UNIVERSITY of SOPRON

HydroCarpath 2021

Catchment and River Processes in Regional Hydrology: Coupling Field Experiments and Data Assimilation into Process Understanding and Modelling in Carpathian Basins

Edited by Péter Kalicz, Kamila Hlavčová, Silvia Kohnová, Milica Aleksić, Viera Rattayová, Borbála Széles, Csenge Nevezi, Zoltán Gribovszki

HydroCarpath International Conference

Catchment and River Processes in Regional Hydrology: Coupling Field Experiments and Data Assimilation into Process Understanding and Modelling in Carpathian Basins

Abstracts and Posters of the Conference

Edited by
Péter Kalicz, Kamila Hlavčová,
Silvia Kohnová, Milica Aleksić, Viera Rattayová,
Borbála Széles, Csenge Nevezi, Zoltán Gribovszki

Vienna, Austria,
Bratislava, Slovakia,
Sopron, Hungary
26 November 2021

Working Committee of Environmental Sciences and
Working Committee of Forestry,
Regional Centre of the Hungarian Academy of Sciences,

Veszprém (VEAB)

The work of editors is partly supported by the *Ministry of Agriculture, Hungary.*

HydroCarpath 2021 online conference
2021-11-26 8:30–14:30

ISBN 978-963-334-414-9 (pdf)
DOI: 10.35511/978-963-334-414-9

Contents

HORA - NATIONAL FLOOD RISK MAPPING IN AUSTRIA

PETER VALENT[1,2], GÜNTER BLÖSCHL[1], JURAJ PARAJKA[1], JÜRGEN KOMMA[1], ANDREAS BUTTINGER-KREUZHUBER[3], ZSOLT HORVÁTH[3], JÜRGEN WASER[3], MICHAEL WIMMER[4], MARKUS HOLLAUS[4], ANDREAS REITHOFFER[5], JULIA EISL[5], MICHAEL HOFER[5]

[1] Institute of Hydraulic Engineering and Water Resources Management, TUW, Vienna, Austria
[2] Department of Land and Water Resources Management, Faculty of Civil Engineering, STU, Slovakia
[3] VRVis, Vienna, Austria
[4] Department of Geodesy and Geoinformation, TUW, Vienna, Austria
[5] IB Humer GmbH, Gmunden, Austria

At the beginning of the millennium, Austria was hit by devastating floods, which caused enormous damage to its population's property, which was estimated at more than three billion euros. In particular, the devastating floods of 2002 led to the emergence of many activities and projects to map and reduce flood risk in the country. One such project is the HORA project, which is aimed at mapping flood risks in detail for more than 26,000 km of rivers throughout Austria. The project is an example of the close cooperation between the public and private sectors, and its results are publicly available and also serve as a basis for determining the cost of real estate insurance near watercourses. The third update of the project, which is presented in the study, includes: a) an updated methodology for determining design flood waves, b) the latest terrain mapping using laser scanning, and c) new flood mapping and visualization techniques.

Within the project, three statistical moments for 782 water meter stations in Austria were determined from the series of maximum annual flows. These were used to derive the GEV distribution parameters used in Austria to approximate theoretical N-year flood frequency curves. The individual statistical moments were interpolated using the Top-kriging geo-statistical method into more than 21,700 profiles on streams with a catchment area of more than 10 km^2. In addition to spatial similarity, other factors were taken into account in the interpolation, such as the effect of the average annual precipitation, the effect of the length of the observed dataset, the effect of lakes and reservoirs on the reduction of flood peaks, and the effect of geology on the shape of flood frequency curves.

A digital terrain model (DTM) in a 1·1 m resolution was constructed from a detailed terrain laser scanning of all of Austria. The DTM was also used to identify dams, levees, bridges or culverts. Through a number of independent computational regions, the hydraulical modelling was conducted for all of Austria. The result of the modelling was a set of three flood maps that could be induced by flood waves with return periods of 30, 100 and 300 years. The results of the project are also available via a simple web app which is available to the general public.

Keywords: flood risk mapping, flood wave, regionalization, TopKriging

Assessment of dimension-reduction and grouping methods for estimating catchment response times

Eszter Dóra Nagy, József Szilágyi

Budapest University of Technology and Economics, Department of Hydraulic and Water Resources Engineering; Budapest University of Technology and Economics, Department of Hydraulic and Water Resources Engineering (nagy.eszter@emk.bme.hu)

Several clustering methods are used in hydrology to enhance the estimation of different runoff characteristics. However, there is no literature available on the efficiency of clustering methods concerning the estimation of catchment response times (Tr). Different catchment response time parameters, i.e., the time of concentration or lag time, are often estimated using empirical equations, including different catchment descriptors (CDs). In order to set up a new empirical equation, we performed a thorough analysis of 61 Hungarian catchments consisting of i) the calculation of the measured value of Tr based on the most recent Detrending Moving-Average Cross-Correlation Analysis (DMCA)-based estimation method using measured rainfall and runoff time-series; ii) an assessment of the 60 CDs for the 61 catchments; iii) a comparative analysis of three dimension-reduction techniques, and; iv) seven clustering methods. Our analysis concluded that the All Possible Regressions method outperformed the other dimension-reduction methods, while the clustering methods performed less predictably. Several clustering methods performed better than the grouping based on geographical units, but the estimation error only decreased in a few cases compared to the regional (one cluster) estimation. The root mean square error of the Wisnovszky equation (the one most often used in Hungary) is 13.6 hours, which was reduced to 6.77 hours and then to 5.80 hours, when the most suitable CDs were identified. Also, two clusters were created based on the catchment widths, respectively.

A COMPARATIVE ANALYSIS OF DISCHARGE MEASUREMENT METHODS

Gábor Keve, János Sziebert, Dániel Koch, Enikő Anna Tamás, György Varga, Fruzsina Majer, Sándor Krikovszky, Johanna Ficsor, Árpád Fekete

University of Public Service, Faculty of Water Sciences, Department of Regional Water Management; Baja, Hungary (keve.gabor@uni-nke.hu)

According to the Water Framework Directive 2000/60/EC (WFD), an analysis of the status of waterbodies and their continuous monitoring has to be carried out based on unified methodologies and standards. Individual prescriptions have to be in harmony with national and international standards in order to ensure the equivalent scientific value and comparability of the data. The international standard EN ISO 748:2007 was issued in 2008. This standard is based on international discharge measurement methods, and it differs in some aspects from the current Hungarian regulation (ME-10-231-16:2009). The goal of our study was to identify and answer questions related to the introduction of this standard into Hungarian practice. The issue is crucial for the hydrometric units of the Hungarian Water Directorates, because if the introduction of a new standard is not correctly substantiated, the consequences could include avoidable economic burdens and/or changes in the quality of the data. The research was targeted at a comparative analysis of the measurement and calculation methodologies of the two standards and was carried out on watercourses in Hungary. Thus we have executed a series of measurements in 31 cross-sections on 18 different watercourses in Hungary. Based on our results, we can state that the difference between the results of the different methodologies does not generally exceed the uncertainties originating from the measurements themselves.

Characteristics and process controls of statistical flood moments in Europe – a data-based analysis

David Lun[1], Alberto Viglione[2], Miriam Bertola[1], Jürgen Komma[1], Juraj Parajka[1], Peter Valent[1,3], Günter Blöschl[1]

[1] Institute of Hydraulic Engineering and Water Resources Management, Vienna University of Technology, Vienna, Austria
[2] Department of Environment, Land and Infrastructure Engineering, Politecnico di Torino, Turin, Italy
[3] Department of Land and Water Resources Management, Faculty of Civil Engineering, Slovak University of Technology, Bratislava, Slovakia

Recent studies have sought to characterize variations of the annual maximum flood discharge series over time and across space in Europe. To further support these studies, we conducted a pan-European assessment of process controls on key statistical properties of these series, including the mean annual flood (MAF), the coefficient of variation (CV) and the skewness (CS) of flood discharges. We analysed annual maximum flood discharge series from 2370 catchments in Europe without strong human modifications covering the period 1960–2010. We explored how the estimated moments MAF, CV and CS vary due to catchment size, climate and other controls across Europe.

The process controls on the flood moments are identified through correlation and multiple linear regression analyses, and the interpretation is aided by a seasonality analysis. Precipitation-related covariates are found to be the main controls of the spatial patterns of MAF in most of Europe except for regions in which snowmelt contributes to MAF, where air temperature is more important. The Aridity Index is, by far, the most important control on the spatial pattern of CV in all of Europe. Overall, the findings suggest that, on the continental scale, climate variables dominate over land surface characteristics, such as land use and soil type, in controlling the spatial patterns of flood moments.

Finally, to provide a performance baseline for more local studies, we assess the estimation accuracy of regional multiple linear regression models for estimating flood moments in ungauged basins.

The impact of rainfall events on the development of degradation processes from the past to the present, case study: Zagozdonka Catchment, Poland

Zuzana Németová[1], Silvia Kohnova[1], Adam Krajewski[2], Kazimierz Banasik[2]

[1] Slovak University of Technology, Faculty of Civil Engineering, Department of Land and Water Resources Management, Bratislava, Slovakia
[2] Warsaw University of Life Sciences – SGGW, Department of Water Engineering and Applied Geology, Warsaw, Poland

Intensive rainfall events and soil degradation processes are in a correlated relationship, where the more frequent occurrence of precipitation events leads to a significant deterioration of degradation processes and may be the trigger of other related processes. Worsening land degradation influences people and ecosystems and pressures the planet towards mass extinction, thereby impacting a sixth of all species. Moreover, it leads to serious consequences for the nutrient and carbon cycles, land productivity, and worldwide socio-economic conditions. In the study an analysis of the impact of precipitation events on degradation processes was performed in a catchment located in Poland (the Zagozdonka river basin) for the period of 1963–2020. Daily precipitation totals were processed as input data for modelling degradation processes using the event and the physically-based EROSION-3D model. Physically-based models are considered to be a younger generation of models with a more innovative and beneficial method for the assessment of different types of degradation processes. A total of 57 simulation runs were separately performed for each year with the land-use structure reflecting the individual years. During the period under review, several intense precipitation events were identified, and their impact on degradation processes was recorded. The paper aims to determine the impact of rainfall events on land degradation processes from the past to the present in order to analyse changes over the centuries; it also emphasize the significance of management practices in correlation with the environment and with regard to ensuring soil protection. To illustrate how changes in rainfall patterns affect soil degradation processes, the tabular results were processed in the form of graphic outputs. The results underline the importance of proper land-use management and soil protection and reflect the response of the river basin to intense rainfall events.

Keywords: intensive rainfall event, soil degradation processes, hydrological extremes

Preparations and preliminary results of flood modeling of the Völgységi creek

Enikő Anna Tamás[1], **Andrzej Strużyński**[2], **Maciej Wyrębek**[2], **Marek Tarnawski**[2], **Dániel Koch**[1], **Daniel Arwonga**[3]

[1] Faculty of Water Sciences, University of Public Service, Baja, Hungary (Tamas.Eniko.Anna@uni-nke.hu; Koch.Daniel@uni-nke.hu)
[2] Department of Hydraulic Engineering and Geotechnics, University of Agriculture in Cracow, Poland (rmstruzy@cyf-kr.edu.pl; maciej.wyrebek@urk.edu.pl; marek.tarnawski@urk.edu.pl)
[3] 3rd y Environmental engineering student, Faculty of Water Sciences, University of Public Service, Baja, Hungary, e-mail: arwongadan@gmail.com

Völgységi creek in eastern Mecsek (Hungary) has been monitored since 1968. The precipitation of the catchment at several points and water stages at 2 gauging stations on the Völgységi creek and at the outlet sections of main tributaries have been measured. The sources of the Völgységi creek lay at 249 m a.s.l., the highest elevation of the catchment is 487 m a.s.l. The length of the stream is 53 km, and the total catchment area is 560km^2. The highest part of the creek can rapidly respond to precipitation, especially during wet years. The upper reach of the Völgységi and the main tributaries of the hilly area can respond even after a few minutes during wet conditions. This is confirmed by flood events monitored in the upper reach. On one hand, flash floods appear more often but on the other hand, average and high discharges have become lower. This can be connected to the changing climatic conditions but more investigations are needed. We have established a new numerical model, which can be used to perform detailed analyses in small time steps with long time series. The model is planned to be calibrated for small, average and high flows.

Design support in Panda for the supplementary treatment of nitrates in treatment plant effluents

Tamás Gábor Pálfy[1,2], Péter Kalicz[2], Zoltán Gribovszki[2]

[1] Ghaemesh Digital Wetland, 38 chemin des Fonts, Sainte-Foy-les-Lyon, 69110, France
[2] Institute of Geomatics and Civil Engineering, University of Sopron, 4 Bajcsy-Zs. Str., Sopron, H-9400. Hungary (tamas@ghaemesh.com)

Free water surface wetlands (FWS) address the nitrogen in carbon-poor effluents of wastewater treatment plants (WWTPs). We present four WWTPs (4000 to 165000 PE) that are located near Sopron, Hungary, as the subject of our investigation. Three of them provide a flow-through biological treatment and the fourth is a Sequencing Batch Reactor (SBR) that is now decomissioned. Although the emission standards have been met, the total nitrogen concentration in the recipient streams falls short of the EU Water Framework Directive (2000/60/EC) . The aim of our study was to model the effect of different FWS designs on the quality of the effluent before decision making takes place.

For our case study, four time series were engineered based on WWTP effluent data. Then, eight FWS that had been featured in the review work of Kadlec (2012) were catalogued; the complete range of the rate of denitrification appearing in the wetlands was covered. The geometry, flow velocity, denitrification rate (coefficient k), and temperature (coefficient θ) parameters were catalogued. The time series and catalogue data were then imported into the Panda Pond modelling tool. We scaled supplementary treatment for the four WWTPs by creating thirty-two simulation setups.

Our results indicate that predictive modelling should avoid settling with median k values and that professionals must seek better hydraulic standardization and sure designs with higher k values instead. According to the best designs, the footprints shrink by a factor of 4.5 to 5.0 compared to the median. We conclude that the FWS wetland standardization could reduce the amount of land needed. Replicability issues would become less of a concern, and evidence-based design of FWS could become mainstream.

Acknowledgements: Special thanks to Tibor Varga and colleagues at Sopron Water for supporting this work with data and technical information.

Influence of catchment parameters on water quality indicators in selected profile of surface stream

Cyril Siman[1,2]

[1] Slovak University of Technology, Faculty of Civil Engineering, Department of Land and Water Resources Management, Bratislava, Slovakia
[2] Institute of Hydrology, Slovak Academy of Sciences, Dubravska cesta 9, 841 04 Bratislava

This paper examines the relationship between river catchment parameters and water quality in the selected profiles of surface streams as represented by two water quality indicators, i.e., total nitrogen and total phosphorus concentrations. Twenty river catchments located in Slovakia were analysed.

Methodically, this work was divided into two parts. The statistical approach was used, in the first part; the relationship between the river catchment's parameters and water quality was evaluated by using the Pearson and Spearman correlation coefficients in 15 river catchments. The river catchment parameters with a significant impact on water quality (the effective parameters) were used in a simple linear regression model for the estimation of the long-term median N_{total} and P_{total} concentrations in the remaining 5 catchments, for which the water quality data was not available. In the second approach, the MONERIS model was used to demonstrate the impact of the river catchment parameters on the N_{total} and P_{total} emissions and the proportion of the emission pathways on the overall annual N_{total} and P_{total} emissions in river catchments with various landscapes.

The results indicate that there is a positive correlation between the N_{total} and P_{total} concentrations and that the river catchment parameters are as follows: proportion of urban areas, arable land, and unconsolidated rocks to the total area of the river catchment, the atmospheric deposition, the number of inhabitants and the load from wastewater treatment plants. A negative correlation was confirmed between the N_{total} and P_{total} concentrations and the river catchment parameters as follows: the proportion of consolidated rocks and the proportion of woodlands to the total area of the river catchment, the mean altitude, the mean slope, the mean annual precipitation, and the mean annual discharge.

The highest contribution to the overall nitrogen emissions was from the subsurface flow; in the river catchments with a higher proportion of urban areas, especially in the western part of Slovakia, point pollution sources also contributed significantly. In the case of the total phosphorus emissions, the most important emission pathway was the agricultural erosion followed by the urban areas and point pollution sources. In the mountainous regions the subsurface flow also contributes significantly. Measures leading to a decrease in soil erosion and the input of nutrients from point pollution sources are the prerequisite for the further improvement of the water quality in the surface streams in the Slovak territory.

Keywords: catchment parameters, surface stream, water quality, nitrogen, phosphorus, model MONERIS, Slovakia

A MORPHOLOGICAL EXAMINATION OF THE DRAVA RIVER

JOHANNA FICSOR[1,2], ALEXANDRA GRADWOHL-VALKAY[2], ERVIN PIRKHOFFER[2], SZABOLCS CZIGÁNY[2]

[1] University of Public Service, Faculty of Water Sciences, Department of Regional Water Management (ficsor.johanna@uni-nke.hu)

[2] University of Pécs, Faculty of Sciences, Institute of Geography and Earth Sciences

Organizations involved in the conservation of natural environment and landscape management need to know possible changes in a riverbed. In order to meet, this need the aim of our study was to map the morphological state of the River Drava in the section between the Mura confluence and Drávaszabolcs. The upsteam part of this reach is typically in a natural state, but the downstream part is heavily modified. To understand the mediated development processes, we examined the relationship between the official midline (from 2013) and the midline based on a sonar bed survey (from 2019). By comparing the center lines, we determined the locations and directions of the typical bed movements of the last seven years.

The value of ASCAT data for the calibration of a conceptual hydrological model

Martin Kubáň[1], Adam Brziak[1]

[1] Department of Land and Water Resources Management, Faculty of Civil Engineering, Slovak University of Technology, Bratislava, Slovakia

Conceptual rainfall-runoff models have been used for decades as a tool for the simulation of the hydrological phenomena. The demand for quality simulation results increases each year. In our paper, we focused on the quality of the input data and the setup of the objective functions. For the multi-objective calibration, we used runoff data with a combination of the soil moisture ASCAT data. In recent studies, a combination of the runoff and scatterometer soil moisture data almost always improved the soil moisture simulation or the reaction of the soil moisture submodel to the rainfall-runoff events in the catchments and did not detect any improvement in the runoff simulation. In our case, we are trying to focus on improvements in both the soil moisture and runoff simulation in the validation period. The validation results showed us that we achieved a better soil moisture simulation, and we also detected an improvement in the runoff simulation in catchments with a lower mean elevation and with a high cover percentage of the agricultural lands.

