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ORAL PRESENTATIONS

BORON REMOVAL FROM WASTEWATER IN A VERTICAL FLOW CONSTRUCTED WETLANDS

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Keywords: Boron removal, toxicity, *Vetiveria zizanioides*, vertical flow constructed wetland, biomass composition.

Excess of boron (B) in the aquatic habitats can cause undesirable B contamination of water, resulting in toxicity of crop and plants, contamination in soil or sediment, and reproductive risks for both animals and human in many semiarid and arid regions. Therefore, water, either from wastewater or other sources of water, should need treatment before being used for irrigation or drinking purposes by human communities, who can suffer from excessive levels of B contamination in water. Several conventional treatment methods including membrane process, ion exchange, and adsorption techniques have been applied for the removal of boron from various types of wastewater. However, removal methods based on conventional strategies are expensive and require costly equipment or chemicals. In comparison to conventional techniques, constructed wetlands (CWs) have experienced significant advancement in recent years to remove pollutants from contaminated water due to their simple operation, eco-friendly properties, and cost effectiveness.

So, in this study, we investigated the performance of a Vertical flow constructed wetland (VFCW) to boron removal. A VFCW bed (0.70 m × 0.24 m²) planted with *Vetiveria zizanioides* were used. The bed was filled with light expanded clay aggregates (Leca®NR 3/8, 10 < Ø < 20 mm). A bottom slope of 2% was applied in order to enable the hydraulic collection of the influent continuously distributed by equidistant sprinklers on the top of the bed. A layer of gravel (diameter 10-50 mm) was placed around the outlet valve to prevent clogging with fine particles. A feeding tank (125L), equipped with a submersible pump (Eheim-1250) was used. The flooding level was maintained at 14% by a siphon on the outlet. Inlet and outlet flow were measured. Wastewater samples were collected daily for immediate characterization or frozen at -20°C. Air and bed temperatures were monitored daily. Rainfall was excluded by covering the beds with a tunnel of

transparent fine plastic. A synthetic wastewater was prepared using boric acid as boron source and micronutrients dissolved with tap water according to the operating conditions under study. Each new condition has been in operation up to pseudo-stationary state. It was used two different and increasing boron concentrations (15 ± 1 and $30 \pm 1 \text{ mgL}^{-1} \text{ B}$) and the flow rate to the VFCW was kept constant, with an hydraulic load (H_L) of $191 \pm 10 \text{ Lm}^{-2}\text{d}^{-1}$.

Every weekday, from Monday to Friday, wastewater samples were taken, and the flow rate measured at the inlet and outlet of VFCW. In those samples, the dissolved oxygen (DO), electrical conductivity (EC), pH, boron (B) were determined.

The results obtained show that it is possible boron removal in VFCW. Removal efficiency obtained up to $60 \pm 10 \%$ of boron was obtained. When boron concentration was the highest the plants stop growth and leaves chlorosis was observed. The micronutrients composition (calcium, magnesium, potassium and sodium) in vegetal biomass decreased when wastewater boron concentration increased.

So, it was possible to conclude, that the VFCW performance decrease when wastewater with high boron concentration of $30 \pm 1 \text{ mgL}^{-1} \text{ B}$ was applied, as well as toxicity signals in plants appear.

CAFFEINE REMOVAL EFFICIENCY IN A VERTICAL FLOW CONSTRUCTED WETLAND

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Keywords: Wastewater, caffeine, emerging compounds, phytoremmenation.

The presence of emerging compounds in water and wastewater has been increasing substantially in recent years. These are synthetic compounds, present in most of today's consumer goods and may pose a potential threat to ecosystems and human health. The vast majority of wastewater treatment plants do not have the required efficiency for their removal. However low concentrations of these compounds in the environment can cause toxic effects and affect the endocrine system, thus becoming a public health problem. Caffeine is a alkaloid, one of the most consumed substances in the world. Therefore, it is present not only in some industrial effluents, but also in urban wastewater. As already mentioned, conventional treatment processes do not allow efficient degradation, so Vertical Flow Constructed Wetland (VFCW) has been presented as a good solution in the removal of pharmaceutical compounds, including caffeine.

This work aims to assess *Vetiveria zizanioides*'s ability to withstand and remove caffeine from. The research was developed in a pilot VFCW (0.4 x 0.6 x 0.70 m) planted with *Vetiveria zizanioides* on an inert matrix of light expanded clay aggregates. The VFCW was continuously fed with synthetic wastewater supply with a mineral medium and caffeine. A synthetic effluent was used to minimize the variations in the concentration of affluent to the VFCW.

The Hydraulic Load (HL) was kept constant at $110 \pm 8 \text{ L m}^{-2} \text{d}^{-1}$. Samples of affluent and effluent from the VFCW were collected daily. They were measured in situ the pH, electrical conductivity (EC), redox potential (Eh) and dissolved oxygen (DO), as well as the air and soil temperature. The caffeine concentration was determined by HPLC-MS and three concentrations were studied of affluent: $3 \pm 1 \text{ mg L}^{-1}$, $4.5 \pm 1 \text{ mg L}^{-1}$ and $9 \pm 1 \text{ mg L}^{-1}$. The study of each Caffeine concentration lasted 4 weeks. Chlorophyll *a* and *b* (*Chl a* and *Chl b*) and carotenoids were determined at the beginning and end of the tests. Average efficiencies of caffeine removal were obtained up to $66 \pm 10\%$. The caffeine levels in the affluent with which the VFCW

were fed affected the content of *Chl a*, *Chl b* and carotenoids. It was verified that the increase of caffeine in the affluent caused a decrease in the content of chlorophyll *a* and *b* and an increase of the carotenoids throughout the tests, thus interfering in the composition of the foliar biomass. This study points to the possibility of using VFCW as a low-cost technology applicable to the treatment of wastewater contaminated with emerging compounds.

METHOD OF COLLECTION OF CONTROL POINTS FOR GEOREFERENCING OF AERIAL AND SPACE IMAGES

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Keywords: geodetic assurance of aerospace survey, referencing of large-scale aerial images, marking of terrain, GCP (ground control points); CP (check points)

Aim. Determination of the elements of external spatial orientation of the surveying systems at the moment of image acquisition is the fundamental task in photogrammetry. Principally, this problem is solved in two ways. The first way is direct positioning and measuring of directions of camera optical axis in the geodetic space with the help of GPS/INS equipment. The second way is the analytical solution of the problem using a set of reference information (often such information is a set of ground control points whose geodetic position is known with sufficient accuracy and which are reliably read on aerial photos of the photogrammetric block). The authors consider the task the second approach, which has several advantages with regard to the reliability and accuracy of determining the unknown image orientation parameters.

Method. For total realization of the potential of the analytical way to determine the elements of external orientation of images, it is necessary to have a certain number of ground control points and to keep the defined scheme of their location on the photogrammetric block or the space image. For main source of input data authors use aerial images of the terrain, which are obtained autonomously from the main survey, have a better geometric resolution and which represent the control reference points. Application of such auxiliary images gives the possibility of automated transferring of the picture of ground control point into images of the main photogrammetric block. In our interpretation, these pictures of ground control points and their surroundings on the ground are called "control reference images". The basis of the work is to develop a method for obtaining the control reference images using quadcopter and transferring of these pictures into aerial or space images of terrain by means of computer stereo identification. To achieve this goal, we have developed processing method for the creation of control reference images of aerial image or a series of auxiliary multi-scale aerial images obtained by a dron from different heights above the reference point. The operator recognizes the GCP once

on the auxiliary aerial image of the highest resolution. Then there is an automatic stereo identification of the control reference image in the whole series of auxiliary images in succession with a decrease in the resolution and, ultimately, directly with the aerial images of photogrammetric block. There are no recognition/ cursor targeting e by the operator-man, and therefore there are no discrepancies, errors or mistakes related to them. In addition, if to apply fairly large size of control reference images, the proposed method can be used on a low-contour terrain, and therefore deal in many cases without the physical marking of points. And this is a way to simplify and reduce the cost of photogrammetric technology. The action of the developed method has been verified experimentally to provide the control reference information of the block of archival aerial images of the low-contour terrain.

Conclusions. The results of the experimental approbation of the proposed method give grounds to assert that the method makes it possible to perform geodetic support of photogrammetric projects more efficiently due to the refusal of the physical marking of the area before aerial survey. The proposed method can also be used to obtain the information for checking the quality of photogrammetric survey. The authors argue that the use of additional equipment - UAV of semi-professional class to obtain control reference images is economically feasible.

OPPORTUNITIES FOR RURAL AREAS IN WATER SCARCE REGIONS BY REUSING INDUSTRIAL AND MUNICIPAL WASTEWATER

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Keywords: agricultural water-reuse, municipal and industrial wastewater, rural development, water-reuse concept, water scarce regions

Introduction – Research objective

Rural areas are generally characterized by agricultural land use and a low population density. Due to a lack of employment and access to basic infrastructural facilities such as a secure water supply and disposal, such regions often face the challenge of rural depopulation. China, the most populous country in the world (Zhu et al. 2013), with ever increasing urbanization rates (Lyu et al. 2016) has to deal with this challenge. For example, approx. 90 % of Chinese villages have a lack drainage channels and wastewater treatment facilities (Dong et al. 2012). Additionally, the effects of worsening climate change such as increasing periods of drought will affect the agricultural production (Wang et al. 2010). Nevertheless, China has to preserve the agricultural sector to feed its huge population (Zhu et al. 2013). As agriculture is the greatest global water user, with 70 % of available water going to the sector (Jiménez u. Asano 2008), reusing wastewater for irrigation is a possibility to contribute to food safety (Jaramillo et al. 2017). With this in mind, China has by far the highest irrigation rates with untreated wastewater (Jiménez u. Asano 2008). As the use of treated wastewater in agriculture benefits human health as well as environmental and economic issues (Jaramillo et al. 2017), water-reuse is becoming increasingly important. However, without the necessary “wastewater, and thus reuse water producers” such as industrial production plants (PP) and housing areas, there is not enough wastewater available that can be treated (Bauer et al. 2019) and provided for irrigation. Thus, a holistic wastewater management concept for rural areas has to be developed by considering new industrial PPs, which process the locally produced raw agricultural products. This will offer more jobs and in turn lead to the development of new housing areas. Hence, enough wastewater will be available to build a Central Wastewater Treatment Plant (CWWTP) with an additional Water Reuse Plant (WRP) in rural areas.

Methodology

For the development of the concept, which is aimed at improving reuse-rates in rural areas, a model region (see figure 1) serves as a basis. Its theoretical location is

in the northwestern/ northeastern region of China, as this is a famous region for cultivating crops. Climatic conditions and increasing water-stress make irrigation necessary, creating opportunities to employ water-reuse in the region. The main idea behind the concept is thus to treat industrial and municipal wastewater in a CWWTP and an additional WRP for agricultural water-reuse. Therefore, the model consists of four components: an industrial development zone including three exemplary PPs, arable land, a population of 200,000 inhabitants and a CWWTP/WRP. Regarding the PPs, common production capacities of agricultural processes of the local field crops are taken into account. Therefore, sugar beets, wheat and potatoes are chosen as an example, and the surface of the corresponding arable land is derived from the required yield of harvested crops. The population relates to a common Chinese rural area, where the total area is based on 50 inhabitants per km², which indicates a sparsely populated area (Li et al. 2018).

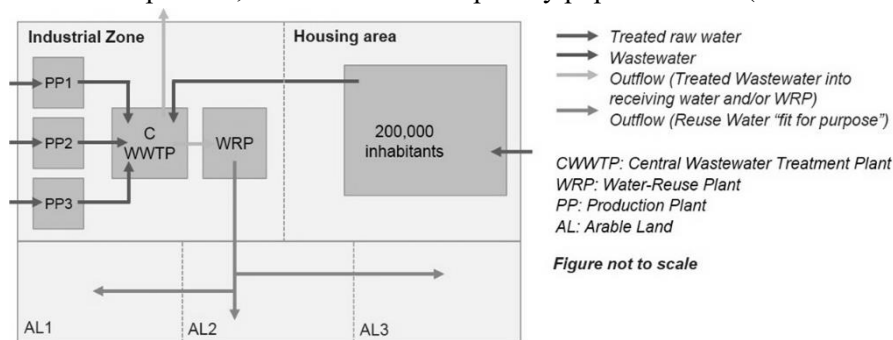


Figure 1 Water-reuse concept for rural areas (own figure)

Results

First calculations show that the area required for the yield must be approx. 80,000 ha and that requires 122.5 Mio m³/a of irrigation supplemental to rainfall. The PP serving the produced crops provides approx. 2 Mio m³ wastewater which can be reused for irrigation. Thus, a water-saving rate of 1.6 % can be achieved by reusing the industrial wastewater, which is generated from its corresponding “raw product”. The reuse-rate can be increased to 8 % by treating the municipal wastewater of ~8 Mio m³/a from the corresponding housing area with 200,000 inhabitants which are connected to the CWWTP and WRP. Consequently, it is essential to link industrial and municipal wastewater flows to achieve higher reuse water rates.

Conclusion

With the settlement of industries which process the local agricultural products, new jobs are created, so that rural depopulation is counteracted. This, in turn, generates more wastewater (from industry and population), making it worthwhile to build a CWWTP/WRP. The CWWTP in turn provides reuse water so that the arable land

can be irrigated. Thus, the concept contributes towards tackling the challenges of climate change and helping people in rural areas to improve their quality of life.

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ON THE VERTICAL ACCURACY OF THE TANDEM-X 30m

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Keywords: TanDEM-X 30 m, WorldDEM™, Runway method, vertical accuracy, DEM

In the first quarter of 2019 the AIRBUS corporation released the latest digital elevation model known as TanDEM-X 30 m (DEM-X). The DEM was developed from the data captured by the tandem of German SAR satellites TerraSAR-X and TanDEM-X (TanDEM). The TanDEM program has been launched in 2007, and the satellites have still been supplying data for both classic remote sensing (e.g., land cover studies), and surveying (e.g., topography and land displacement studies) applications. The uniqueness of the TanDEM program is the helix-like flight formation of the satellites. The main benefit of this orbit's configuration is the single-pass synthetic aperture radar (SAR) data acquisition. This fact eliminates entirely the temporal de-correlation error source, due changes in vegetation cover, including movements of leaves caused by wind. Both satellites receive returning signal simultaneously which allows to maintain an average distance of a few hundred metres from each other. This flight formation allows also for varying of the satellites look angle, which helps to mitigate errors caused by the SAR versus land surface geometry, including shadows, layover.

The SAR data collected by TanDEM program were have been used to produce a commercial product known as WorldDEM™ which is available as Digital Surface Models (DSM) including the "first surface" elevations and Digital Terrain Models (DTM) representing the bare Earth elevation. The spatial resolution of the DEM is 0.4" (approx. ~12 m at the Equator) with the vertical relative/absolute accuracy or 2 m/4 m, respectively. The DEM-X model investigated in this contribution is a DSM which was produced by down-sampling the WorldDEM™ to 1" (or ~30m at the Equator). The DEM-X is distributed free of charge. The DEM-X is a truly global product (pole-to-pole) and produced using data collected just within three years.

The aim of this contribution is to report on the preliminary results of the vertical accuracy assessment of the DEM-X model focusing on the territory of Poland. The method of the accuracy assessment used in this contribution is known as the runway method (RM). The method is based on the error model of a digital representation of a scalar field that is built upon of results of measurements of a certain accuracy. The error model consists three terms, i.e., the instrument-induced, environment-induced and target-induced error. While the first two type of errors are random, hence only experimentally assessable, the latter error component can be calculated based on the parameters of the scalar field. In case of a DEM, the relevant parameters are the spatial resolution of the model and terrain's slope at a given point. The expression of the variance of the target-induced error was published by one of the authors of this contribution over ten years ago already. A useful conclusion of the expression is the fact that the error cases to exist for slope equals to zero independent on the resolution of the model. This conclusion forms a foundation for the runway method. The RM uses flat (slope = 0) structures, ideally made of homogenous surface (to minimise the environment-induced noise). A good candidate for this type of surface is a runway. In addition to the suitable physical characteristics of runways as testbeds, relevant data, including their vertical profiles, are freely available in public domain.

The RM has been used to assess the vertical accuracy of the DEM-X over the runways located in the territory of Poland. The spatial spread of the test sites allows to investigate not only the relative and absolute vertical instrument-/environment-induced error source of the DEM-X, but also its long-term harmonics. In addition, the LiDAR and derived from them DEM, available from the ISOK program were used in this project to assess the suitability of the DEM-X for updating Polish database of vertical information.

The research results indicate a sub-meter vertical accuracy of the DEM-X model. As expected, the standard deviation of the difference between reference and tested model is smaller than of the higher resolution model (WorldDEM™). This is because the low-pass properties of the averaging filter used to down-sample the original WorldDEM™ to DEM-X product.

The main conclusion of the study is that the DEM-X surpass accuracy-wise the existing DEM freely available data products, including AW3D-30 m and SRTM-1"3". In addition, there are strong indications that this model could be used in many situation as a superior alternative elevation product to the national vertical data of Poland.

THE COMMONS, THE OPEN SOURCE APPROACH AND THE GEOSPATIAL ARENA

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Keywords: Open Source, Commons, Tragedy of Commons, Geospatial Software, OSGeo Foundation

Introduction and Goal of the research

Development, maintenance and usage of free and open source software solutions, standards and data can be observed in the geospatial information technology since years. While at the beginning the development was mainly supported by academia and research institutions, more and more also individuals and companies committed themselves to the idea of Open Source and completed their portfolio with freely available components. The underlying principles, motivations and approaches in Geospatial information technologies shall be analyzed and be understood.

Methodology and scope of a research

Regarding the significance of this approach the concept of commons is introduced including the conditions of successfully sharing common goods. However the beneficial output of common resources is endangered by the so-called tragedy of commons, i. e. the human desire to use and exploit the resources without limits. These concepts are transferred to the modern economy, especially to the realm of information technology.

The open source and free software movement can be an approach to overcome the limitations of traditional IT industry. The fundamental principles of this movement, its motivating factors and basic business models of the Open Source realm will be presented.

The interests of individuals must be substantially supported and made visible by a community. In the field of Geoinformatics this happens through the Open Source Geospatial Foundation (OSGeo), a non-governmental organization recognized as charitable supported by associated national and regional partner organizations. Its tasks and structure are explained and presented with respect to scientific education, research and economy.

Based on literature and web based resources the market share of different open source software solutions for general and geospatial IT is analysed.

Main conclusions

Open source solutions contribute significantly to the overall IT economy and market. Its development and distribution principles offer additional options for society and economy to provide solutions to solve geospatial problems and to offer geospatial services. The linked usage of open and closed source solutions is recommended.

THE CARTOGRAPHIC METHOD OF DETERMINING URBANIZATION LEVEL ON THE EARTH'S SURFACE

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Cadastral parcels boundaries form a pattern, which is a result of the process of the ownership land division. The ownership land division is related to urbanization process. The morphological analysis of the parcel pattern enabled to determine a level of urbanization of a selected piece of land on the Earth's surface. The morphological class of the piece of land, which determines its urbanization level, is unambiguously defined by the distribution function of the cadastral parcel areas. The analysis revealed that there are only three levels of urbanization. The size and the shape of the analyzed piece of land is not relevant for the method. The only condition that needs to be fulfilled is the number of the parcels in the investigated area. It has to be sufficiently large so that statistical methods could be applied.

The presented method of analysis called "the method of morphology of the parcel mosaic" is universal because it is based on generic law governing the ownership land division, and it uses only the areas of the cadastral parcels. It uses cadastral maps in the GIS format. The data contained all types of parcels including both developed and undeveloped areas, industrial areas, public utilities, and green areas. Roads and streets were excluded from the analysis. The investigated lands are situated on three continents: Europe, Australia and North America. Thanks to that cartographic method we can easily and continuously monitor the urbanization level of a piece of land. This is because the changes of the cadastral parcel pattern are the first sign of the process of spatial urbanisation.

MACHINE LEARNING TOOLS FOR THE SEGMENTATION OF THE IMAGES OF SHALLOW WATER RESERVOIRS

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Keywords: image segmentation, shallow water , machine learning, Unmanned Aerial Vehicle

The shallow water reservoirs are very interesting objects from the point of view of the dynamics of the phenomena occurring there. Increasingly commoner drones become very cheap and highly effective tools providing huge amounts of graphical data, which in the case of shallow water areas can become a great source of information. In this presentation the results of an experiment showing the distribution of pollutants in sea water are presented. The pictures applied in the research were acquired by the Unmanned Aerial Vehicle. The research was carried out on the Puck Bay (Baltic Sea). One of the first steps when analyzing image data is image segmentation. It is necessary for the classification and identification of objects that are depicted on the considered image. We employed the Weka algorithm, as well tested, and bringing good results and being broadly used in the field of image processing. In this particular case, segmentation is a bit more complicated due to the fact that the main spot of pollution consists of areas of different shades. This is a consequence of the depth of water, the shape of the bottom and the inhabited vegetation and introduces an additional difficulties in the process of image segmentation, analysis and then its subsequent interpretation.

EVALUATION OF THE IMPACT OF THE CONNECTION OF ALQUEVA RESERVOIR IN THE QUALITY OF IRRIGATION WATER AT ROXO SUB-BASIN OF SADO RIVER CATCHMENT

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Keywords: Irrigation water quality, Sustainable management, Roxo sub-basin, Alqueva Reservoir, Portugal.

Alentejo is a region of South Portugal and the main economic activity is the agriculture. The climate of this region is typically Mediterranean and the irregularity of precipitation has been increase with the phenomenon of climate changes.

The Alqueva reservoir is the biggest reservoir in Europe and provides water for more than 120,000 hectares for agriculture. Before the use of this reservoir, the agricultural type practiced was dry agriculture and the main cultivated products were cereals. Now farmers grown horticultural products and make an intensive culture of olives and almond trees.

The Roxo reservoir has been receiving since 2016 around 20×10^6 m³/year of water from Alqueva to meet the needs of its irrigation perimeter.

The aim of this study is evaluate the impact of the connection to Alqueva reservoir in the quality of irrigation water at Roxo sub-basin that belongs to Sado river catchment in order to made a more sustainable management of irrigated area. Indirectly it is, also, intend to contribute to the inversion of the process of desertification of Alentejo.

Before the connection, the water quality of hydraulic system and drainage network of the irrigation perimeter of Roxo's reservoir was monitorized during 2014/2015 and the results were comparing with the monitorization made since 2016 to now.

The quality of water before the connection;

i) Showed a mild to moderate degree of salinity risk; ii) didn't show characteristics to modify the infiltration soil conditions; iii) indicates degree of restriction slight to

moderate due to the amounts of Na^+ and Cl^- ; iv) the drainage network presented toxicity due the chlorides and boron and v) the ammonia nitrogen and nitrate values were low. The application of nitrogenous fertilizers seemed to influence the results.

The quality of the water after mixing is showing a negative impact on the organic matter content, in the nitrogen compounds and an increase in the phosphate nutrients.

A WEB SYSTEM TO ENGAGE PEOPLE IN REDUCING THE ENVIRONMENTAL FOOTPRINT OF A SCHOOL

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Keywords: Eco-Schools, Web, Recycling, Environmental Education

This paper reports the development of an web system solution developed in an higher institution to promote and disseminate the Eco-Schools programme together with school members and local community.

The schools programme officials needed a tool that could better communicate their plan of action and engage the school members to its goals. The web technology was chosen due its capacity to reach to all target members as well due to its familiarity of usage. This system has a front-office where people can explore the following topics: information about the programmes (action plans, members, among others), activities of the action plans, relevant events in environmental area, monitor of water and electricity consumption data, as well, recycling of plastic, paper and batteries quantities, educational games for conservation of the environment, and contacts that allows users to send suggestions and ideas. The system has also a back-office where members can record data that feed the front-office. In particular, the more important task is to record in any time the data about of water and electricity consumption and recycling of plastic, paper and batteries quantities. For each item is recorded too the goal (defined in action plan) of consumption or quantity for a period of one month or one year. This motivate school members to better save this resources and increase recycling to allows school to achieve the goals defined in programme action plan.

The main objective of this work is to develop an online information solution to better engage the academic community in a better environment of their schools and locals. This solution intends to change the behaviour of school members to reduce the consumption of water and electricity in the school, as well, to increase the correct recycling of plastic, paper and batteries. The system also should challenges users to send suggestions of actions and ideas to better reduce the environmental footprint of each school.

This software project follows the waterfall model. The first phase was the system requirements analysis where elicitation was gathered and discovered from stakeholders (local eco-schools officials, schools officials, teachers and students) and other sources using interviews and document analysis. After was developed the

system design composed by the specification of the following models: database, graphical user interfaces and software architecture based in standard guidelines for this kind of systems. In the implementation phase the code programming was done using the Laravel PHP framework, MySql database and the Laragon server system. The testing phase was focused in two parts: system and usability. The system testing tried to verify if each functionality of code is correct and if the system is easy to use, efficient and effective for user.

Regarding the system front-office testing the system was evaluated by a small number of users who liked the system, in particular the parts of monitoring the waste recycling and consumption of critical resources in their schools. The people also found the system easy to use and was natural to them navigate around their functionalities. The back-office part was explored by a small number of users that are familiar with web interfaces and found the system suited easy to use. Some new ideas and suggestions were expressed by users that should be taken in account to improve the system. At this moment we have no accurate data regarding to the impact of the system on the target audience and we expect soon to have results about how people behaviors are changed due the information they receive from the system about waste recycling and consumption of critical resources in their schools.

Concluding, this system is considered very important for eco-schools program to share information about ecological and environment issues in each school. The system should help to fulfill the action plans of the program through the digital information for all school members to participate in the activities proposed, as well, to make the events known for all the target audience. This system should be also very important to allows school members to send suggestions or new ideas about how to reduce consumption of critical resources (water, electricity, among other) as well new methods to waste recycling. But, the main contribution of the system is the data sharing of the waste recycling and resource consumptions that should motivate the community members to gain more environmental awareness trying to achieve the goals defined for each element. We are expecting to have results soon to understand how the system affect people behavior about this issue through a questionnaire applied for target.

MONITORING OF CONIFEROUS FOREST DRYING IN PRECARPATHIAN REGION USING REMOTE SENSING DATA

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Keywords: remote sensing, satellite images, coniferous forest drying, classification, vegetation indices.

Goal of a research. Problems of rational use and preservation of forest resources in Carpathian region of Ukraine are considered as one of the priority tasks of the state level.

The coniferous trees drying is environmental disaster. This situation is caused by two main factors - global climate change and human activities. Strengthening the continental nature of the climate, reducing the humidity of the air, insufficient amount of snow cover creates favourable conditions for the development of harmful insects and pathogens. In the Ukrainian Carpathians, due to the extent of the territory, the degree of coniferous forests drying is not completely studied. In many research papers, the authors point to a significant correlation between deforestation and unsatisfactory state of forest cover.

There is no other option to improve the condition of forest stands as a permanent monitoring and change methods in forest management.

Methodology and scope of a research. The presented research concerns processing of the methodology for detection of forest drying in the Carpathians with using satellite images with medium and high spatial resolution. The object of research is the forests of Tukhlya forestry, Lviv region. The area of forestry is 4888 hectares. According to the nature of the relief, the forests belong to mountains with elevations from 520 to 1000 m.

Based on the processing of visual observations, foresters have established that during the period of observations from 1991 to 2016 coniferous trees have the highest damage. Integral degree of drying is 14-15%.

Two methods were used to obtain reliable information and to automate detection of areas with coniferous drying: on the basis of vegetation indices and controlled classification.

Highlight of results. For the research, satellite images of the summer period, obtained from the satellites GeoEye (2011) and Sentinel-2 (2017) for the part of the Tukhlya Forestry, were processed. The software product ArcGis 10.2 was used for processing.

In the autumn of 2017 and in the spring of 2018, on five areas where coniferous forests were drying, field surveys were carried out to collect verification data. These areas are indicated on orthophotomaps, which are created on the basis of aerosurveying in 2007. The data has been collected by the following criteria: general characteristics of the testing area; the average tree height; the average stem thickness; the average distance between the trees; the percentage of the dominant species and degree of drying. The total surveyed area is about 50 hectares. As a result of the survey, a different degree coniferous plants drying was found: from 10% to 70%. On the slopes of the mountains, areas with dried fallen trees that are overgrown with high grass, bushes, and low undergrowth are discovered.

Controlled classification is carried out by the method of maximum probability on the basis of the created training samples. Training samples characterize such classes as areas with coniferous trees drying, deciduous and coniferous forest, lawns and paths. The class with lawns also includes felling. Histograms and scatter diagrams are used to evaluate the training samples. It is established that classes do not intersect in the future space. For post-processing Majority Filter is used. Majority Filter allows to improve the accuracy of the calculation of areas.

For vegetation assessment, such as normalized difference vegetation index (NDVI), soil vegetation index (SAVI), global environmental monitoring index (GEMI) were used, Vegetative indices allow to estimate vegetation state in images.

Main conclusions. The processing of the transformed images obtained from the results of controlled classification by the image of Sentinel-2 allows to identify larger cells of drying. Satellite images of medium resolution do not allow to detect the degree of drying of trees.

Classification by the image of GeoEye helps to detect changes in tree stands in the initial stages (20-30%). Vegetation indices allow a more detailed analysis of the degree of coniferous trees drying. However, it has been found that for damaged vegetation, vegetation indices correlate with soils, dry grassy vegetation, field roads.

The proposed method allows reliable and fairly accurate monitoring of forest areas, as well as controlling the spread of forests drying and, accordingly, taking timely management decisions.

HYDROLOGICAL PROCESSES MODELING USING GIS

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Keywords: hydrological modeling; HEC-RAS; flooding; hydrology; unmanned aerial vehicles; digital elevation model

Goal of a research. Periodic spring or summer floods and floodings on one of the largest rivers of Ukraine Dniester cause significant economic losses and social tension in the region. Therefore, flood prevention and warning the population about the destructive consequences is part of the state policy.

Hydrological modeling using GIS allows researchers to prevent the population and civil servants to possible losses caused by floods and flooding events by assessing the risk of flooding and reduce the risks of this cataclysm. The studies simulate the Dniester river flooding between town Sambir and village Khatki in Lviv region. The investigated area is characterized by a complex winding shape of the channel, its significant meandering and planned displacements, which were investigated on the basis of topographic maps and satellite images from the last 70 years.

Methodology and scope of a research. The method of investigation of flooded areas as a result of water rise to a certain level has been processed. It includes:

- survey of the area with UAVs;
- the implementation of geodetic and hydrological activities in the field of research;
- creation of DEM based on survey results and analysis of its accuracy;
- hydrological modeling using the HEC-RAS software package;
- determination of flood areas.

In order to obtain a digital elevation model, which is the basis for hydrological modeling, a Trimble UX5 UAV with a Sony NEX-5R camera was used to film the area. To accurately determine DEM coordinates, a standard error for planned coordinates of 6 cm was established; high-altitude coordinates depending on the basis of shooting and the underlying surface equals 0,21 – 0,32m. The DEM was created using the specialized software Pix4D.

GPS data was given as input to the hydrological modeling. The primary objective of the hydrological modeling was a) to determine the geodetic coordinates of the terrain points for the construction of the DEM in a specified coordinate

system, b) estimate the accuracy of the DEM and measure the depths of the channel in the modulated part of the river, which in turn were used to describe the bottom relief. Information about the water flow rate is obtained on hydrographs.

The hydrological information of water flow can be obtained using a) graphs or tables with the data dependencies of the water flow from the absolute elevation, b) the coefficients of the underlying surface roughness, and c) the coefficient of the level of slope of the bed.

Highlight of results. The data for hydrological modeling in HEC-RAS was prepared using ArcMap 10.1 GIS and HEC-GeoRAS utility. HEC-GeoRAS is a set of tools for processing geospatial data in the ArcGIS environment.

