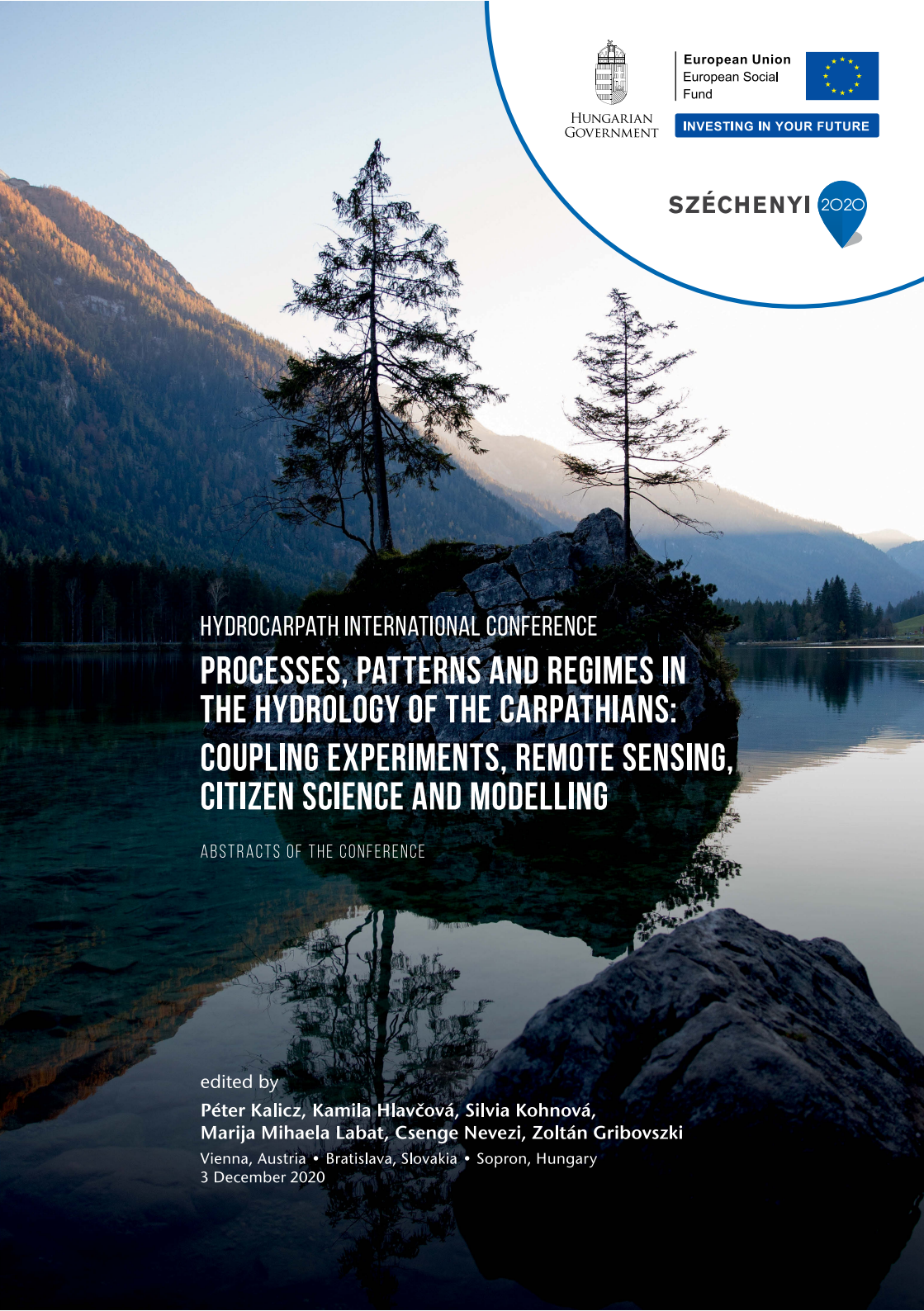

HYDROCARPATH INTERNATIONAL CONFERENCE

PROCESSES, PATTERNS AND REGIMES IN THE HYDROLOGY OF THE CARPATHIANS: COUPLING EXPERIMENTS, REMOTE SENSING, CITIZEN SCIENCE AND MODELLING

ABSTRACTS OF THE CONFERENCE

edited by

Péter Kalicz, Kamila Hlavčová, Silvia Kohnová, Marija Mihaela Labat, Csenge Nevezi, Zoltán Gribovszki

