



Hydrology in natural and anthropogenic environments

Book of abstracts

1st International Scientific Conference
4–7 September 2018, Kraków, Poland



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Table of contents

Plenary session.....	9
<i>Marek Bodziony, Beata Baziak, Wiesław Gądek</i> Effect of soil moisture on the runoff from a small catchment.....	11
<i>Katarzyna Bogacz, Stanisław Małek</i> The influence of selected water reservoirs on biodiversity in Limanowa Forest District, in the Beskid Wyspowy mountain range.....	13
<i>Marta Cebulska, Dariia Kholiavchuk</i> Atmospheric droughts in the Polish and Ukrainian Carpathians in the years of 1984–2015.....	14
<i>Krzysztof Frydel</i> Small-scale water retention in the Kaliska Forest District – practical approach.....	16
<i>Wiesław Gądek, Beata Baziak, Joanna Szajnar, Tamara Tokarczyk</i> Application of the Pearson distribution function type IV to the description of a parametric flow hydrograph.....	18
<i>Angelika Golasz, Krzysztof Owskiak</i> Occurrence of European beaver (<i>Castor fiber</i>) in forest areas in an economic context.....	20
<i>Janusz Gołąb, Elżbieta Badach, Krzysztof Urban</i> Soil moisture content on the slope behind the outlet of equipment for draining forest roads.....	21
<i>Sylwester M. Grajewski, Andrzej Czerniak</i> Engineering solutions facilitating the construction of forest roads on low strength subgrades.....	23
<i>Ewa Jachniak, Barbara Nycz, Michał Holubcik</i> Evaluation of the water quality in the typical submontane dam reservoir at Wapienica....	24
<i>Michał Jasik, Stanisław Małek</i> Seasonal changes of selected physicochemical parameters and water quality in reservoirs of small-scale mountain retention.....	25

<i>Mariola Kędra</i>	
Changing thermal conditions in mountain rivers with significant temperature trends (Polish Carpathians)	26
<i>Mariola Kędra</i>	
Fluvial resources in a medium–height mountain region under climate change	27
<i>Anna Klamerus-Iwan</i>	
Variability in the wettability and water storage capacity of tree crowns	28
<i>Stanisław Małek, Kacper Bierowiec, Milena Przybyłek, Katarzyna Dudek, Mariusz Kormanek, Jacek Banach, Grzegorz Durło</i>	
Leaching out of selected macro-elements for Scots pine, Norway spruce, European beech and pedunculate oak seedlings produced at the container nurseries.....	30
<i>Józef Plewniak, Łukasz Słotwiński</i>	
Safety of timber export traffic on forest slope roads	32
<i>Ewa Słowik-Opoka, Anna Michno, Dominika Wrońska-Wałach</i>	
Description of variability of features characterising the mineral material taken from log steps and boulder steps, located in a stream channel of a small mountain catchment in the Silesian Beskids (Polish Carpathians).....	33
<i>Ewa Słowik-Opoka, Dominika Wrońska-Wałach, Ewa Panaś, Anna Michno</i>	
Analysis of the shape of quartz grains in mineral sediments collected from log steps and boulder steps, located in the mountain stream channel in a small catchment – Carpathian flysch case study.....	35
<i>Rafał Starzak</i>	
The dynamics of soil water storage in the low-mountain stands in the Beskid Sądecki (Western Carpathians).....	37
<i>Robert Szczepanek</i>	
Rainfall spatial variability in ten selected Polish forests, in the years 2015–2017.....	39
<i>Robert Szczepanek, Beata Baziak, Wiesław Gądek</i>	
High-resolution soil field humidity map of Poland, based on global gridded soil information SoilGrids250m	41
<i>Maciej Ziulkiewicz, Michał Górecki, Anna Fortuniak, Anna Walas, Rafał Zakrzewski</i>	
Pollution load balance in the municipal water retention reservoir during a flash-flood event	42
<i>Maciej Ziulkiewicz, Marek Marciniak, Michał Górecki</i>	
Conditions of water movement in hyporheic zone in the context of research on hydraulic gradient	44

Posters.....	45
<i>Anna Cieplak, Aneta Spyra, Agnieszka Babczyńska, Małgorzata Strzelec</i> Reproductive potential measuring as a hutching success of <i>Physella acuta</i> (Draparnaud, 1805) – a case study in an anthropogenic forest pond	47
<i>Grzegorz Durło, Mariusz Kormanek, Stanisław Małek, Jacek Banach</i> Utilization of fully automated moisture control system (SMCS) of peat moss substrate in container seedlings production.....	48
<i>Janusz Gołąb, Bartłomiej Sadowski</i> Testing a simplified methodology for measuring the shape of logging route surface, and obtaining the Digital Terrain Model.....	50
<i>Anna Ilek, Jarosław Kucza, Wojciech Witek, Małgorzata Szostek, Jadwiga Stanek-Tarkowska</i> Influence of initial water content on the filtration coefficient of forest soils	51
<i>Rafał Kozłowski, Robert Kruszyk</i> Study of atmospheric deposition and canopy leaching in two pine stands (West Pomerania, Świętokrzyskie Mountains).....	53
<i>Rafał Kozłowski, Joanna Przybylska, Joanna Kaleta</i> Impact of water retention in the “Cedzyna” dam reservoir on selected physicochemical parameters of the Lubrzanka River	55
<i>Katarzyna Krakowian, Stanisław Małek</i> LIDAR data usage in the interpretation of regularities of underground water outflows location as illustrated with the example of Skrzyczne range in Western Carpathians	57
<i>Justyna Likus-Cieślik, Adam Smoliński, Marcin Pietrzykowski, Andrzej Bąk</i> Sulfur contamination impact on seasonal and surface water chemistry within the reforested area of former sulfur mine	58
<i>Sylwia Łagan, Anna Klamerus-Iwan</i> A sessile drop method in the assessment of properties of the surface layer of needles in selected tree species	60
<i>Krzysztof Owsiak, Bogdan Galas</i> Laboratory-based determination of specific storage coefficient	62
<i>Krzysztof Owsiak, Jakub Jędrzejewski</i> The dynamics of groundwater table fluctuations near a beaver-made backwater pools in the Koszęcin Forest District.....	63
<i>Ewa Słowik-Opoka, Artur Stępień</i> Characteristics of river-bed forms as illustrated with the example of a selected section of the Wisłoka River (in Magura National Park, Dukla Forest District), and their significance for the environment.....	64

<i>Aneta Spyra, Małgorzata Strzelec</i>	
Forest mining ponds – implications of the impact of their recreational use on invertebrate fauna	65
<i>Rafał Starzak, Mateusz Gryglak</i>	
Spatial and temporal variability of topsoil humidity in selected beech stands	66
<i>Wojciech Witek, Anna Ilek, Jarosław Kucza</i>	
The impact of root systems on feeding the rhizoid area with rainwater	67
<i>Maciej Ziulkiewicz, Michał Górecki, Anna Fortuniak, Anna Walas, Rafał Zakrzewski</i>	
Organic pollutants of a small urban river during rainfalls	68
Field session	69
Visiting the Forest District Krościenko and the Czorsztyn water dam	
Rafting on the Dunajec River	

PLENARY SESSION

Effect of soil moisture on the runoff from a small catchment

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Mathematical modeling of the transformation of rainfall into runoff is most often used for the assessment of water resources, and the most popular models are those with clustered parameters. The models independently determine hyetographs of effective precipitation, and perform the rainfall-runoff transformation calculations.

The commonly used SCS–CN (Soil Conservation Service–Curve Number) or NRCS–CN (National Resources Conservation Services–Curve Number) methods are based on the soil permeability, classified in four hydrologic categories, as well as on land use within the catchment. Additionally, one of the three states of the catchment can be defined (I – without vegetation, II – vegetation, dry soil, III – vegetation, wetland). The authors adopted one of the models (HEC–HMS model) in order to carry out the rainfall-runoff transformation calculations. The paper proposes ways to determine the moisture status of the catchment. This information can then be used, by applying mathematical modeling of the rainfall-runoff transformation, to assess the initial conditions prevailing in the catchment. Computer simulations confirm that fixed model parameters do not work for long-term prognoses. Previous attempts to introduce an anterior precipitation index had not solved this problem. The proposed numerical tests aimed to check whether supplementing the NRCS–CN method with information on the initial soil moisture conditions would significantly improve the quality of simulation of the rainfall-runoff transformation. As opposed to the anterior precipitation index, which was determined for several days preceding the simulation, the soil moisture condition in the proposed method is determined for the growing season (from the 1st of April).

The calculations were performed for the rainfall and runoff data from the study area, located within the catchment of the Wielka Puszcza stream (May–October 2017). It is a forest-based catchment, with a predominantly deciduous tree stand. In the catchment, a modern rainfall and runoff monitoring system has been installed, where a water level

is measured using a microwave probe, and verified by photographs of a water level gauge taken with a camera. The data is recorded every 10 minutes.

