emission change. The magnitude of the biogeophysical feedbacks of afforestation on temperature and precipitation has been determined relative to the magnitude of the climate change signal. The simulation results indicate that for summer, afforestation may reduce the projected climate change through cooler and moister conditions in most parts of the temperate zone. The largest effects of forest cover increase can be expected in northern Germany, Poland and the Ukraine. The possible effects of afforestation on the hydrologic cycle have been analyzed for Hungary more in detail. Results may help to identify regions, where forest cover increase has the most favourable effect and should be supported for climate change mitigation. Data provide an important basis of the future adaptation strategies and land use policy.

IMPACT OF LOWLAND FORESTS ON WATER TABLE IN SHALLOW GROUNDWATER AREAS OF THE HUNGARIAN GREAT PLAIN

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Forest cover has significantly increased during the last century in Hungary from 1.1 to 2.0 million ha (nowadays on average of 15000 hectares are forested each year) and most of the forest was planted in Hungarian Great Plain. Hydrological effects of trees differs from that of crops or grasses in that, due to their deep roots, they extract water from much deeper layers. It has been demonstrated that trees cause water table depression and subsurface salt accumulation above shallow saline water table in areas with a negative water balance.

A detailed investigation of situation caused by the afforestation in the Hungarian Great Plain is being carried out through the systematic study of all affecting factors, like climatic water balance, water table depth and salinity, three species, subsoil layering and stand age. At the regional scale altogether 108 forested and neighbouring non forested plots are sampled. At the stand scale 18 representative forested and accompanying forested plots (from the 108) are monitored intensively. In this paper dataset of two neighbouring plots (an oak forest and a pasture) was compared (as one of the first result of this complex investigation). On the basis of the analysis it could be summarized that under the oak forest the water table was 0.44 m lower, and the diurnal amplitude of water table fluctuation was twice as large as under the grass vegetation in July 2012. Both results demonstrate greater groundwater use of forest vegetation.

RAINFALL-RUNOFF MODELLING OF EXTREME HYDROLOGICAL EVENTS IN THE UPPER HRON RIVER BASIN

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Floods have a negative impact on modern society; therefore, there is a need to analyse the possibility of the occurrence of different scenarios for extreme hydrological events in the design of flood defence. In this study the HRON (model type HBV) rainfall-runoff model was used to estimate extreme runoff events in the upper Hron River basin and create the scenarios of extreme hydrological events in daily time steps. The discharge wave was selected and calibrated. Scenarios of extreme runoff situations were created for design rainfall and snow water equivalent (SWE) values and their combinations. The uncertainties in the selection of the length of the discharge wave were assessed while creating scenarios with different design SWE values. The highest value of the simulated daily discharge was obtained in a scenario with design rainfall values with a 100-year return period, which caused an increase in the return period of the original discharge value from 20 to more than 1000 years. The return period of the volume of the flood wave was more than 1000 years from the beginning of the simulations.

USLE2D AS A PART OF THE UNIVERSAL SOIL LOSS EQUATION

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The aim of the paper is to introduce the Usle2D methodology as a part of the Universal Soil Loss Equation for estimating soil loss caused by water erosion based on hydrological, morphological, soil and vegetational conditions. The annual soil loss of arable land has been estimated by the empirical Universal Soil Loss Equation model; subsequently, the Usle2D methodology was implemented for this equation, and the results were compared. The solution was based on topographic maps, a digital elevation model, soil maps, and the current landscape structure map of the municipal cadastre region of Barďovo. The Geographical Information System IDRISI32, Cartalinx and Usle2D programs were used for the calculations.

COMPARISON OF NATURAL AND URBAN CATCHMENTS RUNOFF OF A SMALL STREAM IN SOPRON

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Runoff processes in natural catchments are significantly different compared to urbanized areas, which indicates the human impacts on the runoff process. This study presents one year monitoring of a small stream in comparing runoff from natural, rural and urban sections. The pilot area of this research is the Rák Brook which is the second largest stream of city Sopron (western Hungary). The natural headwater catchment is long-term research area of Hidegvíz Valley Project, therefore we had a good basis to extend the research catchment monitoring in the direction of urbanized lower part of the stream. Three monitoring points are compared along the longitudinal section of the stream. In each point the water stage is recorded continuously, and the discharge is derived by rating curves. With the help of the specific discharge the different sections are well comparable. The differences between the natural and modified catchments are quantifiable with the slope of a regression line on the precipitation vs. specific discharge point clouds.