Vienna, Austria • Bratislava, Slovakia • Sopron, Hungary
3 December 2020

HydroCarpath International Conference

Processes, Patterns and Regimes in the Hydrology of the Carpathians: Coupling Experiments, Remote Sensing, Citizen Science and Modelling

Abstracts of the Conference

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Bratislava, Slovakia,
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RECENT DEVELOPMENTS IN ESTIMATING LARGE-SCALE TERRESTRIAL EVAPORATION WITH MINIMAL DATA

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Recent developments in the complementary relationship of evaporation make it possible to estimate large-scale terrestrial evaporation rates (5-day and longer averages) with an unprecedented accuracy and without any calibration. The method is physically based and outperforms complex remote-sensing, reanalysis, AI-based, and land-surface models, especially when long-term trends are concerned. The approach does NOT need any information on land-surface properties (e.g., land-use, vegetation cover, soil type, etc.), soil moisture status, or precipitation. It requires only net surface radiation (or the duration of sunshine at a minimum), the air and dew-point temperatures, and wind data. It is built on the inherent feedback mechanism in land-atmosphere interactions via the so-called "oasis" effect. The method is especially suited for long-term, continental-to-global scale modeling of the hydrological cycle and especially its long-term nonlinear trends, which are made possible by typically available classical meteorological data.

MEAN ANNUAL TOTALS OF ATMOSPHERIC PRECIPITATION WITH RESPECT TO CYCLONIC SITUATIONS IN THE SLOVAK PARTS OF THE CARPATHIAN MOUNTAINS AND PANNONIAN PLAIN

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Atmospheric precipitation during cyclonic situations was analyzed using weather type classifications. Data from the period from 1991 to 2015 were processed. The cyclonic situations observed were analysed in terms of the frequency of days with a given weather situation during the period 1991–2015. We analyzed cyclones affecting Central Europe from the west and northwest, north and northeast, east and southeast, and south and southwest. We identified a declining number of days that can be classified as cyclonic. The distributions of the mean annual precipitation totals for these cyclonic situations have been visualized. The highest mean annual precipitation totals occurred during Wc, NEc and Ec of the weather types. The lowest mean annual precipitation totals were observed during the SWc1 and Nc types. The percentage of the individual cyclonic weather types and supertypes in the mean annual precipitation total was calculated. Overall, the supertype W + NW with the Wc type occur with the highest frequency, although variations may arise due to windward and leeward effects.

Keywords: atmospheric precipitation, cyclonic situations, mean precipitation total, Carpathian Mountains, Pannonian Plain

AN APPLICATION OF WATER EVALUATION AND PLANNING (WEAP): A SOLUTION FOR SPECIFIC PROBLEMS IN THE STRUCTURAL DESIGN OF A WATER BALANCE MODEL

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The basis of the water management policy of Slovakia is the idea of the sustainable use of water resources. For optimal and successful development, planning and predictions in water management, a detailed picture and knowledge of the need for water in space and over time is needed. Water management balances are one of the primary activities of water management in securing claims for water.

As part of the efforts to model a retrospective water balance in Slovakia, software for a water evaluation and planning system (WEAP) was selected. To maintain the established methodology for processing and evaluating the balance, a procedure for compiling the scheme and data structure of the model was created. The Hron river basin was selected as a pilot area for which the 20-year period in the years 2000-2019 was retrospectively assessed in a monthly step. The goal was to create a fast and efficient procedure for building and calibrating the model using the internal functions of the WEAP software.

Gradually, a methodology for assembly of the reservoir, water use, sub-basin runoff distribution, and water transfers was integrated. The resulting model distributes the outflow from the sub-basin, so that the calculated flow in the gauging stations is equal to the measured flow. Thanks to this function, it is possible to model various flow rate scenarios and freely add and remove inputs to the model without any calibration.

Keywords: WEAP, water balance, model building

COMPARISON OF DIFFERENT HYDRO-METEOROLOGICAL DATA FOR EVENT-BASED HYDROLOGICAL MODELLING

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This study aims to investigate the hydrological efficiency of a satellite (NASA, H-SAF), re-analysis (ECMWF), and measured (OMSZ) data for event-based runoff modelling. First, a catchment with a proper size and availability of data was identified. The Sorok-Perint creek catchment was found to be suitable with two sub-catchments; i.e., the Jáki-Sorok and Arany creeks with areas of 132 and 106 km^2, respectively. The catchment model was created using ArcGIS and HEC-GeoHMS. The model used is deterministic, event-based and lumped; it was built using HEC-HMS. The precipitation, discharge, temperature, and snow data were collected from the above-mentioned data sources. From the available time series, flood events were selected for calibration and validation. The practicability of the data was categorized based on its quantity and timing measures. The different data sources were compared and ranked according to various aspects separately for rainfall and snowmelt modelling.