The software package HEC-RAS is based on a one-dimensional model. The main way of calculation is based on the solution of the flow energy equation, in which energy losses are due to friction and the narrowing or expansion of the river bed is estimated. The 1-dimensional Saint-Venant equation is used to calculate the unstated flow with the finite difference method. The equation follows a numerical method in which the input data are the cross-sectional lines. To ensure the accuracy of the simulation, their interval should not exceed 100 meters. In our study, this parameter is 50 meters.

The construction of cross-section lines must meet a number of requirements. The curves in the riverbed complicates this procedure more than is the case with a straight channel.

The equation of continuity, energy and flow resistance is used for modeling. The continuity equation is described by a constant and continuous period of time. The flow energy equation reflects the total energy of the flow that can be defined as the total water pressure at any point along the entire simulated riverbed. The flow resistance equation is based on the Manning equation, which contains data on the average roughness along the entire perimeter of the flow in the considered section of the channel.

A hydrological model for water flow rates with three levels of elevation (1, 2, 3m) was created.

Main conclusions.

- The DEM was created according to the results obtained from the UAV to the average quadratic error of 0.2 m.
- The technique of hydrological modeling implemented on the part of the Dniester river with a complex configuration of the channel is processed.
- Areas have been designated and area of flooding at different levels of rise of water.

EFFECTS OF LIVESTOCK EXCRETA DEPOSITION ON NITROGEN LOSSES FROM GRAZED GRASSLAND ECOSYSTEMS AND A PRELIMINARY FIELD STUDY IN TIBET, CHINA

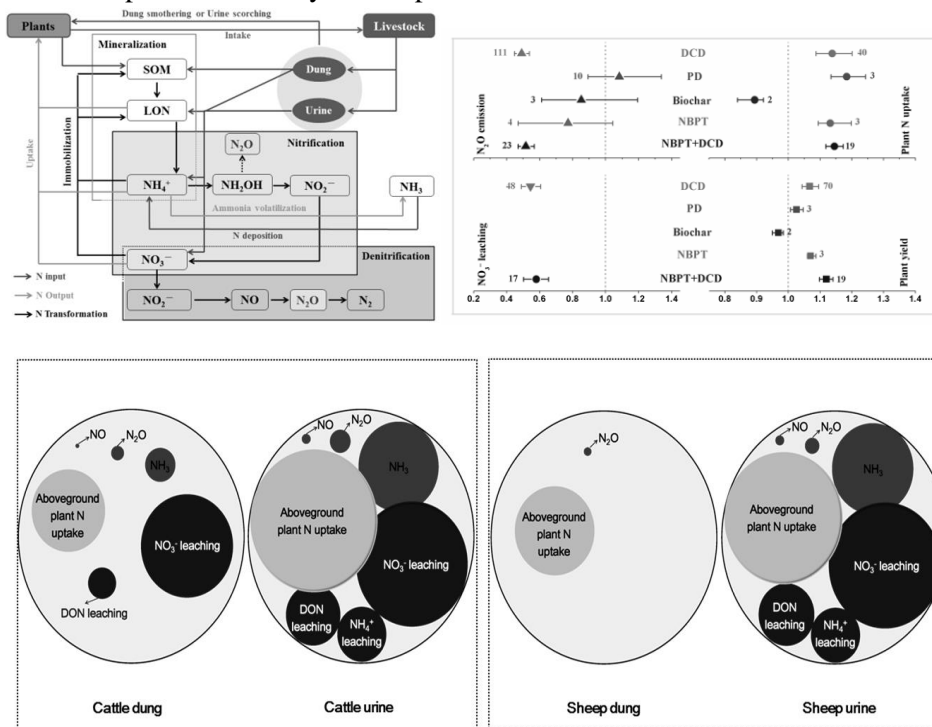
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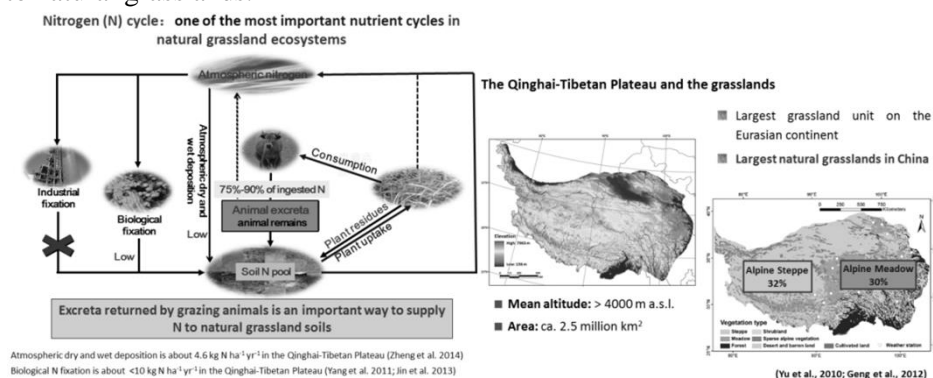
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More livestock is being raised globally (increasing from 3.55 billion in 2000 to 4.24 billion in 2014 for cattle, sheep, goats and horses, based on 2017 FAO data) due to the increasing demand for livestock products, which inevitably results in increased excreta (urine and dung) deposition onto grasslands. Excreta patches are nitrogen (N) transformation hotspots in grassland ecosystems and an important source of N trace gas emissions and leaching. To better understand the N dynamics excreta patches, available measurements from previous studies were summarized and a comprehensive analysis was performed.



Moreover, a preliminary study in Tibet on the effects of livestock dung on N dynamics has been conducted. Although N cycle is one of the most important nutrient cycles in natural grassland ecosystems, for the natural grassland ecosystems in the Qinghai-Tibetan Plateau, no chemical N fertilizers are used, the N source from biological fixation is low ($< 10 \text{ kg N ha}^{-1}$), the N amount from atmospheric deposition is also low (ca. 4.6 kg N ha^{-1}). For grazed grasslands, a lot of grasses are consumed by livestock, but ca. 75-90% of the ingested N can be deposited as excreta (dung and urine), the excreta deposition is therefore considered a key way to supply N to natural grasslands.



Yak and Tibetan sheep are the two main livestock species on the plateau. The number of yaks is > 13 million, while that of Tibetan sheep is > 50 million, and large amounts of excreta are deposited. Excreta patches are the highly active hot spots of N leaching and N_2O emissions, but less information is available on the contributions of excreta patches to N losses from alpine grasslands. As global warming intensifies, which is more pronounced at higher elevations, it is become more urgent to know the influence of excreta deposition on N_2O emissions in the Qinghai-Tibetan Plateau.

ASSESSMENT OF THE RELATIONSHIP BETWEEN THE VALUES OF THE WATER QUALITY ELEMENTS OF THE WATER BODIES AND THE HYDROMETRIC PARAMETERS

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Keywords: water quality, the status of lakes, depths, volume, sedimentation

Human agricultural activities and its development have an inevitable negative impact to the environment. One of the largest ecological issues of today is assessed to be intensive anthropogenic activity in surface water pool resulting in fast eutrophication (Kronvang et al., 2008). Both diffuse pollution and concentrated pollution have a negative impact to surface water bodies. Human activities determine over 90 percent of annual total nitrogen flow and 78 percent of total phosphorus amount (Povilaitis, 2008). It is estimated that 20 to 80 percent of nitrogen is stored in the North Atlantic Ocean (Howarth et al., 1996), 33 percent of nitrogen and 35 percent of phosphorus in Estonia (Vassiljev and Stalnacke, 2005), and 50 percent of nitrogen in Sweden (Ahlgren, 1994). Lithuanian lakes accumulate 27 to 59 percent of nitrogen and 11 to 31 percent of phosphorus (Povilaitis, 2011), of which 27 to 56 percent of phosphorus is accumulated in south-eastern Lithuania (Taminskas et al., 2007). There are about 2850 lakes in Lithuania, which make up 1.4 percent of country territory. 30 percent of those lakes or ponds and 60 percent of rivers do not meet good ecological status.

The goal of a research was to assess the ecological status of Lithuanian water bodies and the impact of morphometric indicators on water quality.

Methodology and scope of a research

Multiple studies were conducted in 30 lakes and 10 ponds located throughout the country in Lithuania in 2014–2018. The following studies were conducted to assess the ecological status of water bodies:

Research on indicators of physio-chemical quality elements. 358 samples were taken. The concentration of total nitrogen (N_b) and total phosphorus (P_b) was evaluated.

Macrozoobentos study samples taken in 2016 September to October. Macrozoobentos studies were conducted using the approved method LAND 57-2003 "Methods of Macrozoobenthos Survey in Surface Water Bodies" of the decision of the Minister of Environment of the Republic of Lithuania on December 24th of 2003 by Order no. 708.

Phytoplankton research. 346 samples were taken. Phytoplankton studies were conducted in accordance with the decision of the Minister of Environment of the Republic of Lithuania on December 24th of 2003 by Order no. 708 LAND 53-2003 Methodology for Survey of Phytoplankton in Surface Water Bodies. Chlorophyll A is determined by spectrophotometric method (LAND 69-2005). The Chlorophyll A EQR has been calculated according to the normative document of the Republic of Lithuania on Environmental Protection approved by the Minister of Environment of the Republic of Lithuania on December 28th of 2005 by Order no. D1-648 (2006, No. 53-123). 320 samples were taken.

The status of lakes by MRI (reference index of macrophytes) principle is assessed by phytobenthos and macrophyte surveys in surface water bodies and ecological status by macrophyte reference index report, 2013–2017.

The status of lakes according to the values of LFI is evaluated according to the reports of "Ichthyofauna and assessment of the ecological status of Lithuanian rivers and lakes by fish indicators" in 2009–2017.

Macrozoobentos samples in lakes and ponds were taken by using O'Hare et al. (2007) methodology.

Danish Stream Fauna Index (hereinafter referred to as DSFI) indicates the taxonomic composition and abundance of zoobenthos in rivers. DSFI EQR is calculated in accordance with the Republic of Lithuania Environmental Protection Standard LAND 57-2003, approved by the Minister of Environment of the Republic of Lithuania in December 24th of 2003 by Order no. 708 (2004, No. 53-1827).

The ecological status of water bodies at risk was assessed in accordance with the decision of the Minister of Environment of the Republic of Lithuania in April 12th of 2007 by Order no. D1-210 the Approved Methodology for Determination of the Status of Surface Water Bodies.

Results

Lake and pond water samples taken from September to October of 2014 - August of 2018. Physicochemical quality indicators (elements) were investigated – N_b, mg/l; is P_b, mg/l;

The lakes surveyed do not classify as good ecological status water bodies by followed elemental data: 50 percent for total nitrogen, 22.5 percent for total phosphorus, 84.5 percent for Chlorophyll A and 72 percent for water bodies studied by macrophyte taxonomy.

Water quality indicators are variables. The development of their metabolism is dependent on the water depth, volume, sedimentation, overgrowth, metabolism time of water bodies, etc.

Hydrochemical and hydrobiological processes occurring in water are constantly closely related to hydromorphological indicators, the most important of which are water depth, volume and metabolism time. These are complex processes that are analyzed insufficiently still. However, it is obvious the status of a deeper and larger volume of water deposit is better. It is known as the self-purification of water, although its nature is not precisely defined, research has estimated that greater water depth and volume in aquatic fauna functioning conditions and water quality indicators are better as mentioned. In addition, the higher water depth and volume are more damaging to climatic and other external variations.

The results show larger the lake's average and maximum depth indicates lower P_b , N_b , macrophyte taxonomic composition values (better ecological status class), higher the average and maximum depth of the lake indicates higher Chlorophyll A EQR, the taxonomic composition of the ichthyofauna, the values of LFI and Lithuanian lakes' macroinvertebrates index (better ecological status class). Linear regression equations developed can be used to calculate the correlation between the value of water quality indicators and water depth.

The research shown that sludge treatment, thus increasing the depth of the lake, can improve the ecological status of the lake by all indicators measured.

It was determined that larger lake area has lower values of P_b ; N_b . This indicates better water body ecological status class. Also larger lake area has a higher taxonomic composition of ichthyofauna in FI; zoobenthos taxonomic composition indicator for LEMI and taxonomic composition of macrophytes MRI which also indicates better ecological status class. However, the larger the area of the lake, the lower the Chlorophyll A EQR values meaning worse ecological status.

It was determined that rapid water exchange improvements on the condition of the lake under nitrogen, phosphorus and Chlorophyll A EQR values. Faster water exchange in the lake indicates lower P_b and N_b values and shows good ecological status class of the water body. Fastest water exchange in the lake also indicates higher Chlorophyll A EQR values and shows good ecological status class of the water body. Nonetheless, slower water exchange correlates with better ecological status of the macrophytic taxonomic composition of MRI, the ichthyofauna taxonomic composition, and Lithuanian lakes' macroinvertebrates index indicator of zoobenthos indicating in better ecological status class of the water body.

Conclusion

When assessed 40 lakes in 2014 to 2018 the study showed that measuring total nitrogen only 50 percent of lakes was assigned having good environmental

status, measuring total phosphorus – only 22.5 percent met the criteria. When measuring Chlorophyll A status – 84.5 percent and 72 percent when measuring macrophytic taxonomic composition and abundance of the lakes met the criteria.

The study proved that higher maximum and average depths of the lakes correlates with lower P_b ; N_b yield and macrophyte taxonomic composition values are – indicates higher ecological status class; higher Chlorophyll A EQR, ichthyofauna taxonomic composition indicator for LFI and Lithuanian lakes' macroinvertebrates index (higher ecological class) values are.

Larger the lake area contains smaller amounts of P_b ; N_b – indicates better ecological status class; higher ichthyofauna taxonomic composition in LFI; Zoobenthos taxonomic composition indicator for Lithuanian lakes' macroinvertebrates index (LEMI) and taxonomic composition of macrophytes MRI (better ecological status class). Larger the area of the lake over all contains lower amounts of Chlorophyll A EQR values (worse ecological class status). Rapid water exchange improves the condition of the lake in addition to nitrogen, phosphorus and Chlorophyll A EQR values. The faster the water exchange in the lake is, the lower the P_b and N_b values (better ecological class status); fastest water exchange in the lake also means higher Chlorophyll A EQR values (better ecological class status). However, slower water exchange indicates better ecological status of the macrophytic taxonomic composition of MRI, the ichthyofauna taxonomic composition and the Lithuanian lakes' macroinvertebrates index indicator of Zoobenthos.

In conclusion, one of the most effective measures to improve the status of water bodies is to increase the depth of shallow, damp water bodies by removing the accumulated sludge.

ERROR ESTIMATION OF ORTHOTRANSFORMATION OF AERIAL IMAGES OBTAINED FROM UAVS ON THE MOUNTAINOUS LOCAL SITE IN THE VILLAGE SHIDNYTSYA

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Keywords ortho rectification; orthophoto plan; aerial survey; UAV; GNSS survey.

The aim of the work is to estimate the error of the ortho rectification of aerial images obtained by unmanned aerial vehicle for a mountain site in the village Shidnytsya with the help of additional grid of points obtained by GNSS-survey. The task is to analyse the difference between the heights of the points obtained two ways: using the map of heights from the UAV survey and using data of GNSS-survey and then to estimate the difference between the real coordinates of the ground control points with their coordinates on the orthophoto plan.

The method of determination of the real value of error of ortho rectification of aerial images obtained by UAV on mountainous terrain is proposed. A local test site with size approximately 70x60 meters was created on the hill in the village Shidnytsya, The site is a part of terrain covered by general aerial survey of the village. On this site an additional GNSS-survey was implemented and a grid of points with measured coordinates was created with step one meter. Processing of the obtained ortho image, height map based on the data of the aerial survey of the entire Shidnytsya and the results of GNSS-survey was realized in the software of ArcGIS. Layer of points of the local test site was overlapping on the aerial image and then this data were compared with the coordinates of the same points obtained from the map of heights.

Results, Comparing the height values of 115 points on the hill slope in the village Shidnytsya, obtained with the help of GNSS-survey with the height values of the same points obtained from the map of heights created on the basis of aerial survey implemented by unmanned aerial vehicle, it was determined that the height values of the points are very different. Due to such differences of obtained heights of the points from their actual values there are significant deviations on ground control points on the orthophoto plan from their actual location on the ground. Authors proposed the method of comparison of height values of points obtained by different methods for determining the magnitude of the error of ortho rectification of aerial images obtained using UAV on the mountainous local area of the village Shidnytsya.

Conclusions. The obtained results of point heights comparison and analysis of the error of ortho rectification of aerial images obtained by unmanned aerial vehicles on the mountainous part of the village Shidnytsya indicate that the ortho rectification of aerial images acquired using UAV on the mountainous area is rather rough.

CALIBRATION OF AUTOMATED VERTICALITY MONITORING SYSTEM OF RADIO-COMMUNICATION MASTS/TOWERS USING GEODETIC MEASUREMENTS

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Keywords: tower construction, calibration, inclinometer, geodetic measurement, total station.

The goal of this research is enhancement of accuracy and reliability of Micro-Electro-Mechanical Systems (MEMS) data used in Automated Verticality Monitoring System (AVMS) of radio communication masts/towers.

The scope of this work is development of calibration methodology of AVMS of radio communication masts/towers using geodetic measurements in order to obtain corrections in MEMS inclinometer measurements relative to the construction's vertical axis.

The proposed methodology is based on relationship between total station topocentric coordinate system and inclinometer platform system of coordinates defended by rotation matrix which contains orientation (yaw), pitch and roll angles. In order to derive yaw, pitch and roll angles from total station measurements at least three reference markers have to be installed on the tower platform: two markers along the inclinometer roll axis and third in perpendicular direction. The transition vector could be determined as differences of topocentric coordinates of two reference markers along the pitch axis in order to identify origin and orientation angle of platform coordinate system. The pitch angle will be easy obtained after platform orientation by rotation matrix around origin of platform coordinate system. In order to calculate roll angle from measurements to third marker a series of rotations using orientation and pitch angles needs to be carried out.

For experimental measurements on the tower construction were installed two dual axis Bewis Sensing inclinometers with precision 0.01° and 0.001° respectively. The measurements from two ground control points were done using Leica Geosystems total station TC802 with accuracy $m_\alpha = \pm 2''$ and $m_s = \pm (2 + 2\text{ppm})$. The differences between measured and calculated pitch and roll angles are considered calibration parameters. In order to increase the accuracy of calibration parameters and estimate the inclinometer measurements standard deviation a series of 15

simultaneous observations were done. Estimated standard deviation of inclinometers and accuracy of calibration parameters are compatible with declared by the manufacturer precision. Analyses of total station coordinate measurements accuracy influence on the pitch and roll angles errors shows that these errors are inverse proportional to the distances between reference markers.

The preliminary results show the possibility to use this calibration methodology in order to determine initial position of the inclinometer installed on the tower constructions. Finally, calibration data will be used for calculation of tower inclination in Automated Verticality Monitoring System developed by S. A. Softcom company in cooperation with state enterprise I. S. Radocomunicatii. The future investigations will be oriented towards combinations of inclinometer data with GNSS observations taking in account deflection of vertical for high television tower constructions in order to increase the accuracy of verticality monitoring.

URBAN WASTEWATER CHEMICAL PRECIPITATION TREATMENT BY HAND WITH HYDROPONIC REUSE

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Keywords: Boron removal, toxicity, *Vetiveria zizanioides*, vertical flow constructed wetland, biomass composition.

Excess of boron (B) in the aquatic habitats can cause undesirable B contamination of water, resulting in toxicity of crop and plants, contamination in soil or sediment, and reproductive risks for both animals and human in many semiarid and arid regions. Therefore, water, either from wastewater or other sources of water, should need treatment before being used for irrigation or drinking purposes by human communities, who can suffer from excessive levels of B contamination in water. Several conventional treatment methods including membrane process, ion exchange, and adsorption techniques have been applied for the removal of boron from various types of wastewater. However, removal methods based on conventional strategies are expensive and require costly equipment or chemicals. In comparison to conventional techniques, constructed wetlands (CWs) have experienced significant advancement in recent years to remove pollutants from contaminated water due to their simple operation, eco-friendly properties, and cost effectiveness.

So, in this study, we investigated the performance of a Vertical flow constructed wetland (VFCW) to boron removal. A VFCW bed ($0.70 \text{ m} \times 0.24 \text{ m}^2$) planted with *Vetiveria zizanioides* were used. The bed was filled with light expanded clay aggregates (Leca®NR 3/8, $10 < \varnothing < 20 \text{ mm}$). A bottom slope of 2% was applied in order to enable the hydraulic collection of the influent continuously distributed by equidistant sprinklers on the top of the bed. A layer of gravel (diameter 10-50 mm) was placed around the outlet valve to prevent clogging with fine particles. A feeding tank (125L), equipped with a submersible pump (Eheim-1250) was used. The flooding level was maintained at 14% by a siphon on the outlet. Inlet and outlet flow were measured. Wastewater samples were collected daily for immediate characterization or frozen at -20°C . Air and bed temperatures were monitored daily. Rainfall was excluded by covering the beds with a tunnel of transparent fine plastic. A synthetic wastewater was prepared using boric acid as

boron source and micronutrients dissolved with tap water according to the operating conditions under study. Each new condition has been in operation up to pseudo-stationary state. It was used two different and increasing boron concentrations (15 ± 1 and $30 \pm 1 \text{ mgL}^{-1} \text{ B}$) and the flow rate to the VFCW was kept constant, with an hydraulic load (H_L) of $191 \pm 10 \text{ Lm}^{-2}\text{d}^{-1}$.

Every weekday, from Monday to Friday, wastewater samples were taken, and the flow rate measured at the inlet and outlet of VFCW. In those samples, the dissolved oxygen (DO), electrical conductivity (EC), pH, boron (B) were determined.

The results obtained show that it is possible boron removal in VFCW. Removal efficiency obtained up $60 \pm 10 \%$ of boron was of obtained. When boron concentration was the highest the plants stop growth and leaves chlorosis was observed. The micronutrients composition (calcium, magnesium, potassium and sodium) in vegetal biomass decreased when wastewater boron concentration increased. So, it was possible to conclude, that the VFCW performance decrease when wastewater with high boron concentration of $30 \pm 1 \text{ mgL}^{-1} \text{ B}$ was applied, as well as toxicity signals in plants appear.

FOOD WASTE MANAGEMENT USING HERMETIA ILLUCENS INSECT

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Keywords: waste management, food waste, environmental protection, circular economy, *hermetia illucens*

Sustainable management of agricultural products and food industry waste is one of the greatest challenges of the 21st century. It is estimated that over 30% of food is not consumed. The waste can cause a negative impact on the environment. Most of the generated food waste can be managed with benefits. This problem concerns practically all countries in the world. One of the attractive food waste treatment technique is the bioconversion method. In the sense of the bioconversion principles, waste are processed using living organisms such as insects. On the other hand agricultural biogas plants more often uses waste for energy production. The insect that can be used for energy production as part of the bioconversion process is *Hermetia illucens*. *Hermetia illucens* (Black Soldier Fly) is a Diptera characterized by a high growth index are source of fats and proteins.

The goal of a research was to determine the biogas and methane efficiency and the fermentation process dynamic of *Hermetia illucens* larvae that were fed food waste.

The obtained substrates was homogeneous and without pollution. The total solid of the substrate was 30.35%, and organic matter content was 92.31% (t.s.). The larvae were fed only by plant origin food waste.

The experiment was carried out under mesophilic anaerobic digestion conditions - 37°C in the 21-chamber biofermentor set in the Institute of Biosystems Engineering in Poznan University of Life Sciences. In the research on biogas and methane efficiency, *Hermetia illucens* larvae were used. The methane fermentation process in batch reactor ran correctly. Fermentation inhibition was not detected. Biogas efficiency for larvae amounted for 197.87 m³·Mg⁻¹ fresh mass. On the other hand methane efficiency, amounted to 126.12 m³·Mg⁻¹, at methane concentration of 64.27%.

Food waste can be used directly as a fermentation substrate it in the bioconversion process. Using food waste and agri-food by-products from the food processing industry to increase insects growth for energy purposes seems to be a rational solution. This confirms the results obtained as part of the experiment.

Acknowledgements

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BIOWASTE TO BIOENERGY: INNOVATIVE POLISH BIOGAS TECHNOLOGIES

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Keywords: biogas production, biowaste usage, peak installation, hydrogen production

During 2012-16 Poland was a market with very low subsidies for renewable energy sources (RES). The crises has started in spring 2012 while the green certificates value (the main support for RES in Poland) decreased from 290 PLN/MWh to less than 100 PLN in January 2013 and even 35 PLN/MWh in June 2016. This situation has shocked whole RES market and in practice – it had stopped most of investment projects in this sector.

However, part of the biogas sector has passed by deep technical and technological transformation issued by more efficient and cost-effective installations working on an extremally broad spectrum of biowaste-based substrates. In consequence, Poland has one of the most innovative biogas markets in the world. This includes unique real-scale installation for H₂ production (up to 2000 Nm³/day) and the performance of existing biowaste-based plant up to 8500 MWh/MW of installed power, which means 97% of theoretical efficiency. In additions, the most modern Polish biogas plants are built as installations generate stable energy and can work as „peak” installations. The analysis made in the Institute of Biosystems Engineering showed that potential of Polish agricultural biogas sector: 3.5 - 6 GW of electric power – even without maize silage used as substrate.

The most recent trends in Polish biogas technologies are related with the construction of modular installations from steel (unification and repeatability, 1 MWe = 10 containers, montage = 6300 working hours). Those installations are characterized by deep digestion, and in consequences, there is no solid fraction in digestate, which issued as 27% higher CH₄ yield. Additionally, those installations have low energy self-consumption and can use an extremely large spectrum of substrates used (including bio-waste).

By concluding, it has to be underlined that the best practice for biogas sector is to biowaste usage in order to obtain green energy and clean environment. Looking on world-level innovative biowaste-based biohydrogen technology production, it has to be underlined that there is still huge potential for producing bioH_2 from biowaste. Polish biogas sector has so huge potential that it can cover whole natural gas import or (in case of cogeneration production) it can replace 2 (planned) nuclear plants.

INNOVATIVE WASTEWATER TREATMENT TECHNOLOGY FOR RURAL AREAS OF LITHUANIA

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Keywords: wastewater, treatment efficiency, LCA

After wastewater treatment plants (WWTP) have been built or restored in many cities, questions regarding WWTP in rural areas of Lithuania are to be solved. Appropriate technological schemes of wastewater treatment for small Lithuanian settlements were analyzed. Technical, technological and economical data of these schemes as well as their concordance with Lithuanian environmental requirements were assessed. It has been determined that the innovative biological wastewater treatment technology including vertical filtration through an active sludge layer (so called VFL method) is the most appropriate one for the treatment of small amounts of wastewater.

The aim of this work was to compare the treatment efficiency, eutrophication and climate impacts of old and new technologies implemented in Leitgiriai WWTP.

The old wastewater treatment plant of Leitgiriai village (situated in Silute district municipality, 41 households) was being selected because it used a typical for rural areas of Lithuania biological treatment technology (the main treatment facility of which – periodical operation ditch with aeration). Wastewater treatment plant was too large, because the actual discharge of wastewater was less than the projected one. The periodical exceedance of pollutant concentrations in treated wastewater was established, removal of biogenic matters was insufficient (36 % according to total nitrogen (TN) and 38 % according to total phosphorus (TP)). The vertical flow labyrinth technology was implemented for reconstruction of this WWTP. The process stages were as follows: aeration, sedimentation, biological nitrogen and phosphorus removal.

The new Leitgiriai WWTP began operation at the end of 2017. The pollution of untreated and treated wastewater has been assessed by identifying the BOD₇, concentrations of suspended materials, total nitrogen and total phosphorus. The

wastewater cleaning efficiency of Leitgiriai WWTP over all analyzed indicators was calculated before and after its reconstruction.

The eutrophication impact and climate impact were calculated to Leitgiriai WWTP. The LCA calculations were based on old and new technologies.

The results show high efficiency of wastewater treatment after WWTP reconstruction, resulting in 97% according to BDS₇, 81 % according to total nitrogen and 80 % according to total phosphorus.

The eutrophication impact of Leitgiriai pilot is 0,0026 kg PO₄-eq/ functional unit after the change and 0,0074 kg PO₄-eq/ functional unit before the change. The part of nitrogen is 47 % and phosphorus 46 %. The eutrophication impact reduces because of the changes of 64 %.

The climate impact of Leitgiriai pilot was 0,13 kg CO₂-eq/ functional unit after the change, and 0,23 kg CO₂-eq/ functional unit before the change. After the change 74 % comes from N₂O, 4 % from methane, 3 % from construction and 14 % from electricity and before the change 58 % from N₂O, 35 % from methane, 3,0 % from construction and 16 % from electricity. Before the change 23 % comes from N₂O, 14 % from methane, 1 % from construction and 61 % from electricity. The climate impact of new technology was 45 % lower than old technology, because annual electricity consumption reduces 85 %.

After the WWTP reconstruction, the wastewater cleaning efficiency has increased twice on average.

Overall result is that eutrophication and climate impacts can be reduced very much by implementing innovative technology, which is suited for the right circumstances and WWTP of small settlement in Lithuania is a good example for that.

INITIATIVES TO REDUCE WATER CONSUMPTION ON A SCHOOL BUILDING: A CASE STUDY OF SCHOOL OF TECHNOLOGY AND MANAGEMENT - IPBEJA

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Keywords: water consumption; water efficiency; daily consumptions per occupant; environmental education; environmental responsibility

The Eco-schools program and the environmental challenges that Humanity faces represent the opportunity for schools to develop annual activities relating to the environment that lead to Environmental Education for Sustainability, promoting the behaviour changes. Eco-Schools it is the largest global sustainable schools programme that encourages students, teachers and schools officials to engage in their environment by allowing them the opportunity to actively protect the environment. So, the schools have privileged conditions for the development of activities of: observation; questioning; diagnosis for action, as well as constituting spaces for research and development of projects, which contribute to sustainable development.

Eco-Schools it is the largest global sustainable school programme that encourages students, teachers and schools officials to participate and engage actively in order to protect the environment, using strategies of environmental education for sustainability.

Cooperation and partnerships between different local and regional institutions, the commitment and the active participation of the different social actors, enhance the integration and expansion of environmental culture and efficient use of resources. Thus, in a partnership within the framework of the Eco-schools program, among other activities, the pressure reducing valve (PRV) was installed in the water connection pipe to Scholl of Technology and Management/Polytechnic Institute of Beja (IPBeja) for the purpose of reducing water consumption waste.

In water supply systems, actions related to sustainable development are reflected in the attitudes towards controlled water consumption in order to avoid water waste.

The aim of this study is to: (1) evaluate the water consumption in the ESTIG building before and after joining the Eco-schools program (2015/16); (2) evaluate the water consumption after the installation of PRV; (3) estimate the water consumption indicator.

To achieve the aims, awareness-raising campaigns, audit (typology and operation of the equipment in terms of water pressure, tap functioning in all and labs and sanitary facilities), water consumption monitoring were carried out.

The results show that: (1) the installation of the PVR allowed a service pressure reduction of around 38%; (2) a reduction in monthly water consumption (from 5% to 41%), with a greater focus in the months following the installation of PRV; (3) the daily consumptions per occupant is lower when the schools applied a conservation plan of water efficiency and (4) an annual and bi-annual reduction of water costs of 16% and 31% respectively, related to the reference year adopted (2016).

In conclusion this action provides a preventive and effective measure to control water waste, without compromising the normal functioning of school activities. Besides contributing to the efficient use of water and promoting the development of sustainability in the IPBeja campus. Although it is a small step towards water resource protection, the developed work is an incentive for the evaluation of institutional collaborations, an example of good environmental practices and a contribution to the improvement of IPBeja environmental responsibility.