PARAMETERS DETERMINATION OF A CONCEPTUAL RAINFALL-RUNOFF MODEL FOR A SMALL CATCHMENT IN CARPATHIANS

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The object of the paper is, first, to determine the parameters of a conceptual rainfall-runoff model for a small catchment in the Little Carpathians (Vištucký Creek), then to analyse how the selected characteristics of the model depend on the rainfall characteristics, and finally to compare obtained results with the study of Sikorska and Banasik (2010). For that purpose a correlation between the lag time (and k parameter) and the sum of the total and effective precipitation was used. The computer programme that was used to obtain the rainfall-runoff characteristics is based on Nash's model of the Instantaneous Unit Hydrograph (IUH) (Nash, 1957). The rainfall characteristics derived in this study are comparable to the results obtained by Spál et. al (2011). Interestingly, the analysis indicated that there is a correlation between the rainfall duration and the lag time, what is opposite to the compared previous study.

THE HYDROLOGIC ASPECTS OF THE NEW SURVEY OF LAKE FERTŐ/NEUSIEDLER WITHIN THE GENESEE PROJECT

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Twenty years after the first joint, Austro-Hungarian survey had been carried out for the Digital Elevation Models of the bottom of the Lake Fertő, a new survey of the lake and the Hanság channel have been planned in the GENESEE project. This new survey is much more developed from methodology point of view, applying ultrasonic measurements, airborne laser scanning and GNSS-based field point surveys. The supreme aim is to create high resolution, accurate and consistent DEMs about the bottom of the lake and about the surface of the sludge. Comparing our results with the former ones can give an overview on the behaviour of the sludge-movement in the near future. A detailed report is given about our actual results.

HYDROLOGICAL CHARACTERIZATION OF THE AGGTELEK KARST SPRINGS

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In Hungary, Aggtelek is one of the best-studied karst regions. Research started in the early 1960's to examine the surface and sub-surface hydrology of region. Investigations conducted by the Ferenc Papp Research Station included hydrometeorological measurements, surface flow experiments and analyses, direct and indirect determination of karst infiltration, and water level measurements in karst wells. Additionally, they examined spring behavior by recording variations of discharge (hydrograph) and physicochemical parameters, such as electrical conductivity, and water temperature. Between 1959-2000 daily measurements were conducted at the 15 largest karst springs. Based on this research, hydrogeologic characterization of the Aggtelek region is well-defined. Using water budget calculations, new methods were developed to determine karst infiltration. Spring discharge hydrograph analyses resulted in better understanding of basin flow characteristics and estimation of same-basin hydraulic properties. Deterministic rainfall-runoff models successfully simulated the hydrologic responses of watersheds in many non-karstic terranes. However, modeling of ground water flow in karstic aquifers has been less successful. This paper will show a conceptual model that will later be used in the HMS hydrological model.

CALCULATIONS OF THE NATURAL RECHARGE ON THE HUNGARIAN GREAT PLAIN

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The Duna-Tisza ridge is one of the largest recharge areas in Europe. There is an international project, which is coordinated by the IAEA to investigate the natural groundwater recharge at some test places in Europe. In Hungary a special research group carries out this special research program at two sampling sites named Méntelek and Kecske-mét. The aim of these researches is to build flow and transport models for the sample sites, which are based and calibrated on tritium isotope measurements and we could estimate the annual groundwater recharge.

The measurements based on the isotope hydrology and the transport modelling. The tritium is formed in the upper atmosphere during $-\beta$ decay. It has a half time, during the tritium decays to ^3He , which is 12.4 years in this case. From the 1950s the high-altitude nuclear tests introduced large amounts of tritium into the atmosphere. Because the short half-time of the tritium we can get some information from the last 50 years happening. MODFLOW is a U.S. Geological Survey modular finite-difference flow model. This computer code can solve the groundwater flow equation.