COMPARATIVE ANALYSIS OF CATCHMENT RESPONSE TIMES AND THEIR DEFINITIONS USING MEASURED AND RE-ANALYSIS RAINFALL DATA

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No solid methodology is available to estimate the true value of catchment response time parameters based on measured time-series. The theoretical differences between time parameters, such as the lag time, time of concentration (Tc), time to peak and time to equilibrium are emphasized, based on the results of a comprehensive analysis of 8 different definitions. The calculations were carried out using measured rainfall and runoff data for 61 Hungarian catchments. The measured values of Tc were calculated using the 8 definitions for 2152 events (35 events per watershed on average). Since the availability of measured rainfall time-series is limited in Hungary, the practicability of European Centre of Medium-Range Weather Forecasts (ECMWF) re-analysis data were examined. Based on the results, ECMWF data is a reliable alternative to assess the response time of medium-sized catchments. Additionally, we identified the most suitable definition of Tc based on both a theoretical basis and practical aspects to ensure objectivity and robustness.

RECOGNITION OF FLUVIAL ICE BY WEBCAMS

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For most Hungarian rivers, especially the Danube, floods and other damage caused by ice have produced and are producing serious problems. The main focus of the research presented in this article emphasizes the advancement of the methodology of monitoring river ice by webcams.

The key objectives are to:

- Develop a fast, automated, cost-effective, and continuous ice-collection method based on web camera images with a precision far beyond their manual or estimation procedures and verify the solution developed through analysis of errors. Solutions that do not require specialized software were preferred.
- Analyze the time pulsation and daily travel curve of the ice jam coverage ratio of the Danube with the high frequency measurement process developed.

The aim of this paper is to promote modernization of Hungarian ice observations and provide a numerical basis for scientific research related to this topic. It has been demonstrated that a web-based, automated river ice-monitoring system can be used as a detail-driven hydrographic tool and can provide more accurate results than the currently used estimation or manual image processing methods.

Significant temporal pulsation and daily periodicity in the ice movement of the Danube reach were observed with the method of determining the ice coverage. The new findings contribute to a more accurate understanding of the spatial and temporal structures of ice floes in rivers, as well as the methodological development of their measurability and reproducibility.

This work is aimed at creating a basis for the modernization of the Hungarian ice-monitoring network. The operation of such a network should ensure that in the future, ice floe forecasting and alarm systems on larger rivers may be established. The time series collected over the past decades also provides data for national research on river ice.

Keywords: fluvial ice, web camera, ice coverage, ice observation, hydrometry

Analysis of the hydro-meteorological data in the Hidegvíz Valley experimental catchment between 2017–2020

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The analysis of meteorological data is a key process in hydrological research. In the Hidegvíz Valley experimental catchment in Hungary, these data have been collected since the 1990s and used for various purposes. In 2018-19, research began that aimed at revealing the connections between the hydrological and botanical characteristics in an elder forest and a neighbouring meadow. Meteorological measurements in both ecosystems helped with understanding changes that occurred in the groundwater levels, soil moisture and vegetation. After this successful one-year long study, we realised that further measurements and their analysis were required because of a need for more accuracy and detail. Moreover, the precise data will also be necessary for future modelling.

The data that was collected in the years 2017–2020 were chosen as a starting database. For the first analysis we selected the three most important meteorological parameters, i.e., precipitation, and the air temperature and humidity. The parameters were measured by automated devices, except for the precipitation. We determined that an automated tipping-bucket rain gauge needs manual control by a Hellmann-type rain gauge, because if the rain intensity is too high, the data is that collected by the automated device will be invalid. The results of the analysis were displayed in graphs and charts.

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Key words: data pre-processing, analysis, modelling

LINKING FIELD OBSERVATIONS WITH HYDROLOGICAL MODEL SIMULATIONS IN A SMALL CATCHMENT

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The aim of this study was to explore the value of field observations for calibrating a hydrological model for small catchments. The analysis was conducted in a small experimental catchment, i.e., the Hydrological Open Air Laboratory in Austria (66 ha). A bucket-type, spatially lumped hydrological model was parameterized according to two approaches. First, the model was calibrated using only runoff data. Second, a step-by-step approach was proposed, where the three modules of the model (snow, soil moisture and runoff generation) were calibrated using a large variety of field observations besides runoff. The model's performance for the two approaches was evaluated on annual, seasonal and daily time scales in terms of how well snow, soil moisture, evapotranspiration, overland flow, changes in storage in the saturated zone, and runoff were simulated. Using the proposed step-by-step approach, the errors in the runoff volume errors in the calibration and validation periods were 0.00 and -0.01; the monthly Pearson correlation coefficients were 0.92 and 0.82, and the daily logarithmic Nash-Sutcliffe efficiencies were 0.59 and 0.18, respectively. Through the use of different sources of data besides runoff, not only runoff but other model fluxes and state variables, were well simulated.