REMOVAL OF SELECTED MICROPOLLUTANTS FROM AQUATIC ENVIRONMENT BY MEANS OF SOLAR LIGHT DRIVEN PROCESSES

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Keywords: anthropogenic micropollutants, solar radiation, photodegradation, titanium dioxide

Introduction: Anthropogenic micropollutants (MPs) are a wide and heterogeneous group of environmental pollutants, which include residues of pharmaceuticals and personal care products, industrial chemicals, pesticides, etc. The above-mentioned substances get into the environment as a result of human activity, e.g. from households, hospitals, industry, service sector or agriculture. A common feature of all MPs is that they occur in the environment at very low concentrations, generally in the range of few ng/dm^3 to several $\mu\text{g/dm}^3$. The biologically treated wastewater is often mentioned to be one of the main routes of MPs into the aquatic environment, because these substances are partially or completely resistant to biological treatment and their transformation products may retain the biological activity of the parent compound. Therefore, in order to completely eliminate MPs from wastewater, new techniques are sought that can be used as a polishing step of the treatment, e.g. solar-light driven processes.

Goal of the research: Two pharmaceuticals (classified as MPs), i.e. sulfamethoxazole (SMX) and diclofenac (DCF), were selected for the study. The compounds are known to be incompletely degraded during wastewater treatment. The aim of the research was to assess the decomposition efficiency of SMX and DCF in the various solar-light-driven processes, i.e. photolysis and TiO_2 -based photocatalysis. The results of the research allowed determining the kinetic parameters of the above-mentioned photochemical reactions.

Methodology and scope of the research: The experiments on photochemical decomposition of SMX and DCF were carried out in a Solarbox system equipped with a xenon lamp that emitted light in the sunlight range. The details on the photoreactor and lamp characteristics can be found in the previous publications [1]. The concentrations of the test substances during the experiment were determined using high-performance liquid chromatography (HPLC). The scope of research included: i) study on SMX and DCF photodegradation at four solar

irradiance ranges (i.e. 250 W/m², 500 W/m², 750 W/m² and 1000 W/m²); ii) study on SMX and DCF photodegradation at various concentrations of TiO₂ (i.e. 100 mg/dm³, 300 mg/dm³ and 500mg/dm³), iii) verification of the photocatalysis efficiency using as a matrix the wastewater after treatment in constructed wetlands (the details on the operational conditions of the system are presented in the previous publication [2]).

Results: The results showed that SMX was partially eliminated in the photolysis driven by the solar radiation. The highest degradation level of this compound, i.e. 62%, was obtained after 120 min of the process performed at irradiance equal to 1000 W/m². In the same conditions, DCF was removed almost completely (i.e. 99%). The addition of TiO₂ increased the efficiency of the decomposition of both substances. In the case of SMX, the reaction rate constant in the TiO₂-based photocatalysis (TiO₂ dose = 500 mg/dm³) increased by two orders of magnitude and in the case of DCF by one order of magnitude (Tab.1). The decay of the investigated substances in the treated wastewater was also successful, however, the effect of the matrix on the reaction rate was observed- for both SMX and DCF, the values of the reaction rate constants were one order of magnitude lower than the corresponding reaction rates constants calculated for the process performed in the distilled water (Tab.1).

Tab.1. The calculated values of pseudo first order kinetic constant (k) of the photodegradation of SMX and DCF in various conditions

Matrix	Irradiance, W/m ²	TiO ₂ dose, mg/dm ³	SMX k, 1/h	DCF k, 1/h
Water	250	0	0.09	0.99
Water	500	0	0.13	1.69
Water	750	0	0.32	2.27
Water	1000	0	0.40	2.95
Water	500	100	1.66	2.63
Water	500	300	15.98	16.32
Water	500	500	36.01	41.30
Treated wastewater	500	500	3.2	5.2

Main conclusions: The results showed that: i) both SMX and DCF are susceptible to degradation in the solar photolysis process, however DCF is more susceptible to such decay; ii) the addition of TiO₂ contributes to the increasing efficiency of the photodegradation process of both substances; iii) the photocatalysis based on TiO₂ enabled the degradation of the tested substances in treated wastewater. It means that the combination of biological treatment with solar-driven

processes can be a very promising technology in the context of removing of MPs from the aquatic environment.

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DEVELOPING WEB BASED 3D HEALTH-AWARE ROUTING FOR PEDESTRIANS AND CYCLISTS

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Keywords: routing, air quality, web-based 3D

As the population of people migrating to cities keeps increasing, concerns have been raised about air quality in cities and how it impacts everyday life. Statistics show polluted air has been responsible for the death of millions of people around the world which made the WHO classify air pollution as the “world’s largest single environmental health risk”.¹

With the help of such governmental enforcement, the portion of nitrogen-oxide in German cities has been kept low compared to other countries. Due to its geographical location and other environmental factors, Stuttgart has been known to have low air quality compared to other cities in Germany. Because of this pedestrians and cyclists are directly exposed to polluted air which is risky to human health on their daily routes. In response to this problem, the idea of creating an application which will help pedestrians and cyclists navigate through a more healthier route was conceived. This application will take air quality into account to calculate healthier pedestrian routes by utilizing open source data to help them make an informed decision.

Since a level of air quality at which no health risk to humans has not yet been reached in German cities, it is important to demonstrate ways of avoiding polluted areas. The approach described here is intended to draw attention to polluted areas and help pedestrians to achieve the lowest possible level of air pollution when planning daily commute routes using a web-based 3D platform. If successfully implemented, the quality-of-life for individuals would increase and the number of air-pollution-related diseases would be reduced. Most importantly, it will help pedestrians with health challenges to make informed decisions as they commute around the city.

¹ <https://www.who.int/mediacentre/news/releases/2014/air-pollution/en/>

To obtain the air quality of a city, we utilize hourly air quality data from The World Air Project², which are obtained from monitoring stations across the world. The data consist of the geolocation of monitoring stations as well as index numbers from 0 (good) to 500 (hazardous) to scale the air quality level in every corresponding monitoring stations. When the air quality index in a specific station is at least between 51 and 100 (moderate), an alternative route for pedestrians or cyclists will be calculated so that they can be informed about the route which takes air pollution into account and allows them to avoid the air polluted area.

Prior to calculating an alternative route, the observed air quality area must be defined so that it will not be included in the calculation when the air quality index is equal or higher than 51. We assume 100 meters around a monitoring station as the observed air quality area since the data does not provide the distance range of monitoring stations. To do the routing calculation, we use routing and navigation service provided by HERE³. To visualize the observed area along with the air quality index and level in the 3D map, a tube is placed in each monitoring station. The height of the tube represents the air quality index, while the color represents the air quality level which also corresponds to a particular health implication.

The implementation is able to visualize air quality level in several areas in 3D map as well as informs health-aware route for pedestrian and cyclist. It automatically adjusts the observed air quality areas based on the availability of monitoring stations. This means there is no further actions must be taken if new monitoring stations are added or existing ones are removed from the data source. Our proposed approach results in a prototype of a health-aware 3D navigation system for pedestrian and cyclist. We believe this system can be further developed along with 3D city models which contain building information that can be used to enhance the air quality data.

² <http://aqicn.org/sources>

THE IMPORTANCE AND CHALLENGES FOR NATURE BASED SOLUTION IN THE CIRCULAR ECONOMY

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Extensive research carried out over the last decades indicates that the freshwater resources on the globe are limited, and human activity contributes to their further degradation and impoverishment. In addition, climate crisis result in unexpected events, such as uneven distribution of rainfall rains and their consequences, i.e. flash floods or long-term periods without precipitation, causing drought. The consequences of these changes are more and more visible and become more noticeable, also in urbanized areas.

Therefore, saving water and purifying various types of wastewater for reuse or retention becomes the basic priority of water and wastewater management. Currently available treatment technologies allow for the removal of all pollutants from sewage of any kind. However, the basic limitation is the necessary energy input and associated cleaning costs. Due to rising energy prices, especially in the last two decades, technologies with low energy requirements are gaining importance. More over in 2015, the European Commission adopted a new, ambitious package concerning the transformation of existing activities into circular economy. The main goal of this concept is to minimize the impact on the environment during creating of products, use and final disposal. It requires the reuse of the components and energy (pollutants) emitted to the environment. One of the main goals pays attention to water and its recovery and reuse as well resource renewal at each level from single building to the whole catchment. It will reward technology solutions such as the nature based solution (NBS) used in water protection and re-use. The advantage of green infrastructures apart from low energy consumption, is their low emissivity. A characteristic feature is the lack of secondary sludge formation during wastewater treatment, and it is possible to design "0-off" systems or even additional production, eg biomass (for energy purposes). It should be noted here that the nature based technology also perfectly fulfils the four functions of ecosystems service: supply (clean water and biomass), support (biodiversity, habitat creation, water and matter support etc.), regulatory (regulation of flooding, temperature, water production) and cultural (recreation, education, aesthetics). Thus, it is not only an alternative to conventional solutions such as e.g. the activated sludge method, but

a solution that provides undeniable benefits. Until now, the basic argument against the widespread use of the green infrastructure was its high surface requirement compared to conventional purification systems. In many cases, however, this is not an actual restriction, especially since different combinations of nature based systems can be used, which are characterized by lower surface requirements. At the same time, the surface of such an object can be treated as a kind of compensation for a degraded environment providing a supporting or cultural function.

CONSTRUCTED WETLANDS: A STATE OF THE ART TECHNOLOGY FOR WASTEWATER TREATMENT

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Keywords: wastewater, constructed wetlands, ecological engineering, innovation

This paper presents the historical development of subsurface flow constructed wetlands (CW) for wastewater through significant research achievements and their practical applications. Nowadays CW technology is a very consolidated one, and applied for a variety of wastewaters and wastes of different origin. However, to attain this level of development, it has been necessary to conduct intensive research programs and findings. In this paper these research achievements are presented and reviewed chronologically.

The initial conventional set up for field scale CW included a pretreatment, a primary treatment and horizontal subsurface CW. This type of system had good capacity for TSS and BOD (>90%) removal, but nitrification was very low, and therefore ammonia removal not significant. Low oxygen concentration in the bulk was the main responsible for low nitrification. In horizontal subsurface flow CW experimental evidence and mathematical models showed the predominance of anoxic and anaerobic biological pathways for the removal and transformation of pollutants. Development of vertical subsurface flow CW was the logical development and continuation of the horizontal flow type. In vertical flow, the wetlands were fed intermittently and therefore saturated and unsaturated periods were alternated. During unsaturated periods air flows into the gravel bed and nitrification is not limited by lack of oxygen. Vertical systems can remove TSS, BOD, as well as ammonia (>80-90%). Field scale experience indicated that vertical flow systems were very prone to clog, causing hydraulic malfunction and low performance. Clogging problems were already observed in horizontal flow systems, but they had a lower impact in comparison to vertical systems. Horizontal systems were able to operate well even showing symptoms of clogging. That capacity of the systems of performing good even having clogging is explained by the "cartridge theory", which says that the wetlands behave as a cartridge, and unless the cartridge is not completely exhausted, the system still can treat wastewater correctly.

Solving the problem of clogging and at the same time maintaining nitrification capacity in vertical systems led to the development of the French vertical systems. In these systems different alternate parallel beds allow feeding and resting periods to be applied. In vertical French systems a layer of sludge is created onto the top of the beds, but during resting times this layer is naturally dried and the wetland recovers the capacity for infiltration.

Latest developments in the field of constructed wetlands include hybrid systems and intensifications to reduce footprint. Hybrid systems combine different types of wetlands such as vertical, horizontal and surface flow, giving place to multiple contaminant removal reactions and therefore effluents of very good quality that can be easily reused. Experience in field scale applications demonstrate high removal rates for these systems including TSS, BOD, ammonia, TN and TP.

HIGH-RESOLUTION URBAN AEROSOL MONITORING USING SENTINEL -2 SATELLITE IMAGES

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Keywords: Aerosol Optical Depth, Sentinel -2, Sentinel -3

Introduction

The study of aerosol concentrations in the atmosphere is essential due to the role they play in Earth's climate. Aerosols absorb or scatter sunlight with an impact on the Earth's energy budget. Subtypes of atmospheric particles, the particulate matter (PM), are under criticism for their adverse effects on human health. The primary goal of our ongoing study is to assess the suitability of Sentinel-2 images to retrieve Aerosol Optical Depth (AOD) at a higher spatial resolution capable of mapping air quality at city-levels. The study area is the Munich city region which has mixed urban and vegetated surfaces and two operational AERONET (AErosol RObotic NETwork) stations.

Methodology

Satellite remote sensing is used to determine the aerosol concentration in the atmosphere based on radiative transfer and atmospheric models. This is based on the scattering and absorption of solar radiation by the aerosols. By using the top of the atmosphere (TOA) radiance received by the satellite sensors and known surface reflectance values, the AOD can be determined as a measure of light extinction due to the presence of aerosols. Readily available satellite AOD products like the Moderate Resolution Imaging Spectroradiometer (MODIS) product MOD04 provide a high temporal resolution for daily based monitoring but at low spatial resolutions (3km and 10km) incapable of detailed urban air quality monitoring. ESA's Copernicus programme also provides aerosol products from their Sentinel-3 and Sentinel-5P satellite missions. The Sentinel-3 AOD product, available since October 2018, has a 300 m spatial resolution, the Aerosol Index (AI) from Sentinel-5P a spatial resolution of 7 km x 3.5 km. The Sentinel-3 SYN AOD is one of the synergy products derived from the Ocean and Land Color Instrument (OLCI) and Sea and the Land Surface Temperature Radiometer (SLSTR) sensors.

The Simplified high-resolution MODIS Aerosol Retrieval Algorithm (SARA) (Bilal et al., 2013) has been used to retrieve AOD from MODIS images at 500m spatial resolution. The inputs of the algorithm are the top and bottom of the

atmosphere reflectances, sun and view angles, and aerosol properties measured by AERONET ground stations. In addition, the stations provide ground-based AOD observations. In this study, SARA is used to retrieve AOD at 550nm from Sentinel-2 images at a spatial resolution of 20m. The aerosol properties, single scattering albedo and asymmetric factor, are obtained from the AERONET stations Munich University and HohenpeissenbergDWD.

Results Analysis

A comparison of the retrieved AOD shows better consistency with AERONET AOD measurements ($R^2 = 0.50$) than MODIS MOD04 AOD ($R^2 = 0.28$). However, Sentinel-3 SYN AOD product has a better agreement with AERONET measurements ($R^2 = 0.60$). Further comparison is carried out to assess the performance over bright urban surfaces and dark surfaces comprising mainly of vegetation with ground measurements obtained from Munich University and HohenpeissenbergDWD stations respectively. The retrieved AOD performs poorly over the bright urban surfaces ($R^2 = 0.37$) while Sentinel-3 SYN AOD has the best consistency ($R^2 = 0.53$). However, in vegetated surfaces, the retrieved AOD ($R^2 = 0.61$) outperforms Sentinel -3 SYN AOD ($R^2 = 0.54$).

Conclusion

From the preliminary results obtained above, Sentinel -2 images exhibit potential in mapping atmospheric aerosols at a higher resolution than existing AOD products. However, the algorithm parameters need further optimization for more reliable results. The next steps in this study are to gain a better understanding of the aerosol properties and improve the Land Surface Reflectance (LSR) retrieval. The influence of LSR is especially pronounced in bright urban surfaces where it results in higher AOD values.

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CHANGES IN INTEGRATION OF HYDROGRAPHIC NETWORK IN THE MIDDLE BIEBRZA FLOODPLAIN BASED ON JOINT HYDROLOGICAL AND REMOTE SENSING OBSERVATIONS

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Keywords: ecohydrology, hydrological connectivity, river, floodplain lake, remote sensing

The hydrological regime is the main force driving processes in river-floodplain systems. This regime is maintained mainly by the “flood pulse” defined by Junk *et al.* in 1989. The flood pulse theory relates to the connections and exchange of water among floodplain water bodies and rivers (herein named connectivity, with an emphasis on surface linkage between water bodies in a floodplain. Connectivity in alluvial rivers is, however, a more complex phenomenon than implied by simple gradients. Hydrological connectivity of abandoned braids may be reduced by vegetation growing on alluvial plugs or increased by upwelling of nutrient-poor ground waters. In the natural state, riverine landscapes, as in the Middle Biebrza River floodplain (NE Poland) exemplify ecological system widely recognized as highly dynamic nature, providing semi-natural ecological conditions. From hydrological point of view their connectivity with the river channel is related to two distinct phases (hydrophases) of hydrological regime: (a) limnophase (LF), when the floodplain lake is isolated from the river flow, and (b) potamophase (PF), when surface connectivity between lake and the parent river occurs.

The aim of the study was to identify riverine landscape dynamics within the middle section of the Biebrza River floodplain examined in the context of landscape evolution, and ecological succession. This is followed by analyses of connectivity between riverine landscape elements based on hydrological determinants of the riverine system as well as remote sensing techniques. During the period of 26th November 2014 till 11th July 2018, the hydrological observations (water level change) was obtained from 4 dataloggers' readouts (Mini-diver© by Van Essen

Instrument, the Netherlands). The duration of PF and LF were extremely important for all floodplain water bodies and expressed in as the Fluvial Connectivity Quotient.

Water extent during potamophases was observed by remote sensing means i.e. Sentinel-1A/B radar images. Totally flooded areas can be identified easily on radar images due to strong specular reflection of microwaves from smooth water surface, so characterized by very weak backscattered signal. The extent of open water extracted from SAR images can be compiled with the limits of isolated oxbows extracted from GIS database showing spatio-temporal pattern of their mutual connectivity. The results of that compilation are not always precise because the hydrological connectivity between very local small recipients can be hidden by vegetation cover. This can be avoided by using complex SAR images permitting to identify partially flooded vegetation (partially submerged) based on backscattered wave phase stability. It is extremely useful in herbaceous wetlands where narrow local streams can be completely invisible beneath long grass. Results showed that floodplain topography is a key factor in the duration of potamophases. We realized that imprecise 3D surface models can be locally corrected by water extent estimations derived from Sentinel-1 images.

Floodplain lake basins characterized by high retention capacity showed a relatively small variation of limnophases, and those with low retention capacity are characterized by a high variability of limnophase periods. The functional periods tend to show a cyclical nature of occurrence. This recurrence is related to the nature and intensity of atmospheric supply of the inundated area.

We observed, that in periods of very high water stages, even small precipitation impulse usually initiates fluvial supply into floodplain lakes. Such a pattern occurred seasonally, after a period of high discharge due to spring snowmelt, or during the wet summer months. After the parent river stages had dropped into the middle range, limnophases were durable, even in the presence of an intense local precipitation.

The most laterally located floodplain lakes do not rely on the riverine supply only. Some of them retain water for longer periods comparing to floodplain lakes located closer to the river due to groundwater supply. Their outstanding feature is the highest habitat heterogeneity resulted from internal factors (including autochthonic matter supply) dominating during limnophase.

ASSESSMENT OF ENVIRONMENTAL CONDITIONS WITHIN THE LIMIT OF THE RIPARIAN WATER PROTECTION STRIPS USING THE WEBGIS TECHNOLOGY

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Keywords: Assessment of environmental conditions, strips and water protection areas, WebGIS technology, blogspot platform.

The goal of this research is the assessing of the current conditions of water protection strips in their role as an effective buffer that prevents water bodies from deteriorating due to soil erosion and pollution. In base of this study the action plan is developing to improve the conditions of the water protection strips for the lakes. The approach focused on the idea of an empirical study (based on observations and field measurements) on the environmental quality. Is proposed an integral analysis of the territory of the protection strips, the processes and phenomena taking place within them, in order to obtain a clear picture of the state of the environment.

The following steps were taken in the study: 1) study of cartographic and bibliographic materials; 2) data collection in field conditions; 3) processing and interpretation of collected data; 4) developing proposals and finding solutions; 5) preparation of reports.

In the scope to administrate, and to assure the visualization and transparency of this study the project blog on the "blogspot.com" platform was created with properly configured geographic interest patterns. Cartographic data were published on Google Maps and integrated in blog. Thus, by accessing the blog, the views of the lake, the points of interest, with the necessary attributes is accessing with the possibility for the spatial analyses.

Action plans to improve the conditions of water protection strips, being developed in consultation with stakeholders and the project blog is used for the monitoring the activities.

The preliminary results show the positive effects and high interest of the stakeholders concerning of WebGIS technology for the assessment of environmental conditions of water protection strips along the Ghidighici and Costesti- Stinca reservoirs.

APPLICATION OF GIS METHODS TO AQUATIC WARBLER *ACROCEPHALUS PALUDICOLA* CONSERVATION

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Keywords: Aquatic Warbler, *Acrocephalus paludicola*, Polesie National Park, GPS, QGIS

In the 20th century the size of the global population of the Aquatic Warbler *Acrocephalus paludicola* decreased by over 90%. As a result this bird has become not only the rarest migratory bird in Europe, but also a globally endangered species with a relatively high risk of extinction. In the 1990's the size of the global population was estimated at 13.5 -21.0 thousands singing males. By the year 2008, the number had decreased to the level of 12.6 -17.0 thousands singing males and the level of 10.5 -14.2 thousands singing males. The present state of the global population reveals a further decrease to approximately 11.0 thousands singing males. Over 90% of the existing global population inhabits only 3 countries: Belarus, Ukraine and Poland. That is why the counting of singing males is an appropriate index and a simple tool in monitoring the population, including the effectiveness of efforts connected with active protection of the Aquatic Warbler's habitats. Field inspections were made between 20th May and 10th June, during the first hatching of the Aquatic Warbler. They could exceptionally be complemented by additional inspections made until the turn of June and July. The counting was carried out between 7.30 and 9.30 p.m., i.e. about an hour or an hour and a half before, and half an hour after sunset, when the singing activity of males is the highest. A group of 5-7 people moved within a distance of 50-70 metres on mapped out routes and counted the singing Aquatic Warbler males. Each observer was equipped with a GPS receiver which served to determine the geographic coordinates of particular singing males. Then, the distribution of males was analyzed in the QGIS program. Based on the analysis, the map of distribution and territory size of males was made. GIS techniques were the most important tool in data processing used for conservation of this smallest migratory bird of Europe.

STUDY OF THE METHOD FOR DETERMINATION OF DIGITAL CAMERA FOCAL LENGTH

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Keywords: calibration, digital non-metric camera, focal length.

Today, using of the non-metric digital cameras (DC) is still relevant and continues to be explored, which, in contradistinction to the expensive metric ones, needs to be calibrated. Calibration of the DC is implemented with the aim of using it as a measuring instrument for aerial survey from an unmanned aerial vehicle (UAV) and for further metric processing of images taken by this camera.

Aim. The main objective is to develop and to investigate the method for determining the digital camera focal length.

Methodology. In the method of determining the focal length as a subject of surveying, a triangular prism is used. This provides an opportunity to improve the processability of the method and, most importantly, to improve the accuracy of the measurements, because the measurements are carried out stereoscopically, what allows to increase the accuracy in compare with monocular measurements in 1.4 times, and thus increase the accuracy of determining the focal length of the DC.

The proposed method for determining the focal length is as follows. The stands of two tripods are dragged to the horizontal position using the overhead level. At first tripod stand, triangular prism is placed such that one of the peaks is directed to the optical axis of the DC, and the base is parallel to base of surveying. At second tripod stand, the carriage is fixed, on which the DC is placed at some distance from the previous tripod. The main optical axis must coincide closely with the central part of the edge of the prism. Surveying is performing from the left point of the basis. After that, the DC is moving by using a micrometer on the size of the basis of the surveying, surveying is performing from the right point of the basis. Next, on the stereopair of digital images obtained as a result of surveying, measure the corresponding coordinates of points on the near and far edges of the prism and determine the digital camera focal length.

Results. The authors analyzed the method for determining the focal length of DC. The apriori estimation of accuracy of determining the digital camera focal length by the proposed method is calculated. For approbation of the method, the focal length of following cameras was determined: Sony ILCE-7R ($f=25$ mm τ_a

$f=35$ mm) and Canon EOS 450D ($f=55$ mm). The focal lengths for the Sony ILCE-7R (27.2 mm and 43.8 mm respectively) and for the Canon EOS 450D (54.96mm).

The difference of the focal length is explained by the movement of the telescope lens in relation to focus on the subject. Regarding the accuracy of the proposed method for determining the digital camera focal length, the study was conducted taking into account all devices and parts which form the measuring complex. As a result, the following parameters were identified: the accuracy of measuring the basis of surveying; accuracy of measuring of heights; accuracy of the measuring of longitudinal parallax; accuracy of the measuring of the difference in parallax. Ignoring of these parameters leads to a significant reduction in accuracy. The precision of the determination of the digital camera focal length was 0,007 mm.

Conclusions. The method proposed by the authors can be implemented for determining the focal length of non-metric digital imaging systems. Later it can be used in various fields of science and technology, for example, to calibrate the DCs used for topographical aerial surveying with UAVs, which will enable to improve the accuracy of coordinates determination of the object on the territory.

ACCURACY INVESTIGATION OF CREATE POINTS CLOUD WITH FARO FOCUS 3D S120 TERRESTRIAL LASER SCANNER

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Keywords: terrestrial laser scanner, points cloud, reflection, intensity.

Goal of a research. Terrestrial laser scanning (TLS) is a powerful method for collecting spatial data. These data can be used in an extensive range of object-based applications. This method of remote sensing allows fast, non-contact and accurate measurement of objects. uncompromising and precise measurement of objects. Terrestrial laser scanning systems deliver 3D coordinates and power of the backscattered laser scan signal of each point which registered it as an intensity value. The values of intensity, which are registered by a TLS for each point of a 3D points cloud, are affected by the characteristic of the measured object and the environment parameters. The backscattered electromagnetic signal is influenced by the power of reflectivity of the scanned object surface, the incidence angle, the distance between laser scanner and object and the atmospheric respectively system specific setting of the TLS-measurement. Therefore, the direct use of these original intensity data is not recommended because they are influenced by multiple variables. Since details about TLS system internal alteration of the signal are often unknown to the user, model driven approaches are impractical. On the other hand, existing data driven calibration procedures require laborious acquisition of separate reference datasets or areas of homogenous reflection characteristics from the field data. This work is to detect changes in intensity directly from the points cloud. The main attention is given to the study of the accuracy of points cloud by changing the distance.

Methodology. Five sets of experiments were conducted with testing target to estimate the accuracy of points cloud. As a test target, white on one side and black on the other, matte mirror surface with a size of 30 cm × 30 cm was mounted on a tripod. The testing target was installed on a tripod through a metal stent that enables the target to rotate was placed. The scanner used was Faro Focus 3D S120, which is a continuous-wave 905 nm terrestrial laser scanner that delivers geometrical information and returning intensities recorded in 11 bits [0 2048]. In the first set of experiments, the target was placed of white side at a distance of 0.65

m from the scanner and then target was rotated on black side. Scanning was performed with horizontal and vertical step $0,009^\circ$. For the rest of the sets, the experiment was repeated similarly at distances of 1.65 m, 3.5 m, 5 m, 9.7 m. A total of 10 scans for all of the sets were obtained. The original recorded intensity values were extracted in a point cloud image created by the standard software Faro SCENE. For each side of target in this study, the average intensity value was used for the analysis. The surface data of the target were manually sampled as largely as possible.

Results. Theoretically, surfaces with high reflectance reflect a large portion of the incident laser radiation, thereby increasing the received signal power and the intensity value.

The distance effect significantly deviates from the radar range equation. Specifically, the original intensity decreases for short distances below 3.5 m. Thereafter, the intensity increases considerably from 5 m to 9.7 m.

Conclusions. The presented investigations show, how the distance dependency of signal intensities vary between distances and color of surface materials. In the future, it is planned to research the larger distances. Eventually, under the assumption that the “increasing intensity with range” behavior originates in the changing overlap of emitter and receiver field of view, also the energy distribution within each footprint becomes important and should be investigated. The final aim is, of course, verifying the findings over natural surfaces.

NEW APPROACH TO ASSESSING LAND FRAGMENTATION USING GIS TOOLS

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Keywords: consolidation works, arable land, parcels

Spatial structure of arable land has a considerable impact on agricultural production space. Land fragmentation parameters allow for the assessment of agricultural activity conditions, what may lead to their improvement. Arable land located in Małopolska Voivodeship is characterized by extensive fragmentation, small surface area, and irregular shape. Low farm income is related to high production costs, which are also caused by unfavorable spatial structure. One of the ways to improve spatial conditions is to implement consolidation works. This allows to organize spatial structure and increase the area of parcels used for agricultural purposes while reducing their number. There are numerous methods to assess the spatial structure of arable land. They make it possible to determine the areas in which repair works, including consolidation works, should be executed. The article proposes a new approach which allows to assess arable land fragmentation. For this purpose, GIS tools were used to implement the developed methodology, analyze the obtained results, and provide their graphical representation. The study area included arable land located in Małopolska.

ASSESSING THE POTENTIAL USE OF FLY ASH FROM BIOMASS COMBUSTION IN FLUIDIZED BED BOILERS FOR AGRICULTURAL AND RECLAMATION PURPOSES

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Keywords: fly ash, biomass, fluidized bed boilers, reclamation

Despite the fact that in Poland almost 90% of electricity is generated from coal, renewable sources of energy are slowly taking a foothold and therefore cannot be ignored by industries which use conventional fossil fuels. In 2005, the share of electricity generated in this way amounted to as much as 96%, while in 2010 this share decreased to 89%, which indicates a rapid development of technologies for obtaining energy from renewable energy sources. Energy from RES in Poland comes mainly from solar radiation, water, wind, geothermal energy, energy generated from solid biofuels, biogas and liquid biofuels, as well as ambient energy obtained by heat pumps. The share of energy from renewable sources in the total energy production increased in recent years, from 2017 to 11.9% to 14.1%. Poland is obligated, by international agreements, to increase its share of renewable energy in its national energy balance up to 15% by the year 2020.

Almost half of the electricity from renewable sources in Poland is derived from biomass. Furthermore, the development of biomass production and combustion sector is one of the elements of "Polish Energy Policy until 2030". Investments in energy generation from biomass are either in the planning stage or have already been implemented in many heat and electric power plants in Poland. Furthermore in Poland co-firing of biomass with coal is performed in almost every heat and electric power plants. However new legislation regarding renewable energies will reward pure biomass power plants with CHP. Sector of biomass has great potential of 684.6 PJ per year. The investment "boom" in the energy sector will result in the generation of an entirely new type of waste. The amount of ashes from combustion of biomass will increase yearly and therefore it will pose a significant problem, which will need to be resolved. Having their own unique characteristics biomass ashes also have differing composition and properties than conventional fly ash from coal combustion. Searching for alternative utilization options is the most desired

approach because in the waste management hierarchy landfill of waste is the final solution. Furthermore, the utilization of ashes from biomass combustion reduces the amount of waste produced and minimizes its ecological impact.

Ashes from biomass combustion are legally considered waste but in reality they may become a useful multi-purpose material. Utilization of ashes from biomass combustion is relatively young, leaving much room for improvement and development. Around the world there are ongoing studies involving the utilization of ashes from biomass combustion; however, in Poland there is only preliminary research being done. Since there will be significant amounts, of these particular wastes, generated in Poland there is a substantial need for a more detail study addressing this issue.

Until now conventional fly ash, derived from in power plants fired with coal fuel, were commonly used for the production of building materials, general-purpose cements, building ceramics, hydraulic binders, binding materials and in road construction (road foundations). The new generation fly ash from biomass combustion produced due to its unfavorable composition are not suitable for traditional management methods. The research involved physico-chemical evaluation of fly ash derived from the biggest in Poland and consequently the world's third biggest biomass power plant in Polaniec. This installation with capacity of 205 MW has the world's biggest and the most advanced biomass circulating fluidized bed boiler. Chemical composition of the examined fly ash determined via XRF method revealed that ash is predominantly composed of SiO_2 (50%) and CaO (18%), however significant amount of K_2O (5%), MgO (4%) as well as P_2O_5 are also present (3%). Composition of fly ash can be compared to the composition of mineral fertilizers. The high content of alkali can cause that the high pH of ash may actually contribute to the improvement of soil quality and fertility as well as the bioavailability of mineral substances for plants. Moreover, acute phytotoxicity tests revealed that there is no clear inhibition of germination and seed growth in most samples. Obtained results allow to draw preliminary conclusions that the tested biomass ash have no toxic properties and can be used in the process of reclamation of degraded land or landfills.