The soil moisture status of the catchment is determined from a water balance between the recorded rainfall, and the theoretical field evaporation. This balance is conducted every year, from the 1st of April until the end of October.

Keywords: discharge, flood wave, catchment, hydrograph, NRCS-CN, SMI (Soil Moisture Index)

The influence of selected water reservoirs on biodiversity in Limanowa Forest District, in the Beskid Wyspowy mountain range

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The construction of water retention reservoirs under the Project “Counteracting the effects of the outflow of precipitation waters in mountainous areas. Increasing retention and maintenance of creeks and related infrastructure in good condition” has aimed at improving water conditions of forest ecosystems, and increasing their biodiversity. The aim of the present study was to analyse the changes in species composition in the vicinity of such artificial ponds or reservoirs built in the Forest District of Limanowa. Research hypothesis was that the construction and size of retention reservoirs affect the species composition of vegetation in their direct neighbourhood.

At reservoirs built in 2013 and 2014, trial areas were established where the occurrence of various plant species were analysed. The surface area of 1 m² was designated at a distance of 1, 5 and 10 meters from the edge of the water. The vegetation in the water was also subjected to analysis. The species composition was inventoried at the beginning and at the end of the growing season. The results were collected in tables, and ranked from the smallest to the largest reservoir.

The research results show changes in the amount of coverage of study areas by different groups of plants: trees, aquatic plants, plants typical to the field environment, and plants typical to the forest environment. The largest variation of species was observed in the closest vicinity of the reservoir, whereas the number of species observed at 10 meters from the edge of the water was smaller. There were also many species introduced along with building material from outside of the forest ecosystem. These species showed copious plant succession. Due to the overly abundant occurrence of field plants, special care should be taken of the water reservoir, such as cleaning the bottom, or mowing its edges.

Keywords: biodiversity, Limanowa Forest District, species composition, water storage reservoir, succession

Atmospheric droughts in the Polish and Ukrainian Carpathians in the years of 1984–2015

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The present study addresses the exploration of atmospheric precipitation deficiency, which was evaluated on the basis of monthly and annual precipitation totals. The Polish and Ukrainian Carpathians served as the study area, where forests cover about 40% of the Polish Carpathians (Soja 2002), and about 68% of the Ukrainian Carpathians (Kruhlov et al. 2013). Sequential series of monthly and annual precipitation totals in the years of 1984–2015 at 23 meteorological measurement stations were analysed. The monthly and annual precipitation data from 14 stations located in the Polish Carpathians were obtained from the Institute of Meteorology and Water Management – National Research Institute, while the data for the 9 stations located in the Ukrainian Carpathians – from the Central Geophysical Observatory of the State Emergency Service of Ukraine. The periods with the precipitation deficiency were defined, while identifying atmospheric drought with the help of Standardized Precipitation Index (SPI), and the probability of the monthly precipitation non-exceedance. In the annual cycle, the lowest monthly precipitation totals were found throughout the whole year. Still, in the Ukrainian part, the highest frequency of the lowest totals was recorded in January (20%), while in the Polish Carpathians, it was recorded in October (20%). In the remaining winter months, the frequency did not exceed 16%. Instead, during the vegetation period, the frequency of the lowest monthly precipitation totals was not higher than 10%, though the most cases of lowest precipitation, both in the Polish and Ukrainian Carpathians, were observed in April, with the frequency of 9% and 6%, respectively. November 2011 was exceptional in terms of low precipitation totals that did not exceed 5 mm, excluding the precipitation totals recorded in Yaremcha.

96% of extremely dry months in the Ukrainian Carpathians were recorded in the 21st century. Only three cases of such months had been recorded earlier. The latter were recorded at the stations of Play, Rakhiv, and Seliatyn in May 1991, August 1986, and April 1995, respectively. In the years of 1984-2015, the extremely dry months, recorded at least at 30% of the stations, were January 2002, February 1986, April 2007, and April 2009, August 2003, November 2011, and December 2004. Besides, the precipitation deficiency in January 2002 was observed only in the Ukrainian Carpathians, whereas in February 1986, it was recorded only in the Polish Carpathians. The year of 2007 was found to be extremely dry in terms of SPI at the majority of Ukrainian stations in the Carpathians, whereas at the remaining stations, no such features were identified. Dry episodes of varying intensity, covering the observation area of at least 20 stations, are characteristic of each month in the annual cycle, throughout the whole studied period.

Keywords: atmospheric precipitation deficiency, Standardized Precipitation Index (SPI), vegetation period, Western Carpathians, Eastern Carpathians

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Small-scale water retention in the Kaliska Forest District – practical approach

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In the mid-1980s, in the area of the Kaliska Forest District, in water-poor tree stands of the Bory Tucholskie (Tuchola Forest) mesoregion, one would find many mid-forest lakes, ponds and swamps in which either there was no water, or water only appeared for a short time after thaw or spring rains. There were many reasons behind the disappearance of water, both biotic and abiotic.

The first cause for the changes in the hydrology of forest areas of the Kaliska Forest District was the phenomenon of progressive climate change known from the literature of the subject.

The second possible reason for the disappearance of water may be the exploration of geological deposits at the turn of the 1970s and 1980s, with an application of the echo-seismic method. Using explosive charges, geologists caused tectonic microquakes that could have affected the thin, impermeable layers of the first aquifer located on the post-glacial sand field.

The reason for the lack of water may also lie in the drainage of the peat land of former lakes that had been carried out in order to adapt the latter for the purpose of carrot cultivation. These areas were located at the edge of the forest, and in the runoff area of water to the Wierzyca River. At the owners' request, about 60 ha of this land was subjected to land improvement, i.e. drained. Unfortunately, this was followed by incorrect operation of hydrotechnical devices, namely the valves, which were left completely open, without regulating the water levels. This had caused a reduction in the level of groundwater, initially only within the drained area, and later also in the neighbouring areas, and in forest areas located higher up.

It cannot be determined how the underground waters from the disappearing lakes or mid-forest ponds and swamps had moved underground, because no such studies had been conducted. Water was not marked in surface tanks; therefore it was not possible to investigate where it travelled underground. However, the flooding of tree stands in the

neighbouring forestry districts, which also occurred at that same time, could indicate the escape of surface water to underground water.

Thanks to the possibility of collecting water from the Czarnowodzki Canal in 1996, work was begun on restoring water to several among several dozens of reservoirs. It was envisaged that the level of groundwater could possibly be raised by water seeping into the ground, and successively filling the dried lakes, mid-forest ponds, and swamps, located throughout the area of about 5000 hectares. The entire work was carried out in two stages, and it was completed by 2003. Throughout the whole period of implementation, and on-going to this day, monitoring of surface water has been conducted in the area covered by the small-scale water retention program for the Kaliska Forest District. Since 2013, professionally installed water gauges have been operating in selected locations.

Keywords: small-scale retention, Kaliska Forest District, backwater

Application of the Pearson distribution function type IV to the description of a parametric flow hydrograph

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The Gamma distribution functions with one shape parameter, used for the description of the parametric flow hydrograph, are not applicable for the Upper Vistula and the Upper and Central Odra. Therefore, it was necessary to search for a different function. In his publication, Strupczewski (1964) proposed, that apart from the Pearson distribution function type III, the Pearson distribution function type IV be used with one and two shape parameters. The feasibility study of the proposed distribution functions was carried out on the data gathered from 60 water gauges; 30 of them were located on the Upper Vistula river, and 30 on the Central Odra river. The parameters of the hydrograph's shape and duration of its rising branch were determined while optimizing the calculated flow descriptors W_{50} and W_{75} as well as the hydrograph asymmetry parameter s . The descriptors were calculated using the Archer method, on the basis of the median of the maximum flow hydrographs.

The calculated courses of parametric hydrographs were compared to a nonparametric hydrograph with regard to the consistency of their volumes, and position of their gravity centres. The Pearson distribution functions type IV, with one and two hydrograph shape parameters, turned out to provide an accurate description. However, the function with two shape parameters has no defined solution, since the condition of the assumed objective function is fulfilled by a very large group of hydrograph shape parameters m and n .

Parametric flow hydrographs must provide the explicit parameters, since they may be applied in any river cross section using the physical catchment descriptors.

It was therefore assumed that the Pearson distribution function type IV with one shape parameter would be the recommended function. An additional advantage of this function is that the inflection point is located between the flow descriptors W_{50} and W_{75} , which allows the exponential function to be used in the description of the rising or receding part.