Keywords: hydrologic model, field measurements, experimental catchment

ASSESSING THE USE OF ASCAT SOIL MOISTURE AND MODIS SNOW COVER MAPS FOR THE CALIBRATION OF THE TUWMODEL

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Progress made in satellite observing technology for soil moisture and snow cover provides opportunities for improving the reliability of hydrological models. In this study, we evaluated the recently processed ASCAT soil moisture (SSM) and MODIS snow cover maps (SSC) for calibration of a hydrological model. The SSM is a new experimental version for enhancing vegetation parameterization technology and ensuring finer spatial resolution. The SSC is obtained by using seasonally variated Normalized Difference Snow Index (NDSI) thresholds. In this study, we evaluated the calibration strategies using runoff observations, SSM, and SSC of different weights in 213 catchments of Austria for a semi-distributed conceptual hydrological model. The results show that the calibration of the TUWmodel using SSM could improve soil moisture simulation and using SSC could improve snow simulation. Using SSM and SSC together could improve both soil moisture and snow cover simulations. Using SSM and SSC individually or jointly has the potential of improving runoff simulations to varying degrees. The improvements in the runoff and soil moisture are more obvious in the low elevation area and arable lands.

EVALUATION OF THE SWAT MODEL FOR SIMULATING STREAMFLOW IN THE CUHAI-BAKONYÉR WATERSHED, HUNGARY.

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Hydrological studies on a watershed scale have been widely adopted as a method to assess and manage important water resources. Therefore, understanding the quantity of water resources distributed spatially and temporally is vital to their sustainable management. The research presented herein therefore evaluates the performance of the Soil and Water Assessment Tool (SWAT) model in analysing watershed hydrology and streamflow variability in Western Hungary. The model was calibrated manually using daily streamflow data from 1998 to 2005, which was then validated by comparing the predictions to measurements from 2007 to 2008. The quality of the predictions was evaluated using two statistical indicators: the determination coefficient (R^2) and the Nash – Sutcliffe Efficiency (NSE). Both, the NSE and R^2 were found to be greater than 0.6 for the calibration period. In the validation period, the R^2 and NSE values were [0.5] and [0.41] respectively. These interesting results obtained with the SWAT model suggest that it could be a promising and suitable decision support tool to predict water balances and yields in other watersheds in Western Hungary for the sustainable management of water resources.

Keywords: Hydrological modeling; SWAT model; Cuhai-Bakonyér watershed; streamflow; SWAT calibration.

HYDROLOGICAL MODELING OF THE GAJA CATCHMENT USING A GR4J LUMPED CONCEPTUAL MODEL

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The daily rainfall-runoff behavior within the Gaja catchment was modeled by comparing predictions from the Génie Rural Journalier (GR4J) conceptual model to rainfall and streamflow data collected over a 30-years period. The catchment covers nearly 500 sq. km. in Hungary's Central Transdanubian Region and is monitored by five stream gauges and seven rain gauges. Our goal is to develop the GR4J model within the R programming language framework in order to provide accurate and stable predictions of streamflow throughout the catchment. To evaluate its performance and to predict streamflow, the GR4J model was applied to the Gaja's five sub-catchments. We used three comparison measures: NSE, KGE, and RMSE over the course of three modeling periods: Calibration, Validation, and Application. The results were used to find the optimum parameters for the GR4J model. A good model performance was achieved for four sub-catchments while an unsatisfactory performance occurred in the fifth; this was due to inadequate meteorological data and a different characteristic pattern of spatial rainfall. We observed that an accurate model could be calibrated and validated based on reliable measurements during a stable climate period of one to several years in one isolated basin of the study area.

THE VARIANCES IN THE PARAMETER AND CALIBRATION EFFICIENCIES OF TWO HBV-TYPE MODELS

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The selection of a suitable model structure is crucial for each hydrological calibration process, because different models can provide different results. In this paper, we focus on how a model's structure can affect the efficiencies of the parameters and also the runoff calibrations.