Keywords: ASCAT, efficiencies, Austria

MODELLING SNOW WATER EQUIVALENT STORAGE AND SNOWMELT ACROSS EUROPE WITH A SIMPLE DEGREE-DAY MODEL

MIRIAM BERTOLA[1], ALBERTO VIGLIONE[2], JURAJ PARAJKA[1], GÜNTER BLÖSCHL[1]

[1] Institute of Hydraulic Engineering and Water Resources Management, Vienna University of Technology, Karlsplatz 13, 1040 Vienna, Austria (bertola@hydro.tuwien.ac.at)
[2] Department of the Environment, Land and Infrastructure Engineering (DIATI), Polytechnic University of Turin, Corso Duca degli Abruzzi 24, 10129 Turin, Italy

Recent studies indicate that changes in snowmelt are potential drivers of the changes observed in the timing and magnitude of floods in Central and Eastern Europe over the past five decades. These studies suggest that warmer spring temperatures have led to earlier and decreased snowmelt, thus affecting floods. These findings are confirmed by the decreasing trend in the extent of spring snow cover across the northern hemisphere.

In order to quantify the impact of changes in snowmelt on the flood changes observed, a measure of the snow dynamics over time across Europe is needed. Satellite-based snow measurement products are only available for the most recent decades, i.e., they are not suitable to investigate the causes of flood changes in the past 50–60 years, and their availability is restricted by the occurrence of clouds.

In this work, we have modeled daily snow water equivalent storage and snowmelt across Europe with a simple degree-day model, using E-OBS daily gridded precipitation and temperature data as inputs of the model. The accuracy of the daily maps of snow water equivalent storage is evaluated using MODIS snow cover images. The modelled daily maps are then used as covariates in a data-based attribution analysis of flood changes.

Analysis of changes in daily discharge characteristics using the MPI and KNMI climate scenarios until 2100 in selected river basins in Slovakia

Zuzana Sabová, Silvia Kohnová

Slovak University of Technology in Bratislava, Slovakia

It is expected that in the future, water will be the resource most severely affected by climate change. Several studies have already shown that small perturbances in the amount and frequency of precipitation can also result in significant impacts on monthly discharges and changes in their regime. Therefore, this study is focusing on an evaluation of changes in average monthly discharges and selected characteristics of maximum and minimum discharges up to 2100 using the MPI and KNMI climate scenarios. Two catchments, i.e., the Jablonica gauging station in the Myjava River basin and the Banská Bystrica gauging station in the Hron River basin, were selected for the analysis. To calculate and compare future changes in the hydrological regime, the daily discharge time series data were used. The data observed were from 1981 to 2010; the modelled data uses the HBV rainfall-runoff model and the modelled data for the MPI and KNMI climate scenarios from 1981–2100. The whole time period was then divided into four time periods, i.e.,1981–2010, 2011–2040, 2041–2070, and 2071–2100. The Indicators of Hydrologic Alteration (IHA) software was used to analyze changes in the average monthly discharges and selected characteristics of the maximum and minimum discharges (m-daily maximum and minimum discharges). The results showed an increase in the average monthly discharges in February, March and April, and a decrease in the average monthly discharges in August and September. An increased incidence and duration of droughts are expected in the future, especially in the summer months, and periods of increased discharges are expected in the spring.

Keywords: IHA software, average monthly discharges, MPI and KNMI climate scenarios, Myjava River Basin, Hron River Basin

Design of the characteristics of control flood waves in conditions of changes in a hydrological regime

Viera Rattayová, Anna Liová, Kamila Hlavčová, Ján Szolgay, Roman Výleta, Peter Valent

Slovak University of Technology, Department of Land and Water Resources Management, Radlinského 11, 810 05, Bratislava, Slovakia (rattayovaviera@gmail.com)

Changes in climatic characteristics and consequent changes in discharges and the hydrological response of watersheds raise questions about the safety of water structures. Water structures are designed based on hydrological characteristics corresponding to the period in which they were constructed. Therefore, changes in flood wave characteristics (shape, volume and culmination discharges) may significantly impact the functionality of these structures.

The study aims to propose a methodology for the construction of design flood waves, which are important for ensuring the safety of water structures. A case study was realized in the Little Carpathians karst watershed of the Parná stream, which is above the Horné Orešany reservoir dams profile.

We selected a set of characteristic flood waves with the maximum annual and maximum seasonal discharges from a 30-year of hourly time series of discharges. A broad spectrum of baseflow separation methods to find a suitable method to separate the base flow from the total discharges were applied. This issue has an important role in the estimation of flood wave characteristics. Using the selected methods of baseflow separation, flood wave volumes and characteristic shapes of the maximum annual and seasonal flood waves were determined. The flood wave volumes and shapes were determined using the Floodsep program.

Subsequently, the statistical processing of the maximum peak discharges determined the N-year maximum annual and seasonal discharges. Then, for pairs of the N-year discharge and their associated volumes, a join distribution of probability was constructed by a copula. From the copula, the associated volume of the N-year culmination discharge was selected, and the probability of exceeding or reaching it was determined. Based on this analysis, a set of control flood waves was determined.

This research provides sufficient results for designing control waves important for assessing water structures with extreme loads and establishing a functional methodology for assessing other water structures in the region.

Isotopic hydrograph separation in the Hydrological Open Air Laboratory, Austria

Borbála Széles[1], **Juraj Parajka**[1], **Ladislav Holko**[2], **Stefan Wyhlidal**[3], **Katharina Schott**[4], **Christine Stumpp**[5], **Patrick Hogan**[1], **Lovrenc Pavlin**[1], **Peter Strauss**[6], **Günter Blöschl**[1]

[1] Institute of Hydraulic Engineering and Water Resources Management, Faculty of Civil Engineering, Vienna University of Technology, Vienna, Austria (szeles@hydro.tuwien.ac.at)
[2] Institute of Hydrology, Slovak Academy of Sciences, Bratislava, Slovakia (holko@uh.savba.sk)
[3] NES, Nuclear Engineering Seibersdorf GmbH, Seibersdorf, Austria (Stefan.Wyhlidal@nes.at)
[4] BOKU University of Natural Resources and Life Sciences, Institute of Soil Science, Stable Isotope Group, Tulln, Austria (katharina.schott@boku.ac.at)
[5] BOKU University of Natural Resources and Life Sciences, Institute for Soil Physics and Rural Water Management, Vienna, Austria (christine.stumpp@boku.ac.at)
[6] Federal Agency of Water Management, Institute for Land and Water Management Research, Petzenkirchen, Austria

Exploring the isotopic composition of precipitation and streamflow in small catchments and the event and pre-event components of precipitation events using two-component isotopic hydrograph separation may better explain overall catchment behaviour, more specifically the sources of the origin of the water. The aim of this study is to investigate the origin of water for different streamflow gauges in a small agricultural catchment that represent different runoff generation mechanisms. The analysis will be performed in the Hydrological Open Air Laboratory (HOAL) in Austria, a 66 ha experimental catchment dominated by agricultural land use. One of the main specialities of this research catchment is that several tributaries of the catchment representing different runoff generation mechanisms are gauged. Two-component isotopic hydrograph separation (for both ^{18}O and ^{2}H) will be conducted for three streamflow gauges (the catchment's inlet and outlet, and a tile drainage system) for multiple events in the period 2013–2018. The results will be linked and interpreted using additional observations such as time-lapse images of overland flows, electric conductivity measurements, groundwater level changes, evapotranspiration measurements, etc. The aim is to explain and discuss the processes of rainfall-runoff generation in small agricultural catchments.

ANALYSIS OF THE IMPACT OF SOIL EROSION MODEL PARAMETERS ON A FINAL EVALUATION OF SOIL EROSION PROCESSES

MATÚŠ TOMAŠČÍK, KAMILA HLAVČOVÁ, ZUZANA NÉMETOVÁ , MICHAELA DANÁČOVÁ,

Slovak University of Technology in Bratislava, Faculty of Civil Engineering, Department of Land and Water Resources Management (michaela.danacova@stuba.sk)

The aim of the study is focused on an evaluation of the input of soil parameters into the physically-based EROSION-2D erosion model. The initial parameters entered into the erosion model directly influence the model results and thereby the resulting evaluation of the soil erosion processes. Soil parameters specific to the selected physically-based EROSION-2D model are hydraulic roughness, erosion resistance, and the correction factor. These parameters were calibrated by comparing the modelled volumes of the soil sediment with the measured data on the experimental plots and by the parameter catalogue. This proves differ as a result of variously. At the same time, it was found that sediment removal is most influenced by the parameters of erosion resistance input and hydraulic roughness in connection with the slope conditions in the area. The correction factor and the initial soil moisture have the most significant influence on the volume of surface runoff.

Keywords: Erosion-2D model, soil parameters, erosion processes, calibration

IMPACT OF THE WATER SUPPLY ON THE SOIL MOISTURE AND GROUNDWATER OF A WOODY PASTURE NEAR KŐSZEG (HUNGARY)

ELŐD SZŐKE[1], PÉTER CSÁKI[3], PÉTER KUTSCHI[2], PÉTER KALICZ[1], ZOLTÁN GRIBOVSZKI[1]

[1] University of Sopron, Hungary (gribovszki.zoltan@uni-sopron.hu)
[2] Őrség National Park Directorate
[3] Self-employed

Long dry periods induced climate change may cause reductions in groundwater resources and soil moisture, and may probably degrade riparian ecosystems. With a reasonable and forward-thinking water supply, unfavorable dry spells can be stopped, and valuable wetlands can be preserved or those that have deteriorated can be restored.

The aim of the research was to evaluate the reconstruction of the Doroszló meadows habitat from a hydrological point of view. Groundwater monitoring wells were installed at 4 selected locations in the area. The surface soil moisture next to the wells was also measured. The water tables in the wells were recorded manually on a weekly basis. Data for the period from April 2019 to October 2021 were processed using several statistical methods such as the "double mass curve" and "treatment-control space-time deviations".

Where was the baseline time period with the treatment compared, the water replacement interventions had a detectable effect on the hydrology of the area.

"EFOP-3.4.4-16-00022 QUALITAS Development of Higher Education in Sopron, Szombathely and Tata"

Keywords: groundwater, surface soil moisture, wood pasture restoration

CHANGES IN A PLANTS AVAILABLE WATER CAPACITY DUE TO THE APPLICATION OF BIOCHAR

NATÁLIA BOTKOVÁ[1,2]**, JUSTÍNA VITKOVÁ**[1]

[1] Institute of Hydrology, Slovak Academy of Sciences, Dúbravská cesta 9, 841 04 Bratislava, Slovakia (botkova@uh.savba.sk)
[2] Institute of Landscape Engineering, Faculty of Horticulture and Landscape Engineering, Slovak University of Agriculture, Tulipánová 7, 949 76 Nitra, Slovakia

Within the context of ongoing climate change, extreme meteorological events occur more frequently in our geographical conditions. Longer periods without precipitation are a stressful phenomenon for agricultural crops, particularly during the growing season. The application of biochar in soil is one of the “modern” technologies for keeping water in the soil. Biochar is a carbon-rich porous material produced from biomass by the process of pyrolysis. Our experiment focused on the impact of different biochar doses (0, 20, 40 and 80 t/ha) on the soils water retention capacity and thus also on the available water capacity of plants. Mixtures of silt loam soil and biochar (produced by a mix of poplar varieties, by pyrolysis at 520 °C) were prepared in laboratory conditions. The results showed that when a higher amount of the biochar was applied, the available water capacity increased by 16% or 39%, respectively. The difference between 40 and 80 t/ha was statistically insignificant (the same for both variants or 39%). We can conclude that a biochar dose of 40 t/ha in this type of soil is enough to increase the soils water holding capacity on agricultural land. Using biochar is thus of great benefit, especially during non-precipitation days.

Comparison of the surface soil moisture in a forest and a neighbouring meadow located in a valley

Csenge Nevezi[1], Dávid Schmidt[2], Előd Szőke[1], Zoltán Gribovszki[1], Péter Kalicz[1]

[1] University of Sopron, Faculty of Forestry, Institute of Geomatics and Civil Engineering
[2] University of Sopron, Faculty of Forestry, Institute of Botany and Nature Conservation

Soil moisture is one of the most important factors that helps sustain an ecosystem's balance. In 2018, research began in the Hidegvíz Valley experimental catchment that aimed to reveal the connections between the hydrological and botanical characteristics in an alder forest and a neighbouring meadow. The data collection started in 2018, and ended successfully after one year in 2019. This study focused on the changes that occurred in the surface soil moisture, groundwater levels, vegetation, and related meteorological parameters. All the results showed that the hydrological factors linked to the botanical characteristics, particularly between the surface soil moisture and the plants' water uptake. After these promising results, we decided to monitor the soil moisture changes and the coenology further by supplementing them with any available historical data.

The first soil moisture dataset collection in this study area started in 2017, but only in the alder forest. One year later the area was expanded to the forest edge and the wet meadow, and the measurements have continued since then. The data collecting method was the Time Domain Reflectometry (TDR), because it is one of the fastest and easiest methods for determining surface soil moisture in this sampling area. However, during the winter, when the surface is mostly frozen, the data cannot be collected with the TDR instrument. After the analysis, the results showed that the surface soil moisture changes are following the precipitation characteristics in all three ecosystems. In general, the wet meadow has the highest value of the surface soil moisture, the forest edge has medium value, and the alder forest has the lowest value. This trend appears to change to the opposite if a longer drought period is occurring, i.e., the alder forest has the highest soil moisture out of the three ecosystems.

The research has been supported by the Ministry of Agriculture in Hungary and the GINOP-2.3.3-15-2016-00039 project.

Keywords: surface soil moisture, ecosystem, TDR

How significant is the hydrological impact of forests in the Hungarian sandy drylands of Kiskunság?

András Szabó[1], Bence Bolla[1], Péter Kalicz[2], Zoltán Gribovszki[2]

[1] Forest Research Institute, University of Sopron, Sárvár, Hungary
(szabo.andras@uni-sopron.hu)
[2] Institute of Geomatics and Civil Engineering, Faculty of Forestry, University of Sopron, Sopron, Hungary

Groundwater depletion in the Hungarian Great Plain has been significant since the mid-1970s, especially in the area of Kiskunság. Although it has been a constant focus for researchers from a variety of fields, the role of the different factors behind this depletion process is still a subject of debate. The Water uptake of forests is also often highlighted as one of the main causes.

A hydrometeorological monitoring system is operated by the Forest Research Institute of the University of Sopron, Hungary. Its aim is to investigate the impact of forests on the hydrological regime at the study area with the help of long-term automated measurements.

A lower soil moisture content was observed under the forest vegetation, but the difference (0.85–1.72%) does not explain the decrease in groundwater. Meanwhile, the groundwater dynamics showed no connection with the type of vegetation or precipitation.

These results highlight the importance of other factors (e.g., climate change, river regulation, and groundwater pumping for industrial, agricultural, and domestic water demands) behind the ongoing processes. More complex and long-term measurements are needed to further investigation of the problem.

EVALUATION OF CHANGES IN THE HYDRO-METEOROLOGICAL DATA AT THE LOCALITY OF THE TURČEK WATER RESERVOIR

ADRIÁN VARGA[1,2], YVETTA VELÍSKOVÁ[2]

[1] Slovak University of Agriculture in Nitra, Faculty of Horticulture and Landscape Engineering,
[2] Institute of Hydrology, Slovak Academy of Sciences (varga@uh.savba.sk)

One of the significant predicted impacts of climate change will be the threat to the availability of drinking water as well as to its quality. Drinking water supply reservoirs will play an important task, the purpose of is to accumulate raw water from precipitation and inflows and subsequently produce drinking water from it using various purification and filtration processes. The Turček water reservoir was put in the operation in 1998. It is the 4th largest water reservoir for the drinking water supply in Slovakia with an area of 54 hectares and a total volume of 9.9 mil. m^3. The hydro-meteorological data obtained was provided to us by the reservoir operator. This data was digitized for 2005–2019 and then subjected to a nonparametric Mann-Kendall statistical analysis of trends, which evaluated whether or not there was a significant trend in the development of each type of data monitored. Significance levels of 0.1%, 1%, 5%, and 10% were used. We were able to reject the null hypothesis, which means that there is no significant trend in the data, except in only one case (July, a significance level of 10%). In the other cases, we could not reject the null hypothesis.

Hydromorphological evaluation of the ecological potential of natural and heavily modified water bodies

Gréta Doláková, Viliam Macura, Andrej Škrinár, Milan Čistý

Slovak University of Technology, Faculty of Civil Engineering, Department of Land and Water Resources Management, Bratislava, Slovakia (greta.dolakova@stuba.sk)

The study examines the hydraulic quality assessment of a Slovak riverine habitat in a stream area, using brown trout as a bioindicator. Abundant research into the hydraulic monitoring of aquatic habitats and microhabitats has been undergoing in Slovakia since 1995. The detailed database contains valuable hydro-morphological, topographic, and ichthyological measurements. The mountain and piedmont streams were selected based on their availability and because heavy modification has a more significant influence on the fish preferences in the upper parts of the stream. The research compares biotic and abiotic parameters of streams to investigate the fish abundance and preferences of microhabitats in software hydrological modeling. The methodology comprises terrain data collection, hydrological modeling of reaches using the Instream Flow Incremental Methodology (IFIM) in the computer Software system for Environmental Flow Analysis (SEFA), and the development of algorithm using a regression model. The study produces an optimal regression relationship to determine the degree of influence of natural and heavily modified water bodies in Slovakia. The result of the regression is output in a form of the Area Weighted Suitability (AWS), which represents the degree of river modification influence on the aquatic habitat gained by a simplified methodology.

This study has been jointly supported by the Scientific Grant Agency under Contract No. VEGA 1592 and APVV-16-0253. The authors thank the agency for its research support.

Keywords: IFIM methodology, heavily modified water bodies, SEFA modelling, regression analysis, bioindicator, aquatic habitat

POSSIBILITIES OF USING STRUCTURAL SUBSTRATE WITH A BIOCHAR COMPONENT IN BLUE-GREEN INFRASTRUCTURE PLANNING

TIMEA PETROVÁ, VIKTÓRIA TYUKOSOVÁ, MARTINA MAJOROŠOVÁ

Slovak University of Technology, Department of Land and Water Resources Management, Radlinského 11, 810 05, Bratislava, Slovakia (timea.petrova@stuba.sk)

The main purpose of implementing a blue-green infrastructure into an urban environment is to use the filtration capabilities of greenery. The conjunction of vegetation with water elements helps to achieve optimal conditions while mitigating the negative effects of climate change. The reduction of the harmful microclimatic properties of an urban environment can be mitigated by a sufficient number of quality "green areas". In the case of a dense urban structure, insufficient conditions for the growth of a root system are some of the main factors influencing growth characteristics and the ability to avoid post-planting stress. Therefore, an alternative use of the substrate, i.e., structural substrate as an element of water retention measures with the vegetation component in places with an insufficient rooting volume or with an unsuitable soil horizon, can be included among the solutions suitable for an urban environment.

The aim of the study is to create the implementation and subsequent evaluation of the growth potential of vegetation due to the unfavourable conditions of the urban environment with a modern method of using structural substrate employing biochar, in comparison with the classical type of substrate used. A model from abroad that grows vegetation in a structural substrate shows considerable potential using a drainage system in areas with low space requirements for the growth of woody vegetation.