Keywords: Parametric hydrograph, Strupczewski's methods, Gamma distribution function, Archer's method, physical descriptor of the catchment, Pearson's distribution type IV

Occurrence of European beaver (*Castor fiber*) in forest areas in an economic context

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Through their activities, beavers affect the functioning of forest management, among other things. The main focus of the present study was the economic aspect of the occurrence of selected beaver families in the Koszęcin Forest District. The following costs were assessed and presented: of exclusion of land from forestry production, compensation for flooded forest stands, costs of accumulated water, approximate cost of the construction of reservoirs of the same volume as the backwater pools, and lost trees around the reservoirs. In order to compare the status before the introduction of beavers to the considered area, and the current status thereof, changes in the species composition and shorting in 1989 and 2016 were determined, based on forest development plans. On this basis, it was found that the profits resulting from the presence of the European beaver in forest areas exceed the losses by PLN 118 172.

Keywords: European beaver, costs, backwater pools, dam

Soil moisture content on the slope behind the outlet of equipment for draining forest roads

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Surface water runoff – which is a natural part of the water cycle in nature – is harmful and undesirable from the human point of view, because its effect on the surrounding environment is in many respects negative, and may be even destructive. The most serious consequence is the acceleration of the water cycle in nature, as well as the erosive action of the runoff. Such runoff, with the coincidence of unfavourable conditions, causes very serious transformations of the terrain, surface area, it destroys the natural environment and infrastructure, and furthermore, it increases the flooding and overflowing of streams. In a forest environment, surface runoff is formed basically only on roads, logging routes, and storage areas, that is, on surfaces with man-made properties of the land cover. The devices used, which drain the communication system, direct the collected water in the form of concentrated streams towards the slope, which often results in serious linear erosive damage, or landslides. The purpose of the present research was to determine the spatial distribution of soil moisture in the area beyond the outlet of the equipment for draining the forest roads, and the possibility of water retention. We also aimed to verify whether the changes in selected soil features affect the possible formation of landslides.

The presented research was conducted in the Gorce National Park, where very steep slopes dominate, and in the Forest Experimental Station in Krynica-Zdrój, in areas with medium-grade slopes. In both areas, four road surface draining devices were selected, and the soil moisture was measured in each of the three measurement series. Soil mois-

ture was tested by the oven-drying-weight method in samples taken according to the same scheme. On the basis of complementary soil studies, the filtration coefficient was determined by a simplified Hazen formula.

The described studies (in both areas) do not indicate statistically significant differences in humidity in places differing according to the distance from the road edge, nor those differing according to the distance from the water runoff line beyond the outlet from the water outlets. Such significance was obtained for medium humidity, grouped according to depths.

Keywords: mountain forests, forest roads, road drainage devices, soil humidity, water retention, landslide hazard

Engineering solutions facilitating the construction of forest roads on low strength subgrades

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In forests, we frequently face problems with ensuring and maintaining road passability in areas with difficult geotechnical conditions for the foundation of a road structure. This is typically connected with permanent or periodical excessive moisture content of the subgrade and the underlying organic soils. A reduction of both the degree of interference in the natural environment, and of the construction costs for such roads may be provided by the technologies based on geo-synthetic materials. The aim of the present study was to investigate the effect of increased moisture content in structural layers of the pavement and the subgrade on load bearing parameters of forest roads, both with improved dirt pavements and hardened unimproved pavements. Measurements were recorded in the dynamic plate test (Light Weight Deflectometer test), conducted in 6 experimental sections before and after their moisture content was increased (flooding of the road section with water or heavy rainfall). Recorded values of load bearing capacity (E_{vd} , s/v) showed that all the variants of pavement structure strengthening based on geotextile (gravel on sand and flat lying geotextile, gravel on sand-filled geotextile matting, sand on flat lying geotextile, or sand on sand-filled geotextile matting) had comparable load bearing capacities, at the same time showing markedly better parameters in relation to debris, which is frequently used to construct embankments in water-logged areas. The results clearly indicate a negative impact of increased moisture content in pavement layers on load bearing parameters of forest roads. For this reason, in our paper we present various engineering solutions that ensure adequate load bearing capacity at adverse ground and water conditions. These recommendations may prove useful in designing new roads as well as in restructuring the existing ones.

Keywords: forest road, geosynthetics, load-bearing capacity, moisture content

Evaluation of the water quality in the typical submontane dam reservoir at Wapienica

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In this publication, the water quality in the Wapienica dam reservoir was defined. It was defined on the basis of the results of analyses, which were conducted in 2014–2016 by the Regional Inspectorate for Environmental Protection in Katowice, the Bielsko-Biala department. The evaluation of the condition of water (environmental potential, chemical composition, water quality) was conducted on the basis of the biological, hydro-morphological and physicochemical elements (including particularly harmful synthetic and non-synthetic substances), also priority substances and other pollutants. The aforementioned evaluation was conducted according to the Regulation by the Minister of Environment, of 21 July 2016 (regarding the classification method of the condition of homogeneous part of surface water, and environmental quality standards for priority substances) [Journal of Laws 2016, item 1187]. The final evaluation of the water condition in the homogeneous part of the reservoir was conducted on the basis of the classification results of the environmental potential, and chemical composition, according to the above-mentioned Regulation. The results of the analyses pointed to the environmental potential of the second class (therefore, good level of environmental potential), whereas in respect to the content of priority substances, the water did not meet the quality standards for polycyclic aromatic hydrocarbons, and therefore it was classified as below satisfactory in terms chemical composition. Unfortunately, the results of the present research indicated that the general condition of water in the reservoir is poor. Additionally, the evaluation of water condition in the reservoir was conducted on the basis of the analysis of planktonic algae, which were conducted in 2015. The observed species of algae pointed to good quality of water in the reservoir, however, with a periodic tendency towards deterioration.

Keywords: quality of water, ecological potential, planktonic algae

Seasonal changes of selected physicochemical parameters and water quality in reservoirs of small-scale mountain retention

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The present work focused on retention reservoirs of small-scale mountain retention. The work was aimed at observing the changes in selected physicochemical parameters of water in small-scale retention reservoirs depending on the season, and seeing how water retention in reservoirs affects water quality. The research was conducted between June and December 2017. Each month, water samples were taken and transported to the Laboratory of Environmental Geochemistry and Areas for Reclamation of the University of Agriculture in Krakow, where the following analyses were performed: measurement of pH, conductivity (EC) and content of cations: NH_4^+ , Na^+ , K^+ , Ca^{2+} , Mg^{2+} and anions: Cl^- , NO_3^- , SO_4^{2-} , PO_4^{3-} , F^- by means of ion chromatograph Dionex 5000. The quality of water was determined on the basis of the Regulation by the Ministry of the Environment of 21 July 2016. The research results and analyses show that changes in water properties occur over time, under the influence of many factors (including atmospheric precipitation, management of the catchment area), and that retention of water in retention reservoirs may affect water quality.

Keywords: small-scale water retention, water chemistry, water quality

Changing thermal conditions in mountain rivers with significant temperature trends (Polish Carpathians)

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Water temperature (T_w) in streams and rivers is a key environmental variable that determines conditions of life, development, and survival of aquatic organisms. As a result of heat exchange with the atmosphere, river water temperature largely follows the ambient air temperature, while the existing environmental conditions (e.g., groundwater recharge, riparian vegetation) and variable flow conditions ultimately decide the thermal conditions in rivers.

The aim of the present study was to evaluate the current thermal conditions in Polish Carpathian rivers over the last 30 years (1987–2016), and to assess the magnitude of water temperature trends. For that purpose, the Mann-Kendal test with the trend-free pre-whitening procedure was used. The analysis focused on daily river T_w , measured for several mountain rivers, and on daily air temperature data for neighboring meteorological stations.

The data were made available for research purposes by the Polish Institute of Meteorology and Water Management – the National Research Institute. Water temperatures were measured for the Vistula River at Skoczów and Goczałkowice (that is, some distance upstream and downstream from the Goczałkowice Reservoir), for the Soła, Skawa, and Raba rivers (at Oświęcim, Wadowice, and Stróża, resp.), as well as for the Dunajec River (at Żabno) and its two tributaries: the Poprad (at Stary Sącz) and Biała (at Grybów).

Research has shown that the significant increasing trends in T_w range from $0.23^\circ\text{C decade}^{-1}$ at Grybów on the Biała River, to $0.78^\circ\text{C decade}^{-1}$ at Wadowice on the Skawa River. Interestingly, an increase in T_w on the Vistula River was higher at Skoczów than it was at Goczałkowice. While the identified trends in T_w are weaker than the corresponding trends in mean air temperatures, the current thermal conditions studied are getting warmer. This may mean an increased risk of thermal degradation of existing water environments in the studied Carpathian rivers.

Keywords: river water temperature, thermal conditions, trend, Polish Carpathians

Fluvial resources in a medium–height mountain region under climate change

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The management of freshwater resources due to climate change can pose a serious challenge, especially when the available water resources are too modest to meet all social needs. On the other hand, even if the water resources are large enough to meet current needs, a change in climatic conditions requires constant adaptation of the water management plans in order to meet future needs.