For this work, we selected 180 Austrian catchments, which we divided into two groups. The first group we called the "Lowland catchments"; there, the runoff is mainly affected by rainfall. The second group we called the "Alpine catchments"; there, the runoff is highly affected by water from melted snow and glaciers. The catchments also have variable morphologies, altitudes, land uses, etc., which were also important for the testing of the runoff model's efficiencies in different conditions. For the calibrations, we used two types of a TUW conceptual HBV-type model in lumped, and semi-distributed versions. We ran the calibration in the period 1991–2000 and compared the efficiencies of the runoff model and the range of the parameters. In the final results, we determined that the semi-distributed version of the model achieved better runoff efficiency results with a lower degree of uncertainty in the range of the parameters.

Keywords: HBV model, efficiencies, Austria

IMPACT OF UNCERTAINTY ABOUT PARAMETERS ON FLASH FLOOD PREDICTIONS IN TWO UNGAUGED HUNGARIAN WATERSHEDS

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In the last 10 to 15 years, rainfall patterns have changed in Hungary; the duration of storms are decreasing, while their intensities are increasing. This trend has a major impact on flash flood events in small watersheds with medium to steep slopes. Within these watersheds, the difference between the base flow and high flow is extreme, and now the differences are becoming even greater. For ungauged watersheds, where little or no flow data are available, predicting flash floods is even more uncertain. However, flash flood events can be predicted by hydrological and hydraulic modelling approaches. In this paper, sensitivity analyses of selected parameters were conducted for hydrological and hydraulic models, and the impact of their uncertainty on model predictions are evaluated for two watersheds.

In most cases, watersheds with higher than average slopes can be represented by lumped hydrological models that require fewer parameters and less data on the spatial scale. Another approach uses 2D hydrodynamic models with precipitation as the upper boundary condition and variations of roughness coefficients to adjust peak flow and arrival time predictions. While lumped parameter approaches are useful, new rainfall patterns can magnify possible errors in assumptions about parameters.

In this paper we examine how imperviousness (hydrological model) and surface roughness (hydraulic model) affect predictions of the peak flow and time to the peak for a short duration/high intensity rainfall event.

Keywords: Numerical modelling, watershed hydrology, hydrodynamics, parameter sensitivity

IMPACT OF LAND USE AND CLIMATE CHANGE ON DESIGN FLOODS IN SELECTED RIVER BASINS IN SLOVAKIA

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Changes in land use are caused both by humans and nature. They can be perceived as a transformational process of a natural landscape that usually gives priority to the functional role of land for economic activities (e.g., deforestation, overgrazing, rapid population growth, urbanization, and industrialization, etc.). The specific factors that affect land-use changes vary not only over time but also by geographical scales.

In recent decades, extreme flash floods caused by short-term rainfall have become one of the most common environmental threats in Europe as well as in Slovakia. This threat is reflected in the large number of studies on extreme rainfall, flash floods, and flood protection. For successful risk management of these extreme events, it is essential to know if they have been (or to what extent they have been) affected by changes in land-use and practices. Although rainfall is the most important external factor that affects the occurrence of floods, attention should also be paid to slow land-use changes, such as:

- changes in forestry;
- increased protection of ecosystems and of natural measures to capture water (e.g., grassing of the territory, afforestation, etc.);
- changes in vegetation in response to climate and ecological changes;
- and other factors.

This research aims to compare changes in land-use for the period from 1990 to 2018 on the territory of Slovakia and to assess the impact of the climate and changes in land use on design floods.

Three river basins were selected and analysed, i.e., the Hnilec River Basin, which is the largest right tributary of the Hornád River; the Štiavnička River Basin, which is a left tributary of the Bystrianka River; and the Veselianka River basin, which a the left tributary of the Biela Orava River. The two selected river basins of the Štiavnička and Hnilec streams are located in central Slovakia, while the Veselianka river basin is located in the north of Slovakia.

Favourable interventions in the way the land is used can bring positive results. Hence, it is important to assess and analyse changes in land use over

time. The results of this research provide an overview of the changes in land use in selected river basins for the last couple of decades. Based on the results, appropriate natural measures will be proposed in future research.

This publication is the result of the implementation of the project: "Scientific support of climate change adaptations in agriculture and mitigation of soil degradation" (ITMS2014+ 313011W580), which is supported by the Integrated Infrastructure Operational Programme funded by the ERDF. This work was also supported by the Slovak Research and Development Agency under Contracts No. APVV- 18-0347.