POLLUTANTS LEACHING FROM AGGREGATES COMMONLY USED IN GREEN ROOFS SUBSTRATES

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Keywords: green roofs, phosphate, heavy metals, rainwater runoff

Green roofs are popular measure of rainwater management in cities. They are constructions made of different layers, each serving the dedicated function. Substrates and materials used in their composition are very important from the point of view of rainwater retention and plant development, but they may have an adverse effect on runoff quality. Literature studies show, that phosphorus and heavy metals are of the main importance. The total roof area covered with green increased in the last years in cities as they are efficient in retention of rainwater and delaying of the runoff, so protecting the cities against floods. As green roofs filtrate significant amount of the rainwater, materials used in substrates composition should be carefully selected to protect urban receivers against pollution. The aim of this study was to assess phosphate and heavy metals leaching from different green roof substrates and its components and to create the list of common materials used in substrates composition with their pros and cons.

Both, commercially made green roof substrates and often used compounds (construction aggregates) were tested in laboratory batch tests for $\text{PO}_4\text{-P}$, Cu, Ni, Cd, Pb and Zn content in water extracts. For the assessment of potential phosphate leaching materials were also extracted in chloric acid. Concentration of $\text{PO}_4\text{-P}$ was analysed on FiaStar analyzer by ammonium molybdate method in the range of 0.005-1 mg/L. Heavy metals concentration in the eluates was analysed using atomic absorption spectrometry. Physical parameters influencing rainwater retention and building construction of all materials were also analysed.

Extracts from most substrates tested in this study were polluted with $\text{PO}_4\text{-P}$, Cu and Zn, while Ni, Cd and Pb were not found in the extracts. From tested construction aggregates, which are a common green roof substrates compounds, Cu and Zn were found in some extracts, some of them also released phosphates. Base of the results of this study, it could be emphasized that a large part of commonly used construction aggregates can be a source of pollution of rainwater

receivers. Therefore, the materials should be carefully tested before using in the green roof substrate composition not only for their physical properties but also for chemical contamination. Some of materials tested in this study are common and so, often used in other applications, mostly as filtration materials in eg. on-site wastewater treatment, regeneration zone of natural swimming pools, backyard pond filters, constructed wetlands or permeable reactive barriers. The list of risky materials developed in this study may indicate which group of materials should be carefully tested before application to avoid pollutants leaching to environment.

TOPOGRAPHIC MAPPING IN THE NATIONAL SPATIAL DATA INFRASTRUCTURE IN UKRAINE

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Keywords: National Spatial Data Infrastructure (NSDI), topographic mapping, Core Reference Dataset (CRD), geoinformation system, topographical data base (TDB).

Goal of a research. The current condition of making managerial decisions on the development of territories and spatial planning is characterized by the GIS widespread use based on cross-sectoral integration of geospatial data. The Core Reference Dataset are particularly important, which is the only topographic basis for the integration of all profile data sets. Such an increase in the significance of the topographic basis, in addition to traditional requirements such as relevance, reliability, accuracy, detail, informality, visibility, requires additional requirements for raising the intellectual level of the basic set that would correspond to the current level of development of GIS and fully provide geospatial analysis and modeling, interoperability of data and the ability to integrate data from different sources. In addition, modern requirements for a basic set of geospatial data require the development of a permanent monitoring and updating system. The purpose of the article is to study the main principles of topographic mapping reforming in the context of the NSDI development in Ukraine.

Methodology and scope of a research. The basis of the research is the analysis of the possibilities of applying the theory of databases and knowledge bases which should be created on the basis of the use of the series of international standards ISO 19100 "Geographic Information / Geomatics", OGC and INSPIRE for solving problems of raising the CRD intellectual level of geospatial data.

Highlight of results. The cartographic approach to the production of digital topographic maps and plans can be described as a system model as the interaction of three systems: a terrain containing a plurality of mapped features; a set of topographical information obtained as a result of topographical surveying and a digital map formed as a result of the processing of topographic information in the GIS environment. With this approach, the digital map is a "cut-off" for a certain time and does not take into account changes in the terrain. In addition, during topographical surveying, as a rule, only topographic characteristics of geospatial features are collected and data from different sources are not integrated. The

production of a digital map occurs in the environment of a specific GIS that does not provide the interoperability of geospatial data collected in other GIS, causes problems in the creation, renewal, exchange and distribution of such data between different manufacturers and users. Therefore, a new system model is proposed that describes the geoinformation approach to topographic mapping in the NSDI. To the traditional components of the topographic mapping system, a topographic data base (TDB) is added, which becomes the core of topographic mapping. Such a database allows to create a set of topographic maps that are formed during the execution of requests to the TDB. At the same time, the model takes into account changes in the terrain, these changes in the area are introduced during the updating of the plurality of topographical information; further there is a process of updating the bank of topographic data and, accordingly, there is the possibility of updating the set of digital maps. The geoinformation approach to topographic mapping in the national geospatial data infrastructure is based on the following principles. The topographical data base is the core of topographical mapping. The TDB should not depend on the software of the instrumental GIS. All digital maps are compiled as a result of the query to the TDB. Improvement of the intellectual level of geospatial data and integration of topographic and profile data in accordance with the standards and specifications. Transition from mapping operations to analytical operations of geoinformation modeling. All topographical data is updated in the TDB as a result of topographical monitoring according to the rules: any artifact object can be put into operation only after the executive topographic surveying with placing into the database of topographical data, and data on natural topographical objects are updated at least once every 3-5 years. It is obvious that the organization of such a system of topographic monitoring is possible only in the NSDI conditions, which requires effective interaction between its participants.

Main conclusions. The proposed new system model that corresponds to the geoinformation approach to topographic mapping in the conditions of the NSDI development involves the formation geospatial data sets in the form of databases and knowledge bases. Organization of such databases in accordance with the series of international standards ISO 19100 "Geographic Information / Geomatics", OGC and INSPIRE provides their high intellectual level, capable of providing geoinformation analysis and simulation of modern GIS. These databases can provide integration of data based on the connection of heterogeneous relational models. Implementation of the infrastructure approach in topographical production and the creation and development of a permanent system of topographical monitoring will ensure the publication of geospatial data in real time practically simultaneously with changes in the terrain, which guarantees the maintenance in the current state of a single topographic basis and, accordingly, Core Reference Dataset for NSDI.

APPLICATION OF GIS METHODS TO BIRD STRIKE MANAGEMENT AT THE MILITARY AIRFIELD

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Keywords: bird strike, airfields, military, GPS

Interactions between military aviation and birds are very complex. That includes impact on avifauna as well as much more important issue the bird strike to military jets. Unfortunately some birdstrikes have catastrophic consequences including loss of pilot lives. That is why the birdstrike risk assessment is so important for air traffic safety. The majority of the birdstrikes occur up to 300 m above the ground, in the vicinity and on the military airfields. Most of the birdstrikes include common and abundant species. In Polish condition for example such as; black headed gulls *Chroicocephalus ridibundus*, white storks *Ciconia ciconia*, rooks *Corvus frugilegus*, and domestic pigeon *Columba livia* var. *domestica*. The presented data shows the application of GIS methods to bird strike management at the Dęblin Military Airfield (DMA) (east Poland). The use of GIS methods has allowed to create hot spots maps of birdstrikes at DMA. GIS techniques have also illustrated spatio-temporal changes in such threats. The efficiency of particular methods of bird management was also tested with GIS assistance.

USING VEGETATIVE INDICES TO QUANTIFY AGRICULTURAL CROP CHARACTERISTICS

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Keywords: vegetation indices, crop status, biomass

Farming is one of the most important branches of Ukraine's economy. In addition, over 30 per cent of country's exports belong to agricultural sector. Most Ukrainian soils are suitable for growing winter cereals. Winter wheat is one of the key crop that is grown throughout the country.

Application of remote sensing data provides monitoring of various canopy characteristics. A challenge is to use vegetation indices (VI), derived from high resolution imagery, to quantify crop status in order to manage high yield production.

Goal of a research

The goal of a research is to monitor of the winter wheat leaf nitrogen concentration (LNC), the above ground biomass (AGB) and leaf area index (LAI) based on remote sensing data for quantifying winter wheat canopy characteristics. There were the following tasks to be resolved in the research: pre-processing of time series remote sensing data; monitoring of winter wheat status through the period of stem elongation to flowering based on VI and crop productivity indicators; evaluation of various vegetation indices for quantifying winter wheat productivity indicators.

Methodology and scope of a research

Crop growth and development can be monitored with remote sensing data of various spatial, temporal and spectral resolutions, acquired at different platforms. A large number of studies are devoted to crop growth indicators, such as leaf area index, leaf nitrogen concentration and their relationship with the crop spectral properties. Various approaches and techniques for providing an efficient crop monitoring are presented in papers. The availability of free remote sensing data as well as commercial satellite data acquisition, and the use of ground-based sensors provides receiving a time series data to monitor crop growth.

The main objectives of this study were to evaluate the ability of linear and nonlinear regression methods based on application of two groups of VI (perpendicular and slope-based) for LNC, AGB and LAI determination, and to estimate the most efficient model.

Per-field measurements were conducted in two locations over three growing seasons both in western part of Forest-Steppe on chernozem soils in production conditions and in northern Forest-Steppe on meadow chernozem soil at the experimental station of NULES of Ukraine. The experimental variables included high agricultural fertilizer background and different varieties of winter wheat. Wheat plants from two 1.13 m rows were collected from each plot to determine their LNC values, AGB and LAI. Pleiades 1A/1B multispectral data were acquired at stem elongation of winter wheat and at earing phase. Images were atmospherically corrected.

Highlight of results

The following VI were used in the study: NDVI, GRVI, EVI, RVI and MSAVI2. To assess the performance of the linear and nonlinear regression models obtained with the use of various VI, the coefficients of determination for both the calibration and validation datasets as well as the root mean square errors were estimated. The highest coefficients of determination (R^2) of the linear regressions between the LNC were obtained both for the NDVI and EVI calculated from the original satellite image spectra (0,943 and 0,951 respectively). The more accurate estimation of the AGB with the nonlinear power model was obtained for EVI vegetation index ($R^2 = 0,927$) at stem elongation stage. Hence to monitor of the plant LAI the exponential model based on EVI provided the higher accuracy compared to the other VI ($R^2 = 0,873$). According to evaluation of the calibration and validation performance, the EVI provided best results to quantify winter wheat vegetation characteristics at stem elongation phase.

Main conclusions

Research demonstrated the strong role of remote sensing data for crop production monitoring. The results of this study showed that application of VI based on spectral channels of Pleiades 1A/1B is one of the effective means for evaluation of leaf nitrogen concentration, above ground biomass and biophysical parameter LAI that are important indicators of crop productivity.

CAUSES OF CHANGES IN THE TERRESTRIAL CLIMATE

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Keywords: global warming, solar cycle, carbon dioxide, total solar irradiance, galactic cosmic rays

The global temperature rise observed for over a hundred years causes a reduction in the thickness of ice covers monitored by satellite altimetry and gravimetry missions, as well as a global increase in the sea level monitored by means of mareographic measurements and satellite altimetry. In order to predict climate change and weather, one should first of all explore the ocean, whose area covers over 70% of the Earth's surface because increase of sea surface temperature with a thickness of 5 m by 1°C heats the entire atmosphere by 1°C. One of the reasons for the increase in this temperature is human activity, which is associated with the production of greenhouse gases, in particular carbon dioxide. The current content of carbon dioxide in the atmosphere is record-breaking and the highest in 800,000 years. Another reason for the increase of this temperature is the energy flowing from the Earth's interior associated with the geothermal heat flow due to the decay of radioactive isotopes of uranium, thorium and potassium. The latest research of the present century indicates that the cause of the global warming may be the variable activity of the solar cycle, which affects the intensity of galactic cosmic rays reaching the Earth's atmosphere responsible for the clouds formation at low altitudes. The presence of these clouds affects the albedo changes that regulate the amount of total solar energy heating the troposphere and sea surface temperature.

COMPARISON OF AMPLITUDE VARIATIONS IN LENGTH OF DAY AND OTHER GEOPHYSICAL TIME SERIES

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Keywords: length of day, El Nino, solar irradiance, Fourier transform, Hilbert transform

A combination of the Fourier transform band pass filter and Hilbert transform was applied to detect amplitude variations as a function of oscillation period in non-tidal length of day (LODR) time series and some chosen geophysical time series driven by climate variability such as e.g. Nino Indices (Nino 1.2., Nino 3, Nino 3.4, Nino 4) available from 01.09.1981 – to now, Southern Oscillation Index (SOI) available from 06.06.1991 to now and total solar irradiance (TSI) data available from 26.02.2003 to now.

The complex-valued oscillation with central frequency ω computed by combination of the Fourier transform band pass filter and Hilbert transform is given by the following equation:

where:

$$z_t(\omega) = FFT^{-1} \{ FFT[x_t] P(\omega, \mu) [1 + \text{sign}(\omega)] \}$$

FFT - Fast Fourier Transform operator

x_t - real-valued time series

$$P(\omega, \mu) = \begin{cases} 1 - \left(\frac{\omega - \mu}{\lambda} \right)^2 & \text{dla } |\omega - \mu| \leq \lambda \\ 0 & \text{dla } |\omega - \mu| > \lambda \end{cases}$$

is the parabolic transmittance function, where⁰

$\omega = \Delta t / T$ - normalized central oscillation frequency,

T – average oscillation period,

Δt - data sampling interval,

λ - half the filter parameter bandwidth,

μ – frequency argument.

The instant amplitudes of oscillation is computed by

$$A(\omega, t) = \sqrt{\{ \Im[z_t(\omega)] \}^2 + \{ \Re[z_t(\omega)] \}^2}$$

Next, the correlation coefficients as a function of oscillation period were computed between amplitude variations in LODR and other geophysical time series.

Using such approach it was possible to investigate similar or out of phase amplitude variations of oscillations in two time series. It was found that that amplitude variations of the annual oscillations in LODR and SOI time series are out of phase.

VISUAL ANALYTICS PLATFORM FOR DETECTING WIND ENERGY POTENTIAL IN AN URBAN ENVIRONMENT

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The urban fabric could be a prosperous environment for wind energy harnessing. Several studies were conducted by researchers in order to profile and assess the energy potential in city blocks or entire cities. In this study we present a server-client web architecture so that areas with high wind energy potential could be located by employing 3D technologies. State of the art approaches utilize wind speed and direction readings to profile an urban area with the aim of investigating its suitability or use numeric solutions via CDF simulations in order to generate a dynamic or static wind velocity field. Performing a dynamic CDF simulation for a whole year would need an enormous computer processing power and would produce a gigantic result in terms of computer storage space. On the other side a static CDF simulation would be insufficient as it is missing the time component. Moreover, the state of the art solutions require high expertise in the area of wind energy and CFD simulations. A web based client-server architecture can be used to assess the wind energy potential in an urban environment by integrating static CFD simulations, wind historical data, Web 3D technologies and OGC Standards which would allow researchers, entrepreneurs and civilians to estimate the yearly yield of such investment.

THE IMPACT OF BIOGAS PLANTS ON ENVIRONMENTALLY-FRIENDLY CHICKEN MANURE MANAGEMENT

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Keywords: waste management, natural fertilizers, biogas, chicken droppings

Since 2012 Poland has dominated European poultry industry, and it is one of worldwide leaders in poultry export with annual production surpassing one billion animals. This makes the poultry industry an important sector of Polish economy. Chicken litter or manure, wastes generated during poultry production, are difficult to manage, which makes research on novel technologies of their utilization timely and important.

Poultry production is inevitably accompanied by generation of excrements with fertilizing properties. Depending on the housing method, whether or not bedding is applied, the by-product of livestock life functions consists of feces only (manure) or contains the bedding (litter). Nonetheless, it should be pointed out at this point, that this by-product of poultry production is a problematic waste that poses threat to the environment and human health if not utilized properly.

The aim of this paper was to evaluate the influence of chicken manure utilization as substrate in agricultural biogas plant on the state of natural environment and agricultural activities.

Biogas production from poultry feces is still, however, an unperfected technology that is hindered by the problem of excessive nitrogen content and the prevalence of ammoniacal form in which this element is present in the substrate. The analysis have shown that constant supply over the year is a significant advantage of poultry manure and litter as renewable resources.

Thus, novel technologies are necessary in order to make production of biogas from poultry manure or litter industrially viable. The development of new method should not only be concentrated on neutralization of the threat posed by these wastes, but also on economical rationality.

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THE EFFECTS OF INFLOW OF AGRICULTURAL WASTE WATER ON BIVALVES BEHAVIOUR

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Keywords: water monitoring, water pollution, bivalves, bioindication

The negative effects of agricultural runoff have been investigated in relation to various issues (accumulation in soil or water, changes in ecosystem structure and functioning). However, the consequences for aquatic organisms still require researches, especially for species with limited mobility like a freshwater mollusc. We checked the changes in the functioning of bivalves in the presence of a natural manure inflow (fermented liquid organic manure). Three different diluted concentrations of this fermented organic liquid manure were checked (1:100, 1:200 and 1:400). Exposure to the highest concentration of fermented liquid manure induced a decline of mean daily shell opening and activity time in *Unio tumidus* (swollen river mussel) bivalve species. The significant differences in behaviour patterns were observed during first 10 minutes after exposure to fermented liquid manure. At lower concentrations, significant differences in bivalves behaviour were evident after at least 6 hours after application of contaminant. Long term exposure (7 days) resulted in decrease of activity time and shell opening level, thus that the effectiveness of water purification by bivalves decreased. Our study suggests that moderately elevated liquid manure concentrations in surface water may alter some ecosystem processes, which are dependent on bivalve behaviour.

TWO-STAGE HIGH PRESSURE ANAEROBIC DIGESTION

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Keywords: biogas; biomethane; high pressure; two-stage

Considering Germany's energy supply, there is a need to supplement the increasing share on volatile energy sources, such as wind and solar energy, by expanding demand power generation and developing new energy storage concepts. Biomethane production, in this case, has the potential to play a major role. As biomethane gas can be fed directly into the natural gas grid, it thus utilizes a large existing energy storage system. In May 2015, in the EU-28 a total underground gas storage capacity of 108.3 billion m³ was available; 7.4 billion m³ more were under construction and 29.3 billion m³ planned. Biogas produced primarily consists of CH₄ (55 to 60%) and CO₂ (40 to 45%), dependent on the fermentation process and on the converted initial substrates. However to achieve the same calorific value as natural gas before grid injection it must be purified, and furthermore compressed to the required pressure level. The current upgrading technologies, such as amine scrubbing, gas separation membranes, organic solvent scrubbing, pressure swing adsorption (PSA) and water scrubbing are highly energy consuming and by that expensive.

In a new, continuous two-stage high pressure anaerobic digestion system, the second process stage runs under increased pressure. The methanogenic bacteria in the methane reactor autogeneratively increase the pressure of the gas. This concept uses the higher solubility of CO₂ in liquid compared to CH₄, providing an opportunity to discharge the CO₂ via the liquid stream from the methane reactor. Through that, it integrates biogas production, purification and pressure boosting within one process and results in a high-calorific biogenic gas gained from the methane reactor. This investigation examined the effects of different operating pressures in methane reactor (10, 25, 50 bar) on biogas quantity and quality, pH value and process stability.

Three operating pressure levels (10 bar, 25 bar, 50 bar absolute pressure) were tested in a continuously operating pressure methane reactor. The used percolate for the methane reactor was produced in four parallel-operated acidogenesis-leach-bed-reactors with a volume of 50 L each, in which the supplied biomass (grass and maize silage) was degraded to organic acids and alcohols. The

pressurized anaerobic filter system consisted storage tanks HP-T1 for the percolate, HP-T4 for the effluent, high pressure methane reactor as an upflow anaerobic filter with a total volume of 21 L and two flash tanks with a total volume of 10 L each. The entire amount of liquid within the methane reactor was circulated in several intervals once hourly. No additional caustic chemicals were added for pH adjustment throughout this experiment.

The analysis of the alcohols, alkaline buffer capacity, ammonium-nitrogen and volatile fatty acids clearly showed no inhibition of the processes. Only the concentration of propionic and acetic acid had slightly increased for the experimental pressure level of 50 bar. The pH value varied between 6.65 ± 0.05 at 10 bar, 6.53 ± 0.04 at 25 bar and 6.55 ± 0.02 at 50 bar. The pH value at 10 bar was significantly higher in comparison to 25 bar and 50 bar experiments. The drop in pH value was caused by dissolution of CO_2 in the liquid. Significant differences were observed in the biogas composition under different operating pressures. The methane content increased from $79.08 \pm 1.01\%$ at 10 bar to $90.45 \pm 0.73\%$ at 50 bar, while the carbon dioxide content decreased from $21.62 \pm 1.28\%$ at 10 bar to $7.86 \pm 0.2\%$ at 50 bar. At higher operating pressures the methane content in the gas raised. The specific methane yield (SMY) in the methane reactor related to the chemical oxygen demand (COD) decreased from $0.33 \pm 0.02 \text{ L g}^{-1} \text{ COD}_{\text{input}}$ at 10 bar to $0.26 \pm 0.04 \text{ L g}^{-1} \text{ COD}_{\text{input}}$ at 50 bar. By increasing the pressure, more CH_4 was dissolved in the process liquid and transferred to the Flash 1, where this dissolved CH_4 was released due to the reduced partial pressure. Summarizing the CH_4 production of the whole anaerobic filter system including Flash 1, the SMY has increased to $0.34 \text{ L g}^{-1} \text{ COD}_{\text{input}}$ at 10 bar and 25 bar. A lower SMY of $0.3 \text{ L g}^{-1} \text{ COD}_{\text{input}}$ was observed at 50 bar.

This investigation of two-stage high pressure anaerobic digestion integrating biogas production, purification and pressure boosting within one process, methane contents above 90% was obtained. In order to provide high conversion efficiency and a low methane slip, making the process feasible, operating pressures below 50 bar should be aimed according to the current study. In addition, the costs of post-production gas purification can be significantly reduced, due to the fact that the size of a subsequent gas purification unit can be decreased. Furthermore, the produced gas can be injected into the transnational gas grids without post pressurization or can be used in the transportation sector as fuel for cars or trucks.

RENEWABLE ENERGY SOURCES IN EUROPE – NEW TRENDS AND TECHNOLOGIES IN BIOGAS PRODUCTION AND UTILIZATION

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Keywords: biogas production systems, biogas utilization, flexibilisation, biomethanisation

The development of modern living as we know it today was enabled by only one crucial resource – fossil fuels. This energy source formed the way we produce, travel and live within a very short period of time and brought our world closer together. Nevertheless, the fossil resources will end soon and the massive development came with a wide range of negative effects. As we all depend strongly on energy, we have to transform the way of energy provision – before the fossil resources will be depleted and the environment is further harmed.

Renewable energy, which can be produced from a wide variety of sources such as wind, solar, hydro, tidal, geothermal and from biomass, will not only secure energy provision and protect the environment, it will also offer, due to its flexibility and diversity, changes for regional economic development. The member states of the European Union have early recognized the need for change, set new political goals and adopted supporting policy measures, resulting in a strong growth of renewable energy consumption across Europe and the leadership in global renewable energy deployment. The goal set to achieve a 20% share of renewable energy consumption in the year 2020 is almost reached. The challenging task for researchers, politicians and industry in the near future is to provide a share of another 80% of renewable energy.

This conference contribution will give an overview about the status quo of renewable energy sources in selected European countries and its respective policy measures with special regards to the development in the biogas sector. It will highlight new trends, innovations and technologies for the following fields that have been established under the given legal framework conditions:

Gas production:

- Single and multi stage biogas production
- Biomethanation (in-situ and ex-situ)

- Flexible Biogas production

Gas utilization:

- Research in CHP-Technology
- Gas upgrading and grid injection
- Biogas as vehicle fuel

As almost all European Countries differ in their natural resources and national energy action frameworks a lessons learned approach will be given to compare and discuss the development in different countries. Biogas production and utilization have to be designed in an efficient and sustainable way in order to avoid competition with food production and conflicts with environmental protection.

ENVIRONMENTAL EDUCATION IN PROTECTED AREAS. SPATIO- THEMATIC ANALYSIS OF KAZIMIERZ LANDSCAPE PARK

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Keywords: GIS, map, spatial, tourism, teaching

The research aims at analysing organized environmental tourism and education field-trips conducted by the Branch of Natural Science of the Nadwiślańskie Museum in Kazimierz Dolny (MNKD) on the area of Kazimierz Landscape Park in Poland with the use of GIS tools and cartographic visualisation methods. The main goal is to show the quantitative and qualitative spatio-demographic data through the lens of the museum education activities. The objective is to visualise these data not only to show the phenomena, but to find relations between group characteristic (age, type, origin), theme topics of the field-trips and natural values and features of the environmentally valuable and picturesque terrain.

Data used for the analyse is a two-year (2018 and 2019) record of field activities of the museum. It contains information on every organized group participating in terrain education through field-trips. All information were gathered in tables, containing date of the trip, its route, number of participants, type of a group (school group, children, adults, mixed), age of participants (mainly in case of school groups) and city or area of origin of them. The data were filtered and prepared for analyse and visualisations with different aspects in mind. City of origin was used to create a map showing spatial impact of the museum offer; the remaining data were used to show characteristics of each field-trip route – the temporal change of its popularity, the relation between its location, main education topic and characteristic of the group (age, type). Beside museum data, other available spatial data were used, including digital elevation model to evaluate the route difficulty, environmental protection data to mark borders of protected areas and location of natural monuments and interesting habitats etc. Tabular data were related with spatial information using attribute tables join feature of GIS software, giving powerful possibilities to expand database information. GIS tools were used to visualise all the information, using different methods, including (mainly) point symbols, point- and line-related proportional symbols and choropleth method.

Introductory map shows the spatial extent of museum offer feedback. It is, however, mainly caused not by the offer itself, but by the nature of the Kazimierz Landscape Park and – to a significant degree – by the values of Kazimierz Dolny city, being one of the most popular tourist destinations in Poland.

Detailed maps of routes reveals information on popularity of routes, relations between routes difficulty, natural, environmental quality and type of group.

The research also proves the usefulness of cartographic presentation and GIS tools in analyse of any spatial data leading to, in this case, optimization of the programme of field-trips and potential target group type and spatial origin.

Maps and spatial data are ubiquitous. They are widely used for business, entertainment, information and research. Having the proper data is a first step to analyse the problem or phenomena. This can offer a solution or improvement. It can also generate knowledge, deeper understanding of human and nature activities and interaction between both. Maps, as graphical language offer much convenient and informing way of communicating spatial-related topics and problems.

The results of analyse and visualisation presented in this paper are to be used in further activities of the Museum as well as analyse of its potential, educational offer and its diversification with teaching effectiveness and targeting in mind.

WEB GIS SOLUTION FOR URBAN PLANNING DOCUMENTATION WORKFLOW

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Keywords: web GIS, urban planning workflow

Goal of a research: Study of using WEB GIS open source solution for workflow organizing of urban planning documentation: zoning permit, building permit, occupancy permit, utilities connection.

Methodology and scope of a research: A web gis solution GISCUIT.COM developed by a moldavian company VEC.MD was used as a framework for implementation of test version of a specialized website PRIMARIA.GISCUIT.COM

Giscuit is a cost-effective web mapping platform built on powerful, cutting-edge, open source geospatial components. The goal is to make it as easy as possible to build more secure, reliable and modern web GIS applications. With Giscuit users stay in control of their content through centralized management of vector and raster spatial data. Giscuit allows users to visualize, share, edit and analyze geospatial data. It has powerful web-based administrator panel with features like data import, layer styling, user management, permissions management, publishing data and more. It is compliant with the Open Geospatial Consortium standards, this is achieved through OpenLayers or PHP MapScript supporting several OGC standards like WMS, WFS, WMC, KML, GML, CSW etc. Giscuit provides a scalable GIS server platform that can be deployed on a single Linux or Microsoft Windows machine, it can distributed across multiple servers or deployed on cloud infrastructure.

Highlight of results: A web based workflow (via only internet browser) was implemented for next types of urban planning documentation: zoning permit, building permit, occupancy permit, utilities connection. A lot of OGC compliant data sources can be integrated in decision making process: oftofoto, cadastral parcels, utilities etc. PostGIS database allows storing data of different types and large size: vector and raster layers, attribute data etc.

Main conclusions: An web gis opensource based solution is extremely work and cost effective for Local Public Authorities for managing urban planning documentation.

ENSURING THE MAINTENANCE OF THE AUTOMATED INFORMATION SYSTEM "STATE ANIMAL REGISTER" IN THE REPUBLIC OF MOLDOVA

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Keywords: informational system, animals, state register, events, registration.

The goal of this work is to analyze and reflect the importance of developing the **Digital Agrarian Registry (DAR)** for the Republic of Moldova, which is based on the implementation of the process of **Electronic Transformation of Government** through the **e-Agriculture principle**, storage and maintenance of information systems in the agro-industrial sector, management and processing of required data from existing electronic registers in order to streamline the development and implementation of development policies in agriculture.

The Animal Identification and Traceability System (AITS), later referred to as the **State Animal Register (SAR)**, is only a component part of the **DAR** and has as its primary objective the food security and consumer assurance with products of animal origin. **AITS** is one of the basic subsystems as an integral part of the traceability process of animal products.

The **SAR Automated Informational System** is a set of elements and procedures that allow the identification and registration of animals and holdings, ensuring compliance of the traceability principle. All animals belonging to the bovines, ovine, caprine, swine, equine, donkeys and descendant species obtained by crossing them, all holdings (households) in which these animals are kept or handled, either farm, sheepfold, fair, slaughterhouse, will be identified and recorded in the **AITS Database**, which constitutes the **State Animal Register**.

For the proper functioning of the **Automated Informational System of the State Animal Register (AITS SAR)** emphasizes the following processes:

- Assurance with means of identification of the Automated Informational System "Animal Register" (Animal Identification and Traceability System) (*AIS "SAR"*).

The identification of the animals shall be carried out by the keeper of the animals, who is obliged to present the respective information for inclusion in the

State Register of Animals. The Animal Identification and Traceability System information are part of the State Register of Animals.

Territorial Office of the National Operator (Territorial Office) (TO), located at the district / municipal level within the **Sanitary-Veterinary Directorates and the Safety of Animal Products (SVD) (NAFS)** through which the National Operator carries out the activity of registering the data regarding the registration of animals and farms, including the events with them.

- Maintenance of Managed Automated Informational Systems. One of these systems is the Automated Informational System "Animal Register"

In the nominated system checks, corrections, periodical updates of the data base are done by generating reports with certain animals in certain time periods, the history of the animal, the owners.

RISK ASSESSMENT OF PHARMACEUTICALS AT TRIBUTARIES OF ALQUEVA RESERVOIR (SOUTHERN OF PORTUGAL)

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Keywords: Alqueva Tributaries, water quality, pharmaceuticals, environmental risk assessment

Degradation of ecosystems at different spatial and temporal scales occurs through multiple stressors, resulting in a loss of biodiversity and in an impoverishment of ecosystem services. Aquatic systems are among the most sensitive, exposed and degraded habitats, due to societal demands for food, drinking water, transport, power generation and leisure activities. This situation becomes much more worrying in regions where the water scarcity is a real problem, as in Mediterranean.