The aim of the present study was to assess potential changes in river flow (Q) in the medium-height mountain region (Polish Eastern Carpathians) over the last 30 years (1987–2016), in comparison with the previous period (1961–1986), as well to evaluate ongoing changes in the climatic conditions (1987–2016 versus 1957–1986). The analysis focused on monthly river flow, measured at several gauging stations, and on monthly air temperature and precipitation data from the neighboring meteorological stations.

The data were made available for research purposes by the Polish Institute of Meteorology and Water Management – the National Research Institute. River flow was measured for the San River and its tributaries: Solinka, Oślawa and Wiar, as well as for the Wisłok and Mleczka rivers.

Research has revealed important changes in river flow, which are discernible on a seasonal and monthly, rather than on an annual, basis. Significant changes involve 5 individual months (January, February, July, September, and December) and 2 seasons, with a significant increase in Q for the winter, but with a decrease for the summer. Significant changes in air temperature and precipitation relate to 7 months and 3 seasons. In general, the simultaneous reduction of rainfall and river flow during the summer, together with a marked increase in the air temperature, can be a serious concern, as it means the overall reduced availability of water in the summer months.

Keywords: water resources, medium-height mountains, climate change, Polish Carpathians

Variability in the wettability and water storage capacity of tree crowns

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The amount of rainfall water retained in tree crowns is one of the main components of the water balance of both forest and urban ecosystems. The water capacity of tree crowns is closely related to the physical characteristics of the plant material itself, which is wettability. A system has been developed for dividing plants from the most hydrophilic, to super-hydrophilous. This classification is based on the size of the angle at which a drop of water adheres to the leaf. The structure of the wax layer responsible for the drop adherence method is associated with chemical changes occurring especially in the aging leaves. Even small changes in hydrophilicity of tree crowns can have portentous environmental consequences in urbanized catchments. The texture of the leaf surface is also affected by the changing environment, mainly the amount of pollution, and the popular diseases of the assimilation apparatus.

The scientific goal of the presented research is to determine the degree of influence of contamination and infection with oak powdery mildew on water capacity and wettability in seasonal terms.

The obtained results confirm the very strong impact of the month in which the samples were taken on water capacity. For healthy common oak leaves, one can observe an increase in the average water capacity from 6.2% of the total simulated precipitation in May, to 20.6% in September, therefore the leaf age and its phenological state can not be omitted in eco-hydrological studies. Along with the growth of the leaf coverage with the white coating of the mycelium, the water capacity and the degree of wettability increased. An additional analysis of photographs from the scanning electron microscope (SEM) showed that the texture of the oak mildew mycelium leads to more contaminants being caught by the mycelium conidia. Leaves infected with oak mildew in 80% of, sampled in September in the city, stopped an average of 35% of the rainfall, and those sampled in the forest, 25% of the rainfall. The inclination angle in the analogous system was 35.5° and 23.6°, respectively. It can be inferred that powdery mildew, occurring in contaminated

areas, intensifies the effect of these contaminants on water capacity and wettability of plant material.

The presented research fills the gap between the analysis of changes occurring in the environment, and the hydrological processes taking place in the treetops.

Keywords: ecohydrology, interception, mildew, pollution, seasonal changes, trees

Leaching out of selected macro-elements for Scots pine, Norway spruce, European beech and pedunculate oak seedlings produced at the container nurseries

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Optimizing good growth and viability of tree seedlings can be achieved with a sufficient amount and the right proportion of nutrients in a specific pattern of their variability, however, leaching out of such macro-nutrients from the container should be taken into consideration as well. The basic principle is rational nutrition and water use in forest nurseries, related mainly to fertilization and rainfall, and current demand of seedlings for nutrients uptake of a given element. The research was carried out on the sample of seedlings produced using the container method at the Container Nursery in Nędza, Rudy Raciborskie Forestry District. As part of the conducted experiment, in 2016 – fertilization was applied to cuttings at the moment the seedling obtained the appropriate standard parameters (*W1*), and achieved the appropriate index of surface coverage by the assimilation apparatus – LAI (*W2*). Water and plant material as well as data pertaining to leaching

out from the containers was collected in 2-week intervals, and chemical analysis of the concentration of elements in water and in individual parts of seedlings was performed. The paper presents the difference between the amount of selected macro-nutrients: N, P, K, Ca, and Mg in the fertilization applied with water, and precipitation, as well as their accumulation in seedlings and their leaching out from the containers for Scots pine, Norway spruce, European beech and pedunculate oak seedlings, produced at the container nursery. New, optimal water applying procedures, and cuttings' fertilization at the moment the seedling obtained the appropriate standard parameters ($W1$), and achieved the appropriate index of surface coverage by the assimilation apparatus – LAI ($W2$), showed significant less leaching of macro-nutrients, particularly for coniferous species compared to control – in which the previous procedure was applied, a standard to date.

Keywords: fertilization, reference seedlings, optimal water and nutrient dose, macro-elements

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Safety of timber export traffic on forest slope roads

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The present work concerns the slope road No. 4/1 in LZD Krynica, leading to forests located on the slopes of the Tylicz - Wojkowa complex. It represents slope roads built in the State Forests, based on preliminary projects, developed according to the guidelines contained in the “Forest Road Network Projects”. The general nature of the preliminary projects, a tolerant approach to technical regulations, and a very simple construction technology, all have meant that the roads constructed in this period deviate from the normative arrangements. Many of the applied solutions can pose a serious threat to traffic safety, especially for the timber transport means that are used currently. The work presents the existing condition in relation to selected parameters that define the given road in longitudinal and transverse direction, such as: horizontal and vertical curves, longitudinal and transverse slope gradients, road crown widths, as well as their impact on the acceptable speed, visibility in the horizontal and vertical plane, acceptable lengths of logs and sets for transporting timber, and conditions for maintaining the equation of motion. All the examined parameters of the slope road significantly deviate from the current standards and they present difficult, even dangerous traffic conditions for the current timber transport fleet.

Keywords: road, traffic safety, normative, parameter

Description of variability of features characterising the mineral material taken from log steps and boulder steps, located in a stream channel of a small mountain catchment in the Silesian Beskids (Polish Carpathians)

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The paper presents the characteristics of the mineral material taken from the stream channel in a small mountain catchment. Diversity of grain size and sedimentological indicators were analyzed for sediment samples taken from log steps (LS), boulder steps (BS), and log-boulder steps (LBS) as well as sediment from the channel along the longitudinal profile of the stream, and sediments accumulated on two bars (B1, B2) and a pool (P). Statistical indicators, such as mean particle diameter (M_z), standard deviation (σ_1), skewness (Sk), and kurtosis (K_g) were calculated. The degree of sorting of the sediment and the type of grain distribution were also determined. The distribution of samples was described in the C/M diagram (C – first percentile, M – median), which signifies the propensity of sediments to transport in a specific load: traction, saltation, and suspension. We have analysed the degree of spatial correlation between grain size, degree of sorting, and treatment of mineral sediments taken along the channel of the mountain stream, with different shapes of the cross-section, and varying geomorphological characteristics. It was found that sediments associated with log steps are characterized by a significant variation in grain size. This feature is reflected in the percentage of sediments in individual fractions as well as the variation in the values of sedimentological indices. Sediments in all samples showed propensity for transport in an environment of high dynamics (traction) without the conditions for deposition of material from the suspension. The sediments taken from boulder steps are much

more homogeneous in terms of grain size than the sediments trapped on log steps, and they are characterized by relatively better sorting. The significance of the thresholds in the modification of the alluvial features are clearly exemplified and emphasized by the features of sediments taken directly from the channel, located in the erosion or transit zone. They are less diverse, much finer, and they are transported in a high-energy environment. They are usually characterized by poor sorting and unimodal grain-size distribution.

Keywords: mountain catchment, stream, log steps, mineral material, sediment indicators

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Analysis of the shape of quartz grains in mineral sediments collected from log steps and boulder steps, located in the mountain stream channel in a small catchment – Carpathian flysh case study

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The paper presents the results of the analysis of the shape of sand grains (0.8–1.0 mm) of Istebna sandstone building mineral deposits collected from the log steps (LS) and boulder steps (BS) located in the channel of the Dupniański stream (Beskid Śląski mountain range in the Polish Carpathians). The research was carried out in order to evaluate the method of dressing of grains in a high-energy fluvial environment. Collected samples were divided into three types/groups: quartz grains (Q), quartz grains coated with weathering envelope (QP), and small sandstone pebbles (P). Samples were analyzed by microscopic tomography using the Morphologi G3 analyzer, taking into account three differentiating criteria: 1) the type of material, 2) the sampling site in longitudinal profile, and 3) the type of steps (LS, BS). The key parameters of the grains (diameter, width, length) were measured, on the basis of which the degrees of rounding, convexity, elongation, and compactness of grains were determined. It was found that the grain diameter values are strongly correlated with the values of convexity and compactness, hence the smallest grains are more concave with slightly rounded corners, while the largest ones have the opposite shape. Sediment samples collected in the upper part of the stream are characterized by higher values of roundness, compactness and convexity than those collected in the lower section of the channel. In addition, the deposits from the upper part of the Dupniański stream contain smaller, compact, convex and more rounded mineral grains than the ones

collected in the lower sections of the channel. The original shape of rounded, convex and compact grains undergoes transformation as a result of fluvial transport, where during high-energy events in the riverbed part of the channel the grains crumble and breaks, thus disintegrating into smaller grains with sharp edges. It has been confirmed that the force of fluvial transport has a significant impact on the shape of the sediment particles, causing them to change, either through crushing, smoothing or grinding.