INVESTIGATING THE CAUSES OF CHANGES IN FLOOD QUANTILES ACROSS EUROPE DURING THE PAST FIVE DECADES

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Recent publications have detected trends in the mean flood behaviour and quantiles across Europe during the past five decades. In this study, we investigated causes of the observed flood trends as a function of the return period with a regional non-stationary flood frequency approach. It consists of a regional Gumbel distribution, the parameters of which were modelled as functions of extreme precipitation, antecedent soil moisture, and snow melt (i.e., potential drivers of flood changes). A Bayesian Monte Carlo Markov Chain approach was used for estimating the parameters. The contributions of each driver to changes in flood quantiles associated with small and large return periods (i.e., 2-year and 100-year floods, respectively) were estimated and compared. Annual maximum flood discharges from 2370 hydrometric stations in Europe and smoothed time series of catchment-averaged precipitation and snow melt were analysed over 5 decades (1960–2010). The results of this study showed that extreme precipitation contributed to positive flood changes in North-western Europe and to negative flood changes in Southern Europe. Its contributions generally decreased in absolute value with the return period. Antecedent soil moisture mainly contributed to negative flood trends in both flood quantiles in Southern Europe. Its relative contribution to flood changes decreases with the return period, while the opposite was observed for extreme precipitation in this region. In eastern Europe snowmelt contributed negatively to changes in both 2-year and 100-year floods.

Keywords: attribution of flood changes; potential drivers of flood change; regional flood frequency analysis

ASSESSMENT OF THE IMPACT OF ANTHROPOGENIC CHANGES AND THE FRAGMENTATION OF FOREST STANDS ON THE QUALITY OF RIVERBANKS

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Forest stands have multiple functions in addition to riverbank protection, erosion control, water protection, and landscaping functions. These functions of forests ensure the proper hydration of ecosystems, which are, however, disrupted by anthropogenic activity. Forest and aquatic ecosystems have evolved and are shaped by human needs. From the set of individual factors that are necessary for the proper functioning of an ecosystem, ecological conditions and forest structures play a central role. The construction of new infrastructures, heavy urbanization, and improper river regulation are the main causes of the fragmentation of habitats. Fragmentation is a dynamic process by which separate areas are increasingly isolated. This increases the range of areas affected by the peripheral factors to which these fragments of forest biota are subject. The fragmentation of forest ecosystems disrupts not only forest ecosystems but also the stability of riverbanks and the quality of surface waters. Through the destruction of forests, the soil is eroded in places where it was previously stabilized by a forests root system. This process causes particles of pollutants from agricultural land and urban areas to enter surface waters. The transformation of forest habitats, the soils and humus layers of which can filter harmful substances from agricultural or urban surface waters, decreases this ability and significantly affects the pollution of surface and groundwater. In our study, we have compared the map data in the research area of the Bratislava, Slovakia, neighborhood of Petržalka from 1782 to the present. During this period, there have been substantial changes in land use that have affected this area negatively.

EFFECTS OF URBANISM ON THE SOIL OF WATERCOURSES IN THE AREA OF KAPOSVÁR (SOUTHWESTERN HUNGARY)

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The purpose of this research was to assess the effects of urbanism on soils near the watercourses of the city of Kaposvár, Hungary. The watercourses are drained by the Kapos stream, which also flows through the city. The length of the Kapos stream is 112.7 km within a 3170 km^2 catchment area. The Kapos catchment consists of the Füred, Zselic, Kisgát, and Deseda creeks. The last two watercourses are the most significant; besides, the Deseda creek forms an artificial lake in the northern part of the settlement.

To detect anthropogenic changes, we examined samples from 15 different sites in the city. Five samples originated directly from the banks of the streams, and 10 samples were located near some of the watercourses. The measurements were carried out according to the usual standards and statutory requirements.

The soil's pH was determined potentiometrically (H2O and KCl, ratio 1:2.5, 12 hours after mixing). We measured a CaCO3 content with Scheibler's calcimeter and determined the soil texture based on the USDA particle-size classifications. Furthermore, the bio-available toxic metal was determined by ICP-OES equipment.