Keywords: urban landscape planning, structural substrate, water retention measures

CHANGES IN THE COMPOSITION AND MORPHOLOGY OF FLOODPLAIN FORESTS RESULTING FROM MANAGEMENT OF THE DANUBE BASIN

VIKTÓRIA TYUKOSOVÁ, TIMEA PETROVÁ

Slovak University of Technology, Department of Land and Water Resources Management, Radlinského 11, 810 05, Bratislava, Slovakia (viktoria.tyukosova@stuba.sk)

The construction of the Gabčíkovo Nagymaros waterworks, which began their operations in 1992, disrupted the natural dynamics of the water regime of the Danube River. These changes in the water regime and the movement of the surface water and groundwater levels caused the modification or loss of habitats that bore the characteristic features of floodplain habitats.

These modifications resulted in changes in the morphology and of the composition of floodplain stands. These changes are traceable in the historical records of dendrological and botanical research. Changes in the branch system of the Danube River and the cutting off of the side channels from the main riverbed blocked the natural migration corridor. Plant diaspores used to be transported by these channels. These corridors allowed only one-way spreads. By the blocking of these migratory routes, the relocation of indigenous species stopped, which thereby prevented the natural regeneration in the structure and of the composition of the floodplain forests. Improper anthropogenic interventions in the landscape, such as the construction of roads crossing the floodplain, the cultivation of monocultures of hybrid poplars, and the deforestation of areas for agricultural purposes, also harmed the state of the biodiversity of the floodplain stands. The changes in the water regime and the consequent intensive agricultural activity on deforested lands caused eutrophication in the area, especially in reaches where the floodplain forest still has a hydrological connection with the main flow of the Danube. These factors have led to changes in the dendrological and botanical composition, that are perceptible when comparing data from 1951 through the present. Average new tree species are added every decade, while the indigenous species are slowly declining.

Keywords: floodplain habitats, indigenous species, forest morphology, floodplain stands

MAPPING RIVERBED MATERIAL WITH DEEP LEARNING – A FIELD STUDY FROM THE DANUBE

ALEXANDER ANATOL ERMILOV, SÁNDOR BARANYA, GERGELY TIKÁSZ, MÁRTON SCHROTT, GERGELY BENKŐ

Budapest University of Technology and Economics, Department of Hydraulic and Water Resources Engineering; Budapest University of Technology and Economics, Department of Hydraulic and Water Resources Engineering (ermilov.alexander@emk.bme.hu; baranya.sandor@emk.bme.hu; tgergely2000lg3@gmail.com; schrott.lorinczmarton@gmail.com; benke.greg@gmail.com)

The constant interaction between a river flow and its riverbed is especially important when it comes to alluvial rivers such as the Danube. These rivers flow in a channel composed of their own sediment. On one hand, they erode their bed in some places by washing away the sediment, while also building it somewhere else and depositing the transported particles where the flow has less energy. On the other hand, a riverbed also influences the flow via hydraulic resistance and friction. This interaction is important in multiple human-related aspects, such as fluvial navigation (maintaining a waterway's depth), bank filtration, flood risk management (shape of a channel) or hydropower (sedimentation problems in a reservoir). On the other hand, the riverbed is the home of many species; hence the mechanism is relevant for ecohydraulic studies. Despite its importance, however, current bed material sampling methods are limited and energy consuming. They mostly provide information at given points of a river, which can be challenging when one wishes to measure and describe the transition zones of a river (e.g., the Hungarian section of the Danube), where silt, sand, and gravel can all be present, thereby creating a varying riverbed composition both over time and in space. As a result, recent studies have been focusing on developing new methods that could replace and further improve traditional methods. In this paper, we introduce an artificial intelligence-based (AI) Deep Learning method, where the algorithm analyses underwater videos by taking images of the river bed from a moving vessel to estimate the local grain size distributions (GSD) of the uppermost sediment layer. The main advantage of this method is its potential in assessing continuous bed material composition data along river transects. A short reach of the Hungarian Danube was chosen, as a case study, where we compared the AI-based GSD information against the results of conventional physical samplings. Furthermore, another novel image-processing method was involved in the study, which uses Wavelet transformation to provide GSD from the images. A thorough comparative analysis of the different techniques was performed to understand their benefits and shortcomings and to outline a combined approach for future applications.

Index

Catchment and river processes in regional hydrology: coupling field experiments and data assimilation into process understanding and modelling in Carpathian basins

International conference, 26 November 2021

ORGANIZERS:
Slovak University of Technology in Bratislava, Slovakia (SUT)
University of Sopron, Hungary (UoS)
Vienna University of Technology, Austria (TUW)
Vienna Doctoral Programme on Water Resource Systems
University of Natural Resources and Life Sciences, Vienna, Austria (BOKU)

VENUE:
Online platform: Microsoft Teams (https://bit.ly/3FNhYhC)

CONFERENCE CHAIRS

Ján Szolgay jan.szolgay@stuba.sk	Slovak University of Technology in Bratislava, Bratislava, Slovakia
Zoltán Gribovszki	University of Sopron, Sopron, Hungary
Günter Blöschl	Vienna University of Technology, Vienna, Austria
Karsten Schulz	University of Natural Resources and Life Sciences, Vienna, Austria

INTERNATIONAL SCIENTIFIC COMMITTEE:

Pavol Miklánek	Institute of Hydrology of SAS, Bratislava, Slovakia
Ladislav Gaál	MicroStep-MIS, Bratislava, Slovakia
Csaba Mátyás	University of Sopron, Sopron, Hungary
Gábor Keve	University of Public Service, Hungary
Juraj Parajka	Vienna University of Technology, Vienna, Austria
Kazimierz Banasik	Warsaw University of Life Sciences, Warsaw, Poland
Milan Kalaš	Join Research Centre, Ispra, Italy
Peter Molnár	ETH Zürich, Zurich, Switzerland

ORGANISING COMMITTEE AND PROCEEDINGS EDITORS:

Kamila Hlavčová	Slovak University of Technology in Bratislava (kamila.hlavcova@stuba.sk)
Silvia Kohnová	Slovak University of Technology in Bratislava (silvia.kohnova@stuba.sk)
Péter Kalicz	University of Sopron (kaliczp@emk.nyme.hu)
Borbála Széles	Vienna University of Technology (szeles@hydro.tuwien.ac.at)

Abstract submission deadline: 30th October 2021
Conference: 26th November 2021
Conference papers: 05th December 2021

CONTACT http://hydrocarpath.nyme.hu; e-mail: milica.aleksic@stuba.sk, viera.rattayova@stuba.sk

PROGRAMME OVERVIEW:

Date	Time	Programme
26 November 2021	08:30-09:15	Registration
	09:15-09:30	Opening: Günter Blöschl, Zoltán Gribovszki
	09:30-10:45	1st Oral Block (5 lectures) Chairman: Silvia Kohnová and Péter Kalicz
	10:45-11:00	Coffee Break
	11:00-12:00	2nd Oral Block (4 lectures) Chairman: Zoltán Gribovszki and Gábor Keve
	12:15-12:45	Lunch break
	12:45-14:15	Short oral presentations and discussion Chairman: Kamila Hlavčová and Borbála Széles
	14:15-14:30	Closure: Jan Szolgay

Detailed Programme, 26 November 2021

9:30-10:45 1st Oral Block

Chairman: Silvia Kohnová and Péter Kalicz

Nr.	*Presenter*	*Title*
1	Valent Peter (TUW/SUT) (15 min)	HORA- National flood risk mapping in Austria
2	Nagy Eszter Dóra (BUTE) (15 min)	Assessment of Dimension-Reduction and Grouping Methods for Catchment Response Time Estimation
3	Keve Gábor (UPS) (15 min)	The comparative analysis of discharge measurement methods
4	Lun David (TUW) (15 min)	Characteristics and process controls of statistical flood moments in Europe - a data-based analysis
5	Németova Zuzana (SUT) (15 min)	The impact of rainfall events on the development of degradation processes from the past to the present, case study: Zagozdonka catchment, Poland

10:45-11:00 Coffee Break

11:00-12:00 2nd Oral Block

Chairman: Zoltán Gribovszki and Gábor Keve

Nr.	*Presenter*	*Title*
6	Tamás Enikő Anna (UPS) (15 min)	Preparations and preliminary results of flood modeling of the Völgységi-creek
7	Tamás Gábor Pálfy (UoS) (15 min)	Design-support in Panda for the supplementary treatment of nitrate in treatment plant effluents
8	Cyril Siman (SUT/ SHMI) (15 min)	Influence of catchment parameters on water quality indicators in selected profile of surface stream
9	Ficsor Johanna (UPS) (15 min)	The morphological examination of the Drava river

12:00-12:45 Lunch

12:45-14:15 Short oral presentations and discussion

Chairman: Kamila Hlavčová and Borbála Széles

Nr.	Presenter	Title
P2	Kubáň Martin (SUT)	The value of ASCAT data for the calibration of a conceptual hydrological model
P3	Bertola Miriam (TUW)	Modelling snow water equivalent storage and snowmelt across Europe with a simple degree-day model
P4	Sabová Zuzana (SUT)	Analysis of changes in daily discharge characteristics using the MPI and KNMI climate scenarios until 2100 in selected river basins in Slovakia
P5	Liová Anna (SUT)	Design of the characteristics of control flood waves in conditions of changes in a hydrological regime
P6	Széles Borbála (TUW)	Isotopic hydrograph separation in the Hydrological Open-Air Laboratory, Austria
P7	Tomaščík Matúš (SUT)	Analysis of the impact of soil erosion model parameters on a final evaluation of soil erosion processes
P8	Szőke Előd (UoS)	Impact of the water supply on the soil moisture and groundwater of a woody pasture near Kőszeg (Hungary)
P9	Botková Natália (IH SAS)	Changes in a plant´s available water capacity due to the application of biochar
P10	Nevezi Csenge (UoS)	Comparison of a forest and a neighbouring meadow surface soil moisture in a valley location
P11	Szabó András (UoS)	How significant the hydrological impact of forests in Hungarian sandy dryland Kiskunság?
P12	Varga Adrián (SUA)	Evaluation of hydro-meteorological data change at the Turček water reservoir locality

P13	Doláková Gréta (SUT)	Hydromorphological evaluation of the ecological potential of natural and heavily modified water bodies
P14	Petrová Timea (SUT)	Possibilities of using structural substrate with a biochar component in blue-green infrastructure planning
P15	Tyukosová Viktória (SUT)	Changes in the composition and morphology of floodplain forests resulting from management of the Danube basin
P16	Ermilov Alexander Anatol (BUTE)	Mapping riverbed material with Deep Learning – a field study from the Danube

14:15-14:30 Closure

THE VALUE OF ASCAT DATA FOR THE CALIBRATION OF A CONCEPTUAL HYDROLOGICAL MODEL

Martin Kubáň, Adam Brziak

Department of Land and Water Resources Management, Faculty of Civil Engineering, Slovak University of Technology, Radlinského 11, 810 05 Bratislava, Slovakia

martin.kuban@stuba.sk and adam.brziak@stuba.sk

ABSTRACT: Conceptual rainfall-runoff models have been used for decades as a tool for the simulation of the hydrological phenomena. The demand for quality simulation results increases each year. In our paper, we focused on the quality of the input data and the setup of the objective functions. For the multi-objective calibration, we used runoff data with a combination of the soil moisture ASCAT data. In recent studies, a combination of the runoff and scatterometer soil moisture data almost always improved the soil moisture simulation or the reaction of the soil moisture submodel to the rainfall-runoff events in the catchments and did not detect any improvement in the runoff simulation. In our case, we are trying to focus on improvements in both the soil moisture and runoff simulation in the validation period. The validation results showed us that we achieved a better soil moisture simulation, and we also detected an improvement in the runoff simulation in catchments with a lower mean elevation and with a high cover percentage of the agricultural lands.

1 TUW model dual

TUW model dual:

- Two soil layers: root zone and surface layer
- 18 parameters
- 3 submodels: snow, soil and runoff

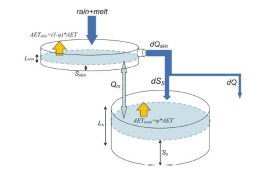


Fig. 1: Structure of the Tuw model dual, Parajka, 2009.

2 Input data

- Input data are in the **daily step** for 209 catchments, all data were divided into **hypsometric zones by 200 vertical meters**
- **Discharge data** – Austrian Hydrographic service
- **Air temperature and Rainfall** – Spartacus (Hiebl, 2016)
- **Potential evapotranspiration** – Blaney Criddle
- **ASCAT data** – for root **SWIr** and surface layer **SWIs** from grid 500x500 m
- Catchments divided by rainfall of snow regimes into two groups **Lowland** and **Alpine**

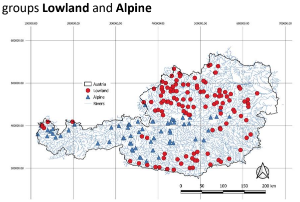


Fig. 2: 209 Austrian catchments, Lowland (red), Alpine (blue)

Information	Attribute	Abbrev.	Unit	Min.	Max.	Median
Area	Area	A	km^2	13.70	6214.00	167.30
Elevation	Mean elevation	MELE	m a.s.l.	353.01	2939.76	1010.73
	Mean slope	SL	%	1.74	43.91	18.84
	Elevation range	ER	m	80.00	3072.00	1279.00
	Roughness index	MRI	-	0.15	0.65	0.38
	Mean daily potential global radiation	MGR	kW·m^{-2}·day	4.73	6.26	5.19
Landuse	Forest percentage	FP	%	0.00	94.59	46.88
	Agriculture percentage	AP	%	0.00	92.86	16.30
	Mean monthly normalized difference vegetation index	MNDVI	-	0.00	0.71	0.60
Soil	Mean field capacity	MFC	cm^3·cm^{-3}	0.29	0.43	0.36
	Mean saturated hydraulic conductivity	MKS	cm·day^{-1}	24.88	327.77	161.17
Climate	Mean annual precipitation	MAP	mm	728.13	2301.84	1274.40
	Mean air temperature	MAT	°C	-2.83	10.30	7.36
	Aridity index	CAI	-	0.18	0.98	0.47
	duration of days temperature below 0 °C	MTL0	-	0.12	0.62	0.20

3 Calibration

Calibration

- For period 2007-2014
- 4 calibration variant for: Discharge (Q), Q+SWIr, Q+SWIs, Q+SWIr+SWIs
- Runoff Model Efficiency (RME), Coefficient of correlation (R)

$$NSE = 1 - \frac{\sum_{i=1}^{n}(Q_{obs} - Q_{simi})^2}{\sum_{i=1}^{n}(Q_{obsi} - \bar{Q}_{obs})^2}$$

$$logNSE = 1 - \frac{\sum_{i=1}^{n}(\log Q_{obs} - \log Q_{simi})^2}{\sum_{i=1}^{n}(\log Q_{obsi} - \log \bar{Q}_{obs})^2}$$

$$RME = \frac{(NSE + logNSE)}{2}$$

Calibration variant (2007-2014)	RME		VE (%)		R surface soil moisture		R root soil moisture	
	Alpine	Lowland	Alpine	Lowland	Alpine	Lowland	Alpine	Lowland
Cal. to Q	**0.83**	**0.75**	-0.05	**0.02**	0.02	0.37	0.23	0.49
Cal. to Q+SS	0.81	0.74	-0.05	**0.02**	0.40	**0.49**	0.36	0.49
Cal. to Q+SR	0.81	0.74	-0.05	**0.02**	0.18	0.38	0.43	**0.54**
Ca. to Q+SS+SR	0.81	0.73	**-0.04**	0.03	**0.41**	0.48	**0.44**	**0.54**

4 Results

Validation

- For period 1991-2000 and 2015-2016
- 3 Validation variant compared with validation for Discharge (Q): Q+SWIr, Q+SWIs, Q+SWIr+SWIs
- Runoff Model Efficiency (RME), in tables (on right) we compared the catchments with the improvement of the RME (marked with [+]) with the catchments where we did not detect any improvement (marked with [-])
- We also compared the median of the catchments characteristic
- In the comparison of the catchments characteristics we detect that improvement were achieved in the groups of the catchments with similar characteristics, e.g. lower mean elevation, lower slopes of the terrain and higher percentage of the agricultural lands.
- In table (right) we can see the similarity of the catchments characteristics in the groups of catchemnts with the improvement of the RME, in this table we can also find the number of improved catchments.

Discharge simulation for the period 1991-2000 (198 catchments)

198	[%]	[Num.]	[+/-]	A	MELE	SL	ER	MRI	MGR	FP	AP	MNDVI	MFC	MKS	MAP	MAT	CAI	MTLT0
Q+SR	**22%**	**44**	**[+]**	223.2	761.0	13.6	1132.5	0.35	5.19	54.4	23.7	0.64	0.36	117.6	1216.2	8.03	0.55	0.17
Q+SS	**22%**	**44**	**[+]**	239.4	849.7	13.2	1056.5	0.35	5.17	57.6	21.9	0.63	0.36	130.4	1173.2	7.86	0.59	0.18
Q+SS+SR	**17%**	**34**	**[+]**	183.5	719.2	8.5	656.0	0.37	5.18	52.1	39.2	0.64	0.35	102.0	1077.1	8.28	0.65	0.17
Q+SR	**78%**	**154**	**[-]**	170.2	1178.1	22.1	1394.0	0.39	5.19	46.4	14.4	0.58	0.36	182.2	1307.4	6.57	0.43	0.22
Q+SS	**78%**	**154**	**[-]**	165.1	1176.9	22.0	1375.5	0.39	5.19	45.5	14.2	0.58	0.36	181.8	1307.4	6.61	0.43	0.22
Q+SS+SR	**83%**	**164**	**[-]**	168.1	1178.1	22.7	1404.5	0.38	5.19	46.4	13.4	0.59	0.36	182.2	1326.0	6.61	0.41	0.22

Discharge simulation for the period 2014-2016

	[%]	[Num.]		A	MELE	SL	ER	MRI	MGR	FP	AP	MNDV	MFC	MKS	MAP	MAT	CAI	MTLT0
Q+SR	**36**	**68**	**[+]**	166.2	738.5	10.44	766.0	0.35	5.17	45.5	31.2	0.63	0.36	106.7	1098.6	8.37	0.62	0.17
Q+SS	**30**	**56**	**[+]**	239.4	754.9	12.43	813.0	0.35	5.17	53.8	26.8	0.63	0.36	125.3	1129.8	7.94	0.59	0.18
Q+SS+SR	**27**	**51**	**[+]**	168.6	744.5	10.83	720.0	0.36	5.17	50.9	38.1	0.64	0.36	103.3	1083.8	8.26	0.64	0.17
Q+SR	**64**	**121**	**[-]**	186.0	1335.4	24.73	1554.0	0.42	5.20	46.9	10.9	0.55	0.36	200.7	1414.7	6.10	0.39	0.24
Q+SS	**70**	**133**	**[-]**	161.0	1270.9	23.61	1427.0	0.42	5.19	46.3	11.4	0.57	0.36	187.4	1380.3	6.42	0.39	0.23
Q+SS+SR	**73**	**138**	**[-]**	178.3	1279.4	23.84	1497.0	0.41	5.19	46.4	11.3	0.58	0.36	192.5	1388.3	6.33	0.39	0.23

5 Discussion

In general, we can conclude that the assimilation of the new ASCAT product to the objective function of the multi-objective calibration significantly improved the correlation coefficients in both the calibration and validation periods, especially in the Lowland catchments (catchments where the rain is a major contributor to the runoff and water from melted snow does not dramatically affect the runoff), except for the catchments with higher forest cover percentages. Improvements were also in the runoff model efficiency in the validation period detected in the Lowland catchments with lower mean elevations, lower terrain slopes, and a higher percentage of agricultural land (compared to the Alpine catchments). What was new compared to the other papers was that we also detected an improved runoff model efficiency and categorized the catchments where the improvement can be expected.