Keywords: stream, log steps, sediment, quartz grains, shape parameter

Acknowledgements

This work was supported by the National Centre for Research and Development and the Polish-Norwegian Research Fund (Grant No. 209947/52/2013-2016).

The dynamics of soil water storage in the low-mountain stands in the Beskid Sądecki (Western Carpathians)

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The amount of water in the soil is a habitat factor, shaping the conditions of plant growth, as well as the health condition and thus the durability of plant communities. From the hydrological point of view, soil retention affects the outflow of water from the catchment, flattening of the freshet wave, and increasing the flow during the low-flow periods. The knowledge of processes related to infiltration, retention, and outflow of water from the soil in connection with the impact of the forest is crucial in connection with the forecasted scenarios of climate change, and the adaptation of forest management to those changing conditions. The region of the Western Carpathians is characterized by high forest cover, but also it is subjected to a clear pressure of urbanization.

The subject of the research consists in the changes in soil water storage capacity occurring in the scale of the growing season in low-mountain beech and fir stands. The aim is to present the variability of short and medium-term water supply in the soil, against the background of hydro-climatic and forest-stand-related factors. We aim to verify the view stating that the values of the losses and the increases in soil water reserves in short-term and seasonal cycles are the result of weather changes and factors related to tree stands. The verification was carried out by means of analysing the atmosphere-stand-soil balance equation, identified based on the results of soil water reserve measurements, recorded electronically every 6 minutes.

The measurement of water storage in soils was carried out in the low-mountain stands located in the Beskid Sądecki mountain range in the Western Carpathians in the years 2016–2017. Soil moisture was measured using the electrical resistivity tomography method, using the proprietary calibration method of measurement systems, which gives results equivalent to the drying-weighting method. Based on these results, using the laboratory-determined properties of the soil, the water reserves in the soil profile

were calculated. On the basis of the curve depicting the water reserves in the soil profile, the supply and loss phases were distinguished, after which the values of water reserve changes were calculated. For the same time intervals, the hydro-climatic characteristics, introduced into the balance equation, were calculated. The supply phase includes the increase in the water reserves after a single rainfall, the amount of potential interception proportional to the plant surface and the weight of the forest litter, as well as the intensity and duration of rainfall decisive for the degree of its use. The phase of losses in the soil water reserves is described by the size of plant transpiration, linearly dependent on the amount of biomass produced, and on the evaporation from the soil surface, which is a function of the amount of solar radiation energy, and wind velocity within the stand.

Keywords: water balance of the forest, water supply in forest soils, atmosphere-stand-soil water balance equation, Western Carpathians

Rainfall spatial variability in ten selected Polish forests, in the years 2015–2017

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Water availability is crucial for forest grow, especially in the vegetation period. Apart from groundwater intake, plants assimilate water from different forms of precipitation in the process of interception. Rainfall (liquid state of precipitation) is an important source of water for trees in Poland. Depending on its origin, rainfall can be uniform over larger areas, or it can vary spatially, mainly during extreme events. Monitoring of rainfall is based mainly on point rain-gauges, but modern radar and satellite products have become a valuable source of information. The main goal of this study was to assess rainfall depth variability within ten Polish forest units, in selected periods (day, month, year).

Several satellite sensor-measure physical parameters related to water content in the atmosphere. One of the recent precipitation estimates is the Integrated Multi-satellite Retrievals for GPM (IMERG v.05B, level 3), provided by *the NASA/Goddard Space Flight Center*. This product is based on several microwave and IR satellite measurement. Precipitation data are available as almost real time after 4 or 12 hours, or as final product after 2 month. Data are published in GeoTIFF format as continuous, global raster dataset with 0.1-degree spatial resolution. For Poland, this corresponds to raster cell sized 7×11 km. From precipitation final product, only liquid fraction was considered. Daily rainfall totals from the years 2015–2017 were aggregated to monthly and yearly totals, but only for the vegetation period (March–September). Ten “Natura 2000” forests, located across Poland, have been selected from vector map of special protected areas provided by The General Directorate for Environmental Protection. The smallest selected forest unit was the Karkonosze (182 km²), and the largest, Ostoja Knyszyńska (1360 km²). QGIS and open source Python spatial libraries (rasterio, fiona, rasterstats, and matplotlib) were used for data processing, analysis and visualization.

Annual totals of rainfall within each forest unit are rather uniform, with differences in the order of 20–40%. The largest rainfall difference (min = 352 mm, max = 601mm) was observed in Karkonosze in the year 2016. Monthly rainfall varied within one forest

up to 90–100 mm (Beskid Żywiecki, May 2015; Ostoja Iławska, July 2015, Uroczyńska Puszczy Drawskiej, July 2016) and 105–150 mm (Karkonosze, May–March 2016, July 2016). Having said that, the largest rainfall depth difference (155 mm) was observed not in the mountains, but in Puszcza Kampinoska, in May 2017. Maximal daily rainfall differences within the given forest were between 41 mm and 83 mm. The outstanding value of 135 mm was observed in Karkonosze.

Keywords: total precipitation, IMERG, satellite, database

High-resolution soil field humidity map of Poland, based on global gridded soil information SoilGrids250m

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The basic parameters used to calculate the flow characteristics in design hydrology are the physical catchment descriptors (PCD). According to the principles of design hydrology, the determination of these parameters combines the description of physical features of the catchment (morphology and land cover) with hydrological processes responsible for rainfall-runoff transformation. From among a number of potential physical catchment descriptors, the most important role is played by the soil moisture. This descriptor can be determined as proposed by the British (PROWET) or by the Irish (FLATWET). We assumed that the determination of soil moisture can be achieved by the pF curve [$pF = \log(-hs)$], that is, the dependence of the matrix potential of the soil hs on the volumetric humidity Θ . For every soil class, the pF curve has defined the so-called point of field humidity, corresponding to the range of volumetric humidity, where the gravitational potential plays a dominant role in water movement within the soil profile. Traditional soil maps for Poland are usually available at small or moderate scales. With recent implementation of machine learning algorithms in satellite remotely sensed data, high-resolution numerical soil maps have become available, like SoilGrids250m with 250 m spatial resolution. Several soil parameters at standard, predefined depths are ready to use as raster layers in this public dataset. We have used granulometric content of mass fraction layers (clay, silt, and sand) for the uppermost part of the soil. For every location (raster cell), content mass fraction has been determined and corresponding soil classes have been assigned on the Ferret triangle. With the known values of Θ and texture specific constant (μ) for the given soil class, we were able to convert soil texture fractions into hydrological soil properties – soil field humidity index (GLEMOK). To make the final map suitable for Polish conditions, with possible application to other European countries, we have reprojected the source layers to common coordinates reference system ETRS89/LAEA Europe (EPSG: 3035). In order to minimize raster distortions, spatial resolution of target raster layer has been changed to 200 m.

Keywords: design hydrograph, physical catchment descriptors

Pollution load balance in the municipal water retention reservoir during a flash-flood event

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The study concerned the Olechówka River in the south of Łódź. The river in question is a receiver and collector of precipitation sewage. Two municipal recreational water reservoirs are located along the course of the Olechówka River. Between one of them and the outlet of the large stormwater collector from the Dąbrowa-Przemysłowa borough, a sedimentation tank is located (“Tomaszowska” pond of $A=1.2$ ha, and $V=17500$ m³), preventing excessive pollution of the Olechówka River. According to previous research, the reservoir is a significant element causing pollution load of the river. Present research, conducted in 2018, involved 24 h observations at sites directly above and below the reservoir regarding: $N-NH_4$, $N-NO_2$, $N-NO_3$, PO_4 , TN and TP, oxygen demand and calcination loss supplemented with flow rate. Samples were collected every hour from 8AM/16.05.2018 to 7AM/17.05.2018 during hydrometeorological conditions corresponding to the *flash flood* phenomenon. The maximum flood water inflow to the reservoir reached 2 m³ · s⁻¹, and the outflow 1 hour later increased to 2.25 m³ · s⁻¹. In the first hour of the flood event, the reservoir began releasing organic nitrogen, mineral substances, and organic substances to the Olechówka River. In the second hour, emission of total nitrogen began, and in the third hour – of mineral nitrogen, total phosphorus, simple organic substances, and total suspension. The emission of mineral nitrogen ceased the soonest (in the 5th hour), followed by the cessation of total phosphorus (in the 7th hour). The reservoir emitted organic substances the longest (until the 10th hour). The

daily balance of pollution load of the reservoir showed retention of total phosphorus, total suspension, and simple organic substances, as well as mineral nitrogen, with simultaneous release of three times more organic nitrogen, and therefore total nitrogen load. The reservoir also released mineral substances, and two and a half times more organic substances. Load of biogenic compounds during the flood event were 30–40 times higher than in normal conditions.