In terms of the impact, the values we measured were mostly slightly alkaline; therefore, the pH was 7.8 on average. One of the samples in the suburbs showed a susceptibility to soil acidification. However, the CaCO3 content was around 7%. Looking at the particle size distribution, we detected sand and loam fractions, which were partly due to the surface of the region and the human influences. Thus, the skeletal percent was only 7%. The bio-available Cd, Co, Cr, Cu, Ni, Pb, Se and Zn measurements showed a limit that was only exceeded at site 22 (21.3 mg Zn/kg), site 37 (23.2 mg Pb/kg), and site 39 (0.95 mg Cd/kg). Sites 37 and 39 are located along the Kapos Stream close to the railway station. The samples showed the properties of the urban soils based on all the parameters we examined. The human factor has caused visible changes, even in the case of the sandier soils that have not accumulated contaminants.

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REDUCING THE NEGATIVE MICROCLIMATIC PROPERTIES OF AN URBAN STRUCTURE BY RESTORING THE RESILIENCE OF THE ELEMENTS OF THE SYNANTHROPIC AND CULTURAL GREENERY

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Creating a proposed urban landscape is a dynamic process in which a portion of structures of an artificial anthropogenic character and an anthropogenically altered natural character change. Due to expansive urbanization, the ratio of these structures has gradually changed in the territory of Slovakia; a trend of decreasing areas of natural character continues at the expense of development. Vegetation structures thus lose their local connectivity networks and become increasingly isolated, thereby reducing biomass production and structural complexity, which leads to an overall reduction in biodiversity. Due to the disruption of the connectivity of bio corridors from the impact of the climate crisis in residential structures, their importance is constantly increasing. To maintain stability in the given localities, proposals for the renewal of green infrastructures are necessary.

Based on an analysis of the urban structures of regional cities in Slovakia and elements of vegetation, the greenery attached to water elements can be identified in most cases as the main component of the system of ecological stability in urban structures. Considering the changes in microclimatic and macroclimatic conditions due to climate change, it is possible to evaluate the disruption of self-regulatory mechanisms by significant disruptions of the landscape patterns. In the case of Slovak regional towns except for Banská Bystrica and Nitra, it is possible to review the low percentage of the utilization of the eco-stabilization function of water elements due to the fragmentation or deterioration of urban woody vegetation.

Keywords: urban greenery, urban landscape planning, synanthropic greenery elements

ASSESSMENT OF THE LANDSCAPE OF A SMALL WATER RESERVOIR WITH AN EVALUATION OF WATER QUALITY INDICATORS

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The main aim of the study is an evaluation of the current state of Ratka, a small water reservoir in Slovakia, and its surroundings, together with an assessment of the quality of its surface water. The Ratka small water reservoir is located in the southern part of Slovakia in the district of Lučenec. Monitoring water reservoirs represents an indispensable part of their technical control to provide a satisfactory fulfilment of the purposes for which they were built. The interaction between reservoirs and the environment is very strong; reservoirs affect the environment, and the environment influences the reservoirs. Therefore, it is important to maintain the good condition of water reservoirs and thus protect the surrounding environment as well.

Ratkas water quality was measured and evaluated in the laboratory and field. The water quality was assessed by various parameters, i.e., the water temperature, salinity, negative decimal logarithm of the hydrogen ion activity, electrolytic conductivity, the total amount of solutes, nitrogen and its compounds, phosphorus and its compounds, the chemical oxygen demand, and the total organic carbon. The assessment of the water quality together with evaluations of the current state of the water reservoir represents one of the most important aspects of water management. Because a large number of chemicals are used nowadays, monitoring water quality plays an important role in water management. The results of the study include a comparison between the terrain and laboratory measurements of the water quality of the Ratka water reservoir with the actual government regulations. The actual state of the small water reservoir was evaluated in a complex way together with a proposal for its renewal leading to an improvement of its condition.

Key words: water reservoir, quality of water, landscape, chemical analysis, terrain measurement

THE MAIN SOURCES OF THE EMISSIONS OF TOTAL PHOSPHORUS AND TOTAL NITROGEN IN THE SURFACE STREAMS OF SLOVAK RIVER CATCHMENTS

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Excess phosphorus and nitrogen in surface streams is one of the main environmental problems that leads to the eutrophication of surface waters and the impairment of the water quality with substantial negative effects on biodiversity, human health, and the economy. The rational management of the phosphorus and nitrogen levels in surface streams requires an understanding of all the lows and pathways between their sources and recipients.

In this study, we identified the most important total phosphorus and total nitrogen emission pathways. We quantified the amounts of total phosphorus and total nitrogen that enter surface streams in a one-year period based on data collected from twenty river catchments on the Slovak territory. For this purpose the GIS-oriented MONERIS conceptual model was used.