Acknowledgements: This work was supported by the Slovak Research and Development Agency under Contract No. APVV-18-0347 , No. APVV-19-034 and the VEGA Grant Agency No. 1/0632/19. At the same time we would like to acknowledge the support from the Stefan Schwarz grant of the Slovak Academy of Sciences. This work has been supported in the frame of the AlpCarp Project No. 2019-10-15-002 under the bilateral program "Action Austria – Slovakia, Cooperation in Science and Education". The authors thank the agency for its research support. This work was also supported by the Slovak Research and Development Agency under Contract No. APVV-18-0347 , No. APVV-19-034 and the VEGA Grant Agency No. 1/0632/19. At the same time we would like to acknowledge the support from the Stefan Schwarz grant of the Slovak Academy of Sciences. This work has been supported in the frame of the AlpCarp Project No. 2019-10-15-002 under the bilateral program "Action Austria – Slovakia, Cooperation in Science and Education". The authors thank the agency for its research support. This work was also supported by the Austrian Science Funds (FWF) as part of the Vienna Doctoral Program on Water Resource Systems (DK W1219-N28), the Austrian Research Promotion Agency (FFG) through the BMon project (Contract No. 866031) in the acknowledgments.

Modelling snow water equivalent storage and snowmelt across Europe with a simple degree-day model

M. Bertola[(1)], A. Viglione[(2)], J. Parajka[(1)], G. Blöschl[(1)]

(1)Institute of Hydraulic Engineering and Water Resources Management, Vienna University of Technology
(2)Department of Environment, Land and Infrastructure Engineering, Polytechnic University of Turin

FWF Der Wissenschaftsfonds.

Introduction and Motivation

Recent studies identified snowmelt as a potential driver of the observed changes in the timing and the magnitude of floods in Central and Eastern Europe (Blöschl et al. 2017; 2019). They argue that warmer spring temperatures have led to earlier and decreased snowmelt, thus affecting floods. These findings are confirmed by the decreasing trend in spring snow cover extents across the northern hemisphere (Estilow et al., 2015).

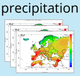
In order to quantify the impact of snowmelt on the observed flood changes, a measure of the snow dynamics in time across Europe is needed. Satellite-based snow products are available for the most recent decades only, i.e., they are not suitable for being used for investigating the causes of flood changes in the past 50 years, and their use is restricted by the occurrence of clouds.

Degree-day model

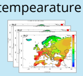
In this study, we model daily snow water equivalent storage and snowmelt across Europe with a simple degree-day model, using daily gridded precipitation and temperature data as inputs of the model.

E-OBS 1950-2018 (0.1 deg, v18.0e) :

precipitation

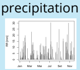


tempearature

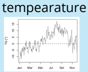


Daily series (pixels):

precipitation



tempearature



Degree-day model

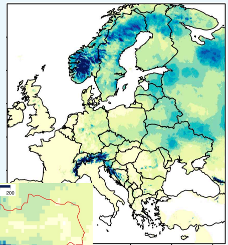
Snowmelt:

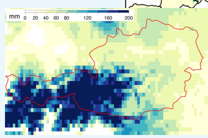
$$M = \begin{cases} 0 & T_A < T_m \\ \min(DDF \cdot (T_A - T_m);\ P_s) & T_A \geq T_m \end{cases}$$

Snow accumulation:

$$P_s = \begin{cases} P & T_A < T_s \\ P \cdot \dfrac{T_R - T_A}{T_R - T_s} & T_s \leq T_A \leq T_R \\ 0 & T_A > T_R \end{cases}$$

We obtain daily maps of snow water equivalent accumulation and melt in (mm) with resolution 0.1 deg





example daily maps for 2010-01-31

Comparison with MODIS snow cover

The accuracy of the daily maps of snow water equivalent storage is evaluated using MODIS snow cover images (MODIS/Terra Snow Cover Daily L3 Global 0.05 Deg CMG, Version 6; Evaluation period: 2000-2010).

Accuracy Index

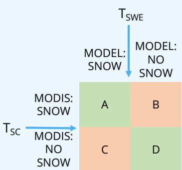
$$AI = \frac{A + D}{A + B + C + D} \cdot 100$$

Overestimation Error:

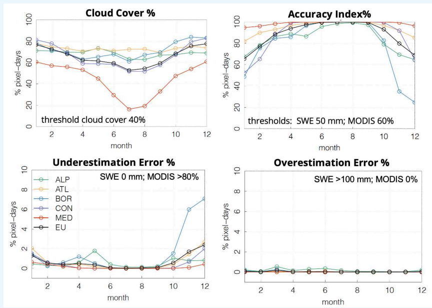
$$OE = \frac{C}{A + B + C + D} \cdot 100$$

Underestimation Error:

$$OE = \frac{B}{A + B + C + D} \cdot 100$$

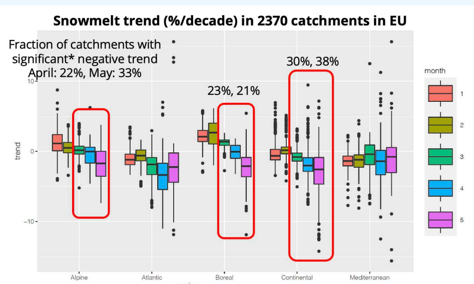


A, B, C, D are the cloud-free pixel-days (assumed threshold for clouds 40%)



Snowmelt changes

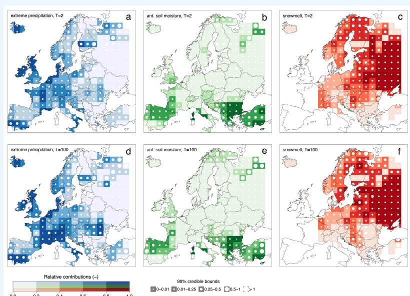
Snowmelt trends are estimated for 2370 catchment in Europe



* Mann-Kendall test at 5% significance level

Outlook

The modelled daily maps are then used as covariates in a data-based attribution analysis of flood changes (Bertola et al., 2021).



Contact: bertola@hydro.tuwien.ac.at

ANALYSIS OF CHANGES IN THE CHARACTERISTICS OF DAILY DISCHARGES USING THE MPI AND KNMI CLIMATE SCENARIOS UNTIL 2100 IN SELECTED RIVER BASINS IN SLOVAKIA

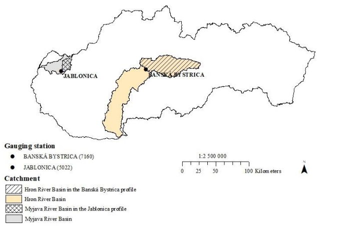
Sabová Zuzana[1], Kohnová Silvia[1]

[1]Slovak University of Technology in Bratislava, Faculty of Civil Engineering STU, Radlinského 11, 810 05, Bratislava, Slovakia
zuzana.sabova@stuba.sk

ABSTRACT

It is expected that in the future, water will be the resource most severely affected by climate change. Several studies have already shown that small perturbances in the amount and frequency of precipitation can also result in significant impacts on monthly discharges and changes in their regime. Therefore, this study is focusing on an evaluation of changes in average monthly discharges and selected characteristics of maximum and minimum discharges up to 2100 using the MPI and KNMI climate scenarios. Two catchments, i.e., the Jablonica gauging station in the Myjava River basin and the Banská Bystrica gauging station in the Hron River basin, were selected for the analysis. To calculate and compare future changes in the hydrological regime, the daily discharge time series data were used. The data observed were from 1981 to 2010; the modelled data uses the HBV rainfall-runoff model and the modelled data for the MPI and KNMI climate scenarios from 1981-2100. The whole time period was then divided into four time periods, i.e.,1981-2010, 2011-2040, 2041-2070, and 2071-2100. The Indicators of Hydrologic Alteration (IHA) software was used to analyze changes in the average monthly discharges and selected characteristics of the maximum and minimum discharges (m-daily maximum and minimum discharges). The results showed an increase in the average monthly discharges in February, March and April, and a decrease in the average monthly discharges in August and September. An increased incidence and duration of droughts are expected in the future, especially in the summer months, and periods of increased discharges are expected in the spring.

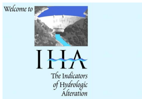
1 RESEARCH AREA



2 MATERIAL AND METHODS

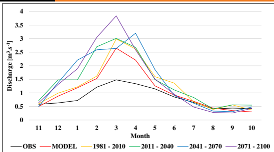
The Indicators of Hydrologic Alteration (IHA) software was created by Brian Richter and colleagues between 1996 and 1998. This program contains important information for anyone to comprehend the hydrological impacts of human activities or make environmental references to watercourses. We used the IHA software version 7.1.0.10. Analyzes were performed by nonparametric statistics and using the hydrological year.

The hydrological characteristics were calculated for four periods, i.e., 1981-2010, 2011-2040, 2041-2070, and 2071-2100. We used in the first time period observed data - OBS (provided by the Slovak Hydrometeorological Institute) and modelled data – MODEL (rainfall-runoff HBV model). We used daily simulated discharges using MPI and KNMI climate scenarios until 2100.

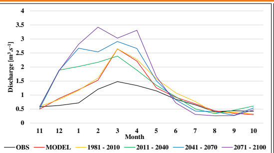


	Data	Time period
First period	OBS, MODEL, MPI and KNMI	1.1.1981 - 31.10.2010
Second period	MPI and KNMI	1.11.2010 - 31.10.2040
Third period	MPI and KNMI	1.11.2040 - 31.10.2070
Fourth period	MPI and KNMI	1.11.2070 - 31.10.2100

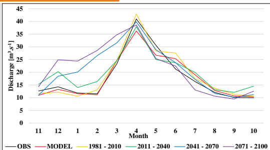
3 RESULTS I. – AVERAGE MONTHLY DISCHARGES



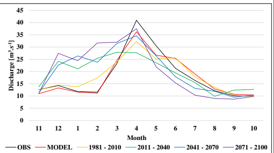
From the graph, which shows the course of average monthly flows in the Myjava - Jablonica gauging station according to the MPI climate scenario, it is evident that the values of the average monthly discharges will increase especially in the month of March by 2100. The lowest average monthly discharges will occur in August and September by 2100.



The course of the average monthly flows in the Myjava - Jablonica gauging station by the KNMI climate scenario reaches the highest average monthly discharges in February and April by 2100. The lowest average monthly discharges will appear in July, August and September in the future.



The highest average monthly discharges are in April in the Hron - Banská Bystrica gauging station for the MPI climate scenario. In this case, modelled data are correctly calibrated because there are no large changes between the observed and modelled data within the first time period.



Analysis of the Hron - Banská Bystrica gauging station using the KNMI climate scenario data points to a decrease in the highest average monthly discharges in April to the future. The course of the resulting values of the average monthly discharges for the KNMI scenario is more irregular.

4 RESULTS II. – M-DAILY MINIMUM AND MAXIMUM

Myjava - Jablonica (5022)		OBS	MODEL HBV	MPI	KNMI	MPI	KNMI	MPI	KNMI	MPI	KNMI
		1981 - 2010				2011 -2040		2041 - 2070		2071 - 2100	
1-day minimum	[m³.s⁻¹]	0.26	0.21	0.21	0.17	0.20	0.20	0.20	0.18	0.18	0.17
3-day minimum		0.28	0.22	0.22	0.17	0.20	0.20	0.20	0.18	0.18	0.17
7-day minimum		0.29	0.22	0.22	0.19	0.22	0.21	0.21	0.19	0.19	0.18
30-day minimum		0.35	0.25	0.27	0.21	0.26	0.24	0.25	0.24	0.21	0.21
90-day minimum		0.46	0.43	0.43	0.30	0.37	0.36	0.39	0.36	0.32	0.29
1-day maximum		8.92	6.09	6.80	6.48	9.06	6.53	6.70	7.19	6.96	8.64
3-day maximum		6.72	5.84	6.58	6.29	8.61	6.31	6.30	6.87	6.84	8.27
7-day maximum		4.54	5.47	6.11	5.93	7.87	5.79	5.87	6.50	6.62	7.75
30-day maximum		3.13	4.07	4.52	4.79	5.74	4.42	4.49	5.02	5.58	5.78
90-day maximum		2.12	2.69	3.07	3.11	4.11	3.27	3.64	3.62	4.09	4.01

According to the MPI scenario, m-daily minimum discharges decrease in the Myjava – Jablonica (5022) gauging station until 2100. For m-daily maximum discharges, the course of the modelled data using MPI scenario applies: an increase by 2040, a decrease by 2070 and a renewed growth by 2100.

For the modelled data of the KNMI climate scenario, the following applies to the m-daily minimum discharges: in the second time period – increase, from the third period, decrease until 2100 to approximately the same values as in the first period. According to the KNMI scenario, m-daily maximum discharges show growth until 2100.

Hron - Banská Bystrica (7160)		OBS	MODEL HBV	MPI	KNMI	MPI	KNMI	MPI	KNMI	MPI	KNMI
		1981 - 2010				2011 -2040		2041 - 2070		2071 - 2100	
1-day minimum	[m³.s⁻¹]	6.87	6.92	6.99	6.82	7.81	6.74	7.48	6.64	7.20	6.36
3-day minimum		7.07	6.99	7.06	6.85	7.85	6.81	7.74	6.71	7.25	6.43
7-day minimum		7.26	7.14	7.18	7.05	7.96	6.94	7.93	6.78	7.37	6.61
30-day minimum		8.18	8.18	7.86	7.75	9.35	7.85	8.96	7.55	8.14	7.47
90-day minimum		10.62	10.90	9.74	9.68	11.08	9.71	11.03	10.71	10.46	8.88
1-day maximum		116.10	87.23	79.21	92.09	95.36	86.51	82.83	85.18	82.70	94.85
3-day maximum		97.90	83.35	76.01	84.59	92.05	81.96	79.08	80.47	79.23	91.41
7-day maximum		81.01	78.13	70.74	78.86	86.84	72.17	69.40	71.35	74.66	83.04
30-day maximum		59.38	55.63	52.28	55.25	62.43	50.57	51.09	56.72	58.03	56.51
90-day maximum		40.53	39.66	39.65	39.36	41.86	36.03	39.75	40.52	43.04	44.63

The Hron – Banská Bystrica (7160) gauging station records higher m-daily minimum and maximum discharges values than the Myjava – Jablonica (5022) gauging station. The modelled data using the MPI scenario have an increasing trend by 2040 and a declining tendency by 2100 at m-daily minimum discharges. For m-daily maximum discharges it is evident: increase by 2040, decrease by 2070 and increase by 2100.

The resulting values for the simulated data for the KNMI climate scenario for the m-daily minimum discharges decline in 2100. From 1-day to 7-day maximum discharge for the KNMI scenario data decreases by 2070 and growth by 2100. For 30-day and 90-day maximum discharges, we see a decrease by 2040 and an increase by 2100.

5 CONCLUSION

The aim of the paper was to evaluate the changes in the average monthly discharges and selected characteristics of the minimum and maximum discharges in the Myjava – Jablonica (5022) gauging station and Hron – Banská Bystrica (7160) gauging station. The results from the Indicators of Hydrologic Alteration program were used for evaluation, in which data for four research period were processed. The observed data, the modelled data using rainfall-runoff model HBV, and the MPI and KNMI climate scenarios data were available.

The following facts concerning the average monthly discharges were found in the paper. For the Myjava – Jablonica (5022) gauging station the highest average monthly discharges until 2100 will occur in March according to the simulated data using the MPI scenario. For the simulated data using the KNMI scenario the highest average monthly discharges will occur in February until the year 2100. For the Hron – Banská Bystrica (7160) gauging station, the highest average monthly discharges will occur in April for the simulated data of both climate scenario. In general, for both gauging stations, the values of average monthly discharges will increase in the winter months and in the summer months their values will decrease by 2100.

In the Myjava – Jablonica (5022) gauging station, the values of the m-daily minimum discharges will decrease in particular. For the values of the m-daily maximum discharges, their growth up by 2100 can be seen. The Hron – Banská Bystrica (7160) gauging station records an increase in m-daily minimum flows up to 2100 for the modelled data using the MPI scenario and a decrease for the simulated data using the KNMI scenario until 2100.

Given the paper results, it can be seen that the KNMI climate scenario is more suitable for the Myjava – Jablonica (5022) gauging station and the MPI scenario is more suitable for the Hron – Banská Bystrica (7160) gauging station for further analyzes.

Acknowledgements: This study was supported by the Slovak Research and Development Agency under Contract No. APVV-20-0374 and VEGA Grant Agency No 1/0632/19. The authors thank the agencies for their research support.

DESIGN OF THE CHARACTERISTICS OF CONTROL FLOOD WAVES IN CONDITIONS OF CHANGES IN A HYDROLOGICAL REGIME

Rattayová, V., Liová, A., Hlavčová, K., Szolgay, J.,Výleta, R., Valent, P.

Department of Land and Water Resources Management, Faculty of Civil Engineering, Slovak University of Technology, Radlinského 11, 810 05 Bratislava, Slovakia

ABSTRACT

Changes in climatic characteristics and consequent changes in discharges and the hydrological response of watersheds raise questions about the safety of water structures. Water structures are designed based on hydrological characteristics corresponding to the period in which they were constructed. Therefore, changes in flood wave characteristics (shape, volume and culmination discharges) may significantly impact the functionality of these structures.

The study aims to propose a methodology for the construction of design flood waves, which are important for ensuring the safety of water structures. A case study was realized in the Little Carpathians karst watershed of the Parná stream, which is above the Horné Orešany reservoir dam´s profile. We selected a set of characteristic flood waves with the maximum annual and maximum seasonal discharges from a 30-year of hourly time series of discharges. A broad spectrum of baseflow separation methods to find a suitable method to separate the base flow from the total discharges were applied. This issue has an important role in the estimation of flood wave characteristics. Using the selected methods of baseflow separation, flood wave volumes and characteristic shapes of the maximum annual and seasonal flood waves were determined. The flood wave volumes and shapes were determined using the Floodsep program.