Occurrence of pharmaceuticals in the aquatic environment is nowadays a well-established issue and has become a matter of both scientific and public concern. Tons of different classes of pharmaceuticals find their way to the environment at variable degrees, after their use and excretion through wastewater and sewage treatment systems.

The main goal of this study was to analyze the possible environmental risk induce by pharmaceuticals at tributaries of the largest reservoir in the Mediterranean region (Alqueva reservoir, South of Portugal). To achieve this goal, the hydrogeomorphology, physicochemical parameters and pharmaceutical concentrations of water tributaries were assessed. Water samples were collected during 2017 and 2018, at four selected tributaries (Zebro, Álamos, Amieira and Lucefécit). Relatively to hydrogeomorphology characteristics, the riparian vegetation is continuous in Amieira stream, semi-continuous in Lucefécit and Álamos and scattered in Zebro stream. Amieira and Álamos are typical intermittent watercourses, that dry during part of the year (only small pools are present in

summer, namely in July and September), whilst Zebro stream presents water in the whole channel, with no flow during summer and Lucefécit maintains flow during all the year. In general, Zebro and Lucefécit presented concentrations of BOD (Zebro: 4.0-35.5 mg L⁻¹; Lucefécit: 2.3-7.5 mg L⁻¹) and total phosphorus (Zebro: 0.18-6.23 mg L⁻¹; Lucefécit: 0.02-1.92 mg L⁻¹) that compromise the support of biological life, regarding nutrient and oxygenation conditions. Relatively to pharmaceuticals, 27 different commonly prescribed drugs, distributed among several therapeutic classes, namely, analgesics and NSAIDs, lipid regulators and cholesterol lowering, psychiatric drugs, antibiotics and β -blockers, were assessed. The pharmaceuticals quantified in higher concentrations were the ibuprofen (2.97-3161 ng L⁻¹), the hydrochlorothiazide (6.28-2726 ng L⁻¹) and the carbamazepine (4.53-3223 ng L⁻¹). Zebro and Alamos presented the highest contamination by this group of environmental hazardous substances, correlated with the presence of wastewater treatment plants upstream the sampling point of each stream. In specific periods of time, the high concentrations of pharmaceuticals detected, may induce risk for the organisms of lowest trophic level, committing the balance of the ecosystems at these streams.

ECO GREEN CAMPUS: CHALLENGES AND OPPORTUNITIES. THE STUDY CASE OF POLYTECHNIC INSTITUTE OF BEJA

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Keywords: *Eco Green Campus*, Sustainability, Eco-Schools, Environmental Audit, Environmental Best Practices Guide

Several international declarations and initiatives (e.g., Higher Education Sustainability Initiative, Principles for Responsible Management Education) regarding sustainability and higher education were launched since sustainable development became part of the agenda. The role of universities in sustainability performance was especially emphasized during the decade of UNESCO Education for Sustainable Development (2005-2014). Sustainability aspects became important determinants even for university rankings. Particularly, it is expected that the green universities, as institutions, will contribute to the sustainability. Committed universities tend to engage more in the implementation of sustainable development in comparison to uncommitted ones.

Universities are experiencing a growing trend to redefine their strategies and organisations along the lines of sustainability. The sustainability has been seen not only as a component of education, research and innovation, but also as a social learning process within and beyond academia.

The present work intends to contribute to the creation of the *Eco Green Campus* in to Polytechnic Institute of Beja (IPBeja).

IPBeja integrate four Schools: Agriculture, Education, Technology and Management and School of Health, with a range of more than 30 courses on offer, including Short-Cycle, Bachelor's Degrees, Post-Graduate Studies and Master's Degrees. In 2017/2018, the staff of Polytechnic Institute of Beja included 256 teachers, 135 non-teaching staff and 2,537 students, making up an academic community around 3000 people.

The adherence of the four schools that belongs to IPBeja, to the Eco-Schools Program allows the: environmental analysis of each; establishment and definition of goals and the accomplishment of activities related to the Environment. This adherence was a starting point for evaluate the premises needed for the creation of an Ecological and Sustainable Campus.

The environmental audit is a diagnostic and assessment tool, that allows characterizing the existing situation in order to identify what needs to be corrected and / or improved, and also, to promote the definition of realistic objectives to be achieved.

The environmental audits were carried out on the four Schools and in the IPBeja common services facilities. Other information, such as consumption of water and energy, waste production and the type of building construction were also collected and treated.

The results shows that it is necessary to implement some measures in order to IPBeja become an *Eco Green Campus*, involving all academic community. The measures suggested are: improvement of resource management; reduction of waste and effluent production; waste recovery; reduction of water and energy consumption; use of renewable energy; promotion of sustainable mobility and adoption of sustainable public procurement.

A concept of an *Eco Green Campus* was proposed: a Campus that, has the aim of achieving sustainable development, has a culture of sustainable use of resources, nature conservation, pollution prevention, promotion of behaviour and attitudes changes, commitment participation and engagement of the academic community. The *Eco Green Campus* main lines action should be: implementation of Best Environmental Practices; education; investigation; internal and external community engagement; communication, information and public participation; implementation of an Environmental Management System.

It was also propose, the IPBeja Environmental Policy and the IPBeja Environmental Best Practices Guide, oriented both for decision-makers and for the entire academic community, which aim is to promote a sense of responsibility in relation to the Environment, to awaken in the academic community a reflection about behaviours that should be adopted.

The creation of an *Eco Green Campus* is simultaneously a challenge and an opportunity to contribute and promote the Circular Economy.

MANAGEMENT OF DRINKING WATER RESERVOIRS UNDER CLIMATE CHANGE

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Keywords: drinking water dams, climate change, physical structure, water quality, management

Goal of the research

Drinking water supply from dams is of great importance, especially in German low mountain regions. In Saxony, for example, almost 50 % of the inhabitants receive drinking water from dams. Although dams are often referred to as artificial lakes, they differ from natural lakes in many ways. Of substantial importance is the fact that drinking water reservoirs are very much influenced by the nature and use of their catchment areas due to their relatively short theoretical residence times of about one year. The physical structure of dams depends on the local climate, but opposite to natural lakes it is strongly influenced by the management of the flow regime. The aim of the investigations was to identify symptoms of climate change and to formulate measures that appear suitable to avoid or reduce negative consequences for the drinking water supply from dams.

Methodology and scope

Water temperature data from one Luxembourgish and 43 German dams (most of them drinking water reservoirs) were analysed with regard to characteristic seasonal patterns, breakpoints and temporal trends. For 18 dams the measurements extended over a period of 30 years and more. At 31 dams, data was collected at intervals of one month or less. From 7 dams records of other variables of water quality were statistically evaluated.

Results

The temperatures in the upper layers of the dams showed predominantly rising trends in all months of the year, especially from April to July. Therefore, the stability of thermal stratification was increasing during summer. The surface temperatures correlate with altitude, longitude and latitude, and volume and surface of the dams. These factors determine specific seasonal thermal patterns. In dimictic dams, the altered temperature regime results in an earlier ice break-up and beginning of spring full circulation, and has also moved the beginning of the summer

stagnation to earlier dates, delays the autumn circulation and thus cause a prolongation of the summer stagnation in many dams. Reservoirs of medium altitudes show a tendency to monomixis as winter ice cover is increasingly missing. Water temperatures in monomictic dams no longer fall below 4 °C in the entire winter and thus they threaten to become oligomictic. In the dimictic mesotrophic Saitenbach Reservoir, these changes in the physical regime have led to increasing phytoplankton biovolumes and abundances of cyanobacteria despite a reduction of the phosphorus import by more than 60 % after 1990. As a result of the prolonged summer stagnation, lower oxygen concentrations or even anaerobic conditions in the hypolimnion occur in late summer causing high releases (e.g. P, Mn) from sediments.

Reducing external nutrient inputs is the most important and the only sustainable way to maintain or improve water quality. In this context, measures in the catchment area (wastewater treatment, agriculture complying with water management), but also to increase the retention of substances in pre-dams should primarily be examined. The diversion of the tributary around the dam during the rising limb of floods proved effective. However, extreme floods are not fully manageable, neither with pre-dams nor with diversions. Thus, the flow-through management of the dams should also aim to counteract the internal accumulation of nutrients and other potentially harmful substances. Dams serving flood protection should be upgraded with outlets allowing the controlled discharge of epi- or metalimnetic water into the underlying river. These allow during the summer stagnation the passage of polluted inflow water through the dam in case of floods and can also be used for setting an optimum temperature regime in the stream underneath the dam that is corresponding to ecological criteria under normal outflow conditions. It is generally advisable and essential in case of the release of compensation water from the epilimnion to dispense the raw water for drinking water supply via the bottom outlet. This may prevent anaerobic conditions in the deep water layers. If this is insufficient, deep water aeration is recommended. When the temperature in the epilimnion has dropped below 14 °C in the autumn and the expected consequences for the water quality of the downstream river are acceptable, full circulation can be initiated by draining off the remaining hypolimnion. If this is done in form of a rinsing surge, conditions simulating a flood and ecologically valuable riverine structures can be created.

Conclusions

Climate change has far-reaching, mostly negative consequences for the water quality of drinking water dams and requires a more sophisticated reservoir management. Last but not least, cost-intensive adaptations of the water treatment technologies are most likely not avoidable in some cases.

EVALUATION OF BIOMASS GROWTH IN NATURAL WASTEWATER TREATMENT PLANT IRRIGATED WITH DOMESTIC WASTEWATER USING ALS LiDAR DATA AND GIS TECHNIQUE

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Keywords: wastewater irrigation, spatial analyses, ALS LiDAR, Canopy Height Model

Goal of research: The primary objective of the presented research was interdisciplinary application of the laser scanning techniques and GIS tools for the estimation of the rate of changes in plant growth (the dynamics of plant growth) in an area under intensive irrigation, without interference in the irrigation regime and the continuous operation of the object, as well as the estimation of the functioning of the wastewater treatment system in the aspect of the status of the plants.

Methodology and scope of a research: The classical trees inventories with diameters of planted trees were realized in 2003-2013. The research was supplemented with documentation of aerial photographs of the observed object from last 15 years in the terms of the number of trees loss in the forest stand. In addition, the research was complemented with LiDAR data from airborne laser scanning (ALS) performed in 2012. The LiDAR data were acquired in the form of classified points cloud with density of 4 points/m². The LiDAR data allowed the creation of a digital terrain model (DTM) with 1 m spatial resolution of the analyzed object. After filtering suitable point classes out of the points cloud, representing the medium and high vegetation (relative height 0.4-2.0 m and > 2.0 m, respectively), a digital surface model (DSM) was created. Next, the DTM and DSM were used to create a Canopy Height Model (CHM) which was also a normalized digital surface model (nDSM). The creation of the CHM allowed to obtain information of the height of every tree on the irrigated area in a given sector and its part.

Highlight of results: Gravity wastewater discharge into the selected plot surface, in the long-term perspective, caused unequal distribution of irrigation dose,

which affected the diversity of plants within the direct impact of supplying ditch (first, center, end stage – average tree height, 23.95 m, 25.78 m, 26.75 m, respectively). The highest trees were overgrown in segments A and D in the end part of the irrigated plots, 27.44 m and 28.41 m, respectively. Irregular wastewater irrigation and related with it pollution overloading of selected plots caused the surface clogging and extension of infiltration time.

Main conclusion: In the area of a treatment plant in which year-round irrigation with mechanically pretreated wastewaters is conducted, vegetation diversity was observed among the sectors in terms of trees height. Intensive irrigation of the area of the treatment plant with mechanically pretreated wastewaters caused colmatation of the surface layers of the soil profile and an extension of the infiltration time and wastewater stagnation in the sectors end sections. Over a multi-year period, gravitational application of wastewaters on the surface of a selected sector causes non-uniform distribution of the irrigation dose, which causes a diversification of plants within the zone of direct influence of the supply ditch (beginning, center, end part of the sector). Within the area of the entire object, the greatest average height was characteristic of trees from the sectors end parts (26.75 m). The laser scanning techniques and the GIS tools create possibilities of estimation of changes in trees height without interference with the operation of the object and without changing the irrigation regime, which allows better control of the object with regard to the status of vegetation.

**INTERNATIONAL PROJECT ON AQUATIC ECOSYSTEMS:
CONTROLLING INVASIVE SPECIES AT ALQUEVA PROJECT -
DIFFERENT INFRA STRUCTURES SAME APPROACH?**

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Keywords: International project, Integrated project, Water, Invasive species, Reservoirs.

At Aeres University of Applied Sciences in Almere a one-year international programme on Aquatic Ecosystem Analysis is run with BSc certification. This programme includes a very appealing cooperation with the partner university Polytechnic Institute of Beja (IPBeja), Portugal: an integrated project of 5 weeks (8 ECTS) where students have to solve a water system issue in the Beja region. In the recent project students from the Aquatic Ecosystem Analysis programme have worked together with IP Beja students and students from Estonia, Germany, Poland, Croatia and Brazil with backgrounds in Agronomy, (Environmental) Engineering, Ecology and Underwater Science and Technology to come with integrated solutions from their multi-disciplinary and international teams. Students have evaluated the project to be very useful for their professional and cultural development as they learn to work independently in a relevant stakeholder setting.

Water systems are very interesting to work with due to their complexity: water systems integrate different scales, users and others stakeholders, ecosystems and different fields of knowledge such as hydrology, engineering and ecology.

In this project the students will take the professional role of Advisor spatial planning for water ecosystems. This project includes an official client (EDIA - Empresa de Desenvolvimento e Infraestruturas do Alqueva, S.A.) and is related to the Guadiana River Basin, the Alqueva dam and the effects of the new irrigation and drinking water infrastructure on the water system. The problems facing the client are the invasive species like the Water hyacinth (*Eichhornia crassipes*) in the Guadiana River Basin which are coming from upstream (Spain). For this the students have found solutions by doing their own system analysis, working with data from the

client and gathering data themselves in the field and in contact with stakeholders. In this way different skills, knowledge and expertise of the group members have to be combined (integrated) to come to the best possible result.

Assessed elements are: (1) stakeholder process; (2) possible measures and advice for best measure based on criteria: realistic, economically viable, environmental impact and stakeholder wishes; (3) quality of the report and presentation.

The proceeds from this project are three-fold:

- useful solutions for the client, worth taking in account by fighting the invasive species;
- a valuable experience for the students, who have proven themselves to be able to work in an International and Interdisciplinary team, in a foreign language while performing a professional role;
- improved international understanding for all people involved, especially the professors who learn from each other's educational systems and culture.

ENHANCED METHANOGENIC PERFORMANCE AND METABOLIC PATHWAY OF HIGH SOLID ANAEROBIC DIGESTION OF CHICKEN MANURE BY TRACE ELEMENTS SUPPLEMENTATION

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Key words: Chicken manure; high solid; methanogenic performance; metabolic pathway; trace element

Research Goal:

High solid anaerobic digestion was a promising technology for the treatment of organic waste for high efficiency bioenergy production and digestate reduction. However, the anaerobic digestion of chicken manure with high solid was a challenge due to the inhibition effects caused by high ammonia levels formed in the degradation. Addition of trace elements has proven to enhanced the resistance and the activity of methanogens under high level ammonia-N environment in anaerobic digestion of food waste, household and albumin, municipal waste and animal manure. In this study, two high solid anaerobic digesters were consecutively operated for 147 days to investigate the effects of of 280 mg/L Fe^{2+} ($\text{FeCl}_2 \cdot 4\text{H}_2\text{O}$) and 2 mg/L Ni^{2+} ($\text{NiCl}_2 \cdot 6\text{H}_2\text{O}$) addition on methanogenic performance. The methanogenic activity, microbial community and quantitative methanogenic pathway was investigated to clarify the role of the addition of the two elements in the long term operated AD process.

Methodology and Scope:

Two parallel continuously stirred tank reactors (CSTR) of 15-liter capacity with working volume of 12-liter were used for mesophilic (37°C) digestion of chicken manure. One was supplemented with 280 mg/L Fe^{2+} ($\text{FeCl}_2 \cdot 4\text{H}_2\text{O}$) and 2 mg/L Ni^{2+} ($\text{NiCl}_2 \cdot 6\text{H}_2\text{O}$) set as the Fe-Ni digester while the other was operated as the control digester without elements addition. The feeding chicken manure had a total solid (TS) content of 150 g/kg. Both digesters were operated at a constant HRT of 20 days, with OLR of 4.8 g-VS/(L·d) and substrate was fed once per day. Biogas volume and composition, and pH value were measured every day. Other parameters including VFAs, TAN, TCOD, soluble COD, and alkalinity were measured every four days. specific acetoclastic methanogenic activity, specific hydrogenotrophic methanogenic activity, methanogenic pathway analysis with 2- ^{13}C isotope probing, and microbial community structure analysis were conducted at 78-80 day.

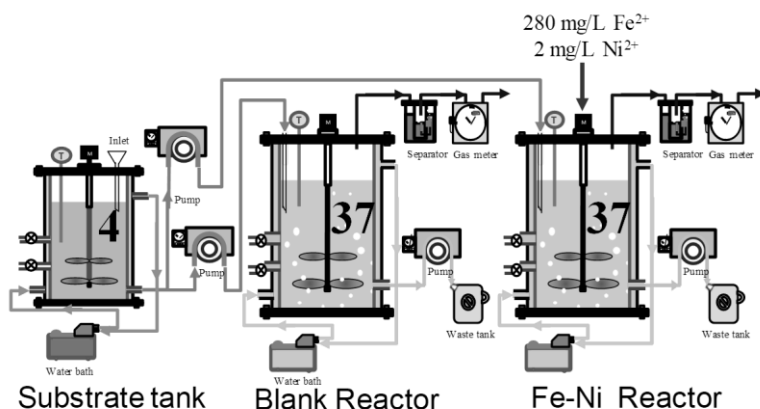


Fig.1 Experimental device schematic

Highlights:

1. Fe²⁺ and Ni²⁺ enhanced long term methanogenic performance at TAN of 6.8/L.
2. Both acetoclastic and hydrogenotrophic methanogenic activity was increased.
3. The microbial communities was identified by high throughout sequencing.
4. Hydrogenotrophic methanogens were out-competed with trace elements

Conclusions:

Addition of 280 mg/L Fe²⁺ (FeCl₂·4H₂O) and 2 mg/L Ni²⁺ (NiCl₂·6H₂O) provided an increment of 34% methane production and a 31% reduction of total volatile fatty acids, which associated with the enhancement of the acetoclastic and hydrogenotrophic methanogenic activity. The high throughout sequencing results found the increased percentage of *Methanosarcina* sp. which may contribute the slight shifts of methanogenic pathway towards acetoclastic methanogenesis.

THE EFFECT OF INCREASING AMMONIUM NITROGEN LOAD IN THE VEGETAL BIOMASS AND THE REMOVAL EFFICIENCIES ON VFCW

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Keywords: ammonium nitrogen, toxicity, *Vetiveria zizanioides*, vertical flow constructed wetland, biomass composition.

Most wastewater, such as industrial and agricultural wastewater, urban drainage, sewage, and landfill leachate contain nitrogen compounds that, discharged without enough treatment, can cause adverse effects in water bodies and environment. To comply with Portuguese Standard, these waters, requires previously treatment, before being discharged. The treatments are feasible with conventional treatment technologies or constructed wetland (CWs). Wetland plants require nutrients for their growth and reproduction. Therefore, nitrogen deficiency rapidly inhibits the plant growth. However high concentrations of ammonium (>0.5 mM) can be toxic to plants, since under high ammonium supplying most plant species are unable to regulate the ammonium influx.

The aim of this work was to assess the growth and physiological responses of *Vetiveria zizanioides* to increments of high ammonium concentrations (from 2.5±0.2 to 38.9±0.8 mM) and also to evaluate the ammonium nitrogen removal efficiencies.

The experimental work was performed in two identical vertical flow constructed wetland (VFCW A and VFCW B) with 0.24 m² x 0.70 m. Both VFCW were planted with *Vetiveria zizanioides* and filled with Leca® NR 10/20. Synthetic effluent was daily prepared and applied three increasing ammonium nitrogen concentration in each VFCW. Three hydraulic load (H_L) were also applied in each VFCW. The water samples were collected in influent and in effluent of each VFCW. The parameters like dissolved oxygen (DO), ammonium nitrogen (NH₄⁺-N) and nitrate (NO₃⁻-N) were measured daily. *Vetiveria zizanioides* plants were visually inspected weekly for signals of toxicity. The concentration of calcium, magnesium, potassium, sodium and phosphorus in the aboveground plant tissue dried were analyzed by Ionic Chromatography.

The results show that plants growth well without obvious symptoms of toxicity or nutrients deficiency. Plants height was not affected by the $\text{NH}_4^+\text{-N}$ concentration applied in each VFCW, although values were used of $[\text{NH}_4^+\text{-N}]$ increasing from 2.5 ± 0.2 to 38.9 ± 0.8 mM. It was not found significantly differences between the plant rate growth in each VFCW ($p>0.05$). Concentrations of K, Mg and P in the plant tissues showed a tendency to decrease, when ammonium nitrogen increased. In opposite, calcium concentration tends to increase when the concentration of ammonium increased.

The results show that $\text{NH}_4^+\text{-N}$ removal occurred in VFCW A and VFCW B, with highest removal efficiencies of $70\pm3\%$ and $60\pm2\%$, respectively. These results were obtained for the smallest ammonium nitrogen concentration. Nitrification was also occurred as well as DO increased in the effluent of each VFCW. So, *Vetiveria zizanioides* seems to be a good option to use in VFCW to treat several kinds of wastewater.

THE GAME TO PROMOTE THE CAPABILITY OF REDUCING, REUSE AND RECYCLING THE WASTE

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Keywords: 3Rs, Unity3D, Eco-Efficient School, Environmental Education

This essay is based on the Eco schools ESTIG project (Higher School of Technologies and Management) of the Polytechnic Institute of Beja. ESTIG has joined the Eco Schools program since December 2015. This is an international program of the Foundation for Environmental Education, developed in Portugal since 1996 by the ABAE. It aims to encourage actions and recognize the work quality developed by the school, within the subject of Environmental Education for Sustainability.

In this context, the Higher School of Technology and Management (ESTIG) has developed a structured and quality project, taking into account the better management and environmental education of the members of the school, greater awareness for changing attitudes, behaviors and citizenship, which leads to better quality of life in the day-to-day life of the school in the community. This essay focuses only on the resources of water, solid waste and energy. To better inform and educate community members of the 3Rs schools - Reduce, Reuse and Recycle, it was decided to develop an interactive 3D game, accessible through the Word Wide Web, which would make them aware of solid objects recycling, and saving the water and electricity. The use of this game was followed by traditional campaigns (posters, pamphlets ...) to raise awareness of energy saving, water and recycling. As most students use interactive games, this instrument can more easily complement and enrich their environmental training. The game based on Unity3D technology, was developed by 2 teachers and 3 students of the Computer Engineering course. The game takes place in a 3D virtual representation of the ESTIG building. Recycling takes place in room H20 where the user can place paper, plastic and glass objects in their containers. In the water saving, which takes place in the bathroom of the sub floor, the user must close the water from open taps in the shortest period. When saving electricity, which takes place in one of the computer lab, rooms on the same floor, the user must turn off the switch of the computer screens that are unnecessarily connected.

The objective of this work was to sensitize the academic community to the current environmental problems, educating their members and how we can tackle

them not only through the traditional means of communication, but also of interactive, more current, more appealing for today's society. In this way, a 3D game, could sensitize them to the unnecessary expenses of water and light, which occurs in the school building, every school year, as well as, for recycling, where we find that sometimes there is no separation of paper and plastic. How can this interactive 3D game contribute to an eco-efficient school?

The project encompassed four phases. The first phase of the project went through the analysis of functional and non-functional requirements of the system, which allowed characterizing the actors that intervene in the system. The second by the stage of the design, that allowed creating the scenarios of use. Followed by the implementation phase, having been implemented in Unity3D, C # and Photoshop. Finally, tests were carried out with the users, which allowed us to evaluate the usability of the game.

The games was evaluated only by a small sampling and all the participants had familiarity with video games, therefore they did not show difficulties during the development of the game, since the average time per game was of 3 minutes and 40 seconds. It should be noted that the tests carried out focused only on the usability and interactivity of the game, and the impact of the game at the 3Rs level - Reduce, Reuse and Recycle has not yet been tested.

We conclude that the game has very particular characteristics, since it was developed specifically for ESTIG. The game allows the user to have a better sense of the physical space of the school, allows to play at random, that is, in the order that the user wishes, shows the user in real time his progress, at the end he is presented the time and the total of points made. In this way, it makes the game interesting to the user.

We realized that we should carry out more tests with a greater number and with a greater diversity of knowledge in a video game environment. Conduct a new audit of these 3 topics, create new questionnaires to verify the effectiveness of the system.

THE INFLUENCE OF ELECTRIC CURRENT DENSITY ON SPECIFIC RATE OF DENITRIFICATION AND THE RATE OF NITROGEN REMOVAL IN ELECTROCHEMICAL AND ELECTROBIOLOGICAL ROTATING CONTACTORS

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Keywords: rotating electrochemical contactor, rotating electrobiological contactor, specific rate of denitrification, rate of nitrogen removal, soil-less cultivation

The aim of the study was to determine the current density on rate of nitrogen compounds removal (r_N) and specific rate of denitrification (r_D) in the electrochemical rotating contractor and electrobiological rotating contactor.

The study was conducted in a one-stage electrobiological contactor (REB) and an electrochemical contactor (REC). In the REB, the cathode consisted of discs with immobilized biomass. In the REC, the cathode consisted of rotating discs, from which biofilm was periodically removed. An aluminum anode was placed in the flow chamber of each contactor. The study employed synthetic wastewater with characteristics similar to wastewater from soil-less cultivation of tomatoes, which is the dominant cultivation method.

The experiments were divided into two stages. The first stage determined the rate of nitrogen compounds removal and specific rate of denitrification that defined load of nitrogen removed with 1 kWh in the REC with discs without immobilized biofilm. Nitrogen compounds were removed during electrochemical reduction of nitrates. The second stage determined the rate of nitrogen compounds removal and specific rate of denitrification in the REB with discs with immobilized biofilm. Nitrogen compounds were removed during hydrogenotrophic and heterotrophic denitrification, electrochemical reduction of nitrates and biomass growth. In each stage, the four hydraulic retention times were tested: 4 h, 8 h, 12 h and 24 h. With each retention time the following densities of electric current were used: 0.63 A/m², 1.25 A/m², 2.50 A/m², 5.00 A/m² and 10.00 A/m², which were selected based on the literature.

In the electrochemical contactor, the linear dependency of the rate of nitrogen removal (r_N) and current density was observed in the examined HRT, confirmed by a high value of the determination coefficient R^2 . In the contactor

operated at HRT of 4 h, the rate of nitrogen compounds removal increased from 0.1 mg N/(cm²·d) to 0.2 mg N/(cm²·d) at the density of 0.63 A/m² and 10.00 A/m², respectively. In the contactor operated at the HRT=24 h, this rate increased from 0.04 to 0.09 mg N/(cm²·d) at the density of 0.63 and 10.00 A/m², respectively.

In the electrobiological contactor, the logarithmic dependency of the rate of total nitrogen removal (r_N) and current density was observed in the examined HRT, confirmed by a high value of the determination coefficient R^2 . In the contactor operated at HRT of 4 h, the rate of total nitrogen removal increased from 0.13 mg N/(cm²·d) at $J = 0.63$ A/m² to 0.31 mg N/(cm²·d) at $J = 10.00$ A/m². The rate of total nitrogen removal of 0.04 mg N/(cm²·d) was lowest in the contactor operated at HRT = 24 h and $J = 0.63$ A/m².

In both contactors, the exponential dependency of the specific rate of denitrification (r_D) and current density was observed during operation at HRT from 4 h to 24 h. The specific rate of denitrification decreased when the current density and HRT was increased. In the electrochemical contactor operated at HRT = 4 h and $J = 0.63$ A/m², the specific rate of denitrification was 6.4 mg N/kWh. In this contactor, increasing of a density to 10.00 A/m² decreased the specific rate of total nitrogen removal to 0.85 mg N/kWh. In the electrobiological contactor operated at the HRT = 4 h and $J = 0.63$ A/m², the specific rate of denitrification was 8.46 mg N/kWh. In this contactor, increasing of a density to 10.00 A/m² decreased the specific rate of denitrification to 1.27 mg N/kWh.

The study showed that, in both electrochemical and electrobiological rotating contactors, the rate of total nitrogen removal increased when the current density was increased and the HRT was decreased.

In both the electrochemical and electrobiological rotating contactor, the specific rate of denitrification, which define load of nitrogen removed with removal of nitrogen with 1 kWh of electric current, decreased when the current density and HRT was increased.

THE MANAGMENT OF ORGANIC WASTE IN THE CLOSED OF RESCUE FOR POLISH SOILS

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The closed-loop economy (CLE), which is gaining popularity, means the production of such goods that can be recycled many times. The proposed activities focus on several priority areas, i.e.: plastics, food waste, critical raw materials, demolition / construction waste, biomass and bioproducts.

The implementation of the CLE idea requires the development of innovative technological solutions, which is associated with the definition of reindustrialisation. It also requires a new look at the product, including all stages of its life, in particular at the stage / in the scope of: design, production, consumption, waste collection and re-use.

The Polish priorities in the area of development of GOZ are: sustainable industrial production, sustainable consumption, bioeconomy and new business models. These areas include problematic and perspective issues important from the point of view of the Polish economy.

Closing the circle of organic matter circulation in nature is one of the basic elements of the circular economy concept. There are three basic, practical premises for the selective collection and treatment of biodegradable waste, which in many aspects: interpenetrate, affect both each other, as well as other elements of the economy increasing the positive effect through synergy.

The practical reasons for selective collection and processing of biodegradable waste are: obtaining raw material in the form of organic matter for application in soil, preferably in the form of stable humus compounds because according to international standards, the content of humus below 3.5% is treated as a manifestation of desertification, therefore, 89% of the area of Polish soils used for agriculture should be included to the soils of low organic matter content hence the necessity of supplying to the soils an external source of organic carbon in the best "soil-forming" form, which is compost (the precursors are only organic, biodegradable waste).

Practical premises of selective collection and processing of biodegradable waste are (continuation): minimization of the harmful effects of biowaste landfilling and burning, and biostabilization costs of the residual fraction, minimization of the contamination by the „bio” fraction of the other material fractions, and thus increasing their value. It is estimated that the total amount of biowaste produced

annually in the European Union ranges from 76.5 to 102 million tons of food and garden waste included in mixed municipal solid waste and up to 37 million tons of waste coming from the beverage and food production sector. On the basis of regulations at the European level, Poland is obliged to reduce the amount of biodegradable waste deposited in landfills in relation to the mass generated in the year 1995 by: 25% until 2010, 50% until 2013 and 65% until 2020. It is primarily this fraction that is responsible for emissions from landfills, mainly arising in anaerobic processes during landfilling - biogas, which due to the content of CH₄ and CO₂ is classified as a greenhouse gas.

In spite of significant positives due to organic recovery / recycling and introduction of its products to the environment based on the actual law, it should be noted that it concerns mainly the total heavy metals content and partial also microbiology, but it is still important to introduce knowledge about organic pollutants. Common in organic material are polycyclic aromatic hydrocarbons (PAHs), dioxins and furans (PCDD and PCDF) – both carcinogenic. These two groups of organic pollutants are persistent in environment – so they are resistant on microbiological (or thermal) decomposition, and additionally could be created in anoxic conditions from organic matter. Both group of compounds have lipophilic character and in spite of relatively big molecules could be absorbed by plants and be a reason of low quality of final yield.