Keywords: biogenic compounds, flash flood, municipal water retention reservoir

Conditions of water movement in hyporheic zone in the context of research on hydraulic gradient

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The hyporheic zone covers the area of joint influence of surface waters and groundwaters. In flowing waters, it occurs in the bottoms of spring niches, streams, and rivers, and in stagnant waters, in the bottoms of lakes and retention reservoirs. Many opinions exist on water movement in the hyporheic zone. They are, however, hypotheses awaiting experimental verification. The article presents results of field research on hydraulic gradient in the hyporheic zone of the Moszczenica River, on several hydrometric cross-sections. The study involves the application of a gradientometer, a new device for the determination of hydraulic gradient in the hyporheic zone. The obtained results permitted the determination of the directions of water exchange in the hyporheic zone of Moszczenica River, for several cross-sections, at low and high water levels. Moszczenica is a river representative of lowland areas. Therefore, observations of water exchange in the hyporheic zone of the river can be useful for the assessment of conditions of water exchange in other rivers of the Polish lowlands.

Keywords: hyporheic zone, hydraulic gradient, gradientometer

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POSTERS

Reproductive potential measuring as a hatching success of *Physella acuta* (Draparnaud, 1805) – a case study in an anthropogenic forest pond

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Physella acuta is an aquatic snail originating from North America, which is known to be a highly successful, worldwide invader. In Poland, it has the status of an alien species but not an invasive one. The study aimed to answer the question as to what is the reproductive potential of *P. acuta*, measured as hatching success. Also, the densities of snails in different types of substrates were assessed. Snails were collected in an anthropogenic pond and placed in aquaria under the same water and temperature conditions until they laid their masses. All of the masses (LM – laboratory masses and FM – field masses) and eggs were measured, counted, and monitored on a daily basis. Hatching was considered to have occurred when juvenile snails had emerged from both the egg and the masses.

P. acuta egg masses were attached to plant remains, leaves and other specimens. They were transparent and deposited in a thick, stiff and relatively strong external casing. After collection, they were found to contain from 29 to 77 eggs per mass, and after transferring them to the laboratory, hatching began after five days. Analysis of the process of the incubation and hatching of the eggs showed that after 5 days all of the juvenile snails from 65% of the masses (FM) had hatched, whereas after 14 days, 100% had hatched. The LM were delicate, transparent and weak. The average number of eggs was similar in the LM and the FM, but a greater number of empty eggs had been found in the LM. A 100% hatching success was observed from the FM, but the snails from the LM were only hatched after seven days (94.8%). A characteristic feature of *P. acuta* is its very high expansiveness, which permits its wide distribution on various continents. This is reflected in hatching success and high density of this species (mean density: 4003 ind/m²).

Keywords: alien species, *Physella acuta*, dispersion, invasion

Utilization of fully automated moisture control system (SMCS) of peat moss substrate in container seedlings production

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Innovative control systems of peat moss substrate water balance for forestry nurseries have primarily focused on the problems related to water retention, which is important in irrigation management strategies, especially those used for seedling cultivation. Water balance within the production fields in the container system determines plant growth and development, physiological activity, as well as effectiveness of fertigation.

This study explores the use of fully automatic monitoring system (SMCS) of peat moss substrate moisture under pine seedlings at Rudy Raciborskie forest nursery in the Silesian natural-forest province. A brand new multipoint system was created and tested for the purpose of this study. The MPI-DN Metronic multichannel electronic recorder was the main part of the layout. Twelve digital probes (with three electrodes) for volumetric water content measurement were used in a distributed configuration. The probes were placed in middle part of the Hiko trays. One pair of probes was placed in each sector of the field, that is, in the inner zone, the middle zone, and the outer zone, in two repetitions. Modbus RTU protocols were used for data transmission, and the results were archived into an internal 2GB memory. One probe delivers 1440 measurements a day. Based on the average substrate

moisture data from the field, the recorder controls the watering system according to the precisely defined parameters. Proper placement of sensors in the field allows for accurate analysis of the temporal and spatial variability of peat moss substrate moisture.

Results of the statistical analysis have confirmed that the peat moss moisture is significantly differentiated within the homogeneous production field of the forest tree seedlings. The average difference in the VWC% of peat moss substrate in forest seedlings production field between sectors was found to be between 6.5% and 9.5%, depending on the location of the containers (trays). The study findings suggest that irrigation systems should be adapted to a specific situation of substrate moisture at the nursery surfaces, aimed at optimized water management.

Keywords: peat moss substrate, irrigation, forest nursery, water content

Testing a simplified methodology for measuring the shape of logging route surface, and obtaining the Digital Terrain Model

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The forest transport network, consisting of roads and logging routes, is the basic, complex object of technical infrastructure, enabling rational forest management that meets the demands of sustainable development of the natural environment. One of the most serious threats to the viability of logging routes and roads, especially dirt roads with unpaved surfaces, is the erosion associated with their use, as well as the surface runoff of water. Among numerous methods for measuring the amount of erosion on transport routes, one method is presented here, which uses a laser distance meter with an accuracy of 1 mm, by means of which the shape of the surface of the trail or road at a given time is determined. Multiple measurements in the same place make it possible to determine the changes in the shape of the surface fragment caused by, for example, repeated passing of skidding tractors. Moving the rangefinder over the tested area can be carried out by means of stepper motors or manually, and the results of the measurements can be sent to the computer either using Bluetooth technology, or by first recording it in the reporter, nevertheless, the most important decision is the selection of the distance grid between the measuring points. The latter directly affects the accuracy of observations, calculations, and the possibilities of the further use thereof.

Data obtained in the present study have a density of $5 \times 20\text{cm}$ in the horizontal plane, but it is possible to redesign that freely, which of course involves the necessary amount of work. Calculations of erosion size and representation of pavement surfaces are performed either in a spreadsheet, or in a GIS environment. The Numerical Terrain Model, generated on the basis of the measurements presented herein, has a $5 \times 5\text{cm}$ pixel, and it can be presented in visualizations, as well as used in further calculations.

Keywords: forest logging routes, surface erosion, laser measurement, NMT

Influence of initial water content on the filtration coefficient of forest soils

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The filtration coefficient is one of the most important hydraulic properties of the soil, and it determines the infiltration of water into the soil profile, as well as the surface runoff. Numerous studies indicate that forest soils are characterized by greater infiltration capacity compared to other types of soil, which is related to the content of a large amount of organic matter. Although the flow of water through the levels containing organic matter is strongly dependent on the water content at these levels, relatively little is known about the impact of the initial water content on the filtration coefficient of forest soils.

The aim of the research was to determine the dynamics of the filtration coefficient of humic and mineral levels of forest soils, in selected stands of the Beskid Makowski mountain range (in the Myślenice Forest Inspectorate). 35 samples with intact structure were collected for testing. The dynamics of the filtration coefficient was determined by measuring the time elapsed since the beginning of the water permeability tests of a given sample until the filtration coefficient has stabilized, that is, the repeatability of the result after 24 hours. It has been found that in the initial stage of research, when the centre of soil substance goes from an unsaturated state to a saturated state, the filtration coefficient of humus levels drops rapidly, which is related to the swelling of organic matter contained in these levels. The coefficient of filtration of mineral levels decreases slightly as the initial water content in the samples increases. The stabilization time of the filtration coefficient ranges from 7 to 12 days in humus horizons, and from 3 to 8 days in mineral levels of the studied soils. The average value of the filtration coefficient of humus horizons in the state

of maximum capacity is more than twice as high as the filtration coefficient of mineral levels, and it amounts to $0.404 \text{ m} \cdot \text{h}^{-1}$.

Keywords: forest hydrology, forest soils, hydraulic conductivity, initial water content, organic matter

Study of atmospheric deposition and canopy leaching in two pine stands (West Pomerania, Świętokrzyskie Mountains)

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The study presents the results of research conducted in the years 2010–2013 in pine stands in Western Pomerania (in Czarne, in a 95 year-old stand) and in the south-western part of the region of the Świętokrzyskie Mountains (in Malik, in a 80-year-old stand). The aim of the study included the determination of the scale of changes in the chemical properties of precipitation in the studied pine stands, and the load of base cations (K, Ca, and Mg) leached out of the canopy. The measuring system in the pine tree stand (in Czarne) consisted of 12 throughfall collectors located under the tree canopy, at nodes of a regular grid, distanced every 4 metres. In the second pine tree stand, the measuring system consisted of 10 collectors, arranged in the shape of the letter X.