OBSERVED PRECIPITATION CHANGES IN HUNGARY WITH AN OUTLOOK TO THE CARPATHIAN REGION

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Climate change is expected to result in significant changes in precipitation in Hungary. Climate indices are used in several projects on climate change as prevailing indicators of changes in extremes. For describing the precipitation changes the number of wet days, days with heavy rainfall, greatest 1-day total, greatest 5-day total, simple daily intensity (precipitation sum/number of wet days), maximum number of consecutive days are analyzed in this paper. The changes of such indices for Hungary from the beginning of the 20th century to present are illustrated and analyzed on graphs and trend maps.

With an outlook to the Carpathian region the preliminary results of the CARPATCLIM project, hold by JRC and lead by OMSZ are introduced in this study. The homogenized, interpolated database is produced in daily temporal resolution for the period 1961-2010 and in 0.1° spatial resolution for many basic meteorological variables. The harmonized database achieved through the tender service in the CARPATCLIM project provides relevant outcomes for studying extremes. Several extreme precipitation indices are presented in this study for the Carpathian region as preliminary results of the investigations of the dataset.

ESTIMATION OF IDF CURVES BASED ON A SIMPLE SCALING METHODOLOGY IN SELECTED SLOVAK STATIONS

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A simple scaling methodology is used for estimating design rainfall, especially in places without rainfall measurements. In this study we applied a simple scaling method for estimating design rainfall values at three selected rain gauge stations in Slovakia. The data consisted of a historical rainfall dataset from 1961 – 2005. After deriving the monthly scaling exponents, we calculated the design values and IDF curves, which were finally compared with historical ones published in 1973 by Šamaj and Valovič.

SPATIALLY EXPLICIT DATA AND KNOWLEDGE FOR THE BLACK SEA BASIN, THE ENVIROGRIDS PROJECT

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The ENVIROGRIDS is going to provide spatially explicit data and knowledge for the GEOSS Societal Benefit Areas. The ENVIROGRIDS @ BLACK SEA CATCHMENT PROJECT is particularly targeted the needs for spatial data of the Commission on the Protection of the Black Sea Against Pollution (BSC) and the International Commission for the Protection of the Danube River (ICPDR). ENVIROGRIDS, being one of the flagship projects of the European Commission, is a pilot application of GEOSS and INSPIRE for the Black Sea Catchment.

After the project finishes, the sustainability of the Observation System is guaranteed through the connection to the United Nations, thanks to the UNEP/GRID team that is coordinating the project and promoting the data policy principles of GEOSS, by building a dedicated SDI. The Global Earth Observation System of Systems (GEOSS) is an international voluntary effort that aims at enhancing the relevance of Earth observations through the connection of existing SDIs and Earth Observation infrastructures. Through GEOSS, it is aimed to provide full access to spatial data on the environment on a non-discriminatory basis.

GEOSS puts a thematic focus on the nine so-called ‘Societal Benefit Areas (SBA)’, which are expected to gain the largest benefits from an effective implementation of GEOSS. The SBAs aim at: Reducing loss of life and property from natural and human-induced disasters, Understanding environmental factors affecting human health and well-being,

Improving the management of energy resources,

Understanding, assessing, predicting, mitigating, and adapting to climate change,

Improving water resource management through better understanding of the water cycle,

Improving weather information, forecasting and warning,
Improving the management and protection of terrestrial, coastal and marine ecosystems,
Supporting sustainable agriculture and combating desertification, and
Understanding, monitoring and conserving biodiversity.