BIODECOLORIZATION OF ANTHRAQUINONE DYES USING IMMOBILISED MYCELIUM OF *BJERKANDERA ADUSTA* CCBAS930

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Keywords: white-rot fungi, versatile peroxidase, anthraquinone dyes, immobilization

Synthetic dyes are widely used in many industries, such as textile, cosmetic, pharmaceutical and food industries. Anthraquinone dyes are most widely used for the dyeing of cotton, wool and silk. Textile industry produces the largest amount of dye effluents. In recent years, with the increase in demand for textile products, the global textile production has increased rapidly and reached about 140.84 million tons in 2012. Currently, wastewater containing textile effluents are treated using physicochemical methods: ozonation, adsorption and membrane filtration. In recent years biological methods using microorganisms to remove contaminants are gaining in importance, supplementing or presenting an alternative to conventional methods. The biological methods are attractive because of their low costs, environmental safety and common societal acceptance. Particularly promising in this regard are white-rot fungi (*Basidiomycetes*). The most frequently mentioned biological mechanism of contaminant removal by these organisms is biodegradation, involving exploitation of the natural ability of the fungi to synthesize extracellular ligninolytic enzymes. Owing to the low substrate specificity of these enzymes, they can be used for biodegradation of natural and synthetic aromatic compounds that are structurally related to lignin. Decolorization and biodegradation abilities of different *Bjerkandera* spp., including *B. adusta* strains, were widely studied, and basically include azo, anthraquinonic, triphenylmethanes and heterocyclic dyes. Studies using the anamorphic stage of *Bjerkandera adusta* CCBAS 930 have shown that this strain can remove a wide spectrum of aromatic compounds from an aquatic environment. In previous studies the *B. adusta* CCBAS 930 strain has been shown to exhibit decolourizing activity on synthetic dyes with an anthraquinone structure (monoanthraquinones: Carminic Acid and Remazol Brilliant Blue R; polyanthraquinones: Poly-R), triphenylmethane dyes (Brilliant Green) and heterocyclic dyes (erythrosine).

The aim of this study was to determine the effectivenesses of anthraquinone dyes: Alizarin Blue Black B (ABBB), Acid Blue 129 (AB129), Carminic Acid (CA),

Remazol Brilliant Blue R (RBBR), Acid Green 25 (AG25) and Poly R-478 decolorization and peroxidases production by immobilised mycelium of *B. adusta* CCBAS 930.

Anamorphic stage of *B. adusta* CCBAS 930 was isolated from the black earth soil (Pheozems, FAO classification) from a field near Lublin, South-Eastern Poland. Immobilised mycelium (Na-alginate beads) of *B. adusta* CCBAS 930 was incubated with 0.01% solutions of anthraquinone dyes (150 rpm, 28°C, 7 days). Samples were collected every day and following parameters were estimated: the degree of decolorization of anthraquinone dyes using an UV/VIS spectrophotometer, phenolic compounds and free radicals concentrations and activity of peroxidases: horseradish-type (HRP-like), ligninase (LiP) and manganese dependent (MnP) and versatile (VP). At the end of the experiment, the degree of bio- and phytotoxicity was estimated.

The results showed that the use of immobilised mycelium of *B. adusta* CCBAS 930 significantly reduces the time of decolorization of ABBB, AB129, CA and RBBR. After 7 days decolorization degree of CA, AB129, ABBB and RBBR was 75.50%, 65.08%, 56.57% and 25.64%, respectively. In immobilised cultures of *B. adusta* CCBAS 930 with 0.01% of anthraquinone dyes activity of all tested peroxidases was detected, but HRP-like and VP was characterized by the highest activity. Activity of HRP-like and VP systematically increased reaching the maximum after 7 days, 35.64 - 80.32 and 50.20 - 106.43 U mg⁻¹ protein, respectively. During the immobilised culture of *B. adusta* CCBAS 930 with 0.01% anthraquinone dyes, a systematic decrease in the content of phenolic compounds (50-60%) and free radicals was observed (70-85%). Decolorized post-culture fluids were characterized by lower bio- and phytotoxicity.

OPEN GEODATA - CHANCES AND CHALLENGES

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Keywords: open geodata, open by default, evaluation of geoportals

Geodata is the fuel for any GIS application. Whereas 20 years ago the acquisition of geo baseline data took a mayor share of the total cost of ownership of an GIS application, this picture has changed with the advent of open data policies. Open data, i.e. data which can be used freely by everybody as defined e.g. by the open knowledge foundation [1], is not restricted to governmental data but includes other data producer like the civil society, research institutions and Universities as well as the private sector. There exist several initiatives to promote the idea of open data like the open data charter [2], and its benefits are well documented though they are difficult to quantify. Social benefits as strengthening the democracy, citizen participation and transparency are complemented by economic benefits as promoting innovation, new business models, multiple use and avoiding multiple data capture and maintenance. These benefits are embedded in the general trend of digitalization, which can be understood as the use of digital technologies to change business models to provide new revenues. This is in particular supported by fundamental geodata, which is the base of many other geo-related applications and business ideas. E.g. the European Commission report about Re-using Open Data [3] lists geospatial and earth observation data with a share of more than 33% as the most requested datasets.

The general benefits of an open data policy have been recognized by many European governments, and they have changed their attitude towards their data policies, including geo baseline data. It can even be observed a change of paradigm towards an open by default policy, i.e. the concept in which a government makes all its data public accessible free of charge by default as a basic principle, without the necessity of setting up a request by a potential user whereas any exceptions from this rule has to be justified by the administration. In Germany, the new paradigm has been introduced by the First Law amending the E-Government Law in 2017. It has been implemented e.g. by the Federal Agency for Cartography and Geodesy, so that all their geodata is accessible by their geoportal by everybody free of charge. But following the principle of subsidiarity, the agency is only responsible for geodata on the federal level, that is data for small scale maps, whereas most GIS applications are implemented and develop their full potential on the regional or

even the local level. On the regional level, i.e. the level of the different states, the situation in Germany is very heterogeneous. Whereas some states like North-Rhine Westphalia have already implemented an open by default policy, other states like Baden-Württemberg are more restrictive. On the local level, i.e. the level of municipalities and counties, the situation is even more heterogeneous. To promote the idea of open data, easy finding, easy access and easy integration of the data sets into other applications is a must. A prerequisite for achieving this is the use of standards, which make interoperability possible. These interoperability issues include technical, syntactical and semantic interoperability; starting from W3C protocols via the definition of interfaces of services and ending up with reference models for different application domains. It is often criticized, that open data may be misused, as there is no proper understanding of the content and the intention of the data. In this context, metadata including data quality description is an important issue. With a proper and understandable description of the data the fitness-for-use can be clearly identified and the risk of using the data can be evaluated.

The objective of this study is to report about the state of the art of the implementation of open data policies focussing on geodata in Germany. This includes an evaluation of the national, regional as well as local level, not restricted to open governmental geodata but considering other providers as well. Other providers of open geodata beside the state mapping agencies and the well-known OpenStreetMap community are e.g. the statistical offices and the German railway. To reach the goal of the study, different geoportals as access points for geodata have been analysed. This evaluation includes the number and topics of data sets available, the services for viewing and for downloading provided, the definition and use of metadata, the user-friendliness of the portals, existing restrictions and licensing, etc.

The study shows that the situation in Germany is very heterogeneous. To find open data resources others than the state mapping agencies offer is quite difficult, as no unique and nation-wide registry exists. The data is offered in different formats and with different level of metadata description. quality description is still an issue which has to be improved. As different data formats and different licensing policies exist, it is quite difficult to integrate open governmental geodata and volunteered geoinformation.

[1] Open Knowledge Foundation. <https://okfn.org/> [accessed 3/5/2019]

[2] Open data charter, <https://opendatacharter.net/> [accessed 3/5/2019]

[3] European Commission Directorate General for Communications Networks, Content and Technology: Re-using Open Data, 2017.

https://www.europeandataportal.eu/sites/default/files/re-using_open_data.pdf [accessed 3/5/2019]

MONITORING OF THE PLANNED DISPLACEMENTS AND LANDSCAPE CHANGES OF THE RIVERINE AREA OF THE PART OF DNIESTER RIVER

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Keywords: monitoring; landscape; satellite images; topographic maps; supervised classification.

Relevance of a research. In connection with climate change, including the effects of global warming, and through anthropogenic factors in Ukraine, especially in the Western Region, spontaneous flood phenomena became more frequent, leading to devastating consequences. Floods are the main cause of changes in riverbeds and the landscape of the riverine areas, therefore the problem of monitoring the displacement of the channels and changing the landscape of the riverine area is relevant.

The results of river channel displacement monitoring should be taken into account when designing and constructing hydrotechnical objects, power lines at river crossings, the laying of gas pipeline networks, establishing boundaries of protected areas, studying of the state border areas for setting the border along the river fairway.

Goal of a research. The purpose of this paper is to research the planned displacements of the riverbed of the Dniester river for the period 1874-2015 and detecting changes in the landscape of the riverine area for the period 2000-2018 in the transition area from the mountainous part of the river to the plain one using topographic maps, remote sensing data and GIS technologies.

Methodology and scope of a research. The following materials have been used to identify and analyze changes in the position of the Dniester riverbed in the research area:

- maps of the Austrian period for the year of 1874, scale 1:75 000;
- maps of the Polish period for the year of 1923 and 1930, scale 1: 100 000;
- maps of the Soviet period for the year of 1978, 1985 and 1988, scale 1: 100 000;
- satellite image from UAV Landsat-7 for the year of 2000;
- satellite image from UAV Landsat-8 for the year of 2015 and 2018.

Binding of topographic maps to the coordinate system of satellite images, that is WGS 84, was made to research changes of the channel using cartographic materials. Binding of maps is made on the reference points: crossroads, bridges, mountain peaks, etc. The processing is carried out in ArcGIS 10.2 software.

The Composite Bands procedure is used for the processing of satellite images to create a composite images. Its purpose is to combine three spectral RGB channels, the combination of which provides the best contrast of the object (river) under research against the background of the terrain.

Highlight of results. Channels 5, 4, 1 were used for a satellite image from UAV Landsat-7, and channels 7, 5, 3 for Landsat-8 correspondently. Applying the Pansharpening procedure has improved the resolution of images from 30 to 15 meters.

The tortuosity coefficients of separate sections of the riverbed of the Dniester River are determined, which are substantial; this indicates the unstable nature of the riverbed and its meandering.

The supervised classification was carried out using the method of maximum probability by images received from satellites Landsat-7 for the years of 2000 and Landsat-8 for the years of 2018. Reference samples of up to 400 pixels in different parts of the image were used for its implementation. The following classes are distinguished: hydrography, arable land and nude soils, forest, herbaceous vegetation, building. A special filter was used to smooth the obtained classified image, making it possible to eliminate single pixels with mixed brightness.

Main conclusions. Due to the analysis of the riverbed planned displacement of the Dniester River according to cartographic materials and satellite images for the years of 1874-2015 the maximum displacement of the channel at the research area having the length of about 50 km., is established, in some areas being 640-870 meters.

It was established that for 18 years the area of forests and arable land increased by 2630 and 2850 hectares, respectively; the territory occupied by herbaceous vegetation decreased by 9940 hectares, but the area of urbanized territories increased by 5330 hectares. The increase in the areas of plowed land and forest plantations, as well as the growth of settlements areas, testifies to the influence of anthropogenic factors on the riverine areas of the Dniester River.

THE INTERACTIONS OF ORGANIC XENOBIOTICS WITH MANGANESE OXIDES IN TRANSITION ZONES

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Keywords: manganese oxides; organic xenobiotics; water pollution; wetlands;

The pollution of surface waters, groundwater and even drinking water with organic xenobiotics originates from point sources such as wastewater treatment plants and from non-point sources such as agricultural drainage waters, spray-drift, leaching and drain flows (Barbosa et al., 2016; Vymazal and Březinová, 2015). The water streams from agriculture and livestock areas are an important source of organic xenobiotics, particularly pesticides, which are used to improve productivity, as well antibiotics and personal care products, which are often introduced onto the fields with manure or in reclaimed wastewater used as irrigation water. The input of organic xenobiotics from croplands and other agricultural areas into water bodies can be potentially reduced by transition zones on the interface between the terrestrial and aquatic ecosystems, which either occur naturally or as man-made structures (buffer strips) (Vymazal and Březinová, 2015). The drainage from agricultural fields may pass through these zones before entering surface waters (Arora et al., 2017; PES, 2017). In the transition zone, the soil is alternating from unsaturated and well-aerated to saturated and is influenced by the adjacent water courses (Vymazal and Březinová, 2015; Reddy and DeLaune, 2008). Fluctuating water levels in the buffer zones result in the occurrence of intermittent periods of oxidation and reduction (Reddy and DeLaune, 2008). In natural wetlands, such cyclic conditions have been found to support the action of complimentary degradation processes and therefore offering enhanced attenuation of some organic xenobiotics as compared to continuously oxic or anoxic zones (Passeport, 2010). Additionally, also high spatial heterogeneity of transition zones can result in wide diversity of redox conditions in these ecotones (Reddy and De Laune, 2008). This wide range of redox conditions encountered in the transition zones can affect both biotic and abiotic conditions. Notably, abiotic transformations of organic xenobiotics in transition zones are poorly understood and often ignored in remediation scenarios (Shin and Cheney, 2004). The contribution of abiotic processes to the degradation of organic xenobiotics is often limited to clay-mineral catalyzed hydrolysis and sorption (Shin and Cheney, 2004). Moreover, the identified transformation products are often

attributed solely to biodegradation processes neglecting the contribution of the abiotic transformations such as redox processes associated with manganese (Mn) and iron cycling.

The known interactions between organic compounds and the Mn cycle in the oxic-anoxic transition zones include: (i) manganese oxides (MnOx)-related phenomena as adsorption, hydrolysis, and/or redox reactions (Remucal and Ginder-Vogel, 2014; Li et al., 2015); (ii) reactions mediated by Mn(III) as an intermediate in biotic and abiotic reactions; and (iii) metabolic and cometabolic biodegradation especially by manganese-reducing bacteria (MRB) and to poorly defined extent by manganese-oxidizing bacteria (MOB). MnOx are considered to be the strongest naturally occurring oxidants and are capable of oxidizing a wide range of organic compounds under environmentally relevant conditions both oxic and anoxic (Remucal and Ginder-Vogel, 2014). The general mechanism of organic xenobiotics transformation by MnOx assumes that the organic compounds are first adsorbed to the oxide surface to form a precursor complex, then electrons are transferred within the complex, and finally organic oxidation products and Mn^{2+} ions are released (Forrez et al., 2009).

In natural environment Mn is most commonly found as Mn(II), Mn(III) and Mn(IV) (Remucal and Ginder-Vogel et al., 2014; Hu et al., 2017). Under reducing conditions Mn(II) is favoured, whereas under oxidizing conditions it prevails in the form of Mn(III/IV)-oxides. Most naturally occurring MnOx in soils and sediments were formed in the processes mediated by microbes (mainly bacteria and fungi) because the abiotic oxidation of Mn(II) occurs at much lower rate (Remucal and Ginder-Vogel, 2014). Additionally, it was found that the activity of MOB and MRB may be responsible for degradation of some organic xenobiotics. MRB are able to metabolically degrade organic matter including some organic xenobiotics while respiring Mn(IV), while MOB may indirectly degrade organic xenobiotics by oxidizing Mn(II) to biogenic MnOx and intermediate Mn(III) species (Liu et al., 2016; Meerburg et al., 2012).

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HYDROMORPHOLOGICAL MONITORING OF FLOWING WATERS IN POLAND- A NEW METHOD BASED ON THE HYDROMORPHOLOGIC INDEX FOR RIVER USING GIS TOOLS

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Keywords: rivers, hydromorphology, monitoring, fluvial ecosystems

The method based on original metric called Hydromorphological Index for Rivers (HIR) was developed in 2017 by the interdisciplinary group of experts from different institutions: Poznan University of Life Sciences, Institute of Meteorology and Water Management - National Research Institute, Warsaw University of Life Sciences, University of Agriculture in Krakow, Adam Mickiewicz University, The Provincial Inspectorate of Environmental Protection in Poznan and Walbrzych and WWF Poland. The method was introduced for the hydromorphological monitoring of flowing waters in Poland in 2018. The method allows assessment of every river types in Poland including both lowland rivers as well as mid-altitude and highland streams. The system can be used to assess the natural and heavily modified rivers as well as artificial channels, and in principle was created as precise, easy to implement and relatively inexpensive.

The basis of the proposed system is a field survey, which is supplemented by analysis of Geographic Information Systems data and remote sensing materials. Field surveys carried out by the proposed system allows to collect large number of parameters describing various hydromorphological attributes of the surveyed river section. The river evaluation and classification is principally based on field survey, which is carried out along a standard 500 m or 1000 m long watercourse site, depending on the river width. Observations are conducted in two stages: first on 10 uniformly distributed spot-check profiles (spot-checks, transects), and later within the sweep-up stage when the entire survey site is considered.

Studies based on Geographic Information Systems and remote sensing materials delivers tens of variables gathered from various databases, mainly public, such as Hydrographic Map of Poland MHP, Geoportal, Topographical Data Base, General Directorate for Environmental Protection (GDEP) Geoservice, et al. It aims to deliver introductory data for the field survey stage. Moreover, the GIS analysis also provide preliminary assessment for those water bodies that are not included in the field survey scheme. A PC or laptop working station with an efficient web

connection is necessary for the preliminary assessment based on GIS resources and remote sensing materials. Specialized software is required, that enables to analyse and visualize vector and raster data, as well as to work with databases. These requirements are fulfilled, among others, by such software as: ArcGIS, QGIS and MapInfo.

Description of the river environment in the system is characterized by objectivity and is well suited for statistical analysis. The method gives repeatable results and is highly resistant to error due to personal factors, so that research carried out by different people have low level of volatility. The studies are based on recording of elements of river environment that can be clearly identified on the basis of the manual and after completion of the several-days training. It is assumed that a person familiar with the method, equipped with the necessary field equipment, is able to perform a survey of the river section in the field in less than two hours.

Basing on the field survey supplemented by analysis of the GIS data and remote sensing materials the complex evaluation of the hydromorphological conditions is gathered, including the principal classification of the hydromorphological status meeting WFD criteria. Analysis of the GIS data and remote sensing materials already enable to estimate the hydromorphological conditions of a river site. This approach enable for preliminary classification of hydromorphological status of non-surveyed water bodies.

Basing on the field survey, the HIR value can be estimated for the considered river site and comparing with the reference conditions the hydromorphological quality status in the five-class system can be calculated. Properly selected, representative survey sites (one or more depending on the heterogeneity of the environment), enable classification and evaluation of entire surface water bodies in the framework of the national environmental monitoring.

Presented system is fully compliant with the requirements of the European Committee for Standardization CEN (Comité Européen de Normalisation) related to WFD. Moreover, the prepared methodology of hydromorphological observations is consistent with the standard EN 14614: 2004 (Water quality – Guidance standard on determining the degree of modification of river hydromorphology) and its Polish counterpart, i.e. PN-EN-14614: 2008.

LANDSCAPE INDICATORS BASED ON REMOTE-SENSING DATA AS A TOOL OF MONITORING ENVIRONMENTAL VALUES OF AREAS OF DIFFERENT LEVEL OF ANTHROPOGENIC TRANSFORMATION

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Key words: landscape indicators, landscape quality, remote-sensing

Landscape indicators based on remote-sensing data (LIRS) are used to concluded on different characteristic of environment including: biodiversity, water quality, evaluation of landscape patterns and their changes and structural complexity. Generally, three kinds of indicators are mostly used: landscape metrics, *indicators based on the variability of spectral data* and geomorphometric indices. The aim of the research was to establish a categorization of LIRS composing of a minimum set of indicators which fulfil the requirements set to any efficient indices which are: reliability, measurability, stability and independence; and to test this categorization in reference to areas of different level of anthropogenic transformation including built-up areas, agricultural areas and forest and semi-natural ecosystems. The set composed of ten indicators including: Number of Patches (NP), Mean Patch Size (MPS), Patch Richness Density (PRD), Class Area Proportion (CAP), Edge Density (ED), Mean Proximity Index (MPI), Modified Shannon's Diversity Index (MSHDI), Mean elevation a.s.l. (ME), Mean elevation difference (MED), *Normalized Difference Vegetation Index* (NDVI). The result showed that a developed categorization allowed to generally concluded on environmental values of analysed areas. Its advantage derives from the fact that may be used in relation to areas of different level of anthropogenic transformation. Indices such as: MPS, MPI and MSHDI occurred to be especially useful. The detailed monitoring, however, need the application on other, not-based on remote sensing data, indicators inter alia related to air, water and soil quality.

PRODUCTION VALUE OF AGRICULTURAL LAND - A FACTOR DETERMINING THE CONSOLIDATION OF LAND - CASE STUDY

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Keywords: cropland, grassland, land consolidation, land classification

The land as a means of work and agricultural production is a very important, if not the most important, good of the farmer. Over the centuries, the spatial structure of the Polish village was shaped by historical, legal, socio-economic, political, economic, technical and demographic conditions. A characteristic feature of the land is the fact that it is a part of nature, used for crop production, but at the same time it is not a product of human labor, which means that it can not be replaced by another means of production or enlargement of its surface. Soil quality is one of the most important factors determining the potential for high income from agricultural activity. The agricultural quality of soils is determined by bonitation classes, and the suitability of soils for growing particular plants or their assemblages - soil and agricultural complexes. For the area of the whole country, a homogeneous soil classification was made, taking into account morphological features and physical properties. This study constitutes a broad descriptive and cartographic material in the form of classification maps made in the scales of the record map. In the study of spatial and economic phenomena of rural areas, the method of grouping individual villages into larger typological units is used due to the similarity of the adopted features. This classification was used in the development of the method of land estimation for the purposes of land consolidation and exchange works. As a utility classification, it can have better use in economic practice by including it in one form as an indicator of production value and than as a soil bonification factor. This is the purpose of the work, which is to calculate the suitability index for arable land and grassland for the purpose of separating similar villages in this area

The research was carried out in 116 villages of the Łęczna powiat situated in the Lublin province. Surface data of individual land classes was obtained from land and building records, and the basis for calculating the indicator were point values assigned in a 100-point work scale.

TESTING THE POSSIBILITY OF TAKING MEASUREMENTS ON OBLIQUE IMAGES

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1. Aim of the study: to check the possibilities of using available data (aerial photographs with available aerotriangulation), without specialist adjustment using software for stereoscopic photogrammetric measurements.

2. Topicality of the study

In recent years, aerial oblique images have become a very popular source of photogrammetric data. The area covered by these views is growing rapidly not only at dawn, but also in Poland. The amount and visibility of details by recording the image at an angle in different directions is greater than in typical vertical photographs. Literature and presentations of dedicated systems indicate the possibility of making photogrammetric measurements. It seems natural to use oblique aerial photographs in independent photogrammetric measurements or as supplementary measurements for measurements using vertical photographs.

3. Materials and software used

The aerial photogrammetric oblique images and aerotriangulation results obtained as part of the project were used for the analysis:

"Making digital, photogrammetric aerial photographs and diagonal photos, developing a numerical terrain model and an orthophotomap with the delivery of a desktop application to manage oblique images and an Internet site for the publication of diagonal images"

Photographs covering the area of Bielsko-Biała were used.

* Photogrammetric oblique images in 4 directions: E, N, S, W:

Standard : : TIFF File

Format : : JPEG Compressed 24 bit RGB data, Q= 4

Pixels per Line : 11608

Number of Lines : 8708

Samples per pixel : 3

File bits per sample : 8

Actual bits per sample : 8

Tiled file, tile dimension : 256

Number of tiles along a row : 46

Number of tile rows : 35

Number of overviews : 9

Overview sampling method: Gaussian

Scanning device resolution : 300 : lines/inch

* Aerotriangulation - ZI Intergraph files independent for each direction of display:

Camera

control

model

photo

project

* Photogrammetry software - ImageStation Stereo Display 2016, Microstation V8i

4. Test fields

60 test fields were designated in the tested area. The test areas have been uniformly distributed over the whole area so that they cover both densely built-up areas and areas with very limited development. Each test field contained from one to several buildings or permanent structures enabling unambiguous interpretation and measurement in the case of correct visibility on the appropriate for stereoparas.

5. Measurement and observation

The measurement was made using the PhotoStation Stereo Display 2016 photogrammetric station in the Microstation environment.

* Unambiguously interpreted measurements were made in the designated test fields and visible details. The measurement was made independently for each direction of the photograph and on each available for a given direction the stereopar on which the test fields were registered.

* Comparison of results was made. * On all the stereopares used, diagonal images (defined in ZI design files) on most models there is a very large parallax. Large parallax causes that only small central fragments of models (on which the parallax phenomenon is the smallest) allow stereoscopic observation and measurement.

* In areas where measurement is possible, the accuracy reaches as much as tens of centimeters compared to photogrammetric measurement based on vertical imaging

* There are very large differences in the measurement of the same elements between consecutive pairs of images in a given direction of camera observation and between observations on stereopares in different camera observation directions.

* Using the software used, the measurements are very time-consuming. Both the measurement itself due to the significant stereopar inclination and the "navigation" itself in the project (various projects for different camera viewpoints) take a considerable amount of time.

6. Summary

The oblique images used in the test along with the results of aerotriangulation do not meet the requirements of photogrammetric measurements and can not be used to carry out stereoscopic measurements. The measurement accuracy achieved in the test, very large differences in the measurements of the same elements make it impossible to use the product in further measurements. The large parallax of the stereopares created and the significant differences in the measurements of the same unambiguously interpreted elements on various stereopares indicate a process of aerotriangulation, unadjusted for stereoscopic measurements.

IMPACT OF ENGINEERED NANOPARTICLES ON MICROBIAL TRANSFORMATIONS OF CARBON, NITROGEN, AND PHOSPHORUS IN WASTEWATER TREATMENT PROCESSES

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Keywords: Wastewater treatment; Nanoparticles; Inhibitory effect; Exposure; Microbial processes

Nanotechnology is one of the fastest developing technologies today. Engineered nanoparticles (ENPs) are typically defined as particles with at least one dimension between 1 and 100 nanometres (nm) in size. The physicochemical and electronic properties, e.g., considerably higher specific surface area, surface reactivity, and increased quantum effect, associated with materials in this size range substantially differentiate these materials from their bulk counterparts (Kumar et al. 2017). Owing to these unique properties, the production and use of ENPs have grown rapidly over the last two decades (Kwak and An 2016) and ENPs have been widely incorporated in numerous consumer and industrial products, e.g. dyes, health care products, cosmetics and food packing materials (Roco 2011, Vance et al. 2015).

Daily water use and disposal may be not free of ENPs, particularly certain metal-oxide nanoparticles. For example, textiles, plastics, and cosmetics are commonly used household products that often contain some ENPs, such as silver nanoparticles (Ag NPs), zinc oxide nanoparticles (ZnO NPs) and titanium dioxide nanoparticles (TiO₂ NPs). The ENPs are released during washing and end up in the wastewater that flows into wastewater treatment systems (Lorenz et al. 2012, Windler et al. 2012). Thus, the use and potential environmental risks of ENPs are subjects of increasing concern, social debate and several government reports. Accordingly, concern regarding the impact and possible risks of these ENPs has led to multiple investigations on their dynamic transport and fate in the aquatic environment (Yang et al. 2014b).

Extensive investigations on microbial transformations of carbon (C), nitrogen (N) and phosphorus (P) in various wastewater treatment systems have been performed and have undoubtedly enabled the mechanisms of such transformations to be more evident in the last few decades. However, understanding of the interactions among C, N, and P might still be insufficient, owing to the

simultaneous complex competition among electron donors and acceptors in their transformation pathways. Besides, the incorporation of ENPs would make their relationship more complex owing to different susceptibilities of the various functional microbial communities to ENP exposure.

The publication record under the scheme of this topic in the Web of Science shows a booming tendency in the last five years, indicating increasing concern from scientists, and shows the increasing transparency of the knowledge “black box”, etc. However, the conclusions drawn from different studies often lead to fragmented overall knowledge, some of which are even contradictory. The recently published reviews in the similar topic have mainly described the advances on the analytical developments of ENPs and discussed the fate of ENPs in the drinking water treatment and wastewater treatment processes (Wang and Chen, 2016; Park et al. 2017; Joo and Aggarwal, 2018). The information on the specific interactions of often reported ENPs among microbial transformations of C, N, and P in different centralized wastewater treatment systems (e.g. activated sludge systems and sequencing batch reactor) and decentralized eco-treatment systems (e.g. constructed wetlands) is still insufficient.

This presentation will introduce the impact of 6 often reported ENPs in 5 types of treatment systems. We found that exposure to most of the investigated ENPs at low concentrations doesn't adversely influence the growth of the heterotrophic microbes, which are responsible for organic matter removal. The impacts of ENPs on various microbial nitrogen transformation processes have been investigated. Dosing of ENPs often causes acute microbial nitrogen removal inhibition at various concentrations, but does not influence long-term operation due to microbial adaption. No significant negative effects on biological phosphorus removal in different wastewater treatment processes have been reported after both short-term and long-term exposure (except copper nanoparticles). Environmentally relevant concentrations of ENPs have been reported to enhance the photosynthetic capacity of wetland plants, whereas chronic inhibition to photosynthesis was found in exposure to high concentrations of ENPs. Inhibition effects are often overestimated in pure cultivated toxicity test assays compared to testing with artificially prepared wastewater containing various ingredients or with real wastewater. Potential ligands in real wastewater can bind with ENPs and lower their dissolution. Some challenges exist regarding detection and quantification techniques of ENPs at environmental concentrations, modeling of engineered nanomaterial release on a worldwide scale, and inhibitory mechanisms to microbial transformations.

IMPROVING FURFURAL TOLERANCE OF RECOMBINANT *E. COLI* IN THE FERMENTATION OF LIGNOCELLULOSIC SUGARS INTO ETHANOL

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Key words: Lignocellulose, Furfural, Ethanol, Fermentation

Lignocellulose is an abundant renewable resource that can be converted into fuels and chemicals by biocatalysts. In contrast to starch, sugarcane, and sugar beet, the use of lignocellulosic residues and short rotation trees would not directly compete with food production. Lignocellulose is designed by nature to resist deconstruction(1). Dilute acid pretreatment of lignocellulose has been widely investigated to increase enzyme access to cellulose and hydrolyze hemicellulose. During this acid pretreatment, small amounts of side products including furans, carboxylic acids, and aromatic compounds are produced that retard microbial fermentation.

Furfural has been shown to cause DNA damage in *Escherichia coli* and to inhibit growth until furfural has been substantially metabolized to the less toxic alcohol. Strategies have been developed to reduce the toxicity of dilute acid hydrolysates. A chromosomal library of *Bacillus subtilis* YB886 was screened to identify *thyA* that increased the furfural tolerance of *E. coli* LY180(2). The enzyme L-1, 2-propanediol oxidoreductase(encoded by *fucO*) is an NADH-linked, iron-dependent group III dehydrogenase. This enzyme has a broad substrate range that includes furfural. Expression of *fucO* from plasmids has been used to improve furfural tolerance in *Escherichia coli* based fermentations for ethanol and lactic acid (3). We relied on site-specific mutagenesis and growth-based selection to identify a *fucO*(L7F) mutant that exhibited a 10-fold increase in cytoplasmic activity and less than 2-fold increase in catalytic efficiency (4), which proved a further increase in furfural tolerance. Thus, overexpression of *fucO* or L7F are beneficial for furfural tolerance in Ethanol fermentation.

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SOME PROBLEMS OF THE MANAGEMENT OF STATE AND PUBLIC SECTOR LAND

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Keywords: public land, resources, global trends, conflicts, information system.