Subsequently, the statistical processing of the maximum peak discharges determined the N-year maximum annual and seasonal discharges. Then, for pairs of the N-year discharge and their associated volumes, a join distribution of probability was constructed by a copula. From the copula, the associated volume of the N-year culmination discharge was selected, and the probability of exceeding or reaching it was determined. Based on this analysis, a set of control flood waves was determined.

This research provides sufficient results for designing control waves important for assessing water structures with extreme loads and establishing a functional methodology for assessing other water structures in the region.

1 STUDY AREA AND INPUT DATA

- Design flood waves were processed for the profile of Horné Orešany reservoir dam´s profile, which is located on the Parná River in rkm 25.00.
- The watershed area is 45.59 km^2 and it is located in Small Carpathians.

Fig 1. Catchment location

- The discharge data - SHMÚ water gauge station 5250 Horné Orešany - Parná, specifically:
  - the hourly discharges Q [m^3.s^{-1}] for the period 1.11.1988-31.12.2019
  - the culmination discharges Qcul [m^3.s^{-1}] for the period 1.11.1988-31.12.2019.
- The average daily precipitations - SHMÚ precipitation station Dolné Orešany for the period 1.11.1988-31.12.2013.
- The average daily air temperature - SHMÚ station Modra-Piesok, for the period 1.11.1988-31.12.2013.

2 METHODS

- Selection of discharge waves based on their occurrence in year
- Four groups : spring season, summer season, winter season and annual maximum discharges

- Base flow separation
- Base flow separation was realized by graphical and filtering methods
- Parameter sensitivity on Eckhardt digital filter was examined
- The results from base flow separation methods were compared and we select the best fitted method for following analysis

- Separation of discharge waves
- **The separation of waves** as well as the calculation of the baseflow have been processed by methods in the FloodSep programme (Valent, 2019)

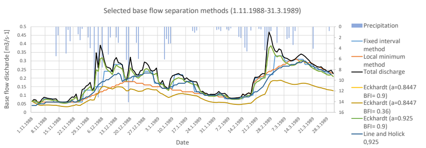
- Selection of representative shape of waves
- Shape of control wave was determined using the methods programmed in FloodSep
- In each group representative shapes with percentile parameter : 50%, 70%, 90% were determined

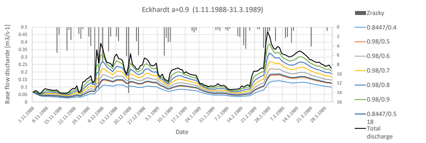
- Local estimation of N-year maximum discharges
- 100-year flood discharge was use

- Volume of flood waves derived by the join probabilty of culmination and volumes – copula function
- Volume with the probability of exceeding or reaching 0.5, 0.7 and 0.9 was used

2 RESULTS

Base flow separation





Representative shape of waves

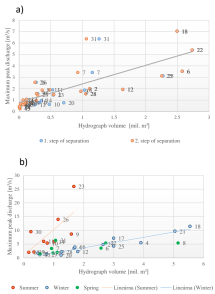


Fig 3. Results of discharge wave separation in : a) spring season, b) annual maximum discharge,

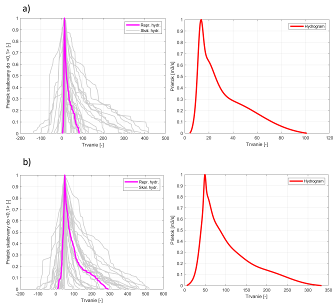


Fig 4. Representative hydrogram of scaled waves (left) and smoothed representative (right), parameter percentille 50%, for: a) spring season, b) annual maximum discharge

Sets of control flood waves

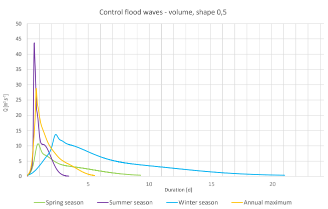


Fig 5. Set of control flood waves with conditional volume 0,5 and percentile 50%

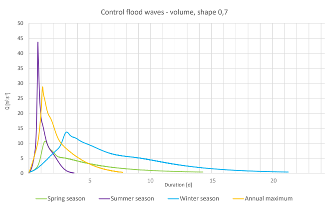


Fig 6. Set of control flood waves with conditional volume 0,7 and percentile 70%

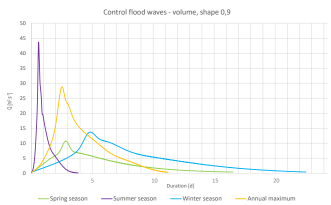


Fig 7. Set of control flood waves with conditional volume 0,9 and percentile 90%

Table 3. Parameters of control flood waves

Group	Q_{100} [m^3.s^{-1}]	V [mil. m^3]			tc [h]		
		0.5	0.7	0.9	0.5	0.7	0.9
$Q_{an,max}$	28.80	3.253	4.736	8.146	132.8	184.8	269.2
Spring season	10.69	2.405	3.11	4.46	222.9	343.1	397.1
Summer season	43.70	2.271	2.432	2.671	82.0	89.2	92.4
Winter season	13.72	7.109	7.642	8.415	506.0	511.2	540.7

4 CONCLUSION

In the study we deal with the design and construction of a set of flood control waves, which represent a critical load of waterworks during flood loads. A control flood wave is defined as a theoretical flood wave determined by the culmination discharge with a selected probability, time course and volume with associated probability. The time course was obtained by assigning a conditional volume to a specific wave shape, the shapes being influenced by the percentile value.

This results represent sets of control waves, with each set being homogeneous from the point of view of definition and it is up to the operator to decide which waves will be chosen to assess the safety of the water structures.

TECHNISCHE UNIVERSITÄT WIEN Vienna University of Technology

Vienna Doctoral Programme on Water Resource Systems www.waterresources.at

FWF Der Wissenschaftsfonds.

INTERNATIONAL CONFERENCE - CATCHMENT AND RIVER PROCESSES IN REGIONAL HYDROLOGY: COUPLING FIELD EXPERIMENTS AND DATA ASSIMILATION INTO PROCESS UNDERSTANDING AND MODELLING IN CARPATHIAN BASINS

Isotopic hydrograph separation in the Hydrological Open Air Laboratory, Austria

B. Szeles[1], J. Parajka[1], L. Holko[2], S. Wyhlidal[3], K. Schott[4], C. Stumpp[5], P. Hogan[1], L. Pavlin[1], P. Strauss[6] and G. Blöschl[1]

[1] Institute of Hydraulic Engineering and Water Resources Management, Vienna University of Technology, Austria; [2] Institute of Hydrology, Slovak Academy of Sciences, Slovakia; [3] NES, Nuclear Engineering Seibersdorf GmbH, Austria; [4] BOKU University of Natural Resources and Life Sciences, Institute of Soil Science, Stable Isotope Group, Austria; [5] BOKU University of Natural Resources and Life Sciences, Institute for Soil Physics and Rural Water Management, Austria; [6] Federal Agency of Water Management, Institute for Land and Water Management Research, Austria

MOTIVATION

Exploring the isotopic composition (oxygen and hydrogen) of precipitation and streamflow and the event and pre-event components of streamflow during precipitation events in small catchments → **Explain overall catchment behavior.**

Aim: to investigate the origin of water in the Hydrological Open Air Laboratory, Austria.

→ **Tool**: two-component isotopic hydrograph separation (^{18}O and ^{2}H) linked with additional observations (time lapse images of overland flow, soil moisture and groundwater level changes, electric conductivity and turbidty measurements).

METHODOLOGY

Overview

→ **Step 1**: Selection of **32 precipitation events** between 2013-2018, when available:

- Isotopic composition of precipitation (^{18}O and ^{2}H),
- Isotopic composition of streamflow (^{18}O and ^{2}H) at catchment outlet (MW), catchment inlet (Sys4) and one or both erosion gullies (E1 and/or E2) (see Figure 1),
- Precipitation amount and stream discharge.

Additionally during most events also available:

- Isotopic composition of streamflow (^{18}O and ^{2}H) at a tile drain (Frau2) (see Figure 1),
- Soil moisture (catchment average of all stations over all depths and 1 selected station for 4 depths) and groundwater levels (1 deep and 1 shallow piezometer),
- Time lapse photos at weather station,
- Electric conductivity at catchment outlet,
- Turbidity at catchment outlet and 2 erosion gullies (E1 and E2).

→ **Step 2**: Collection of **properties of each event** (e.g. maximum runoff, sum of precipitation, precipitation intensity, time of concentration, overland flow occurrence, maximum soil moisture and groundwater level, etc.).

→ **Step 3**: Two-component isotopic hydrograph separation (IHS) (Pinder and Jones, 1969):

$$Fe = 1 - \frac{C_t - C_e}{C_p - C_e}$$

where

Fe – event water fraction,

C_t – tracer concentration in the stream,

C_e – event component (rainfall or snowmelt),

C_p – pre-event component.

Here:

- ^{18}O and ^{2}H applied as tracers,
- Fe calculated only for peak discharge,
- Using hourly temporal resolution discharge and precipitation data,
- Incremental weighting of precipitation isotopic composition for IHS.

Assuming:

- Event and pre-event components isotopic contents significantly different,
- Event water maintains constant spatio-temporal isotopic signature, or any variations can be accounted for,
- Pre-event water maintains constant spatio-temporal isotopic signature, or any variations can be accounted for,
- Vadose zone contribution must be negligible, or the isotopic signature of soil water must be similar to that of groundwater,
- Surface storage contributes minimally to streamflow.

STUDY AREA

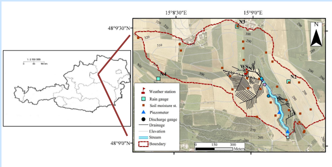


Figure 1. Study area: Hydrological Open Air Laboratory in Austria.

Table 1. Study area: Hydrological Open Air Laboratory (HOAL), Blöschl et al., 2016.

Drainage area		66 ha
Stream length		590 m
Elevation		268÷323 m a.s.l
Geological designation		Tertiary sediment, fractured siltstone
Pedology		Cambisols, Kolluvisol and Planosols
Land use		Agrucultural
Average annual (2002-2015)	**Discharge**	178 mm/year
	Precipitation	784 mm/year
	ET+dS	606 mm/year

PRELIMINARY RESULTS

Event properties

7 winter
8 spring
13 summer
4 autumn

Precipitation amount: 7÷96 mm
Max precipitation intensity: 2÷39 mm/h
Avr precipitation intensity: 0.5÷6 mm/h

23 frontal
9 convective
precipitation events

Deep groundwater well (H01)
Max: -4.8÷-0.2 m relative to ground surface
Time between runoff peak at outlet and Max GWL: -18÷46 h

Shallow groundwater well (BP02)
Max: -0.3÷0.2 m relative to ground surface
Time between runoff peak at outlet and Max GWL: -4÷25 h

Maximum runoff
Outlet: 3÷557 l/s
Erosion gullies: 0÷88 l/s
Inlet: 2÷29 l/s
Tile drain: 0.2÷10 l/s

Time of concentration
Outlet: 1÷36 h
Erosion gullies: 0÷39 h
Inlet: 1÷35 h
Tile drain: 1÷35 h

Runoff coefficient (Chen 2020)
Outlet: 0.02÷0.33
Inlet: 0.01÷0.10
Tile drain: 0.004÷0.290

Selected 1 SM station at catchment centroid (P06)
Infiltration excess: 16 events
Saturation excess: 1 event
Other (no data, no reaction, reaction at the same time): 17 events

Catchment average SM
Max: 0.31÷0.41
Beg. of event: 0.29÷0.40
Time between runoff peak at outlet and Max SM: -7÷11 h

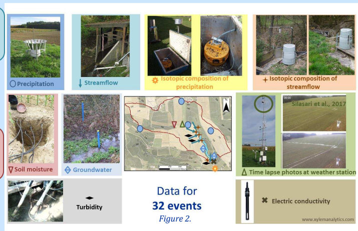


Figure 2.

Suspended sediment load at outlet
Max: 0.3 kg/h÷73 t/h
Time between runoff peak at outlet and Max SSL: -17÷19 h

Suspended sediment load at erosion gullies
Max: 0÷20 t/h
Time between runoff peak at gullies and Max SSL: -10÷1 h

Time lapse photos of overland flow
Overland flow and ponding observed in the valley bottom: 6 events
Overland flow not observed: 4 events
No data/too high crops: 19 events
Snow/snow melt: 3 events

Electric conductivity at outlet
Min: 168÷618 uS/cm
Beginning of the event: 393÷805 uS/cm
Time between runoff peak at outlet and Max electric conductivity: -18÷1 h

Example event

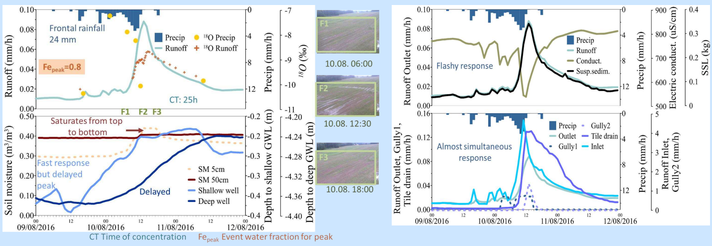


Figure 3. Event on 10 August 2016.

CHALLENGES and OUTLOOK

→ Out of 32 events: all winter and 1 late autumn event with snow omitted from analysis (uncertainties due to frozen soil, snow melt, etc.) - IHS for 24 events, for peak runoff,

→ IHS with plausible results (event water fraction between 0 and 1) - only for 15 events for outlet, due to uncertainties.

→ Two-component isotopic hydrograph separation of all events for catchment outlet between 2013-18 (even when not all additional data are available, e.g. when erosion gullies did not react),

→ Identification of multiple thresholds (in soil moisture, groundwater levels, sediment load, etc.) during rainfall events,

→ Understanding where the water comes from during multiple events,

→ Investigation of the links among the event water contribution, precipitation characteristics and behavior of the soil moisture and groundwater table to understand better which pathways are dominant during different events.

REFERENCES

Blöschl, G. et al. (2016). The Hydrological Open Air Laboratory (HOAL) in Petzenkirchen: a hypothesis-driven observatory. *Hydrol. Earth Syst. Sci.*, 20, 227-255.

Chen, X. et al. (2020). Spatial and temporal variability of event runoff characteristics in a small agricultural catchment. *Hydrological Sciences Journal*, 65(13), 2185-2195.

Pinder, G.F., & Jones, J.F. (1969). Determination of the ground-water component of peak discharge from the chemistry of total runoff. *Water Resources Research*, 5(2), 438-445.

Silasari, R. et al. (2017). Potential of time -lapse photography for identifying saturation area dynamics on agricultural hillslopes. *Hydrological Processes*, 32(21), 3610-3627.

CONTACT

Borbála Széles

Institute of Hydraulic Engineering and Water Resources Management,
Vienna University of Technology, Austria

szeles@hydro.tuwien.ac.at

THE IMPACT OF THE SOIL EROSION MODEL PARAMETERS ON THE SOIL EROSION PROCESSES

Matúš Tomaščík, Kamila Hlavčová, Zuzana Németová, Michaela Danáčová

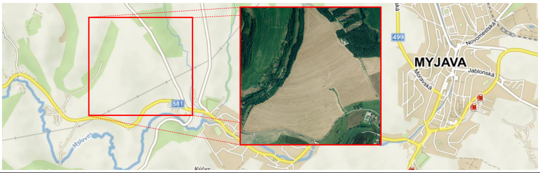
Department of Land and Water Resources Management, Faculty of Civil Engineering, Slovak University of Technology, Bratislava, Slovakia

ABSTRACT

The aim of the study is focused on an evaluation of the input of soil parameters into the physically-based EROSION-2D erosion model. The initial parameters entered into the erosion model directly influence the model results and thereby the resulting evaluation of the soil erosion processes. Soil parameters specific to the selected physically-based EROSION-2D model are hydraulic roughness, erosion resistance, and the correction factor. These parameters were calibrated by comparing the modelled volumes of the soil sediment with the measured data on the experimental plots and by the parameter catalogue. This proves differ as a result of variously. At the same time, it was found that sediment removal is most influenced by the parameters of erosion resistance input and hydraulic roughness in connection with the slope conditions in the area. The correction factor and the initial soil moisture have the most significant influence on the volume of surface runoff.

1 STUDY AREA

The study area on the Turá Lúka hilly agricultural field has an area of 0.29 km² and is mainly represented by slopes with arable land and an erosion gully with seven small wooden check dams inbuilt to stabilise the gully.