ENVIROGRIDS will provide pilot applications for each SBA with a focus on water. ENVIROGRIDS is a capacity building project that aims at encouraging the implementation of GEOSS and INSPIRE principles and associated technologies as widely as possible. Several free courses are being organized in the Black Sea countries on the implementation of SDI. An e-learning platform is also under construction. The ENVIROGRIDS project has so far produced several guidelines concerning working with Inspire and GEOSS. These guidelines are freely available via our website. The project will create interesting datasets to explore different scenarios of climate, land cover and demographic changes in the catchment, and their impacts on water resources. Several pilot studies will also be implemented in different countries on the other Societal Benefit Areas. All the data created by ENVIROGRIDS will be made freely available through web services on the ENVIROGRIDS geoportal, where all the available data covering the Black Sea countries will be exposed. The ENVIROGRIDS SDI is built as an open platform where any organisation will be able to register its information.

COMPARISON OF TWO HYDROLOGICAL MODELS IN THE CONTEXT OF CLIMATE CHANGE IMPACT

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Change in river runoff under the conditions of changed climatic conditions in a partial mountainous catchment Váh were evaluated using two different hydrological models - conceptual spatially-lumped water balance model HBV and the fully distributed hydrological model WetSpa. In this study attention was mainly paid to changes in the seasonality of runoff and its components, changes in extremes, i.e., floods and droughts and the extent of their extremity, the occurrence and duration of droughts, and the occurrence of extreme run-off periods. It is optimal to use regional climate models to monitor such changes. Therefore, the climate model used in this study was a regional climate ALADIN–Climate model which was developed within the Sixth Framework Program CECILIA (Central and Eastern Europe Climate Change Impact and Vulnerability Assessment). The ALADIN–Climate regional model has a very high resolution – 10 km. The climate characteristics, such as air temperatures, precipitation totals, and relative air humidity, were simulated by the ALADIN–Climate model in daily time steps using the A1B emission scenario. Both hydrological water balance models were calibrated in a daily time step with data from the period of 1981–1995 and validated with data from the next 10-year period, i.e., 1996–2005. Based on the outputs of the ALADIN–Climate model, possible changes in the runoff for two future time horizons, i.e., 2021–2050 and 2071–2100, were estimated for the partially mountainous Váh catchment, which is located in Slovakia.

HYDROLOGICAL CHARACTERISTICS OF A COMMON OAK AND A HERBACEOUS VEGETATION SITE IN THE NORTH-EASTERN PART OF THE HUNGARIAN GREAT PLAIN

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Increasing pressure on groundwater due to land use change (e.g. afforestation) and future climate change will alter the recharge of groundwater aquifers, causing shifts in water table levels and hence influence the available groundwater resources. The effect of land use change on groundwater resources has initiated a major scientific debate during the last decades between foresters and experts in water management in Hungary and in several other countries. The aim of this study was to compare water balances of two different vegetation covers, a groundwater dependent oak forest and a nearby fallow area in the Hungarian Lowland.

Water balance components for an oak and a fallow plot, exposed to similar weather conditions and with similar soils were estimated and compared by calibrating the Hydrus 1-D model using measured soil water content and groundwater levels. The difference in the groundwater consumption was analysed in detail during dry and wet growing seasons.

Transpiration at the fallow plot was only about two-thirds of that in the oak forest, while groundwater consumption was three times higher in the forest than at the fallow plot throughout the two-year study. During the dry growing season, the proportion of groundwater use from the total transpiration reached up to 90% at the oak plot. According to the model, in the dry growing season in 2007 both vegetation covers relied significantly on groundwater resources while in

2008 the consumption of groundwater was notably reduced due to the wet weather at both plots.

SOIL WATER STORAGE AND CLIMATE CHANGE

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Wetland ecosystems exist in a transitional zone between aquatic and terrestrial environments. They are sensitive to indirect changes in regional hydrology, which implies that climate change represents a serious threat to many wetland ecosystems. Climate change mainly affects ecosystems through changes in air temperature, the regional precipitation regime, surface runoff, snow cover, the length of the winter season, groundwater storage and evapotranspiration. Climate change in wetland sites is significant when considering changes in soil water storage, which may also change the hydro-ecological conditions of wetland ecosystems and endanger rare wetland plant and animal communities. Therefore, in this paper, we are dealing with the consequences of climate change on soil water storage in the Zelenka National Nature Reserve. The impact of climate change was solved by meteorological characteristics modified by the GISS98 and CCCM2000 climate scenarios. Soil water storage was determined by the GLOBAL mathematical model for the time periods 2010, 2030 and 2075 in a 20-year time interval and compared with the reference period of 1971-1990.