The obtained results confirm that after precipitation has had contact with plant surfaces, there is an increase in its mineralisation. This is due to the process of enrichment of throughfall with elements leached out of needles and leaves, as well as coming from dry deposition, washed out from plant surfaces. In spite of water loss via interception, the annual average load of ions under the canopy in both stands exceeded that in bulk precipitation. In both stands the highest enrichment as expressed by the enrichment factor was recorded for potassium, at 7.0 (in Malik), and 5.8 (in Czarne). Apart from potassium, high enrichment levels as compared with bulk precipitation were found for nitrates (3.7), and for sulphates (1.7) in Malik, and for ammonium ions (2.4), chlorides (2.5), and magnesium (2.0) in Czarne. The research, based on the canopy budget model, indicates that in the case of potassium, its load leached out of needles and leaves accounted for 74.4% (in Czarne), and 85.8% (in Malik) respectively, of its total deposition on the forest floor.

In comparison with potassium, the range of magnesium leaching was smaller, amounting to 25.8% in Czarne, and 23.6% in Malik. In the case of Ca, no canopy leaching was observed for this element in the pine stand in Czarne. For a pine stand located in Malik, canopy leaching accounted for 38.0% of its total deposition on the forest floor.

Keywords: bulk precipitation, canopy budget model, scots pine, throughfall

Impact of water retention in the “Cedzyna” dam reservoir on selected physicochemical parameters of the Lubrzanka River

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The analysis of selected physicochemical parameters and chemical composition of water was conducted in 2017–2018 in the Lubrzanka River (in Świętokrzyskie Mountains, Poland), and in “Cedzyna” dam reservoir (area of 64 ha). In order to assess the impact of the reservoir on the river water quality, the research was conducted in the points located at the river inflow to the reservoir, in the reservoir itself, and at the river outflow. Once a month, water temperature, pH, conductivity, and dissolved oxygen were measured on-site, and water samples were collected and analysed for the content of major ions (HCO_3^- , Na^+ , NH_4^+ , Mg^{2+} , K^+ , Ca^{2+} , Cl^- , NO_2^- , SO_4^{2-} , and NO_3^-) as well as for dissolved metals (Cr, Co, Cu, Ni, Zn, Mn, Al, and Fe). The data was used to calculate the following eco-chemical indices: acid neutralising capacity ANCaq, alkalinity ALK, and acidity Ma%. Retention of water in the reservoir caused an increase of its temperature by an average of 2°C, with the maximum increase by over 4°C in August and September. The content of dissolved oxygen was higher in the river outflow from the reservoir than in the river inflow between May and December, and lower between January and April. The content of major ions and conductivity of water was decreased by water retention in summer, while in autumn and winter the values of the analysed parameters varied, and were generally higher in the river outflow. The values of ANCaq and ALK indices were higher in the river outflow in autumn and winter; however, the retention of water from April till August decreased its alkalinity. The acidity of water (Ma%) was on average lower in the outflow from the reservoir, and the greatest differences were noted in September (reduced value

of the index) and in January (increased value). Among the analysed forms of nitrogen, the reduction of nitrates was the most effective, with a decrease caused by water retention in the reservoir by 90% in July and August. No unequivocal trends were noted in the case of nitrites and ammonium. The content of the analysed trace elements was on average lower in the river outflow from the reservoir; however, periodic increases were noted in the case of chromium, copper, and zinc, which may indicate a release of metals from the reservoir's bottom sediments.

Keywords: dam reservoirs, ecological status of surface water bodies, Świętokrzyskie Mountains, water chemistry

LIDAR data usage in the interpretation of regularities of underground water outflows location as illustrated with the example of Skrzyczne range in Western Carpathians

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The mapping of underground water outflows (springs, bog springs and outflows of intermediate type) was performed on the slopes of the Skrzyczne range over an area of 28.2 km², in the years: 2009, 2011, 2012, and 2018. The position of all underground water outflows was measured using GPS Vista HCX device. The GIS project applying LIDAR data was created in QGIS environment. Thanks to the application of LIDAR grids and derivative layers, some regularities of underground water outflow locations were discovered. Using LIDAR data has led us to the conclusion that underground water outflows occur within landslide areas, mostly along the landslide boundaries and in the escarpment between the residuum and the colluvial deposit. The data also demonstrated the correlation between the dip of the sandstone layers, and the number of springs (more numerous on the obsequent slopes). The LIDAR imagery also provided information that the location of the underground water outflows didn't always correspond with the location of the incisions, however, the shifts of such outflows were consistent with the directions of sandstone fissuring.

Keywords: LIDAR, underground water outflows, Skrzyczne, flysch mountains

Sulfur contamination impact on seasonal and surface water chemistry within the reforested area of former sulfur mine

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We present an assessment of seasonal changes and a chemometric study of surface water parameters on reclaimed and reforested areas of a former sulfur mine, where the mineral was extracted using the Frasch method. Water samples were collected four times in 15 monitored sampling points located on streams and ponds within the restored forest ecosystem. Water characteristics such as pH, electrical conductivity (EC), ion concentrations (Ca^{2+} , Mg^{2+} , K^+ , Na^+ , Li^+ , NO_3^- , SO_4^{2-} , Cl^- , HCO_3^- , F^-), and total P, S, and Al were determined in laboratory conditions. A chemometric study with the application of the principal component analysis with PCA method using the EM (expectation-maximization algorithm) procedure was employed in order to determine seasonal changes and similarities or dissimilarities between the water samples. The obtained results indicate an overall low seasonal and spatial variability of the investigated surface water parameters: mean pH for seasons from 6.2 to 6.7, EC 1819–1990 ($\mu\text{S} \cdot \text{cm}^{-1}$), S 380.7–484.2 $\text{mg} \cdot \text{L}^{-1}$. However, the occurrence of hot spots was found (in 3 out of 15 monitoring points), which typically displayed very low pH (below 4.0), high EC (above 2000 $\mu\text{S} \cdot \text{cm}^{-1}$), and high sulfur content (above 400 $\text{mg} \cdot \text{L}^{-1}$), or a large proportion of calcium ions associated with the neutralization of sulfurous soils. Trace elements occurred in very low concentrations, because most of the sampling points had

a high pH. Local hot spots with a low pH and high sulfate concentration indicate an AMD threat, which should be monitored.

Keywords: sulfur, mining, surface water, acid mine drainage, chemometric analysis

A sessile drop method in the assessment of properties of the surface layer of needles in selected tree species

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The assessment of the interaction of plants with water is the basis for the consideration of topics related to atmospheric precipitation, the chemical composition thereof, and the reaction of plants to external conditions varying according to different areas. Adaptation capabilities of plants and the impact of environmental changes, for instance air pollution over the years, can be assessed using the example of conifers. These studies focus on the analysis of wettability and hydrophobicity/hydrophilicity of the plant needles surface, based on the measurement of water contact angle. Diversity of plant surfaces, in particular their polarity or non-polarity in the interaction of interfacial adhesion or cohesion forces, provide the basis for determining the value of surface free energy (SFE) by analytical methods.

In order to determine the contact angles and the SFE of plant material (tree needles) sampled, comparative studies were carried out using the Owens-Wendt, Zisman and Van Oss-Good models for the surface of fir and yew needles, analyzing their upper and lower surfaces both directly after collecting (with sediment), and again after cleaning (without sediment).

Ten drops of 0.5 μ l volume of each liquid – water (W), diiodomethane (D), and glycerol (G) – were placed on each surface type. The temperature during the measurements was $21 \pm 1^\circ\text{C}$. Using the SeeSystem software, the contact angle was determined based on the Young-Laplace equation.

For both types of needles, similar relationships were observed in relation to changes in the contact wetting angles. Analyzing the change in the contact angle with the dii-

odomethane, an increase in the angle after removal of the sediment from both the upper and lower surface of the needles is observed. A similar tendency was revealed for wetting the surface with water, namely, the removal of the sediment caused an increase in the contact angle and thus an increase in the hydrophobicity of the surface of the needles. However, the assessment of the wetting angle of glycerin on the surface of needles in each of the analyzed cases indicates a decrease in the value of surfaces cleaned of sediment.

Keywords: surface free energy, wettability, contact angle

Laboratory-based determination of specific storage coefficient

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Specific (gravitational) storage coefficient is one of the basic parameters making it possible to calculate the changes in water reserves in the saturation zone of forest soils. The correct determination of this parameter is vital for the proper calculation of the water balance of atmosphere-stand-soil. The tests were carried out on sorted river sand, at varying degrees of sample compaction. In order to determine whether the method of soaking with water affects the values obtained, the samples were soaked in a natural way – by slowly immersing the sample in water, and artificially – by placing the sample in a vacuum chamber. The specific storage coefficient was determined by the centrifugation method. Additionally, for each sample, the coefficient of permeability was determined, using the unsteady flow method. For the obtained data, a descriptive characteristic was presented, and a non-linear model was proposed in order to estimate the specific storage coefficient.