The most important emissions pathway for total phosphorus is agricultural erosion, which makes around a 36% contribution to the overall total phosphorus emissions. The second pathway is the subsurface flow (23.5%). The point pollution sources and urban areas not connected to the sewer system also have a not negligible impact. The urban areas connected to the sewer system, surface runoff, natural erosion, atmospheric deposition, and drainage systems only make a negligible contribution.

Most of the total nitrogen emissions enter surface streams via the subsurface flow (62%). In some cases drainage systems (11%) and point sources (9%) also contribute significantly.

A negligible contribution to the annual total nitrogen emissions come from emission pathways as follows: agricultural erosion, urban areas not connected to a sewer system and urban areas connected to a sewer system, atmospheric deposition and natural erosion.

The proportion of emission pathways on the overall total phosphorus and total nitrogen emissions have similar features. Only in some cases distinct differences also occur, depending on the different site-specific situations and interactions between the anthropogenic activities and natural conditions (river catchment parameters). The MONERIS model is a useful tool to quantify these relationships on a catchment scale.

In the context of total phosphorus and total nitrogen, it is in general possible to recommend measures for Slovakia that may improve water quality

in surface streams. The key factors would mainly involve decreasing nitrogen surplus on agricultural land and also erosion from agricultural areas in the case of total phosphorus. In addition, the reduction of nutrients originating from point pollution sources may lead to further water quality improvements in both cases.

QUALITY OF AN AQUATIC HABITAT OF REGULATED STREAMS

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The research presents an assessment of regulated mountain and piedmont streams in Slovakia and the quality of their aquatic habitats, after self-naturalization processes without other than the initial anthropogenic modifications. All the streams modelled, including regulated and natural reaches of the streams, are designated in a Slovak trout zone established by Ministry of the Environment of the Slovak Republic. Other regulated reaches are in urban areas and registered on a heavily modified water bodies list according to the Water Framework Directive 2000/60/ES. The highly modified water bodies are extensively influenced by river regulations, concrete panels, channel narrowing, and large amounts of urban runoff pollution. On the other hand, natural streams offer rugged geomorphological structure and various fish shelter possibilities. Therefore, a natural channel serves as a bio-corridor that leads to the preservation of the natural features of valuable stream habitats. The outcome of the ecohydraulic modelling of this study is the Area Weighted Suitability (AWS), which is based on Instream Flow Incremental Methodology (IFIM) using Hydrocheck software and a computer software System for Environmental Flow Analysis (SEFA) for performing 1D modelling. During the field measurements, it was noticed that due to the absence of further anthropogenic modifications since the initial regulation, some regulated streams display signs of self-renaturalization by natural river processes, such as the creation and sedimentation of a new natural streamline.

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Keywords: renaturalization, regulated streams, heavily modified water bodies IFIM methodology, SEFA modelling, brown trout, habitat quality assessment

THE IMPACT OF A WATER SUPPLY ON HYDROLOGY OF A WOOD PASTURE NEAR KŐSZEG (HUNGARY)

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Long climate change-induced drought periods will probably cause reductions in groundwater resources, which will probably degrade riparian ecosystems (such as marshes). With a reasonable water supply, unfavorable dry spells can be stopped, and these valuable ecosystems can be preserved.

The aim of the research was to evaluate hydrological data in the reconstruction of a habitat Doroszló meadows from one year to another after a water supply intervention. Groundwater monitoring wells were installed at 4 selected locations in the area. The soil moisture next to the wells was also measured. Groundwater wells that were screened at their bottoms (2-4m), started 1m below the surface. The water tables in the wells were recorded manually at weekly sampling intervals and with an accuracy of 1 mm. The wells were drilled with a 70-mm auger. The PVC well casing had a diameter of 50 mm. For detecting the groundwater level, Dataqua measuring tape with a LED sensor was used, while Delta-T HH2 instrument was used, for measuring the surface soil moisture. Data for the period from April 2019 to October 2020 were processed using several statistical methods.

While evaluating the wells during the control period (the analysis of the relationship of the wells with the control well), we found that Well-1 and Well-2 behaved similarly. The impacts of the water supply on the water table were examined with a “double mass curve” and “treatment-control space-time deviations” based approach. In the case of the “treatment-control space-time deviations” the spatial and then the temporal differences were calculated between the control and treatment-influenced wells to evaluate the effect of the interventions. The results of the groundwater level analysis showed that the control well had also been impacted by the interventions (the water supply) therefore, a positive effect on the water table can only be detected for Well-3.

Compared to the data obtained during the baseline time period and the data from the control well, the water replacement interventions had a detectable effect on the hydrology of the area.

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