MOISTURE CONTENT FLUCTUATION IN FOREST ROAD SUBGRADES

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Forest roads are constructed in sensitive environment, frequently in protected areas. As such establishments, they have a great impact on the hydraulic conditions of the region. Water content of the road subgrade has a major effect on the bearing capacity of the pavement as well. The aim of the research work is to quantify the fluctuation of the moisture content in the subgrades of forest roads. First results show relationship between soil moisture content and vegetation, and between soil moisture content and cumulated rainfall data.

ASSESSMENT OF MEAN ANNUAL MAXIMUM DISCHARGES AT UNGAUGED SITES USING ANNs

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In this paper Artificial Neural Networks (ANNs) are applied for assessing mean annual maximum discharges at ungauged sites. The methodology was tested for 145 small basins in Slovakia with areas ranging from 20 to 300 km². At the first, mean annual maximum discharges (index floods) were estimated for all the catchments. At the second, the catchments were divided into ten homogenous pooling groups using a clustering method, and for each pooling group mutually independent catchment characteristics were selected. The neural network was applied as a simple multilayer perceptron with one hidden layer and with a back propagation learning algorithm. Hyperbolic tangents were used as an activation function in the hidden layer. The efficiency of the methodology was tested by Nash-Sutcliffe and a correlation coefficient. The comparison showed better results for the index floods estimated in catchments divided into homogenous pooling groups.

URBAN RUNOFF MODELLING BASED ON A SUBCATCHMENT IN SOPRON

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The object of my work was building a hydrological model by using SWMM, dynamic rainfall-runoff simulation software. I had to show rainfall-runoff problems of the urban subcatchment area in Sopron via this model. I used lots of data from the parameter measurement process of a rainfall canals in a subcatchment area for the model building. This parameter measurement process was made by Institute of Geomatics and Civil Engineering Sopron, Hungary at 2010. I completed these data with own locality observations.

I made some rainfall simulations run with different rainfall amount settings, when the model was built up. I analysed rainfall diversion problems of subcatchment area with low intensity long term (9.1 mm / 10 h), and high intensity short term rainfall events (31 mm / 1.5 h). Running of the model showed some important problems about the water capacity of net of rainfall-ditch. Much of ditches of analysed area were sensibility for a high intensity, short term rainfall amounts rather than low intensity, long term rainfall events. In the future these information witches are given by the model can be used during planning of suitable rainfall-ditches, in considering of critical parts.

SIMULATING THE RAINFALL-RUNOFF PROCESS ON THE BASIN OF BÜKKÖS CREEK

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It has become basically relevant to get an appropriate introspection in catchment processes in order to predict floods which may occur easily under the extreme weather conditions of nowadays. Numerous empirical formulas exist in Hungary, which can be applied within certain limits (season, size of the watershed), furthermore using them in specific watersheds eventuate dissimilar results. In our study we execute hydrological analysis of a small watershed namely, the basin of Bükkös Creek, found in the Hungarian Visegrádi-hegység. The discharge values received from the authorities were checked by expeditional measurements several times at the outlet in 2011. These data were the foundations of the further calculated unit hydrograph (with traditional hydrologic methods) and rating curve. Finally we built a HEC-HMS model to simulate the hydrologic response of the watershed for different rain events. By calibrating and validating the model for two periods (winter and spring) with different runoff ratios, we were able to provide an approximation not only for the peak discharge but also for the whole runoff volume.