Keywords: specific storage coefficient, centrifugation method, coefficient of permeability

The dynamics of groundwater table fluctuations near a beaver-made backwater pools in the Koszęcin Forest District

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In recent years, we have observed a significant increase in the European beaver population. This particular species affects the environment through its engineering activities, including the construction of dams, and it also affects forest ecosystems. The paper presents the dynamics of groundwater table fluctuations in the vicinity of the beaver-made backwater pool in the area of the Koszęcin Forest District. Based on previous studies, a location was selected in which a heightened activity of beavers had been observed. On the watercourse, three gauges were placed near the larger dams, and six piezometers were installed in each of them. Locations of dams and piezometers were determined by geodetic methods. A numerical terrain model was created on the basis of LIDAR data, on which the location of dams and piezometers was plotted. A hydroizohypse and hydroisobath map was drafted, and the average volume of water collected by the beavers in the pools they had created was calculated. The granulometric composition of soil layers was also determined, which in turn facilitated the determination of the filtration coefficient and gravitational filtration.

Keywords: European beaver, groundwater table, backwater pool, dam

Characteristics of river-bed forms as illustrated with the example of a selected section of the Wisłoka River (in Magura National Park, Dukla Forest District), and their significance for the environment

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The work presents the results of field measurements of bed forms, observed on a selected section of a submontane river, in terms of their significance for the environment. The research involved 10 gravel-sand bars, which were located on the Wisłoka River section with the length of 650 m (the Magura National Park, Dukla Forest District). As a part of the field studies, morphometric measurements of the bars and the channel were carried out. At the same time, the inventory of vegetation and living organisms on the bars and the banks was taken. Studies have shown that bars play an important role in the development of the diversity of plant and animal species, shaping the dynamics of ecological succession. The importance of channel forms in the environment is an important issue, including the aspect of regulation and re-naturalisation of rivers and streams, as well as the protection of forest ecosystems.

Keywords: submontane river, sand-gravel bars, ecosystem, biodiversity

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Forest mining ponds – implications of the impact of their recreational use on invertebrate fauna

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Knowledge of the impact of recreational use on aquatic environments would be incomplete without understanding the responses on the part of the fauna. That is why the study of environments, which are used for recreation is necessary, compared to habitats which are not used in this way. We examined the correlations between invertebrate distribution and diversity patterns of benthic assemblage composition, with special emphasis on freshwater snails, in forest mining ponds serving for varying recreational uses. The study was based on samples of benthic invertebrates, physico-chemical samples of the water, and multivariate species analysis. Mining ponds varied in their salinity indicators, but not in their macrophytes' richness. Benthos composition and density differed markedly between the various mining ponds (recreationally used ponds: 755, ponds with no recreation use: 2629 ind./m²). Huge differences were also observed in the density of *Oligochaeta*, *Hirudinea*, *Coleoptera*, *Trichoptera*, and *Diptera*. Gastropods were more diverse and abundant in the mining ponds, which are not used for recreational purposes. Based on the obtained results, it can be concluded that the density and diversity of benthos assemblages differ depending on the recreational use of ponds, and they are also influenced by the content of phosphates, ammonia, and TDS. This study can be of potential expediency for freshwater conservation as an example of artificial waterbodies hosting diverse communities. Ponds of anthropogenic origin, especially mining ponds, are created in many countries, and they are more and more frequently used in various types of recreation, for instance, by anglers. This is of particular importance to the management of environments, and to the recreational ecology.

Keywords: recreation, benthos, human-made ponds, mining ponds, snails

Spatial and temporal variability of topsoil humidity in selected beech stands

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Soil moisture, as seen in small scale, varies depending on its retention capacity, micro-forms of the terrain, as well as tree stand characteristics, assuming the uniformity of precipitation over tree crowns. The application of geo-statistical methods makes it possible to analyse data, which take into account both the features of objects, and their location within the geographical space.

The subject of the present research is the volume humidity of the top layer of forest soil, determined by the TDR (Time Domain Reflectometry) method. The main purpose of the work was to recognize the spatial and temporal distribution of soil moisture in two stands of beech (*Fagus sylvatica* L.), differing in their vertical structure and in their age structure. We have also attempted to answer the practical question of how to choose the location of a single measuring point, so that it would reflect the changes across the largest possible surface area. The research areas were located in a seed production tree stand, managed by partial cutting, and a fragment of the forest in the Łabowiec Reserve (Nawojowa Forest District, in Beskid Sadecki mountain range). Two square measurement nets had been set, with a side length of 36 m and a fixed measuring network of 3 m. In mesh nodes, from September 2015 to June 2016, soil humidity measurement was performed six times. The area distribution of the moisture diversity of the top soil layer was made by interpolation using the ordinary kriging method.

Considerable, time and surface variability of soil moisture was observed within the studied areas, up to several dozen percent. The seasonal variability of soil moisture and the impact of current hydro-climatic conditions were confirmed. The influence of the vertical and horizontal structure of the beech stand on temporal and spatial distribution of humidity was observed. The analyses applied in the study did not allow us to clearly determine the impact of the terrain and the presence of dead wood on the distribution of soil moisture within the measurement grid. The use of mesh spacing every 6 m and every 3 m gave the best results from statistical perspective.

Keywords: soil moisture, spatial variability, TDR, kriging, Łabowiec Reserve, common beech

The impact of root systems on feeding the rhizoid area with rainwater

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The water reserve in soil is one of the factors determining the production possibilities of a forest habitat. The ability of soils to retain water largely depends on their infiltration properties. It is generally assumed that forest soils are characterized by high infiltration capacity, but little is known about the impact of living root systems on the filtration coefficient of this type of substrate. Rainwater falling on the surface of forest soil, and infiltrating gravitationally deep into the profile, when it reaches the root zone, can be partially slowed down and it can slightly change the direction of further movement within the soil medium, in line with the course of the roots. The subject of the present research was the impact of living root systems of selected species of forest trees on the infiltration of rainwater into the soil profile.

The research objective was to determine the dynamics of the distribution of rainwater flowing down the trunk of experimental trees up to 2 m high, to the water absorbed by the soil by gravitational infiltration, and the water that reaches the root hair (rhizoid) area along the root surface. 5 live trees were harvested, with a sufficiently large lump of soil with an intact structure along with its protective system of root drains established at the points where the roots were cut at the outer border of the sample. The experimental trees were collected from the Niepołomice Forest District. The measurements were carried out by means of controlled sprinkling of the entire surface of the collected monolith, while simultaneously controlling the amount of water flowing out of all drains. These experiments were carried out at a specific time, corresponding to specific rainfall events, and while maintaining similar humidity of the soil medium before each experiment. The obtained results showed a high variability of the volume of water retained by the soil, as well as of water leaving the soil body along the surface of the root systems. This variability can be explained by the compactness of the soil, which may be linked to its water permeability. The more compact the soil, the greater the proportion of water transported along the roots.

Keywords: infiltration, filtration coefficient, root system, rhizoid area

Organic pollutants of a small urban river during rainfalls

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Rivers in the city are exposed to the influence of a number of different contamination, which translates into a very complex hydrogeochemical image. Especially interesting are flood events, when a small watercourse received, over a short period of time, an inflow of a large load of pollution from the urbanized catchment. This inflow of pollutants includes organic substances, for which susceptibility to self-cleaning processes is very varied. For initial identification of the specificity of organic pollution during the flood, round-the-clock measurements were conducted on the Olechówka River. Research consisted of sampling the water in order to measure the oxidisability and the content of dissolved volatile organic compounds. Comparison of both indicators was used in order to determine the nature of the flow of organic pollutants from the urban area, and to verify what role is played by the reservoir in this process.

Keywords: organic substances, oxidisability, volatile organic compound

FIELD SESSION

Visiting the Forest District Krościenko
and the Czorsztyn water dam

Rafting on the Dunajec River



Fot. Daniel Urbaniak



Fot. Daniel Urbaniak



Conference Theme

The Conference aims to gather scientists and practitioners dealing with issues in the field of hydrology and engineering in natural and anthropogenic areas, as well as other disciplines related to Earth Science. The topics of the conference will include issues such as: Water balance between atmosphere-stand-soil; Interception; Stemflow; Impact of pollutants on water management of plants; Water resources; Water reservoirs; Water energy; Water pollution; Protection of water environment; Freshwater ecology; Water processes occurring in rivers and mountain streams; Flood events; Erosion processes; Soil retention; Forest hydrology; Irrigation of forest nurseries; Hydro-physical soil properties; Soil hydrophobicity; Drainage systems for forest roads; Technical solutions for rainfall-induced landslide management; GIS in Hydrology; Hydrological modeling.

The Conference will provide an excellent opportunity to present research results and to discuss current trends in hydrology, as well as to create a platform for exchanging experiences at the interface between theory and practice. A rich agenda will be supplemented by the field session.

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