The aim of the research was to present methodological assumptions regarding the management of public real estate resources. A method of expert was used to compare various specific solution (F.A.O., F.I.G., World Bank). Attention was paid to methods of land management according F.I.G and F.A.O. solutions and recommendations. Public real estate models of management and global trends was presented too. Land governance and public land management consists use of land for political influence and extent of land disputes and mechanism for resolution. Three simple categories for land policy indicators were important: tenure security, land access , and governance of land resources. Main land policy principles and themes in international development are very important. Some countries have a tenure called state land, (eg. Poland) , but many do not. Concept of ownership being a bundle of rights and state land varies in quantum of rights. State rents land as well as owning it. Can be long or short lease or license to occupy. Important is relationship between The State and private owners. Public land is often badly managed because there are many different types of public land rights and lack of technical ability to manage these. Other problem is different functions of public land. Public land management is critical factor for ensuring good governance in the land administration of a country. The need of a strategy:

- the objectives of state land differ and require different policies and approaches;
- strategies for acquiring , keeping , and disposing land are very important;
- policies and processes for implementation can be done.

The asset management plan should be dynamic:

- monitored what works or does not (what news policies),
- regularly revised.

Good policies and good management approaches require good information. Decision should be based facts and objective analysis. Good records of property assets are needed. State land is often an area of conflict between different groups and important is raise awareness of risk that can arise from change system of management.

Some recommendations for reduce conflicts related to land was done. Detailed test results have been verified. Main conclusion is that public real estate resource requires a new management method based on the spatial information system (real estate management system).

Public land management system has always been controversial. Important is to adopt new, innovative approach to managing public land to improvement creative solutions. State land and public land have different goals , and different rules about management.

Reforming the management of public land must contribute to deliberate policy and development principles. International cooperation in land management is a necessary step towards harmonization.

POSTERS

ENERGETIC TREATMENT OF CATERING WASTE IN THE PROCESS OF ANAEROBIC STABILIZATION OF MULTICOMPONENT MIXTURES WITH BIOGAS EXTRACTION

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Keywords: catering waste, biogas, energy yield, energetic utilization

Goal of a research. The strong local impact of dispersed energy sources indicates the need to look for solutions to diversify renewable energy sources. Catering waste is a source of biomass rich in carbohydrates and protein. As a source of organic substrates, 20 catering establishments offering food products have been identified. The morphological composition of waste indicates: dairy products, bread, meat, vegetables and fruits.

The goal of the study is to determine the biogas productivity of catering waste and to develop technological assumptions for the local system of electricity and heat production in cogeneration. In the scope of the study the following were specified: determination of the morphological composition of the organic substrate stream, study of biogas productivity on the laboratory scale of a representative mixture of organic substrates and development of technological assumptions for waste biomass management for the group of analysed catering establishments.

Material and methods. Morphological composition was obtained by biomass segregation and determined by weight method. Selected physical properties of biomass were determined with the use of recommendations included in the standards: PN EN 12880: 2004, PN-75/C-04616/01 and PN-EN 12879:2004 The pH of monosubstrates and mixtures was determined by potentiometric method. Biogas efficiency tests (biogas productivity) were carried out in accordance with DIN standard [DIN 38 414-S8] in a multi-chamber fermenter. For the preparation of inoculum was used methanogenic thermostated biostat with a capacity of 1650 ml. The capacity of a single fermentation chamber is 1000 ml. The produced biogas is stored in eudiometer tanks. The capacity of each biogas tank is 1200 ml [KTBL-

Heft-84 2009]. The measurement of biogas components: methane (CH_4 % v/v), carbon dioxide (CO_2 % v/v), hydrogen sulphide (H_2S ppm), oxygen (O_2 % v/v) was performed using the Alter Bio 16 measurement system. Oxygen concentration was tested to control anaerobic conditions on a laboratory scale.

Results and conclusions. The composition of the laboratory mixture was determined on the basis of the percentage of the components of the aggregate sample. A mixture of substrates with the following composition was tested: meat 12.33 % m/m, bread 23.57 % m/m, vegetables 51.65 % m/m, fruit 7.67 % m/m, chicken eggs and egg shells 4.85 %. The dry matter content of the mixture was 10.56 % m/m. The content of organic matter in the mixture was 74.53 % m/m. At the mineralisation level of 22.32 %, the accumulated biogas yield of $329.67 \text{ Nm}^3 \cdot \text{Mg}^{-1} \text{ VS}$ was obtained. In the process of formation of multicomponent mixture the following treatments were used: increase of protein (meat) content by 6.27% m/m, decrease of fibrous vegetables content by 4.17% m/m, use of calcium carbonate as a buffer ingredient. Biogas with an average methane content of 51.74 % v/v was obtained. HRT was 20 days. The obtained data made it possible to analyse the process of total management of the mass of solid substrates obtained from catering establishments ($857.25 \text{ kg} \cdot \text{month}^{-1}$). The daily mass of solid substrates (28.57 kg) hydrated to the moisture of the standard mixture theoretically requires the volume of the reaction chamber of 3.466 m^3 , increased by the factor of the chamber filling (1.25). The biological load index (LRO) of the fermentation chamber will be $3.26 \text{ kg VS} \cdot \text{m}^{-3} \cdot \text{day}^{-1}$. The theoretical average hourly yield for the designed reaction chamber in the HRT period is 140.12 dm^3 of methane.

For the obtained methane volume it is possible to generate heat to support the process of anaerobic utilisation under mesophilic conditions. Taking into account the theoretical hourly methane yield (140.12 dm^3), the combustion of biogas should generate 1.22 kWh of heat. This means that the system has enough heat for the utilization function. To obtain excess energy, the yield of the biogas substrate mix needs to be improved.

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CADASTRAL WORKS PERFECTED IN THE NEW INFORMATION SYSTEM MOLDLIS FROM REPUBLIC OF MOLDOVA. PERSPECTIVES

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Keywords: Geographic Information System, real estate, cadastral works, interoperable, the graphics database

Moldlis is an informational system of real estate in the Republic of Moldova that includes both the registration of real estate and its rights. Moldlis consists of 8 modules and is provided with maximum flexibility and possibility of integration with different existing cadastral systems.

Cadastral work is processed only in two basic modules: Case Management and Graphics Database. Case management is a subsystem, it handles cases and is interoperable with other modules. This subsystem manages the working process with graphical data. No change can be made unless the case is opened in the given module. The Graphical Database is the module that manages graphical objects (the descriptive part and the real estate part), this module contains the tools for creating, modifying and extinguishing them.

A weak point is that the system is not yet fully developed, only the Chişinău, Balti and Anenii Noi localities are currently being introduced in the graphics database, but by employing the qualified staff, the system development will be quickly and qualitatively achieved .

The information system Moldlis in the future offers many opportunities both to the cadastral engineers and to the beneficiaries.

DESIGN AND ANALYSIS OF THE FEATURES OF A TOURIST HIKING TRAIL ON THE TERRITORY OF THE GORGAN MOUNTAIN RANGE

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Keywords: tourist hiking trail; geoinformation technologies, DEM, GPS navigation device

In the Ukrainian Carpathians active tourism is becoming increasingly popular. One way to meet the needs of tourists is to create hiking trails of various complexity and themes. For travellers, the existence of detailed and up-to-date information about the features and parameters of the chosen trail is extremely important for proper preparation for the passage and accompaniment during the journey. In the process of planning, analyzing and plotting of tourist trails, modern geoinformation technologies provide a wide range of opportunities for professionals and ordinary users. Authors consider development of the tourist hiking trail using space images, topographic maps and internet resources of geospatial data. Application of modern geoinformation technologies and geospatial data sources greatly expands the possibilities of designing and filling with useful information of tourist hiking trails.

The aim of the work is to analyse possibilities of modern means of geoinformation technologies for development of tourist hiking trails.

To accomplish this aim the following problems are planned to be solved:

- analysis of theoretical principles and requirements for the creation of tourism products;
- analysis of software products and geoinformation technologies that will be used in research;
- collection and analysis of cartographic and descriptive data on the chosen territory;
- design of tourist hiking trail using the application GPSies;
- carrying out the study of the parameters of the designed trail in the mountain using the Garmin GPSMAP 60cx navigator;
- final formation of tourist hiking trail based on the results of the field study and development of practical recommendations for its passage.

The method. When creating tourist hiking trails it is necessary to take into account a considerable amount of information that will be related to the chosen area. The diversity of these data depends on the purpose and objectives of the trip.

Authors consider the following sources of data: cartographic and geospatial data, remote sensing data, field research data, statistical and literary information. A tourist route was planned and created on the territory of the Gorgan mountain range. The main works were implemented using the website GPSies. GPSies is free program which allows design, view and download tracks which have been recorded by a GPS device. It also has option to download designed trail and put it onto GPS device to use during the travel. Next step was field studies of all segments of the trail. It was done using the Garmin GPSMAP 60cx navigator and software for resulting data processing Garmin BaseCamp.

Results. In the result of the study there were developed tourist hiking trail on GPSies site. The planned trail includes information about length of the trail, height difference, average speed and allows to prepare for future research and correctly calculate the time and resources needed for the travel. Field study was implemented using the Garmin GPSMAP 60cx navigator to collect technical parameters of the designed trail. Additionally there were investigated natural conditions, attraction places, provision by drinking water, availability of transport connection and other. As result the following parameters of the route were defined as length, passage time, average speed, lifting and descent speed, steepness and difficulty of the path, the possibility of occurrence of natural obstacles, availability of places for overnight and sources of drinking water.

Conclusions. There were designed tourist hiking trail in the form of a radial hike from the village of Tatariv to the mountain n valley Khomyak and Mount Khomyak with returning the same way. The study result show that developed trail is recommended for the tourists who are experienced in the mountain hiking. On the basis of the performed researches, authors can conclude that the design of a tourist hiking trail in online environments provides sufficient accuracy of the data to implement these trail into life. But field studies show the importance of provision by additional descriptive information about the peculiarities of the trail, as there are some places with dangerous slopes and other natural obstacles.

CHANGES IN PARTICLE SIZE DISTRIBUTION IN HYDROPONIC LAGOONS WORKING AS A THIRD STAGE OF WASTEWATER TREATMENT

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Keywords: particle size analysis, wastewater treatment, granulometric composition, laser granulometer, hydroponic lagoon

Goal of a research

The aim of research was to evaluate changes in the particle size distribution in two hydroponic lagoons working as a third stage of wastewater treatment. The main reason of conducted research is the need of understanding processes of suspended solids formation and their characteristics during the flow through the hydroponic lagoon. The hydroponic ditch is designed as an artificial river which should provide processes of water self-purification. The main task of plants and other organisms inhabiting this semi-natural environment is to uptake nitrogen and phosphorus compounds to avoid eutrophication in the receiving water bodies. However the flow of wastewater through the ditch can also lead to outflow of excess suspended solids because of algae growth and changes in the agglomerates structure. Information about the size of suspended solids as well as their fractal dimensions gives the wider picture of the nature of purification processes occurring in hydroponic lagoon.

Methodology and scope of a research

The samples of wastewater were collected from two hydroponic lagoons being the third stage of sewage treatment. The research objects were located in the south-western part of Poland, 51°44'N, 15°35'E and 50°27'N, 17°00'E. Wastewater samples were taken twice (during the winter and summer half of the year) from the several sampling points - always from the inflow of biologically purified sewage, the middle points of the hydroponic lagoon and the outflow of treated wastewater. 800 ml of the wastewater sample was then transported to the laboratory to test the granulometric composition of sewage with the use of the Malvern Mastersizer 2000 laser granulometer. To provide homogeneous probe for laser diffraction measurements, the Hydro MU dispersion paddle with stirrer was used. The calculations of fractal dimensions were performed using an Excel spreadsheet prepared by Malvern Instruments Ltd., with a restricted computational procedure.

Highlight o results

In all samples taken from hydroponic lagoons the range of particles size was very wide (less than 0.1 – more than 1000.0 μm). In both of the objects the changes of particles diameters during the flow through the hydroponic ditch in the winter season, were not very noticeable especially in the first sections of the lagoon. The differences occurred at the outflow of the lagoon where in the first object the decrease of particles diameters occurred while in the second object at the outflow the increase of particles diameters was observed. In the summer season the amount of the biggest particles diameters was higher at the outflow in the first object while in the second one the changes were very small so the size of particles can be considered as stable during the flow through the hydroponic ditch. The fractal dimensions (Df) of particles measured in all wastewater samples showed a similar tendency – in general, the Df of particles was smaller at the end of the ditch comparing to the fractal dimension of the particles flowing into the lagoon.

Main conclusions

The analyses of granulometric composition of wastewater flowing through the hydroponic lagoons in two different wastewater treatment plants (WTPs) in the summer and winter half of the year showed a lot of similarities. The changes observed between suspensions from two objects were connected with the differences of hydroponic ditch construction (length, depth, used plants). In the object with shorter hydroponic ditch the differences between amount and size of particles were more noticeable than in the longer one. In both of the WTPs the slight decrease of fractal dimension of particles was observed but still was close to 2.0. The Df of particles close to 2.0 gives an information that the particles shape is not linear (Df = 1.0) but have more developed surface. This information may pay a key role in determination the impact of discharged particles on the receiving water bodies quality as well as can be the main factor that allows to improve the system of suspended solids removal.

A DISTINCTIVE SHAPE OF CADASTRAL PLOTS BORDERING THE RIVER MŁYNÓWKA IN STRZELCE WIELKIE

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Keywords: morphological analysis, cadastral map, parcel shape

Morphological analysis is a widely used method, applied in many scientific disciplines: geodesy and cartography, geology, medicine, biology or in urban geography. In geodesy and cartography mathematical morphology refers to a method for the analysis of spatial structures based on the images obtained from remote sensing devices. The term “morphology” means studying geometric properties of objects in space, whereas “mathematical” suggests using for this purpose mathematical tools from such areas as: set theory, topology, stochastic geometry and bar modeling. In recent years many studies have shown that morphological analysis of digital cadastral maps provides information on the urbanization levels of areas under examination. A cadastral parcel was the basic area unit used in the analyses.

This paper presents the morphological analysis of the structure created by the borders of cadastral parcels located in Strzelce Wielkie. In particular, the relationship between the perimeter and the area of the parcels bordering the river Młynówka river flowing through the town was determined. The analysis indicates that a typical parcel situated on the river Młynówka has a significantly elongated shape similar to the shape of parcels located in urban areas. The urban areas were located in five cities. The calculated coefficient of plot shape demonstrates that parcels bordering the river are seen as attractive and that the river bank is used in the most optimal way.

QUANTITATIVE CARTOGRAPHIC METHODS IN REAL ESTATE MARKET ANALYSIS

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Keywords: Real estate, cartographic analysis, geoportal

The amount and accessibility of information property valuers can use in the process of the real estate valuation has increased with the development of informatization. Market analysis is the first stage of this process. It aims at the identification of factors influencing the real property value. Market analysis consists in determining the characteristics of the area where the real property is located and finding features that have significant impact on the value of the property. The results of market analysis, the availability and the amount of data may affect the selection of a valuation method.

Having a database with all transactions made on a specific market, most often obtained from the Register of Real Estate Prices and Values, one needs to choose a database of representative real properties. It needs to be done according to clearly defined criteria. This stage of the analysis is most time-consuming; however the correctness of all subsequent analysis depends on the reliability of this first selection.

This paper discusses using quantitative cartographic methods in the analysis of undeveloped land properties located in the cadastral territory of the Municipality of Zakopane. These data refer to sale and purchase transactions of undeveloped land properties between January 2011 and December 2015. Quantitative cartographic methods were applied in order to demonstrate the importance of the reliable selection of representative real properties and its impact on the acquisition of information about the real estate market under examination. These methods were also used to investigate the spatial distribution of the transactions and of the unit prices of undeveloped land properties. Cartographic analysis was conducted using the ArcGIS software and maps available on the Tatrzański Municipal Geoportal.

THE STATE AND NEEDS OF THE DEVELOPMENT OF WATER SUPPLY AND SEWERAGE INFRASTRUCTURE IN THE RADZYŃ DISTRICT

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Key words: water supply network, sewerage network, collective wastewater treatment plants, household wastewater treatment plants, septic tanks

The state of water supply and sewage removal systems is an important indicator of civilization development. In addition to the ecological and economic effects, the development of the sanitary infrastructure brings many benefits of a social and economic nature, as it contributes to improving the living conditions of the inhabitants and the development of entrepreneurship.

The paper presents the current state of water supply and sewerage infrastructure and the need for expanding this infrastructure in Radzyń District. The district is located in the northern part of Lublin Voivodeship. The following communes belong to Radzyń District: the municipal commune of Radzyń Podlaski and 7 rural communes: Borki, Czemierniki, Kąkolewnica, Komarówka Podlaska, Radzyń Podlaski, Ulan Majorat, Wohyń. The analyses were carried out using the official statistical data and the results of surveys conducted in 2016 by the employees of the Department of Environmental Engineering and Geodesy of the University of Life Sciences in Lublin. The scope of the survey included the number of inhabitants, the number of collective wastewater treatment plants with a capacity of more than $5 \text{ m}^3 \cdot \text{d}^{-1}$, the number of household wastewater treatment plants, the number of active septic tanks and the length of the water supply and sewerage systems.

The data show that the water supply network in Radzyń District is well developed. The most significant percentage of the population using the water supply network has the rural commune of Radzyń Podlaski – 99.9%, while the smallest, commune Komarówka Podlaska – 54.5%.

The survey showed that there was a very large disproportion between the development of the sewerage and water supply systems. The largest percentage of the population using the sewerage network has the municipal commune of Radzyń Podlaski – 99.7%. The smallest percentage of users of collective sewage disposal

systems was recorded in the rural commune of Radzyń Podlaski (7.2%). The commune of Ulan-Majorat does not have a sewerage system. The survey conducted in 2016 shows that 8 collective wastewater treatment plants operated in Radzyń District at that time. The total capacity of the treatment plants is over $5,300 \text{ m}^3 \cdot \text{d}^{-1}$. In 2016, Radzyń District had about 1,000 household wastewater treatment plants.

The presented data show that the condition of the sanitary infrastructure in rural communes of Radzyń District is unsatisfactory and requires the investment activities mainly aimed at expanding collective sewage disposal and treatment systems as well as developing a network of household wastewater treatment plants.

REMOVAL OF TEXTILE DYE (RBBR) FROM WATER ENVIRONMENT BY FUNGI FROM LIGNOCELLULOSIC COMPOSTS

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Keywords: textile dye, Remazol Brilliant Blue R, water environment, *Trichoderma* sp., peroxidase activity

An inherent part of the industry is burdensome and harmful by-products, which are still an unresolved problem due to the lack of safe and effective ways of their removal and management. The textile industry, apart from processing raw materials into fibers, fabrics or knits, produces colored wastewater as by-products containing various pollutants, *inter alia*, dyes among which, anthraquinone dyes such as remazolic blue are one of the most important. Remazol Brilliant Blue R (RBBR) belongs to these harmful textile dyes, which, after getting into the waters, destroy living organisms. Existing physico-chemical methods of removing these pollutants are not environmentally friendly because they contribute to the formation of secondary toxic colorless products. Biological methods are the environmentally friendly, alternative methods of decolorization of post-dye wastewater. Currently, many scientific centers are searching for effective strains of microorganisms that can be used in the decolorization and detoxification of post-industrial wastewater. *Trichoderma* sp. strains, which are hydrophilic fungi that grow well and sporulate in the aquatic environment, including wastewater, seem to be very promising in this regard. Especially those that are isolated from natural environments rich in lignocellulosic organic matter. There is a connection between ligninolytic capabilities of fungi and the ability to biodegrade other aromatic combinations, including color compounds.

The aim of the work was to evaluate the abilities of six strains of the genus *Trichoderma*, selected from lignocellulosic composts, to remove anthraquinone dyes from the aquatic environment. Selected strains: *T. asperellum* Samuels, Lieckf. & Nirenberg, *T. lixii* (Pat.) P. Chaverri, *T. harzianum* Rifai and 3 *T. citrinoviride* Bissett strains were identified to the species using molecular methods (nucleotide sequences) and traditional methods (phenotypic traits). The nucleotide sequences of the identified strains were submitted to GenBank. The biodegradation abilities of the tested *Trichoderma* strains were evaluated in aqueous solutions obtained after

cultures containing 0.02% Remazol Brilliant Blue R (RBBR) as a substrate. Periodically, the percentage of RBBR decolorization was determined as a reliable indicator of detoxification of anthraquinone dyes and the activity of horseradish peroxidase, superoxide dismutase and xylanase was also determined. The concentration of phenols and the pH of the post-culture liquid were also measured. In order to show the relationship between the analyzed parameters, a correlation analysis was used at the significance level of $p < 0.05$.

On the basis of the obtained results, it was found that the highest RBBR decolorization abilities showed *Trichoderma asperellum* and *T. harzianum* strains. Darkening of the medium was observed in *Trichoderma citrinoviride* strain cultures. It was also shown that RBBR decolorization significantly increased with the higher peroxidase activity and was significantly negatively correlated with the appearance of low-molecular phenols. The dynamics of changes in horseradish peroxidase activity, superoxide dismutase and xylanase in aqueous post-culture solutions of the tested fungal strains depended significantly on culture duration as well as on the strains themselves. It was found that peroxidase activity in cultures of *Trichoderma asperellum* strains was highest for the first 14 days of the experiment; in cultures of three *T. citrinoviridae* strains on week 16 and 20 and in *T. lixii* and *T. harzianum* cultures at the end of the experiment, i.e. on day 28 and 32 of the culture. Superoxide dismutase in *T. lixii* and *T. citrinoviride* cultures reached the highest level up to the 16th day of culture. High activity of this enzyme was recorded after day 20 in *T. asperellum* and *T. harzianum* cultures. The activity of xylanase in cultures of all fungal strains was high till day 12 of the culture. This was confirmed by the significantly negative correlation between the activity of this enzyme and duration of the experiment. Furthermore, it was shown that the level of hydroxyphenols and methoxyphenols was significantly negatively correlated with the activity of enzymes in the studied post-culture liquids and was significantly higher on days 28 and 32 compared to the initial dates which indicated progressing RBBR biodegradation.

Fungi of the genus *Trichoderma*, in particular *Trichoderma asperellum*, through the high percentage of Remazol Brilliant Blue R decolorization, release of redox enzymes and low-molecular phenolic compounds, can catalyze the biodegradation and detoxification of colored anthropogenic pollutants of aromatic structure. In addition, the high ability of *Trichoderma* adaptation to the aquatic environment, including sewage, provides them an advantage over other fungi in the bioremediation of aquatic environments.

EFFECT OF THE FLAX FIBERS ON THE MECHANICAL AND BIODEGRADABILITY PROPERTIES OF BIOCOMPOSITES BASED ON PLASTICIZED STARCH

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Keywords: biocomposite, biodegradation, flax fiber, starch, plastics

On the market in the European Union from 2021, it will not be possible to produce disposable products from traditional plastics, such as cutlery, plates, straws, a stirrer for beverages and chopsticks. These materials should be replaced with biocomposites obtained with the use of plant materials, which will ensure their biodegradability and energy recovery. Given the above, the production of biocomposites was proposed and their studies were planned stating the suitability as an all-alternative material for the above products. Biocomposites were obtained in the process of extrusion of plasticized starch with the addition of fine flax fiber in a share from 10% to 30% of dry weight of starch. As a plasticizer, technical glycerine was used, in a share of 20% of dry weight of starch. A modified single-screw extruder was used to produce the samples of biocomposites. The extruder was equipped with a raw material dispenser, a plasticizing system consisting of a compression screw (rotational speed 60 rpm⁻¹), a heating element (temperature 60–130 °C) and a cooling system. The finished product had the shape of a tube with a diameter of 17 mm and a thickness of 1.5 mm. In the first step, these products were subjected to bending tests and mechanical impact tests. The test results were compared for traditional plastic materials. The samples were then subjected to biodegradability tests under anaerobic conditions. The research was carried out in a laboratory bioreactor (BioReactor Simulator BRS, Bioprocess Control, Sweden) with an automatically controlled mixing system of the charge and measurement of the amount of separated biogas. The methane fermentation process was carried out in thermophilic conditions (temperature 55 °C) with continuous mixing of the batch. The experiment was conducted for four weeks. The biogas potential and

biodegradability of specific biocomposites introduced into the bioreactor were determined. All samples tested proved to be very susceptible to biodegradation and were completely degraded within 20 days of the experiment. High biogas potential and high concentrations of methane in biogas were obtained. It was found that the tested biocomposites can be utilized in energy recovery processes in installations used for biogas production.

STUDY OF THE APPLICATION OF FLOATING BEDS OF MACROPHITES (*VETIVERIA ZIZANOIDES* AND *PHRAGMITES AUSTRALIS*) IN PILOT SCALE FOR THE REMOVAL OF HEAVY METALS AND OF ÁGUA FORTE STREAM IN THE ALENTEJO REGION (PORTUGAL)

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Keywords: Eco-rehabilitation; Macrophytes; Floating bed; Metals.

In the South Alentejo region (Portugal), the surrounding area of Roxo stream features sections completely sterile, calling into question the productivity of agricultural activities there located. This may be due, in addition to others, to the affluence of the Água Forte stream, which contains heavy metals from the Acid Mining Drainage (AMD) of the former deposits of the Aljustrel mine. In view of this situation, it is considered relevant to solve this problem, using effective solutions for the removal of pollutants and environmentally sustainable.

Eco-rehabilitation projects for surface watercourses aim to remedy these modified and degraded bodies of water. River rehabilitation and restoration covers a wide range of measures, with a common emphasis on the natural functions of rivers, which may have been lost or degraded by human intervention. The aim of this work is to test at a pilot scale the possibility of using floating beds constructed with recycled materials and two species of macrophytes (*Vetiveria zizanioides* and *Phragmites australis*). For this purpose, a pilot plant was built consisting of three tanks, where floating beds were installed, water quality and macrophyte performance were monitored and evaluated.

The results show a good performance of the pilot plant, with a decrease in the heavy metals in the water of the tanks of *Vetiveria zizanioides* and *Phragmites australis*, namely: Cu (69%); Zn (63%); Fe (29%) and Mn (38%). In *Vetiveria zizanioides* and *Phragmites australis* follicular growths were 1.65 ± 0.825 and 0.5 ± 0.25 cm / month and in the root part 0.56 ± 0.28 and 1 ± 0.5 cm / week, respectively, evidencing the ability to survive in waters containing AMD without the occurrence of severe damage in external morphology and anatomy, although its growth has been inhibited. However, a good removal capacity of the heavy metals was verified by the macrophytes. It was concluded that the floating bed system is an environmentally sustainable alternative, allowing a greater removal of heavy metals in the long term, in order to comply with the recommended maximum values (MRV) existing in Portuguese Legislation (Decree -Law nº236/98) for irrigation.

**THE INFLUENCE OF SALT USED FOR ROADS DE-ICING
ON CHLORIDES AND SULPHATES CONCENTRATION
IN THE BYSTRZYCA RIVER ON THE AREA OF LUBLIN CITY**

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Keywords: chlorides, sulphates, salt, river, water quality

In recent years, there has been observed a significant increase in the concentration of sodium and chloride ions in surface waters located in the neighborhood of roads. Application of salt for de-icing is the main contributor to degradation of the quality of surface and subsurface water. Excessive use of sodium chloride causes not only irreversible changes in the natural environment and corrosion of cars but also damages the road surface. The continuous development of road infrastructure increases the use of road salt and at the same time contributes to some negative ecological effects. Roads de-icing is, however, a necessary measure for proper road maintenance in winter in countries with a moderate and cool climate.

The aim of this work is to evaluate the influence of salt used for roads de-icing on the concentration of chlorides and sulphates in the Bystrzyca River in Lublin.

The research was carried out in 2018-2019. As a part of the study, samples of water from the Bystrzyca River were collected from 9 characteristic points in Lublin, along the roads with high traffic density and under bridges over the river. In the analyzed water samples there were determined such indicators as: pH of water, temperature, electrolytic conductivity and the concentration of chlorides and sulphates. Physical and chemical analyzes of water were made according to commonly used methods.

On the basis of the initial tests that were carried out, there was found an increase in the content of chlorides, sulphates and electrolytic conduction along with the course of the Bystrzyca River. It was also shown that the highest concentrations of these indicators were observed during the winter months, in which the largest amounts of road de-icing salts were used (January, February, March).

In order to protect surface water against salinity caused by salt used for roads de-icing, it is necessary to take appropriate measures that will prevent degradation of water quality. For this purpose, for example, it is recommended to apply halophilous plants on roadsides and street nature stripes. It is also necessary to look for new chemicals that will be cheap in production and will not have a negative impact on the quality of surface and groundwater.

EFFECTIVENESS OF CONTAMINANTS REMOVAL IN THE SUMMER AND WINTER SEASON IN A SMALL SEWAGE TREATMENT PLANT OPERATING BASED ON THE TRICKLING BIOFILTERS TECHNOLOGY

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Keywords: trickling biofilters, denitrification, small sewage treatment plant

This study aimed to evaluate operation technology and functioning of facilities for the treatment of municipal sewage in a small wastewater treatment plant operating based on the trickling biofilters technology, in the winter (February) and summer (June-July) periods. Additional analyses were conducted to determine the effectiveness of contaminants removal in particular facilities of the technological system tested. Study results indicate that the sewage treatment plant operating based on the trickling biofilters technology ensures effective removal of organic compounds, total nitrogen, total phosphorus, and total suspended solids. In the summer period, the effectiveness of contaminants removal reached 92%, 52.9%, 97.9%, and 99.9%, respectively, whereas in the winter season it was lower and reached 69.5%, 12.4, 93.0, and 95.0%, respectively. Treatment effectiveness achieved in this study was referred to results of investigations conducted in the same sewage treatment plant 24 years ago. Results obtained may provide a valuable guideline to designers and operators of small sewage treatment plants.

CONCENTRATIONS OF ORGANIC AND BIOGENIC POLLUTANTS IN WASTEWATER AFTER MECHANICAL TREATMENT IN THE ASPECT OF BIOLOGICAL REACTOR DESIGN

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Keywords: wastewater, organic and biogenic pollutants, mechanical treatment, bioreactor design.

The aim of the study was to determine the concentration of organic pollutants expressed by BOD₅ and COD as well as the concentration of biogenic pollutants expressed by ammonium nitrogen, total nitrogen and total phosphorus in wastewater after mechanical treatment which is then subject to biological treatment. The obtained results should contribute to calibration of computer programs which support the design of biological reactors that use activated sludge technology. In addition, the quantities of the analysed indicators in raw wastewater were determined in order to calculate their reduction rate in the mechanical treatment process. Additionally, the susceptibility of wastewater after mechanical treatment process to biological degradation of organic and biogenic pollutants was analysed. The study was conducted over a period of 24 months in the years 2017 and 2018. In the given period, 112 samples of raw wastewater and after mechanical treatment were collected and subjected to physicochemical analysis. Pollutants in wastewater were determined by the following indicators: BOD₅, COD, ammonium nitrogen, total nitrogen and total phosphorus. Raw wastewater samples were taken from a well before the technological sequence and the wastewater samples after mechanical treatment were collected from the sewer which discharged wastewater from the primary settling tank. The wastewater analysis was carried out in accordance with the reference methods defined in the Regulation of the Minister of the Environment which were in force during the research period. The investigated wastewater treatment plant in Nowy Scz was designed for typical daily inflows: $Q_{av,d}=30\,000\text{ m}^3\cdot\text{d}^{-1}$ and 120 000 Population Equivalent (PE).