COMPARATIVE HYDROBIOLOGICAL STUDY ON THE NATURAL AND HEAVILY MODIFIED SECTIONS OF THE RÁK STREAM

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The study was dealing with the biological water quality of the Rák stream at Sopron. The main aim of the investigation was estimating the human impacts through the changes on the macroinvertebrate communities between the upper, nearly undisturbed sections and the lower, regulated courses crossing the settlement. Samplings were taken three times in 2011 according to the seasonal changes: each in spring, summer and autumn. In the spring of 2012 the sampling session was continued. The material has been classified with stereo microscope, determined on family level and evaluated using the Hungarian Macrozoobenton Family Point System. The records show high probability of nutrient load on the lower, regulated section supposed to coming from surface inflow and waste water. In contrary the upper flow does not have much human impacts so there are natural values and rarities among others a good population of a strictly protected dragonfly *Cordulegaster heros* which has community interest listed in the Annex II. of the EU Habitats Directive. Furthermore the upper section is regarded as a reference site of its category in the terms of the Water Frame Directive because of its good ecological status. Further studies on the Rák stream seem to have high importance because of conservational issues and reference status focusing on the structural and functional aspects of the community and the decomposing process based on quantitative samples. The monitoring program has been run so far should go on in the same way to produce comparable data to check up effects of the recent water works and local developments along the course within the settlement.

ESTIMATION OF FLOOD PEAK TRAVEL-TIME ON THE HRON RIVER: A CASE STUDY

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The discrete state space representation of the Kalinin-Miljukov model was used as the basis for a multilinear discrete cascade flood routing model. The time distribution scheme of model inputs was employed in the setup of the multilinear model and the travel-time parameter of the model was allowed to vary with discharge. The relationship between travel-time of flood peaks and peak discharge was studied on a reach of the Hron River. A polynomial and piecewise linear model of that relation has been considered. The shape and parameters of the piecewise model were fitted by optimisation of the multilinear model performance on a large flood wave with the help of a genetic algorithm in three settings. The resulting relationship fitted empirical data on travel times and was consistent with the physical interpretation of the factors determining the relation. The fitted empirical piecewise linear model was used to model the variability of the time parameter in the discrete state space representation of the Kalinin and Miljukov model on five verification floods. The modelling results showed that the inclusion of empirical information on the variability of the travel-time with discharge even from one flood enables satisfactory accuracy for the prediction of the flood propagation process.

MODELING OF WATER QUALITY CHANGE IN CATCHMENT OF ABANDONED ORE MINE SITE

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Generally, the waste dumps of abandoned multi-ore mines have huge heavy metal content which influences significantly the water quality of surface and subsurface catchments. There are some dangerous one which have high toxicity. To know the migration processes of these metals is important because their ecological and health risks are notable.

My research site is the abandoned ore mine site of Rudabánya where the migrations of mercury, lead, copper, zinc are investigated. After the completion of mining operations the huge open pit of Rudabánya was filled up by the precipitation and a lake was formed. The previous researches established that the heavy metal content of sediment in case of mentioned elements is high. It is easily thinkable that a part of this heavy metal content washed into the lake from waste dumps because there are many dumps around the lake. The final aim of my work is to construct the hydrodynamic model of waste dumps and utilize it for transport modeling.

Generally, the flow in the waste dumps is unsaturated flow. For modeling it in Rudabánya WHI UnSat Suite Plus v. 2.2.0.1 program was applied. One module of that program is VS2DT (Variably Saturated 2-D Flow and Transport Model) which is an unsaturated zone (vadose) modeling package and based on the Richards equation. The model describes transport of heavy metals with unsaturated water flow. The paper describes the results of prediction of the changes in water quality of this very special small watershed.

SPLIT SAMPLE CALIBRATION OF THE HVB MODEL USING ARTIFICIALLY GENERATED FLOWS

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Most of the studies that assess the performance of various calibration techniques have to deal with a certain amount of uncertainty in the calibration data. In this study we tested HBV model calibration procedures in hypothetically ideal conditions under the assumption of there being no errors in the measured data. This was achieved by creating an artificial time series of flows, which were created by the HBV model using parameters obtained from calibration of the measured flows. The artificial flows were then used to replace the original flows in the calibration data, which was then used for testing how calibration procedures can reproduce known model parameters by split sample calibration, where the input dataset is split into two halves with each of them being calibrated separately.