2 METHODS

In this study, we will focus on the possibility of the parameterization of the Erosion-2D model. The Erosion-2D model describes the erosion processes in a complex way and is therefore constructed based on the following components:

1. The digital elevation model, which includes interpolation of a 1 m grid from the input data, calculation of the topographic parameters from the slope profile, calculation of the individual catchment area and length of the flow path for each cell (runoff concentration),
2. The Infiltration model which includes rainfall infiltration (Green-Ampt approach)
3. The runoff and erosion sub model performs the simulation calculations

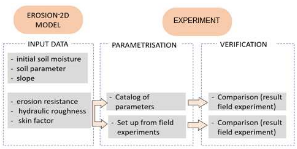


Fig. 2 Conceptual scheme of the methodology

Tab. 1 Parameters of the EROSION-2D model according to the catalog of parameters, for the soil type located in the studied area

Bulk density [kg/m³]	Organic matter [%]	Erosion resistance [kg.m.s⁻²]	Manning roughness [s.m⁻¹/³]	Canopy cover [%]	Skin factor [-]	Clay [%]	Silt [%]	Sand [%]
1800	1,15	0,0008	0,015	0	1	10	36	48

3 RESULTS

Tab. 2 Summary of precipitation simulations in EROSION-2D (calculated on an area of 1m²), A) – catalog parameter, B) set up Manning roughness C) set up Erosion resistance D) set up Skin factor E) set up all parameters together

Experiment No.	Scheme	Initial soil moisture [%]	Erosion resistance [kg.m.s⁻²]	Manning roughness [s.m-1/3]	Skin factor [-]	Sediment Volume [kg/m]	Terrain - sediment Volume [kg/m]
	A)	37,4	0,0008	0,015	1	0,8809	
	B)	37,4	0,0008	6,5	1	0.0238	
1	C)	37,4	0,028	0,015	1	0,0239	0,0240
	D)	37,4	0,0008	0,015	25,5	0,0243	
	E)	37,4	0,0055	0,25	0,9	0,0243	
	A)	38,6	0,0008	0,015	1	0,9291	
	B)	38,6	0,0008	10	1	0,0194	
2	C)	38,6	0,053	0,015	1	0,0143	0,0142
	D)	38,6	0,0008	0,015	30,09	0,0143	
	E)	38,6	0,00695	0,45	0,9	0,0143	
	A)	25,9	0,0008	0,015	1	1,4064	
	B)	25,9	0,0008	0,068	1	0,5715	
3	C)	25,9	0,00198	0,015	1	0,5685	0,5800
	D)	25,9	0,0008	0,015	7,1	0,5690	
	E)	25,9	0,00065	0,1	0,9	0,5733	
	A)	20,5	0,0008	0,015	1	0,9214	
	B)	20,5	0,0008	0,06	1	0,4034	
4	C)	20,5	0,00182	0,015	1	0,4051	0,3933
	D)	20,5	0,0008	0,015	2,65	0,4021	
	E)	20,5	0,001	0,045	0,9	0,3990	

* Bulk density 1800 [kg/m³], organic matter 1,15 [%], cover 0 ~ 80 [%]

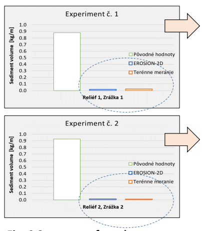
Verification process:

- Setup group 1 (rainfalls 1,2) – erosion resistance 0,0062 [kg.m.s-2], roughness 0,4 [s.m⁻¹/³], cover 55 [%], skin factor 0,9 [-]
- Setup group 2 (rainfalls 3,4) – erosion resistance 0,001 [kg.m.s⁻²], roughness 0,073 [s.m⁻¹/³], cover 8 [%], Skin factor 0,9 [-]

Tab. 3 Experiments: 4 artificial precipitation

Exp. No.	Intenzity [mm/min]	Duration [min]
1	3.2	10
2	3.2	10
3	5.1	12 (4x3)
4	5.0	12 (4x3)

Experiment No. 1 and 2: duration of the artificial precipitation 10 minutes (without interruption).
Experiment No. 3 and 4: artificial precipitation lasting 12 minutes (4 separate precipitation)



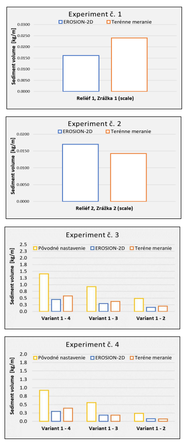


Fig. 3 Summary of results simulation

Tab. 4 Verification (summary from the rainfall simulation)

Exp. No.	Variant (single rainfall)	Total time [min]	Initial soil moisture [%]	Setup group 1 Sediment Volume [kg/m]	Setup group 2 Sediment Volume [kg/m]	Terrain Sediment Volume [kg/m]
1	1	10	37,4	0,0161	-	0,0240
2	1	10	38,6	0,0170	-	0,0142
	1 - 4	12	25,9	-	0,450	0,580
3	1 - 3	9	25,9	-	0,298	0,374
	1 - 2	6	25,9	-	0,158	0,199
	1 - 4	12	13,2	-	0,299	0,393
4	1 - 3	9	13,2	-	0,183	0,187
	1 - 2	6	13,2	-	0,079	0,073

4 CONCLUSION

Simulations in the physically-based EROSION-2D erosion model have shown that the soil parameters entering this model are very sensitive to erosion-transport processes. Therefore, it is appropriate to pay increased attention to them (when selecting and setting them) to obtain reliable results for a given precipitation episode, given the type and condition of the soil and type of area. The results from the field experiments show that outputs from the rainfall simulations can be reproduced successfully. Based on those outputs, the process of determining a model´s parameters can be successfully performed. The disadvantage is seen in the area of the small simulator. The experimental results of the small-scale simulator are susceptible to measurement and model errors. It is necessary to work with a more significant number of measurements and analyse the results. In conclusion, it is possible to state that the model overestimates the amount of sediment on higher slopes, which can be modified by a higher degree of roughness.

Acknowledgement

This work has been funded by the VEGA grant agency under the contract numbers VEGA 1/0632/19. The authors are grateful for their financial support.

Impact of the water supply on the soil moisture and groundwater of a woody pasture near Kőszeg (Hungary)

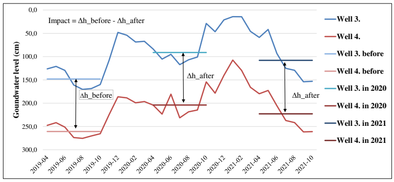
Előd Szőke[1], Péter Csáki[3], Péter Kutschi[2], Péter Kalicz[1], Zoltán Gribovszki[1]

[1] University of Sopron, 9400 Sopron, Bajcsy-Zs. u. 4., Hungary
[2] Őrség National Park Directorate
[3]Self-employed
E-mail: elod0324@gmail.com

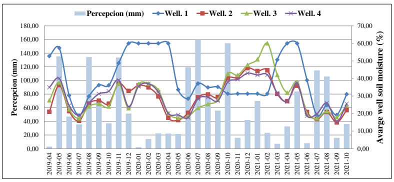
1. figure: The location of the groundwater wells in the habitat reconstruction project area near Kőszeg

Long dry periods -induced climate change may cause reductions in groundwater resources and soil moisture, and may probably degrade riparian ecosystems. With a reasonable and forward-thinking water supply, unfavorable dry spells can be stopped, and valuable wetlands can be preserved or those that have deteriorated can be restored.

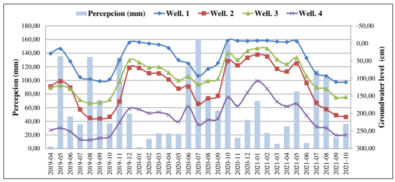
The aim of the research was to evaluate the reconstruction of the Doroszló meadows habitat from a hydrological point of view. Groundwater monitoring wells were installed at 4 selected locations in the area. The surface soil moisture next to the wells was also measured. The water tables in the wells were recorded manually on a weekly basis. Data for the period from April 2019 to October 2021 were processed using several statistical methods such as the "double mass curve" and "treatment-control space-time deviations"



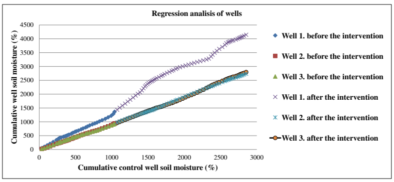
2. figure: Treatment-control space and time deviations



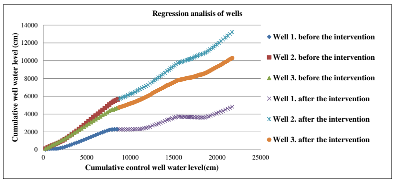
3. figure: Changes in soil moisture and precipitation patterns.



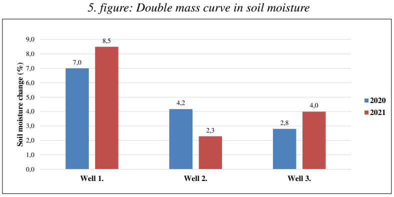
4. figure: Changes in groundwater levels and precipitation patterns.



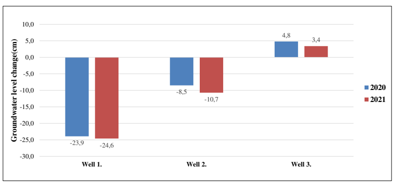
5. figure: Double mass curve in soil moisture



6. figure: Double mass curve in groundwater



7. figure: Change in soil moisture relative to the control well



8. figure:Change in groundwater level relative to the control well

This research was supported by the "EFOP-3.4.4-16-00022 QUALITAS Development of Higher Education in Sopron, Szombathely and Tata"

CHANGES IN A PLANT´S AVAILABLE WATER CAPACITY DUE TO THE APPLICATION OF BIOCHAR

Natália BOTKOVÁ[1,2], Justína VITKOVÁ[1]

[1] *Institute of Hydrology, Slovak Academy of Sciences, Dúbravská cesta 9, 841 04 Bratislava, Slovakia, vitkova@uh.savba.sk*
[2] *Institute of Landscape Engineering, Faculty of Horticulture and Landscape Engineering, Slovak University of Agriculture, Tulipánová 7, 949 76 Nitra, Slovakia*

INTODUCTION

Within the context of ongoing climate change, extreme meteorological events occur more frequently in our geographical conditions. Longer periods without precipitation are a stressful phenomenon for agricultural crops, particularly during the growing season. The application of biochar in soil is one of the “modern” technologies for keeping water in land. Biochar is a carbon-rich porous material produced from biomass by the process of pyrolysis.

MATERIALS AND METHODS

In laboratory conditions were prepared samples with recalculated biochar in amount of 0, 20, 40 and 80 t/ha (Fig. 1). The used soil was classified as silt loam. The used biochar was produced from mix of different poplar varies (Populus) by pyrolysis at 520 °C. Soil water retention curves (Fig. 2) were determined from samples with volume of 100 cm³ through the use of standard pressure plate apparatus. Available water capacity was determined from SWRC as different between hydrolimits field capacity (pF 2.5) and wilting point (pF 4.2).

Fig. 1. Mixtures of soil and biochar in amount of 20, 40 and 80 t/ha.

	soil	P_20	P_40	P_80
AWC (-)	0.1257	0.14665	0.1751	0.1754

Table 1. Available water capacity (AWC) at pure soil samples (soil) and mixtures soil with biochar rate of 20 t.ha⁻¹ (P_20), 40 t.ha⁻¹ (P_40) and 80 t.ha⁻¹ (P_80).

RESULTS AND CONCLUSION

Our results showed that higher amount of biochar increased available water capacity (AWC) by 16% or 39%, respectively. The difference between 40 and 80 t/ha was statistically insignificant (same for both variants = 39%). We found out positive effect of used biochar on retention capacity. We can conclude that a biochar dose of 40 t/ha in this type of soil is enough to increase the soil´s water holding capacity on agricultural land. Using biochar is thus of great benefit, especially during non-precipitation days.

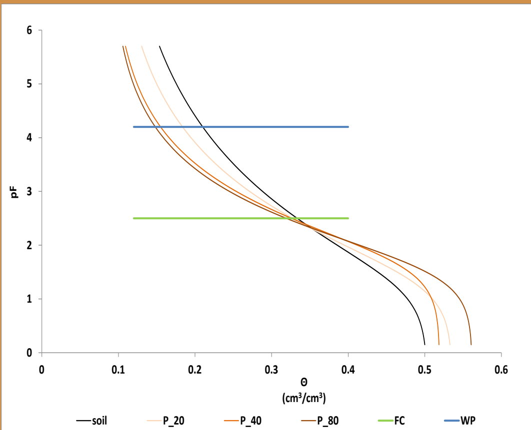


Fig. 2. Soil water retention curves at pure soil samples (soil) and mixtures soil with biochar amount of 20 t/ha (P_20), 40 t/ha (P_40) and 80 t/ha (P_80) in comparison with soil hydrolimits field capacity (FC) and wilting point (WP).

ACKNOWLEDGEMENTS: This study was supported by Scientific Grant Agency No. VEGA 2/0155/21, by EIG CONCERT-Japan project No. EIG JC2019-074.

COMPARISON OF THE SURFACE SOIL MOISTURE IN A FOREST AND A NEIGHBOURING MEADOW LOCATED IN A VALLEY

Csenge Nevezi[1], Dávid Schmidt[2], Előd Szőke[1], Zoltán Gribovszki[1], Péter Kalicz[1]

[1] University of Sopron, Faculty of Forestry, Institute of Geomatics, Civil Engineering and Hydrologics

[2] University of Sopron, Faculty of Forestry, Institute of Botany and Nature Conservation

Soil moisture is one of the most important factors that helps sustain an ecosystem's balance. In 2018, research began in the Hidegvíz Valley experimental catchment that aimed to reveal the connections between the hydrological and botanical characteristics in an alder forest and a neighbouring meadow. The data collection started in 2018, and ended successfully after one year in 2019. This study focused on the changes that occurred in the surface soil moisture, groundwater levels, vegetation, and related meteorological parameters. All the results showed that the hydrological factors linked to the botanical characteristics, particularly between the surface soil moisture and the plants' water uptake. After these promising results, we decided to monitor the soil moisture changes and the coenology further by supplementing them with any available historical data.

The first soil moisture dataset collection in this study area started in 2017, but only in the alder forest. One year later the area was expanded to the forest edge and the wet meadow, and the measurements have continued since then. The data collecting method was the Time Domain Reflectometry (TDR), because it is one of the fastest and easiest methods for determining surface soil moisture in this sampling area. However, during the winter, when the surface is mostly frozen, the data cannot be collected with the TDR instrument. After the analysis, the results showed that the surface soil moisture changes are following the precipitation characteristics in all three ecosystems. In general, the wet meadow has the highest value of the surface soil moisture, the forest edge has medium value, and the alder forest has the lowest value. This trend appears to change to the opposite if a longer drought period is occurring, i.e., the alder forest has the highest soil moisture out of the three ecosystems.

Figure 1: The sampling area in the Hidegvíz-valley.
The brown line stands for the main research building, and the white is for the local meteorological station. The green line stands for the soil moisture and coenology sampling area; the green dots are marking the actual measuring points.

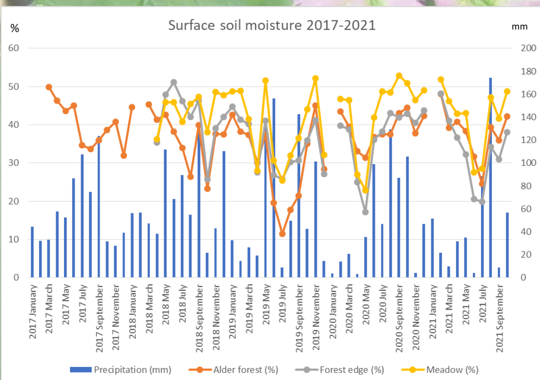


Figure 2: Surface soil moisture between 2017-2021.

Wet meadow dominant plant species

C_1 layer (21-37 %)	C_2 layer (118-140%)	
Alopecurus pratensis (Meadow foxtail)	***Alopecurus pratensis*** (Meadow foxtail)	**D layer (25-35%)**
Dactylis glomerata (Orchard grass)	***Poa pratensis*** (Common meadow-grass)	
Rumex acetosa (Common sorrel)	***Aegopodium podagraria*** (Ground elder)	
	Cirsium oleraceum (Cabbage thistle)	
	Rumex acetosa (Common sorrel)	

Table 1: Dominant plant species and coverage in the wet meadow.

Figure 3: The wet meadow and the alder forest sampling area.

Alder forest dominant plant species

A layer (Canopy; 40-80%)	B layer (Understory; 20-30%)	C layer (Herb; 90-130%)	
Alnus glutinosa (Common alder)	***Corylus avellana*** (Common hazel)	***Stachys sylvatica*** (Hedge woundwort)	**D layer (Forest floor; 80-95%)**
Ulmus glabra (Wych elm)	***Cornus sanguinea*** (Common dogwood)	***Aegopodium podagraria*** (Ground elder)	
		Galeobdolon luteum (Yellow archangel)	

Table 2: Dominant plant species and coverage in the alder forest.

The research has been supported by the Ministry of Agriculture in Hungary and the GINOP-2.3.3-15-2016-00039 project.

How significant is the hydrological impact of forests in Hungarian sandy drylands of Kiskunság?

András Szabó[1*], Bence Bolla[1], Péter Kalicz[2], Zoltán Gribovszki[2]

[1]Forest Research Institute, University of Sopron, Sárvár, Hungary
[2]Institute of Geomatics and Civil Engineering, Faculty of Forestry, University of Sopron, Sopron, Hungary
*szabo.andras@uni-sopron.hu

Introduction

Although groundwater depletion in the Hungarian Great Plain, especially at the Kiskunság Area has been a constant focus for researchers from a variety of fields, the role of the different factors behind this process is still a subject of debate. The aim of the hydro-meteorological monitoring system operated by University of Sopron is to investigate the impact of forests on the local hydrological regime. The results highlight the importance of other factors (for e.g.: climate change, river regulation, groundwater pumping for industrial, agricultural, and domestic water demand) behind the ongoing processes.

Materials and methods

The study site is located at "Nyíri" forest (Fig. 1a; 46°58'2.69" N; 19°33'12.86" E) near to Kecskemét-Méntelek in the Kiskunság region. Manual groundwater measurements were conducted weekly until 02.07.2019. followed by automatized data collection. Soil moisture content was measured weekly in the upper 80 cm layer of soil a a grassland, a black locust *(Robinia pseudoacacia)* stand, and a black pine *(Pinus nigra)* forest stand. Supplementary groundwater data was collected in every 3 days at a monitoring well surrounded with small-scale farms, 3.5 km away (Fig. 1b; 46°56'30.53" N; 19°37'52.56"E). Precipitation data was also collected at „Nyíri" forest (É 46° 58' 03,69"; K 19° 33' 10,34")

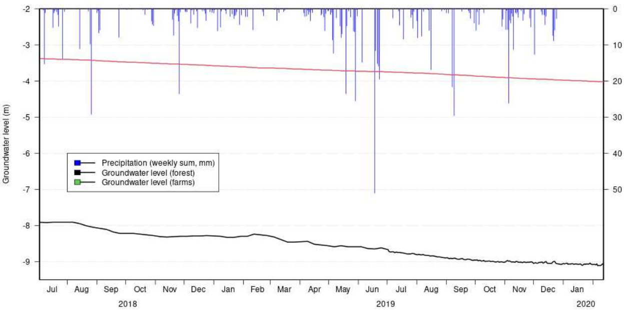


Figure 2.: Groundwater level and precipitation at the monitoring wells.

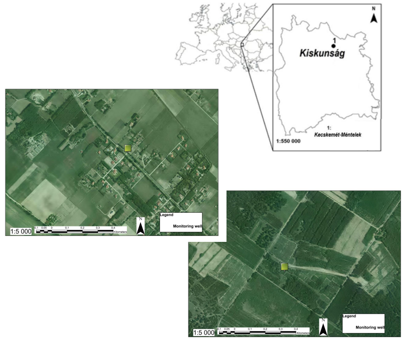


Figure 1.: Location and surroundings of the study sites

Results

- The data showed atypical groundwater dynamics at both of the measurement points: There was no observable recharge under farmlands and very limited recharge occured under forest during the whole study period (Fig. 2.). A near-continuous decrease was measured at both sites.
- Similarly the groundwater showed very limited or no response to the precipitation. Even the extreme amount of precipitation (113 mm between 16. and 24.06.2019.) has not increased observed groundwater levels.
- Although soil moisture content was lower under forests (Fig. 3.) compared to grassland (by 0.6% and 1.7% average in case of black locust and pinus nigra respectively), this difference do not explain the observed rate of grondwater level decrease.

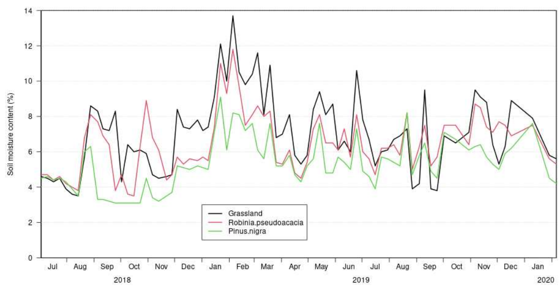


Figure 3.: Soil moisture content under different vegetation cover (0-80 cm)

Conclusion

- Groundwater recharge from precipitation is not significant even at relatively shallow (3-4,5 m) groundwater levels, regardless to the vegetation type of the surface.
- Groundwater dynamics is not related to the yearly cycle of evapotranspiration.
- Water-uptake of forest vegetation don't decrease the soil moisture content significantly.
- It can be concluded that vegetation type is not the main factor behind the groundwater decrease at the studied area.
- In order to clarify the relative effect of the different vegetation type and other factors, long-term and complex monitoring is needed.

UNIVERSITY of SOPRON | FOREST RESEARCH INSTITUTE

Acknowledgement

The authors would like to acknowledge the financial support from the „Hydrological study of forests at Sand Ridge area" (EGF105/2021) project and from the Ministry of Agriculture. The authors also would like to thank EMMRE project for the meteorological data.

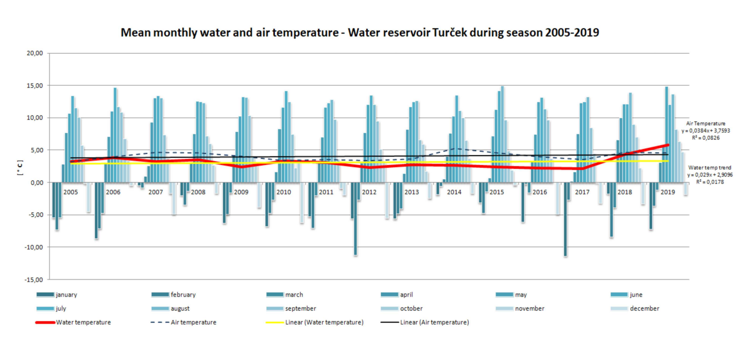
Evaluation in the hydro-meteorological data changes at the locality of the Turček water reservoir

10th International Conference
2021
26 November
Vienna
Austria

Adrián Varga[1, 2], Yvetta Velísková[2]

[1]Slovak University of Agriculture in Nitra, Faculty of Horticulture and Landscape Engineering,
[2]Institute of Hydrology, Slovak Academy of Sciences

Corresponding author
Email: varga@uh.savba.sk.



Reservoir	Basin	Total volume mil.m³	Year of commissioning
Rozgrund	Hron	0.5	1774
Hriňová	Hron	7.6	1965
Klenovec	Slaná	6.7	1974
Bukovec	Bodva	21.4	1976
Starina	Bodrog	47	1988
Nová Bystrica	Váh	31.6	1989
Málinec	Ipeľ	21.5	1993
Turček	Váh	9.9	1998
Tichý potok	Poprad	24	?

The Turček reservoir is located at the confluence of the Turiec and Ružový rivers above the village of Turček. The altitude in the locality of the dam profile is 719m asl. The total volume of the tank is 10.6 mil. m3, while its storage content is 9.9 mil. m3 (the tank is filled twice a year) and the constant volume is 0.3 mil. m3 of water. The average amount of water supplied to the water treatment plant is 15.8 million m3 / year. The total area of the basin is 29.5 km².

Climate change trends in Slovakia

According to the document of the Ministry of the Environment of the Slovak Republic (MoE SR, 2018), climate change in Slovakia in the years 1881 - 2017 manifested itself as follows:

-the average annual air temperature increased by about 1.73 ° C;

-spatially different trend of the annual total atmospheric precipitation on average by about 0.5%

-decrease in relative humidity (in the south of Slovakia by 1900 by 5%, to the rest of the territory less);

-a decrease in the values of all characteristics of the snow cover up to an altitude of 1000 m in almost the entire territory of the Slovak Republic (nevertheless, an increase was recorded at a higher altitude);

-increasing potential evaporation and reducing soil moisture

Impact of climate change on water quality

1. Increasing the frequency of inflow of turbid water due to the increase of heavy rains,

2. Stagnation of tank circulation due to global warming,

3. Increased risk of toxic chemicals in raw water due to the increase of pests,

4. Increase in trihalomethane production due to rising water temperature,

5. Increased risk of pathogenic microorganisms in tap water due to rising water temperature.

Air and water temperatures are generally rising, although some months have a declining trend.

In the observed period 2005 - 2019, the total air temperature increased by 0.57 ° C and water temperature by 0,43 ° C.

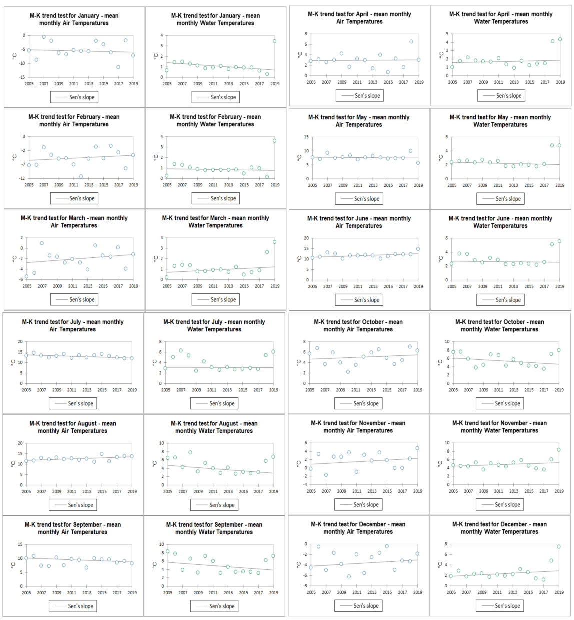
The results of the Mann-Kendall test show that using the 0.1%, 1%, 5% and 10% significance levels, the null hypothesis cannot be rejected, which means that there is no trend in most data cases except for air temperature at level of significance 10% in July.

An increase in air temperature results in an increase in water temperature (according to some studies by 0.6-0.8 ° C to + 1 ° C air), which can reduce the pH of water, dissolved oxygen, and increase the conductivity of water; where TDS in water is directly related to conductivity. For each 1 ° C increment, the conductivity increases by 2-4%. Temperature affects conductivity by increasing ion mobility and, in addition, the solubility of many salts and minerals.

Table Results of M-K trend analysis for mean monthly air and water temperatures, significance 5%

Mann-Kendall trend test results

1. November – January	**Air XI.**	**Water XI.**	**Air XII.**	**Water XII.**	**Air I.**	**Water I.**
Kendall's tau	0.134	0.181	0.077	0.162	-0.086	-0.314
S	14.000	19.000	8.000	17.000	-9.000	-33.000
Var(S)	407.333	408.333	407.333	408.333	408.333	408.333
p-value (Two-tailed)	0.519	0.373	0.729	0.428	0.692	0.113
Z	0.644	0.891	0.347	0.792	-0.396	-1.584
1. February – April	**Air II.**	**Water II.**	**Air III.**	**Water III.**	**Air IV.**	**Water IV.**
Kendall's tau	0.191	-0.077	0.183	0.105	0.048	0.067
S	20.000	-8.000	19.000	11.000	5.000	7.000
Var(S)	407.333	407.333	406.333	408.333	408.333	408.333
p-value (Two-tailed)	0.346	0.729	0.372	0.621	0.843	0.767
Z	0.941	-0.347	0.893	0.495	0.198	0.297
2. May – July	**Air V.**	**Water V.**	**Air VI.**	**Water VI.**	**Air VII.**	**Water VII.**
Kendall's tau	-0.162	-0.086	0.287	-0.067	-0.387	-0.010
S	-17.000	-9.000	30.000	-7.000	-40.000	-1.000
Var(S)	408.333	408.333	407.333	408.333	404.667	408.333
p-value (Two-tailed)	0.428	0.692	0.151	0.767	0.053	1.000
Z	-0.792	-0.396	1.437	-0.297	-1.939	0.000
2. August – October	**Air VIII.**	**Water VIII.**	**Air IX.**	**Water IX.**	**Air X.**	**Water X.**
Kendall's tau	0.314	-0.257	-0.219	-0.276	0.115	-0.181
S	33.000	-27.000	-23.000	-29.000	12.000	-19.000
Var(S)	408.333	408.333	408.333	408.333	407.333	408.333
p-value (Two-tailed)	0.113	0.198	0.276	0.166	0.586	0.373
Z	1.584	-1.287	-1.089	-1.386	0.545	-0.891



HYDROMORPHOLOGICAL EVALUATION OF THE ECOLOGICAL POTENTIAL OF NATURAL AND HEAVILY MODIFIED WATER BODIES

Gréta Doláková, Viliam Macura, Andrej Škrinár, Milan Čistý

Department of Land and Water Resources Management, Faculty of Civil Engineering, Slovak University of Technology, Radlinského 11, 810 05 Bratislava, Slovakia
greta.dolakova@stuba.sk

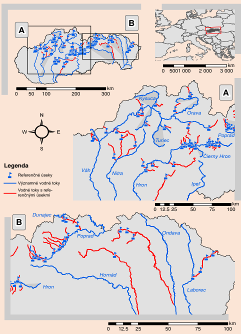
ABSTRACT

The study examines the hydraulic quality of a Slovak riverine habitat in a stream area, using brown trout as a bioindicator. Abundant research into the hydraulic monitoring of aquatic habitats and microhabitats has been taking place in Slovakia since 1995. A detailed database contains valuable hydro-morphological, topographic, and ichthyological measurements. The mountain and piedmont streams were selected based on their availability and because heavy modifications have a more significant influence on the fish preferences in the upper parts of a stream. The research compares the biotic and abiotic parameters of streams to investigate fish abundance and the preferences of microhabitats in hydrological modeling software. The methodology comprises terrain data collection, the hydrological modeling of reaches using the Instream Flow Incremental Methodology (IFIM) in the computer software System for Environmental Flow Analysis (SEFA), and the development of an algorithm using a regression model. The study produces an optimal regression relationship to determine the degree of influence of natural and heavily modified water bodies in Slovakia. The result of the regression is output in the form of the Area Weighted Suitability (AWS), which represents the degree of the effect of river modification on an aquatic habitat gained by a simplified methodology.

1 STUDY AREA AND DATA

The study area in the given localities represents natural and regulated reaches of mountain and piedmont streams across the Slovakia.

1) REFERENCE REACHES: The already existing database consists of 58 reference reaches measured since 1995, which have a natural character. These data were used to derive the regression equation.



2) VERIFICATION SECTIONS OF FLOWS: 20 natural reaches and 13 modified sections of mountain and piedmont streams for calibration.

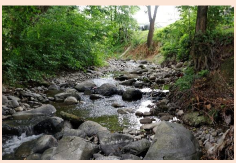


Fig.1: NATURAL REACH Olšava river, Bodrog basin, eastern Slovakia the village of Davidov

Fig. 2 : REGULATED REACH of Olšava river, Bodrog basin, eastern Slovakia the village of Sačurov

2 METHODOLOGY

- Determination of reference river reaches
- Topographic and hydrometric field measurement of reference reaches
- Ichthyological survey of reference reaches of streams
- Selection of fish species, bioindicator of an aquatic habitat quality
- Hydrollogical modeling - Influence of habitat characteristics on the area - Area Weighted Suitability (AWS)
- Correlation and regression analysis of flow characteristics and their influence on the quality of aquatic habitat.

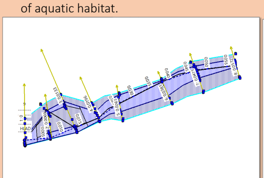


Fig. 3 Topographic output – REGULATED REACH of the Dolinský creek (Hydrocheck software)

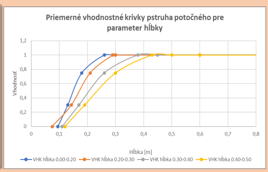
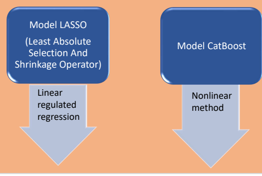


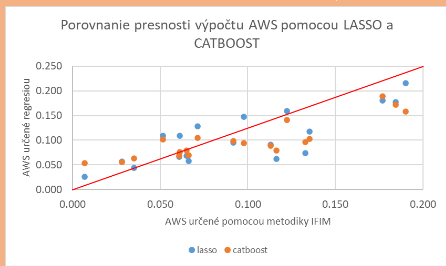
Fig. 4 Generalized habitat suitability curves (V. MACURA, Z. ŠTEFUNKOVÁ, M. MAJOROŠOVÁ, P. HALAJ a A. ŠKRINÁR, 2018. Influence of discharge on fish habitat suitability curves in mountain watercourses in IFIM methodology. Journal of Hydrology and Hydromechanics. 2018, roč. 66, č. 1, s. 12–22. ISSN 13384333)

3 RESULTS

Results of regression

Regression models used:





A smaller PBIAS and a higher correlation coefficient indicate that the nonlinear CatBoost model provides better regression-derived AWS values. The LASSO linear model is less accurate, but can be more easily expressed using the following equation:

$$AWS = 0.000627 * p_{p,max} + 0.040032 * S_{Lok} - 0.037282 * S_{Lok} * š_{Lok} + 0.234242 * p_{p,max} * S_{Lok} + 0.021169$$

Where: Slok - site area taking into account the number of shelters [m2] according to the equation:

$$S_{Lok} = \frac{d_{Lok} * š_{Lok} * n_{100m}}{100}$$

4 CONCLUSION

- The protection and revitalization of river systems and their aquatic biodiversity is currently limited by funding, so the whole process must begin with the identification of priorities and thus ensure the effective redistribution of financial resources to areas with a greater need for revitalization.
- The aim and the result of the research was to create a methodology for determining the degree of impact on mountain and piedmont streams.
- The methodology was created on the basis of basal hydromorphological parameters measurable in the field survey using simple equipment. Such a methodology is significantly simpler than the determination of AWS using the SEFA hydraulic model, which requires a demanding geodetic survey of the overall topography of the section, and the input biotic parameters are determined from a previous ichthyological survey. Obtaining this data is technologically and time consuming, and with modeling in the SEFA program, the procedure is too demanding for quick and practical use.
- The methodology based on the regression equation is significantly simpler and easy to use in practice. Based on statistical calibration and testing of the equation, it follows that the method provides significantly similar results as SEFA.

Acknowledgements:

This study has been jointly supported by the Scientific Grant Agency under Contract No. VEGA 1592 and APVV-16-0253. The authors thank the agency for its research support.

POSSIBILITIES OF USING STRUCTURAL SUBSTRATE WITH A BIOCHAR COMPONENT IN BLUE-GREEN INFRASTRUCTURE PLANNING

Ing. Timea Petrová, Ing. Viktória Tyukosová, Ing. Martina Majorošová, PhD.

Department of Land and Water Resources Management, Faculty of Civil Engineering, Slovak University of Technology, Radlinského 11, 810 05 Bratislava, Slovakia

timea.petrova@stuba.sk

ABSTRACT

The main purpose of implementing a blue-green infrastructure into an urban environment is to use the filtration capabilities of greenery. The conjunction of vegetation with water elements helps to achieve optimal conditions while mitigating the negative effects of climate change. The reduction of the harmful microclimatic properties of an urban environment can be mitigated by a sufficient number of quality "green areas". In the case of a dense urban structure, insufficient conditions for the growth of a root system are some of the main factors influencing growth characteristics and the ability to avoid post-planting stress.

Therefore, an alternative use of the substrate, i.e., structural substrate as an element of water retention measures with the vegetation component in places with an insufficient rooting volume or with an unsuitable soil horizon, can be included among the solutions suitable for an urban environment. The aim of the study is to create the implementation and subsequent evaluation of the growth potential of vegetation due to the unfavourable conditions of the urban environment with a modern method of using structural substrate employing biochar, in comparison with the classical type of substrate used. A model from abroad that grows vegetation in a structural substrate shows considerable potential using a drainage system in areas with low space requirements for the growth of woody vegetation.

1 Introduction

Biochar is a carbon formed by pyrolysis - high-temperature combustion of plant and other organic material without the presence of oxygen. The use of biochar has long been used as a soil additive to improve the structural and qualitative properties of the soil. Biochar retains their original content of nutrients as a vegetation component (except nitrogen), which are slowly released into the soil, thus improving soil properties. The sorption properties of biochar on the occurrence of pollution in soil and water components include the reduction of soil emissions, heavy metals in industrially polluted soil, and the modification of biochar to achieve the sorption of pharmaceutical products and greenhouse gases. The use of biochar as the main component of the structural substrate shows significant positive effects on the growth and prosperity of vegetation in unfavorable conditions of dense urban structure.

2 Research area

In the past, biochar has been used as an additive to improve soil properties, but in recent years, experimental biochar has been used as a major substrate component with a combination of aggregates in an urban environment. This is a significant opportunity in use in environments with significant negative environmental conditions (pollution associated with the immediate vicinity of the traffic road, lack of rooting space for vegetation, occurrence of urban heat islands, lack of precipitation during the growing season, interconnection of planting with infiltration elements). The given use of the structural substrate is in combination with the use of rainwater (surface runoff) by drainage layers from the street environment. Drainage layers are formed by a combination of aggregates of different fractions, which bring down the impacts to the layer of the structural substrate using biochar around the root system of vegetation. The possibilities are in the complete replacement of the classic structural substrate, which reduces the negative properties of the urban environment using purely natural renewable components.

3 Materials and methods

The choice of the reference area was limited by several conditions typical of the urban environment, namely close contact with the traffic road, exposed position towards microclimatic conditions and insufficient root space factor. Therefore, the location of the town of Piešťany in the immediate vicinity of the road was chosen, in places with a high level of built-up area and plenty of solar radiation throughout the day. Piešťany is included in the map outputs of the climate division in the zone 6b, which corresponds to zone -20.5 to -17.8 ° C. The scale has been used since the 1980s and the territory of Slovakia is located in a transitional area of oceanic and continental influence and does not take into account the specific conditions of the site, which slightly reduces the accuracy of the division. Nevertheless, the territory of Piešťany can be designated as the locality of the zone 6b-7a (if we take into account the effects of climate change).

The town of Piešťany is located on the right river bank of Váh in the northern outcrop of the Danube plain, at the foot of the Považský Inovec mountain range which belong to the Inner Western Carpathians.