WEIGHTED USABLE AREA OF THE FISH COVERS FOR BROWN TROUT ON THE DRIETOMICA RIVER

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The ecological status of a river is influenced by many factors, of which the most important are fauna and flora, which in this paper are defined as "habitat". During the years 2004, 2005, 2006 and 2011, research on hydroecological quality was evaluated in a reference section of the Drietomica River. Drietomica is a typical representative river of the Slovak flysch area and is located in the north-western part of Slovakia, in the region of the White Carpathians. In this article the results of microhabitat modeling a microhabitat by means of the Instream Flow Incremental Methodology (IFIM) are presented. For the one-dimensional modeling, the River Habitat Simulation System (RHABSIM), was used to analyze the interaction between a water flow, the morphology of a riverbed, and the biological components of the environment. The hydroecological quality was evaluated after detailed ichthyological, topographical and hydro-morphological surveys. The main step was assessing the biotic habitat characteristics through the suitability curves for Brown trout. Suitability curves are a graphic representation of the main biotic and abiotic preferences for a microhabitat's components. The suitability curves were derived for the depth, velocity, fish covers and degrees of the shading. Nineteen fish covers were closely monitored and evaluated to evaluate the quality of the aquatic habitat. The results of the Weighted Usable Area ($WUA = f(Q)$) were evaluated from a comprehensive assessment of the reference reach of the Drietomica Stream.

RAINFALL INTERCEPTION BY LITTER OF THREE DIFFERENT FOREST ECOSYSTEMS IN SOPRON HILLS

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The climate modifier and water storage effects of forests have been published for decades in scientific literature. There are also a fairly lot paper can be found in the theme of forest crown interception, but hardly any publications analyse in detail forest litter interception, through depending on mainly the mass of the forest litter it can be a non negligible part of forest water budget. In this paper we present the results of a four years long forest litter interception investigation in case of three different forest ecosystems (a Common Oak, a Beech and a Spruce forest) in Sopron Hills. On the basis of the dataset we analyzed the composition of forest litter from moisture characteristic point of view. We determined the factors most affecting the water uptake and the storage capacity of forest litter. Interception loss equations and desiccation curves had also been outworked successfully in case of the above mentioned three ecosystems.

REGIONAL SNOW ASSESSMENT AND EARLY WARNING OF SNOWMELT INDUCED FLOODS

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Precipitation falling to the land surface is one of the most important elements of the hydrological cycle, and it is the only input term of the water balance on the earth surface. In those areas of the Earth where a part of the annual precipitation falls in form of snow the rhythm of the hydrological cycle, that is that of the water balance within the year, follows a pattern that deviates from that of the precipitation record. Precipitation falling in solid state enters the hydrological cycle with a time lag that might be as much as several months after the precipitation event. Therefore, instead of considering the observed values of precipitation when describing various elements of the hydrological cycle, it is more expedient to take the surface water income into account. This is the fraction of precipitation which is present in the land surface in liquid state. Consequently the most important task of the various snow models is to transform the observed precipitation values into surface water income values.

The HOLV snowmelt model is developed by Hungarian National Hydrological Forecasting Service (VITUKI OVSZ). The model originates from the early 80's and it is under continuous development, while recently its distributed version over a grid with 0.1 degree resolution is in use to assess snow accumulation and ablation. The snowmelt model has a flexible structure; it is able to change its own structure in function of data availability. In case when only precipitation and air temperature data are available temperature index method is used. When also other data are accessible (cloudiness, dew point, wind speed) using of energy balance model is to be preferred. If there are suitable data available for calculation of the energy terms, the energy balance method can be applied. Otherwise the degree-day or temperature index method can be used. The temperature index is considered

time-variable, as a consequence of seasonal changes of the solar radiation values corresponding to the same air temperature, and even of changes of the albedo of the snow surface. The calculations need to be carried out with a daily time step. Since the application presumes conditions free of snow when started, it is proper to begin the calculations at the time of the year when the catchments are covered with minimum quantity of snow.

Spring time runoff largely depends on the snowmelt component and it gives a possibility estimate expected seasonal volume of flow and flood peaks. Seasonal forecasts based on the relationship between snow resources and expected precipitation during spring months have been analyzed for Danube and Tisza rivers.