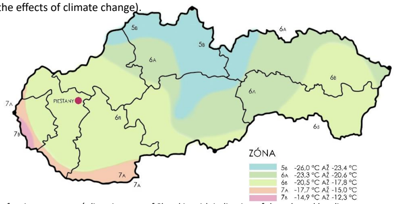


FIG. 1: Map of the division of resistance zones / climatic zones of Slovakia with indication of the selected locality

Rezistance zone	1		2		3		4		5		6		7		8		9		10	
	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b
Temperature from (in °C)	−51.1	−48.3	−45.6	−42.8	−40	−37.2	−34.4	−31.7	−28.9	−26.1	−23.3	−20.6	−17.8	−15	−12.2	−9.4	−6.7	−3.9	−1.1	1.7
Temperature to (in °C)	−48.3	−45.6	−42.8	−40	−37.2	−34.4	−31.7	−28.9	−26.1	−23.3	−20.6	−17.8	−15	−12.2	−9.4	−6.7	−3.9	−1.1	1.7	4.4

TABLE 1: Division of resistance zones / climatic zones in Slovakia

The planting was carried out in mobile containers simulating insufficient rooting space and microclimatic conditions of the urban environment such as the occurrence of urban heat islands, substrate overheating, high evaporation, etc.. The mobile containers for the exterior greenery were made of wooden construction. For research purposes, two sizes were made: type A -70x130x70 cm and type B - 70x70x70 cm, two pieces of each size. The type A container was created to place 2 pieces of Carpinus betulus 'Fastigiata' and the type B container for 3 pieces of Photinia × fraseri. The implementation involved planting a control sample using a standard planting procedure in a substrate intended for container plantings and subsequently in a structural substrate. The substrate suitable for container planting / planting in mobile containers consists of natural light peat, wood fibers and the supplied moisturizing component of the water-soluble fertilizer.

Acknowledgements:
This work was supported by the Slovak Research and Development Agency under the Contract VEGA 1592.
The author thank the agency for the research support.

Composition of the structural substrate

The substrate model consists of a mixture of gravel aggregate, a conventional substrate and a biochar component. The given ratio was used to implement tree planting in street spaces with limited possibilities for the rooting system of vegetation or in projects in the immediate vicinity of traffic routes. The ratio used (see Fig. 2) is 6/8 of the volume of 4-8 mm fraction aggregate, 1/8 of the substrate suitable for container green and 1/8 of Sonnenerde organic biochar. After mixing the individual components, a mixture was created, which was used to plant of 2 pieces od deciduous trees *Carpinus betulus* 'Fastigiata' and 3 pieces of evergreen truss, Photinia × fraseri. After selecting suitable habitat conditions, the containers were placed and then planted. To ensure the suitable drain, layers of aggregates of different fractions were formed in the vessels. First, the lower layer contained the washed aggregate fraction 100-200 mm, then the fraction of washed aggregate 63-150 mm and the last drainage layer was made of washed macadam fraction 16-32 mm. Subsequently, layers of substrate and structural substrate were laid.

FIG. 2., 3., 4. : Composition of the structural substrate, Structural substrate mixture after mixing, Drainage components

The choice of vegetation material took into account the conditions of the reference area and the type of planting. Selected species consider several habitat aspects such as suitability of planting in paved areas, growth properties, habitat of tree species, allergenicity, resistance to frost / climazone (see TABLE 1) and sensitivity to higher temperatures and solar radiation, tolerability of the cut and overcrowding requirements. Carpinus betulus 'Fastigiata', from climate zone 5b, was selected to represent tree woody vegetation. It is a deciduous tree with a compact type of crown. The crown is initially narrow, regular but later slightly widens, making the cultivar suitable for tree alley.

4 Results

The use of the structural substrate in the conditions of Slovakia has not yet been implemented. The next stage will be the evaluation of the microclimatic properties of the area and their impact on the vegetation in the classical substrate compared to structural substrate with biochar. Measurement and data collection takes place throughout the year, starting with planting. First, quantitative and qualitative parameters of vegetation are recorded: bio-indicative properties of vegetation (soil moisture, soil reaction, exposure of vegetation to sunlight) and weather conditions. The second type of monitoring is focused on increments during the growing season - determining the growth potential. Monitoring of the state of vegetation will take place during the entire vegetation period. Photinia × phraseri was selected as a representative of evergreen bushes from climate zone 6a.

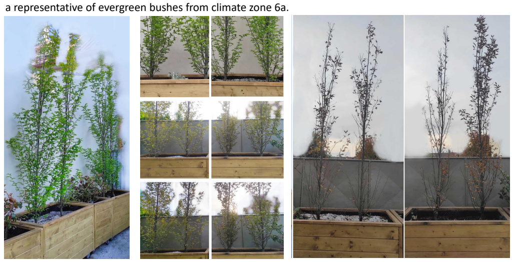


FIG. 5, 6., 7., 8.: Trees Carpinus betulus 'Fastigiata' directly after planting, during the growing season and at the end of the growing season

5 Conclusion

The aim of the implementation is to evaluate the growth potential of vegetation with respect to the unfavourable conditions of the urban environment with a modern method of growing in a structural substrate using a biochar component, in comparison with the classic type of substrate used. The model of growing vegetation in a structural substrate abroad shows considerable potential with the use of a drainage system in areas with insufficient space requirements for the growth of woody vegetation. The implementation is focused on the collection and evaluation of parameters associated with the growth properties of vegetation in the urban environment. The benefit of the project lies in the use of modern methods of urban cultivation in the design of landscaping in urban areas and the general applicability of the method to areas with a lack of space or the occurrence of the disturbed urban soil profile.

CHANGES IN THE COMPOSITION AND MORPHOLOGY OF FLOODPLAIN FORESTS RESULTING FROM MANAGEMENT OF THE DANUBE BASIN

Ing. Viktória Tyukosová, Ing. Timea Petrová

Department of Land and Water Resources Management, Faculty of Civil Engineering, Slovak University of Technology, Radlinského 11, 810 05 Bratislava, Slovakia

viktoria.tyukosova@stuba.sk

ABSTRACT

The construction of the Gabčíkovo Nagymaros waterworks, which began their operations in 1992, disrupted the natural dynamics of the water regime of the Danube River. These changes in the water regime and the movement of the surface water and groundwater levels caused the modification or loss of habitats that bore the characteristic features of floodplain habitats. These modifications resulted in changes in the morphology and of the composition of floodplain stands. These changes are traceable in the historical records of dendrological and botanical research. Changes in the branch system of the Danube River and the cutting off of the side channels from the main riverbed blocked the natural migration corridor. Plant diaspores used to be transported by these channels. These corridors allowed only one-way spreads. By the blocking of these migratory routes, the relocation of indigenous species stopped, which thereby prevented the natural regeneration in the structure and of the composition of the floodplain forests. Improper anthropogenic interventions in the landscape, such as the construction of roads crossing the floodplain, the cultivation of monocultures of hybrid poplars, and the deforestation of areas for agricultural purposes, also harmed the state of the biodiversity of the floodplain stands. The changes in the water regime and the consequent intensive agricultural activity on deforested lands caused eutrophication in the area, especially in reaches where the floodplain forest still has a hydrological connection with the main flow of the Danube. These factors have led to changes in the dendrological and botanical composition, that are perceptible when comparing data from 1951 through the present. Average new tree species are added every decade, while the indigenous species are slowly declining.

1 Study Area And Input Data

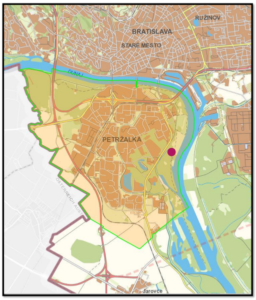


Fig 1. Location of the research area
(https://zbgis.skgeodesy.sk)

The studied area lies in Petržalka. Petržalka is a city district of Bratislava with the largest population (about 100,000 inhabitants) and one of the most densely populated areas in Slovakia and Central Europe. It was originally a rural village near Bratislava located on the right bank of the river Danube.

Remains of floodplain stand on the territory of Petržalka, and in its vicinity are preserved fragments of the former continuous large area of the Bratislava floodplain stand. These habitats were located here much sooner before the construction of Petržalka was even began. From historical data, we can restructure the habitat composition which is native and autochthonous.

serial num.	Latin name - English name		measuring height (cm)	trunk circumference (cm)	hight (m)	diameter (m)	damage percentage		basic social value in €	damage	loc.	k/d	taxon	resulting social value in €	notes	age
1	2		3	4	6	7	8	9	10	11	12	13	14	15	16	15
TREES:																
1	Populus nigra	black poplar	130	452	18	12	3	30	3319.39	0.6	1.3	1	0.8	3452.17	saplings at the base	180.80
2	Populus nigra	black poplar	130	378	16	10	3	30	2522.74	0.6	1.3	1	0.8	2623.65		151.20
3	Negundo aceroides	ash maple	130	210	12	9	3	50	1493.73	0.6	1.3	1	0.8	1553.48		84.00
4	Negundo aceroides	ash maple	130	185	13	6	3	30	1294.56	0.6	1.3	1	0.8	1346.35		74.00
5	Robinia pseudoacacia	black locust	130	105	15	7	3	30	863.04	0.6	1.3	1	0.8	897.56		42.00
6	Robinia pseudoacacia	black locust	130	142	14	8	3	30	1161.79	0.6	1.3	1	0.8	1208.26		56.80
7	Salix alba	white willow	130	364	18	9	2	20	2522.74	0.8	1.3	1	0.8	2623.65	irregular tree crown	145.60
8	Salix alba	white willow	130	289	17	10	3	30	2124.41	0.6	1.3	1	0.8	2209.39		115.60
9	Populus nigra	black poplar	130	97	16	5	3	30	763.46	0.6	1.3	1	0.8	794.00		38.80
10	Ailanthus altissima	varnish tree	130	75	12	6	4	50	564.30	0.6	1.3	1	0.8	586.87	saplings at the base	30.00
11	Robinia pseudoacacia	black locust	130	194	15	8	3	20	1493.73	0.8	1.3	1	0.8	1553.48		77.60
12	Populus nigra	black poplar	130	289	14	10	3	20	2124.41	0.8	1.3	1	0.8	2209.39		115.60
13	Populus tremula	european aspen	130	173	16	12	4	32	1294.56	0.6	1.3	1	0.8	1346.35		69.20
14	Ulmus laevis	ulmus laevis	130	89	16	10	3	20	663.88	0.8	1.3	1	0.8	690.43	irregular tree crown	35.60
15	Fraxinus excelsior	european ash	130	321	11	11	3	20	2323.57	0.8	1.3	1	0.8	2416.52		128.40
16	Padus racemosa	bird cherry	130	98	6	4	3	15	763.46	0.8	1.3	1	0.8	794.00		39.20
17	Salix alba	white willow	130	396	18	9	3	15	2522.74	0.8	1.3	1	0.8	2623.65		158.40
18	Salix alba	white willow	130	421	15	12	3	20	2854.68	0.8	1.3	1	0.8	2968.86		168.40
19	Populus alba	white poplar	130	258	17	12	3	15	1925.25	0.8	1.3	1	0.8	2002.26		103.20
20	Populus alba	white poplar	130	197	14	10	3	20	1493.73	0.8	1.3	1	0.8	1553.48		78.80
21	Acer campestre	field maple	130	123	10	9	3	30	1062.21	0.6	1.3	1	0.8	1104.69		49.20
22	Acer campestre	field maple	130	148	11	9	3	30	1161.79	0.6	1.3	1	0.8	1208.26		59.20
23	Fraxinus excelsior	european ash	130	95	12	5	3	40	763.46	0.6	1.3	1	0.8	794.00	saplings at the base	38.00
24	Acer campestre	field maple	130	187	13	9	3	30	1294.56	0.6	1.3	1	0.8	1346.35		74.80
25	Acer campestre	field maple	130	178	13	8	3	30	1294.56	0.6	1.3	1	0.8	1346.35		71.20
26	Populus nigra	black poplar	130	254	17	10	3	30	1925.25	0.6	1.3	1	0.8	2002.26		101.60
27	Negundo aceroides	ash maple	130	149	14	8	3	20	1161.79	0.8	1.3	1	0.8	1208.26		59.60
28	Acer campestre	field maple	130	162	15	9	3	30	1294.56	0.6	1.3	1	0.8	1346.35		64.80
29	Crataegus monogyna	oneseed hawthorn	130	72	7	4	3	42	564.30	0.6	1.3	1	0.8	586.87	rot on the trunk	28.80
30	Crataegus monogyna	oneseed hawthorn	130	85	7	5	3	25	663.88	0.3	1.3	1	0.8	690.43		34.00
31	Fraxinus excelsior	european ash	130	194	16	9	3	26	1493.73	0.3	1.3	1	0.8	1553.48		77.60
32	Salix fragilis	crack willow	130	89	12	5	3	34	663.88	0.6	1.3	1	0.8	690.43		35.60
33	Fraxinus excelsior	european ash	130	98	16	6	3	36	763.46	0.6	1.3	1	0.8	794.00		39.20
34	Salix fragilis	crack willow	130	152	13	10	2	25	1161.79	0.3	1.3	1	0.8	1208.26		60.80
35	Salix fragilis	crack willow	130	149	16	11	3	30	1161.79	0.6	1.3	1	0.8	1208.26		59.60
36	Acer campestre	field maple	130	146	15	9	2	19	1161.79	0.8	1.3	1	0.8	1208.26		58.40
37	Ulmus leavis	ulmus laevis	130	98	9	9	2	15	763.46	0.8	1.3	1	0.8	794.00		39.20
38	Acer campestre	field maple	130	110	10	7	3	32	962.62	0.6	1.3	1	0.8	1001.13		44.00
39	Ulmus laevis	ulmus laevis	130	175	16	9	2	21	1294.56	0.8	1.3	1	0.8	1346.35		70.00
40	Ulmus laevis	ulmus laevis	130	135	9	10	3	32	1161.79	0.6	1.3	1	0.8	1208.26		54.00
41	Padus racemosa	bird cherry	130	60	6	4	4	46	497.91	0.6	1.3	1	0.8	517.83	bad statics, irregular tree crown	24.00
42	Padus racemosa	bird cherry	130	63	6	5	2	29	497.91	0.6	1.3	1	0.8	517.83		25.20
43	Negundo aceroides	ash maple	130	91	11	9	3	31	763.46	0.6	1.3	1	0.8	794.00		36.40
44	Fraxinus excelsior	european ash	130	85	9	6	3	30	663.88	0.6	1.3	1	0.8	690.43		34.00
45	Negundo aceroides	ash maple	130	93	8	7	4	45	763.46	0.6	1.3	1	0.8	794.00	bad statics	37.20

Fig 2. Table of measured values from the type area Starý Háj

Fig 3. Location of the trees in monitoring area STH1

Fig 4. Photo from the monitoring area STH1

2 Methodology

Selection of monitoring areas

The definition of the solved mapping area will be in the sense of established steps. The selection of type areas will occur by locating sections along the Danube River in Petržalka. We used military mapping, orthophoto maps, and vector maps of the current state of the area. These maps helped to choose our monitoring area. On our monitoring area of 751 m² expanses, we have used a Nautiz X6 GPS receiver and the MAPUJ program, which directs data directly to QGIS.

Inventory of tree composition in a selected area

To determine the current state of conservation of indigenous species in the model area, and to compare the species composition with historical sources, we have used standardized methodologies of the arboricultural standard of 2019 and ŠOPSR.

Processing and evaluation of data measurement

The tree inventory includes:

- location of trees
- determination of taxon and determination of dendrometric characteristics of individual trees
- in some cases, the list of trees may also include a record of stumps, including the determination of their dimensions

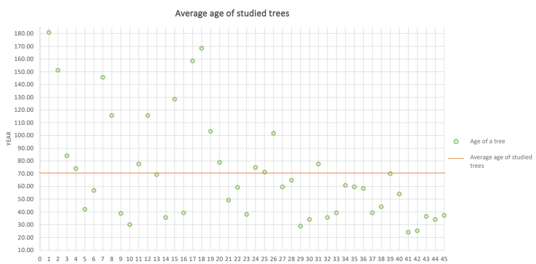


Fig 5. Chart of averaged age of studied trees

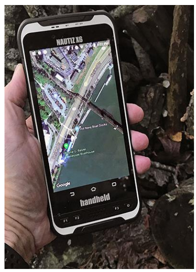


Fig 6. a Nautiz X6 GPS receiver

3 Results And Conclusion

The field survey confirmed the hypothesis about the current state of the composition of floodplain stands near the built-up area of Petržalka. The plant composition points to indirect interventions by anthropogenic factors in the structure of the studied habitat. To preserve these habitats, it is necessary to properly manage the given localities and to minimize anthropogenic interference with the ecosystem in certain areas. 45 trees were evaluated in the Starý Háj monitoring area. Invasive species in the herb floor were present at the site, but only on the edge of the habitat. Namely, they were the species Asclepias syriaca and Impatiens glandulifera. There is quite widespread black locust, in addition to which there are typical tree species corresponding to the plant composition of willow-poplar floodplain forest. The average age of studied trees is 70,4 years, which led us to the conclusion that some of the trees were part of the research in the past. As we can see in fig.6 the dendrological structure of floodplain forests is changing. On average every decade increases the composition by 2 or 3 indigenous tree species which is very alarming.

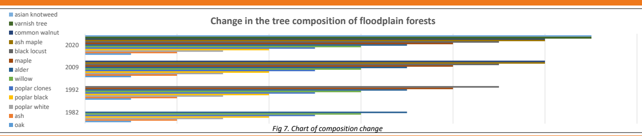


Fig 7. Chart of composition change

SLOVAK UNIVERSITY OF TECHNOLOGY IN BRATISLAVA
FACULTY OF CIVIL ENGINEERING

Hydrocarpath conference 26.11.2021

Mapping riverbed material with Deep Learning – a field study from the Danube

Alexander Anatol Ermilov; Sándor Baranya*; Gergely Tikász*; Márton Schrott*; Gergely Benkő**

**Budapest University of Technology and Economics, Department of Hydraulic and Water Resources Engineering*

I. Motivation:

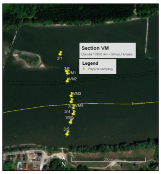
Traditional bed material sampling methods are:

- time- and energy consuming
- in many cases not representative samples

II. Idea:

Image processing may provide faster and more detailed information.

Measuring vessel with the applied camera.



Traditional sampling points of one of the river sections (1 out of 4) on the Danube.

III. Research:

Comparing results of a traditional method to image analyses (Artificial Inteligence and Transferable Wavelet Method; both from underwater videos of the riverbed along the sections). Results divided into 3 main sediment size categories: sand, gravel and cobble.

Traditional (bell) sampler and a collected, dried sample.

Underwater image of the bed and the fractions defined by the AI.

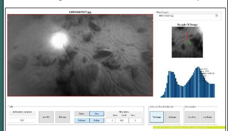
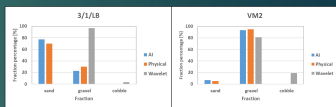


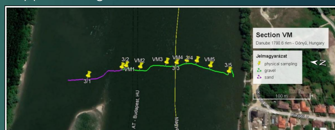
Image of the bed and its GSD from the Wavelet method.

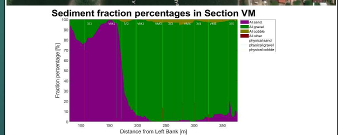
IV. Results:

1) Generally ***good matches*** of the AI with the traditional method in the measurement points. Wavelet was not able to measure sand however.



2) The AI made it possible to have ***a spatially more detailed riverbed surface grainsize distribution***, given to any point along the measured cross-sections.





National Research, Development and Innovation Office Hungary

Új Nemzeti Kiválóság Program

Innovációs és Technológiai Minisztérium