In the work, the amount of pollutants in raw sewage was verified so as to determine the type of incoming sewage. In the next stage of the analysis, the characteristic values of the analyzed indicators in wastewater after the mechanical treatment process were determined. Based on the analysis, it was found that in raw sewage the median BOD₅ was $567.8\text{ mgO}_2\cdot\text{dm}^{-3}$, COD – $1686.0\text{ mgO}_2\cdot\text{dm}^{-3}$,

ammonium nitrogen - $78.0 \text{ mgNH}_4 \cdot \text{dm}^{-3}$, total nitrogen – $109.5 \text{ mgTN} \cdot \text{dm}^{-3}$ and total phosphorus – $21.3 \text{ mgTP} \cdot \text{dm}^{-3}$. Based on the results of the tests, it was found that the values / concentrations in the raw sewage corresponded to the concentrations typical for domestic wastewater. Values and concentrations in wastewater after mechanical purification expressed in median were as follows for BOD_5 was $356.4 \text{ mgO}_2 \cdot \text{dm}^{-3}$, COD – $1108.4 \text{ mgO}_2 \cdot \text{dm}^{-3}$, ammonium nitrogen – $49.0 \text{ mgNH}_4 \cdot \text{dm}^{-3}$, total nitrogen – $87.6 \text{ mgTN} \cdot \text{dm}^{-3}$ and total phosphorus – $17.5 \text{ mgTP} \cdot \text{dm}^{-3}$. The COD / BOD ratio in sewage after mechanical purification was on average 2.5 and at the same level was the median. In the case of the COD / BOD5 dependence, it was found that in almost 9% of cases, wastewater is not susceptible to automatic biodegradation. In the case of BOD_5 / TN dependence it was found that in 21% of cases sewage flowing into the bioreactor is not susceptible to the biodegradation of total nitrogen. The dependence of BOD_5 / TP in mechanically treated wastewater indicates that 13% of cases are not susceptible to biodegradation of total phosphorus. In order to intensify the processes of biological wastewater treatment in the bioreactor, in the periods of low content of organic compounds (BOD_5) in the sewage inflowing, an additional source of easily decomposed organic carbon, e.g. sewage from a distillery, should be added.

OPTIMIZATION OF THE PERCENTAGE OF SEWAGE FROM SEPTIC TANKS FOR STABLE OPERATION OF A WASTEWATER TREATMENT PLANT

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Keywords: wastewater, sewerage system, septic tanks, organic and biogenic pollutants.

The aim of the study was to determine optimal amount (percentage) of the sewage from septic tanks that may be mixed with the sewage transported via the sewerage system without causing large fluctuations in organic pollutants content in the total amount of sewage undergoing treatment.

- The analysis covered:
- quantity and quality of the sewage from septic tanks,
- quantity and quality of the sewage supplied via sewerage system, effects of quantity and quality of the septic tank sewage on general quantity and quality of treated sewage.

Quantity and quality of the septic tank sewage and the sewage supplied via the sewerage system were monitored 2014-2016 years. During this period, 4 samples of each type of sewage were collected and analyzed at monthly intervals.

The data on COD, BOD₅ Total Nitrogen and the amount of the sewerage system and septic tank sewage were used to calculate the values of these indicators in the mixture of sewage undergoing treatment. This was performed using a weighted average represented by the following formula (1):

$$S_x = \frac{W_1 \cdot Q_1 + W_2 \cdot Q_2}{Q_1 + Q_2} [\text{mg} \cdot \text{dm}^{-3}] \quad (1)$$

where:

S_x – value of the indicator in the sewage mixture ($\text{mg} \cdot \text{dm}^{-3}$),

W_1 – value of the indicator in the sewerage system sewage ($\text{mg} \cdot \text{dm}^{-3}$),

W_2 – value of the indicator in the septic tank sewage ($\text{mg} \cdot \text{dm}^{-3}$),

Q_1 – amount of sewerage system sewage ($\text{dm}^3 \cdot \text{d}^{-1}$),

Q_2 – amount of septic tank sewage ($\text{dm}^3 \cdot \text{d}^{-1}$).

The data on the share of both types of sewage in total amount of sewage and on organic and biogenic pollution (BOD₅, COD and Total Nitrogen) were used to carry out an analysis of partial correlation. The aim of this analysis was to determine the effect of two independent variables, i.e. the share and value of the specific indicator, on the value of this parameter in mixed sewage undergoing treatment.

Partial correlation analysis for BOD₅ revealed that the value of this parameter in the mixed sewage was affected by both the amount of septic tank sewage (%) and BOD₅ in this type of sewage. However, partial correlation results suggested that BOD₅ in the mixed sewage was to a greater extent affected by the percentage of septic tank sewage than by BOD₅ in this type of sewage. The effect of percentage share of septic tank sewage on BOD₅ in the sewage mixture amounted to $R_c=0.93$, and the influence of BOD₅ in the septic tank sewage on BOD₅ in the total amount of sewage equaled to $R_c=0.71$. According to a scale described the first correlation is nearly perfect, and the second is very high. COD was found to be more dependent on the percentage of septic tank sewage in the sewage mixture and correlation of these two parameters was $R_c=0.94$. The value of COD in the sewage mixture depended on its value in the septic tank sewage that was $R_c=0.73$. According to the above-mentioned scale, the correlations of these variations were nearly perfect and very high, respectively. Total Nitrogen was found to be more dependent on the percentage of septic tank sewage in the sewage mixture and correlation of these two parameters was $R_c=0.87$. The value of Total Nitrogen in the sewage mixture depended on its value in the septic tank sewage that was $R_c=0.64$. According to the above-mentioned scale, the correlations of these variations were nearly perfect and very high, respectively. All Significance of the resulting correlation coefficients was determined using Student t test for significance level of $\alpha=0.05$. The correlations were proved significant in both cases.

The level of organic pollutants, expressed by BOD₅, COD and Total Nitrogen, was many times higher in the septic tank sewage than in the sewage transported via the sewerage system. Partial correlation analysis showed that variability and fluctuations of organic and biogenic pollution in the sewage mixture depended to a greater extent on the percentage of septic tank sewage than on the level of organic pollution in this sewage. With basic data on the quantity and quality of the sewage transported via the sewerage system and septic tank sewage, optimum percentage of septic tank sewage may be determined for any treatment system. In the analyzed wastewater treatment plant the percentage of septic tank sewage in the total volume of treated sewage should be around 5%.

INFLUENCE OF SURFACE WATERS ON BIODIVERSITY OF FOREST HABITATS

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Keywords: biodiversity, phytosociological, floristic indicator, surface waters

Forests in Poland belong to one of the most complex and richest ecosystems. Thanks to their natural features to neutralize pollutants or decompose organic matter, they affect not only their internal microclimate, but also distant areas, affecting the general state of the biosphere. They store water, purify the air, smooth climate and are a mainstay for native flora and fauna. Water, on the other hand, gives shape to forest ecosystems, affects their stability, durability and diversity.

The aim of the study was to determine the impact of water resources on biological diversity of forest biocenoses, by determining the species composition of the studied phytocoenoses and comparing them with adjacent habitats. Seven habitats located close to various hydrological objects, including natural and artificial water reservoirs, wetlands, peat bogs, drainage channels, rivers and springbeds, were subjected to direct phytosociological research (using the Braun-Blanquet method).

Periods of abundant rainfall contributed to the permanent open water table in the examined hydrological objects. Saturation of the ground therefore, created optimal conditions for the formation of phytosociological and ensured a constant water level in the studied habitats, preventing them from dehydration. The observations showed that the diversity of forest communities associated with hydrological objects is much larger compared to typical forest habitats due to the co-occurrence of phytocoenoses of floodplains and swamps. The analyzed indicators of biodiversity (Margalef, Shannon and Shannon-Wiener), despite the same level of groundwater assumed different values. The lowest value (1.75, 0.76) assumed poorer habitats related to drainage channels, and the highest ones were related to occurrence of rivers (8.82, 3.83) and springs (8.10, 3.52).

IMPACT OF RESTORATION OF RAISED BOGS ON THE QUALITY OF PINE STANDS

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Keywords: peat bog; restoration; humidity; water; forest stand quality

In the natural environment, the key factor for biodiversity development is water availability. As a result of natural processes and the human impact, the natural balance is often disrupted. These negative processes also impact peat bogs. In view of significant changes in the structure of peat ecosystems that have occurred as a result of peat bogs draining, in recent years a number of activities have been undertaken to restore degraded ecosystems and/or reconstruct the most valuable, and at the same time, the most strongly dehydrated ecosystems. The main aim of the conducted research was to show effects restoration of three raised bogs (Gązwa, Zielony Mechacz and Sołtysek) located in the Warmian-Masurian Voivodeship in Poland, where restoration works were carried out in 2012-2013. A comparative analysis of hydrological conditions based on quantitative and qualitative assessment of water resources was made. Analysis of changes in water resources was performed as a result of restoration and their impact on the quality of pine stands (*Pinus sylvestris* L.) growing on peat bogs and in their immediate vicinity. Trees growing in the bog area grew very poorly to the thickness compared to their non-wetlands in the same age, where they achieved even 3-4 times larger diameters. Trees that grow on the peatland reached more than 70% smaller dimensions than trees growing outside that area. Over last 20 years, the average diameter of birch trees outside the bog increased by almost 10 cm, while trees within the bog area did not increase breast height DBH by as much as 1 cm. The obtained results clearly indicate an increasing tendency of decreasing annual growth of pine on the studied peatlands. The reason for limiting the growth rate of pines is the increase in humidity caused by drainage operations. As a result of the drainage operations carried out, the water in the closest vicinity of the peat bogs also increased, which resulted in a slight reduction in the growth of the pine growing on the adjacent habitats.

RARE EARTH ELEMENTS ACCUMULATION IN *TARAXACUM OFFICINALE* COLLECTED IN URBAN AREAS OF PRISTINA (KOSOVO) AND POZNAN (POLAND)

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Keywords: rare earth elements, soil contamination, *Taraxacum officinale*, bioaccumulation, translocation

Rare earth elements are called „industry vitamins” due to their use in modern IT technologies. Their properties make possible to improve the physic-chemical and mechanical properties of modern materials as well as to decrease the weight of the IT devices. The exceeded extraction and import of these elements, especially in China caused an increase of their concentration in environment, both at areas directly connected with the anthropogenic activity and in ecosystems not treated by human activity. Moreover, several publications brought different information about their real biological role. As far, there is no limit determined for these elements in environmental components and for human health, so it is important to monitor their concentration in environment and evaluate their role for living organisms.

The aim of the study was to evaluate accumulation of rare earth elements (REEs) in dandelion (*Taraxacum officinale*) collected from urban areas of Pristina and Poznan. For this purpose the samples of leaves, roots and soil were collected in each city from 10 research sites. Experimental sites were selected nearby typical facilities for big cities like: airport, old town, motorway, high-density housing areas, lake, park, rural areas, low-density housing areas, big river and train station.

All elements were analysed by inductively coupled plasma optical emission spectrometry followed by microwave-assisted sample digestion by concentrated nitric acid. To characterize the ability of bioaccumulation and translocation of REEs in plants three indicators were calculated: bioaccumulation factor (BAF), translocation factor (TF) and contamination factor (CF). PCA analysis was applied for visualisation relations between REEs accumulation in plants and research sites.

Based on our results we can conclude, that *Taraxacum officinale* can represent divers level of REEs accumulation in samples collected from various sites in two different cities. The accumulation was related to land use nearby the sampling site and to soil contamination.

EFFECTS OF IBUPROFEN AND VENLAFAXINE ON BEHAVIOURAL PARAMETERS IN FRESHWATER BIVALVE *UNIO TUMIDUS*

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Key words: Ibuprofen, Venlafaxine, biomonitoring, *Unio tumidus*

The aquatic ecosystems pollution by pharmaceuticals is presently recognized as a serious threat. The therapeutic agents may contaminate aquatic ecosystems via sewage discharges as well as improper disposal or industrial waste. Very few studies focused on the effects of pharmaceutical pollutants on behaviour of invertebrates. In this study the effects of venlafaxine and ibuprofen on activity of the *Unio tumidus* were studied. The study based on the series of laboratory experiment with the use of rge standard Biological Early Warning System. The changes in shell movements were measured by a Hall sensor (a transducer for magnetic field strength) and small ferrite magnet, connected to each other. All shell movements were measured continuously and recorded by software. Changes in behaviours were analysed at concentrations such as in wastewater discharged into surface waters (3.4, 6.8 and 13.6 $\mu\text{g l}^{-1}$). At dosage of 3.4 $\mu\text{g l}^{-1}$, ibuprofen affected the activity time and shell opening level. The reduction in activity was particularly evident during the first few days. The same dose of venlafaxine caused hyperactivity of bivalves during the first few days of exposition. The highest doses (13.6 $\mu\text{g l}^{-1}$) same drugs promoted reduction of activity and shell opening level. Moreover, exposure to these pharmaceuticals resulted in the reduced water filtering time and hence its purification. The effects shown by these therapeutic drugs on *Unio tumidus* may reflect potential negative effect for the other aquatic species.

THE POSSIBILITIES OF USING THE FIBROUS NATURAL MATERIALS AS ABSORBENTS FOR REMOVING ALIPHATIC HYDROCARBONS (C₇-C₁₅) FROM AN AQUEOUS SOLUTION

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Keywords: sorption, hydrocarbons, broadleaf cattail seeds, peat, coconut fiber, mercerization

Sorption of oil-related products (including mainly the propellants) is the very basic process that counteracts spreading these types of pollution into environment. Plenty of synthetic substances (including the monoaromatic hydrocarbons) must be removed both from the surface and underground waters. The aim of this study was to present the research's results on the possibilities of using natural fibrous materials (also waste materials): broadleaf cattail (*Typha latifolia* L.) seeds, peat and coconut fiber as a sorbents of aliphatic hydrocarbons from an aqueous solution. In order to increase sorptive capacity, tested materials was submitted for the process of mercerizing in hot (80°C) water. The removal of aliphatic hydrocarbons (C₇-C₁₅) dissolved in water was carried out by means of the "batch method". All the conducted experiments have shown a high sorption level of the analysed pollutions from an aqueous solution. The best sorptive qualities appeared for the peat. Total sorption capacity obtained for coconut fiber was lower than in case of peat, but the worst sorption properties was noted for broadleaf cattail seeds. The process of the seeds mercerizing that was conducted with the use of hot water appeared to be most effective in case of seeds.

Used natural fibrous materials appeared as effective, and (except of peat) environmentally friendly and economically sorbents of hydrocarbons from water solution.

INFLUENCE OF MORPHOMETRIC PARAMETERS OF MIDFIELD RESERVOIRS ON BIOACCUMULATION OF HEAVY METALS BY *TYPHA LATIFOLIA*

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Keywords: water reservoirs, heavy metals, bioaccumulation, *Typha latifolia*

There is a correlation between the quality of water and the content of substances in aquatic plants. Therefore, plants can be used to monitor the content of heavy metals and other pollutants in water. In addition, in aquatic ecosystems, where the inflow of pollutants is often discontinuous, analysis of plant tissues provides information on water quality during the period considered. Bioaccumulation of metals depends on many biotic and abiotic factors, such as pH, temperature and the amount of ions dissolved in water. It also differs between plant species. The macrophytes rooted in the bottom can accumulate pollutants at a higher level regardless of their content in the aquatic environment. The research covered 7 field water reservoirs located in north-eastern Poland (N: 54°08', E: 20°36') in the south-western part of the mezoregion of the Sępopolska Plain. The is used agriculturally. About 20 years ago, drainage was done on it, and the water reservoirs occurring in depressions were deepened. The aim of the research was to determine the influence of selected morphometric parameters of deepened water reservoirs and characterize their catchment on the ability to accumulate heavy metals in a *Typha latifolia*. The assessment was made using Bioaccumulation Factor (BF) and Translocation Factor (TF). The degree of overgrowth of the coastline of water reservoirs depended on their size as well as the basin area. A lesser impact on the amount of vegetation in the reservoirs was their depth. The depth of the reservoir and its basin area had the greatest impact on the content of heavy metals in bottom sediments. Smaller amounts of metals were found in bottom sediments of lakes with small depths and volumes of water, supplied from a small basin area. The bioaccumulation of iron in the roots and leaves of the broadleaf club was influenced by the size of its catchment, affecting the conditions of its inflow to the reservoir. In small and at the same time deep reservoirs, the smallest values of Bioaccumulation Factor Mg, K, Fe and Zn and Mn were found in plant roots. The study was supported from the EU ERANET 2017 Water JPI Joint Call project "Water Harmony-Closing the Water Cycle Gap With Harmonised Actions for Sustainable Management of Water Resources".

THE USE OF THE CCME-WQI INDEX TO ASSESS THE POSSIBILITY OF USING WATER RETAINED IN MIDFIELD WATER RESERVOIRS

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Keywords: midfield water reservoirs, water quality, CCME-WQI

Midfield water reservoirs can have different functions in the areas used for agriculture. The possibility of using water in them retained is dependent on both its quantity and quality. Location water reservoirs in areas of intensive agricultural production creates a threat of contamination with nutrients, flowing mainly in the form of surface runoffs, ground inflow, or supply with water flowing from the drainage system. Water quality is difficult to estimate due to the large number of factors that affect it and a large number of parameters of water. To facilitate the interpretation of the results of field and laboratory tests of water quality with reference to adopted standards, water quality indices were developed. Many WQI index calculation methods refer to the drinking water quality requirements set by the WHO as universally recognized and used standards. It gives the opportunity to compare the quality of different types of water located all over the world. WQI indexes in relation to water quality standards is helpful for a specific economic use (e.g. fish farming, drinking by animals, irrigation, bathing and water sports) and proper water resources management. The research covered 15 mid-field water reservoirs located in north-eastern Poland (54°08 'N, 20°36' E). Based on the results of laboratory and field tests on the quality of water retained in them, in relation to drinking water quality standards and water treatment for drinking, salmon and carp fish farming, drinking by animals and bathwater, water quality indices were calculated using the method proposed by the Canadian Council of Ministers for Environment (CCME-WQI). Waters from mid-field reservoirs should not be used for human consumption, even after treatment. However, they can be used for irrigating agricultural land. There is no risk of intensive replacement of calcium and magnesium contained in the soil sorption complex by sodium contained in the water used for irrigation to a degree harmful to the soil structure. The water of the analyzed tanks can be used for carp fish farms. It can also be used for practicing recreational forms that do not require direct contact with water. The study was supported from the EU ERANET 2017 Water JPI Joint Call project "Water Harmony-Closing the Water Cycle Gap With Harmonised Actions for Sustainable Management of Water Resources".

POSSIBILITY OF USING MACROFITS AS BIOINDICATOR HEAVY METALS DEPOSITED IN THE BOTTOM SEDIMENTS

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Keywords: bottom sediments, macrophytes, heavy metals, biomonitoring

Bottom sediments provide a record of the influence of the catchment on water reservoirs. In the bottom sediments, organic matter, minerals, substances that are difficult to decompose and toxic, such as hydrophobic organic compounds and heavy metals, can be immobilized. Through chemical and biological processes they can be returned to water, and their mobility depends on the chemical form. They are not biodegradable in the environment and can therefore be accumulated in living organisms. In large quantities, they can cause phytotoxicity in plants and negative effects on the condition of entire ecosystems. Toxic action of these elements causes disturbances of water management and mineral nutrition of plants, reduction of photosynthetic activity and oxidation of cellular components. Shoreline vegetation of water reservoirs, especially macrophytes, are often used as bioindicators to assess the state of heavy metal pollution of aquatic ecosystems.

The aim of the research was to assess the use of *Typha latifolia* and *Phragmites australis* as bioindicators of heavy metals deposited in bottom sediments of the Sząbruk water reservoir located in the mesoregion of the Olsztyńskie Lake District on the border between the villages of Uniszewo and Sząbruk. Bottom sediments and macrophytes were collected from points located in designated transects. In the analyzed samples Cr, Ni, Pb, Mn, Zn, Fe and Al were determined. The sediments were classified based on indicators of pollution and ecological risk (PLI, I_{geo} , RI). Based on them, it was found that the content of the majority of heavy metals tested did not exceed the geochemical background. Only the content of Zn, Cu, Ni and Fe was higher than it, however it did not pose a threat to living organisms. Mobility of the analyzed heavy metals in plant tissues is illustrated by the translocation factor (TLF). The highest value of the translocation coefficient (root - leaf) was characterized by Zn and Ni, the least mobile was Al and Fe. Studies have also shown that the pH has a large influence on the mobility of metals: higher values of the coefficient were observed at lower pH values. To assess the migration of metal ions from bottom sediments of the reservoir to the leaves and roots of the studied plants, as well as the level of actual accumulation of individual ions in

reference to the bioavailability of individual metals, the enrichment factor was used. Its values indicate that bottom sediments were the basic source of the analyzed elements in *Typha latifolia* and *Phragmites australis*. The conducted research has shown that macrophytes rooted in the bottom of the reservoir, can be used as bioindicators to assess the pollution of bottom sediments with heavy metals, and thus constitute a valuable element in the biomonitoring of aquatic ecosystems.

EFFECT OF DIESEL FUEL TEMPERATURE ON THE NITROGEN OXIDES EMISSION FROM A COMPRESSION-IGNITION ENGINE

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Keywords: diesel fuel, compression-ignition engine, nitrogen oxides emission

Thermal engines are divided into two groups, compression-ignition and spark-ignition engines. The widespread use of engines from the first group is favoured by higher efficiency and the resulting lower carbon dioxide emissions. Unfortunately, the combustion process carried out in these engines is responsible for the high emissions of nitrogen oxides caused by the greater availability of oxygen in the combustion chamber. Nitrogen oxides are now considered to be the most toxic gases emitted by engines and for this reason large units are equipped with Selective Catalytic Reduction (SCR). However, there is no economic justification for using such systems in low power engines. Therefore, other methods of reducing the emission of nitrogen oxides are being sought. One of these methods is considered to be a thermal fuel activation.

The goal of our research was to determine the effect of the temperature of diesel fuel supplied to the engine fueling system on the nitrogen oxides emission from the self-ignition engine. Experiments were carried out on an experimental CHP unit equipped with a diesel engine with indirect injection and a power of 9.5 kW. The emission was measured in accordance of procedure D1 described in the ISO 8178-4. In total, three tests were carried out for three different fuel temperatures, which were 20, 40 and 55°C respectively. The obtained results allow us to conclude that for the engine used in the tests, the thermal activation of diesel fuel causes a slight increase (1.5-2.0%) in nitrogen oxides emissions. So this method cannot be used in practice to reduce emissions.

APPLICATION OF AERIAL IMAGES TO PROVIDE SANITARY PROTECTION OF MINERAL WATER SPRINGS

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Keywords: water springs, sanitary protection zone, ground survey, topographic maps, aerospace data

The purpose of the work: to establish the possibility of application of aerial images for monitoring the sanitary protection zone (SPZ) of therapeutic water springs on the example of the recreational area Skhidnytsya (Ukraine).

Relevance of the subject. For centuries, mineral water has been serving humanity owing to its healing properties. Since the middle of the 20th century, due to the intensive use of natural resources, the rapid growth of industry, agriculture and other production branches, the environmental situation is significantly deteriorating. Therefore, the global problem is the protection of the environment from the inappropriate use of natural resources. In full measure this applies to the recreational areas of the Ukrainian Carpathians with a large number of mineral water springs that need to be protected and preserved.

The content of the work. It is known that sanitary protection zones are organized in the three zone bends. The first zone bend is of the strict regime includes the territory of the location of springs, parcels of all water supply constructions and networks. Its purpose is to protect the water-diverting structure and facilities from accidental or malicious pollution and damage. The second zone bend protects the springs and the water network from microbial contamination. The third zone bend protects from chemical contamination.

An analysis of the feasibility of application of ground survey, topographic maps and aerospace data for mapping the zone bends was carried out. For the first bend it is expedient to use ground-based survey (a small area with a radius of 30-50 m), and for mapping the boundaries of the second and third bands it is possible to use aerospace data (maps on a scale of 1: 10000 - 1: 25000).

A series of experiments was performed to determine the real possibilities of identifying new objects within the second and third bands. The color aerial photographs of the Skhidnytsya area, obtained by the camera LMK-1000 in the scale of 1:20000 (with focal length 152 mm). They were increased to the scales 1:2000 and 1:5000. According to the results of photos interpretation there were revealed 10 categories of objects in the sanitary protection zones. Interpretation properties were

evaluated on a four-point scale. The results of the experiment are presented in the report.

Conclusions. The obtained results indicate that most objects are confidently recognized on aerial photographs. This means that within the recreational area it is easy to monitor the state of the territories and receive objective information about the changes that take place. Instead, the control of the pumping of waste water, the detection of defective wells, sanitary supervision of the improvement of the settlement and some other activities should be carried out by traditional methods.

METHODOLOGY OF GEOINFORMATION DESIGN OF TRANSPORTATION ROUTES

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Keywords: transport logistics, GIS technologies, automatic route laying

One of the main tasks of transport logistics is, as it is known, reducing the time and cost of delivery of goods, which is solved on the basis of designing the best routes of transportation. This can take into account the status and the state of roads, various kinds of restrictions, for example, one-way roads, prohibitions of turns at the corresponding crossroads, speed limitations, and others. Application of modern GIS technologies allows us to process these data and, based on the received information, to analyze the proposed solutions, which in turn allows us to quickly and rationally solve various tasks.

For developing the methodology, the authors were guided by the following basic requirements:

- for designing it is necessary to use cartographic data, placed on servers with free access,
- application of GIS technologies should be based on the use of available software products.

The technology of design of transportation routes includes the following types of works:

- * collection of map data
- * vectorization of input data and creation of vector map layers,
- * mapping with automatic route layout and designing optimal routes for transport.

Stage 1: Available cartographic data includes maps, satellite images of different resolutions, and other services such as Google Earth, Google Maps, Google MapMaker, Bing Maps, Yandex.Maps, Ukrainian Cadastre, etc. We are encouraged to download a raster image or a map of the area using the program SAS. Planet 15. However, unlike the mentioned services, all downloaded maps can be stored by the user and can be viewed even without connecting to the Internet.

Stage 2. ArcGIS software package was used to vectorize the raster image and record it in the required formats, namely ArcGIS Desktop modules, as an

integrated set of professional desktop GIS applications. ArcMap environment was used for digitizing, and five shape files in a common coordinate system (buildings, highways, large streets, small streets, and access roads to buildings) are created in ArcCatalog. Vector map layers are imported into the GPSMapEdit software package.

Stage 3. Using the software package GPSMapEdit we implement the technology of creating an electronic navigational map, which includes the creation of maps with automatic route laying, checking the quality of creating a road graph, testing the road graph and compiling the map.

All stages of the developed methodology have been demonstrated at the example of design of transport services in Lviv. There was created electronic road network map for GPS navigators of GARMIN type. The complex of tests of the received product, in particular testing of the road graph, compilation of the test map, checking the quality of creating of road graph, and other were carried out.

The report is illustrated by many figures, including:

- fragment of a photo of a city of Lviv with a road network,
- view of the downloaded map in ArcMap working environment
- fragment of the vectorized map of the city of Lviv in the software package ArcGIS,
- display mode of the nodes of the road graph,
- the planned route of goods delivery.

It is proved that the offered method allows to receive an electronic maps for GPS navigators and to design optimal routes of transportations in automatic mode.

SPATIAL MODELLING OF PEATLAND AREA BY MEANS OF DIGITAL PHOTOGRAMMETRY

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Keywords: UAV, digital elevation model, fire hazardous area, peatland

Objective: to develop a technology for creation of digital elevation model and a digital model of coverage of the territory of a fire hazardous area of the peatland using the processing of images taken from an unmanned aerial vehicle.

Relevance of research. Peat fires have a significant impact on the ecological conditions of the territory. As a result of combustion of peat, the emission of combustion products into the atmosphere increases significantly, the biosphere is destroyed, rare plant species disappear and other negative impacts appear. Therefore monitoring of such territories for decades is an urgent task of many experts .

The content of the work. One of the components needed for a qualitative decision of monitoring tasks is the presence of a digital elevation model (DEM) and a digital model of coverage of the territory (DMCT). If they are available, you can accompany the geomorphological analysis of the surface of a peat, determine the most dangerous areas, to build longitudinal and transverse profiles, to design a network of ground observation points and measure the temperature and humidity of a peat.

Authors have worked out and implemented the technology of creation of DEM and DMCT based on photogrammetric processing of digital images obtained from unmanned aerial vehicles. The technology includes: field work design, aerial survey project, fieldwork complex (marking of geodetic points and points with measurements of humidity and temperature of peat, geodetic survey, aerodynamics, photogrammetric processing of images on digital photogrammetric stations).

The proposed technology is fully implemented on Stoianovskii peatland (Ukraine, Lviv region). The paper presents the results of processing images and illustrative material, in particular 3D-models, longitudinal and transverse profiles with the results of measurements of soil moisture.

Conclusion. The conducted complex of the field and office works has confirmed the effectiveness of the proposed technology. Created spatial models can serve as a reliable information source for experts of different profiles.

FUTURE CLIMATE IN POLAND ON THE BASE OF SELECTED CLIMATE CHANGE SCENARIOS

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Keywords: climate change; temperature; vegetation period

The climate is a very important element shaping the environment, therefore determining the resources and properties of the climate and its possible changes, is of great importance. The GISS scenario for Central Europe was chosen, when determining potential climate changes for the area of Poland. It was assumed that the CO₂ concentrations will double to the end of XXI century, causing the increase in the mean annual temperature by 2.8°C, with an increase in winter by 3.2°C and in summer by 2°C. Annual precipitation is predicted to increase by 10% – 15% in winter with no change in summer. The WGENK algorithm was used to generate data for 20 locations around Poland based on the climate characterisation for the period 1985-2005; a set of synthetic data was created which meet the assumptions of the adopted change scenario. The following synthetic data were used to determine selected characteristics of a vegetation period for each station: mean and extreme dates of the start, end and duration of a vegetation period; mean, maximum and minimum value of the average daily temperature, maximum temperature, minimum temperature; total precipitation; hydrothermal conditions in the period from April to September were characterised by hydrothermal index (HT index). Depending on its value, each month was classed as dry ($K \leq 1.3$), optimum ($1.3 < K \leq 2.0$) or humid ($K > 2.0$).

A comparative analysis of the basic parameters associated with the duration of the vegetation period showed that it is expected to increase. The forecast of mean data of the start of a vegetation period seems to be earlier at least about 13 days according to data from the period 1985-2005. According to the adopted change scenario, the mean temperature of the vegetation period will increase from the current by 1.2°C to 1.7°C. Elongation of the vegetation period by a month will increase the number of days with precipitation by more than 10 days on average and the total precipitation during the vegetation period, which ranged from 370 to 390 mm during the period 1985-2005, will increase on average more than by 100 mm.

A comparative analysis of hydrothermal index for the period from April to September has shown that a larger proportion of dry periods is to be expected in the future, with a decrease in the duration of humid periods, whereas the frequency of the optimum periods will remain on a comparable level.

CLIMATE OF NORTH-EASTERN POLAND IN LIGHT OF A SELECTED CLIMATE CHANGE SCENARIO

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Keywords: climate change, vegetation period, temperature, NE Poland

Determining potential climate changes with the GISS scenario for Central Europe, it is assumed that the double CO₂ concentration will be achieved by the end of XXI century. It is predicted mean annual temperature to increase by 2.8°C (increase in winter by 3.2°C and in summer by 2°C). Annual precipitation will increase by 10% – 15% in winter with no change in summer. The WGENK data generator was used to produce data for three stations: Olsztyn, Suwałki and Białystok for the period 1985-2005; a set of synthetic data was created which meet the assumptions of the adopted change scenario. Since it is possible to achieve the assumed changes in many ways, 300 possible courses of weather changes in an annual arrangement were developed, which made it possible to trace the variability of new climatic conditions and to indicate potential extreme and mean values. The actual and synthetic data were used to determine selected characteristics of a vegetation period for each station: the mean and extreme dates of the start, end and duration of a vegetation period; the mean, maximum and minimum value of the average daily temperature, maximum temperature, minimum temperature and total precipitation; and the number of days with precipitation.

A comparative analysis of the basic parameters associated with the duration of the vegetation period showed that it is expected to have increased by 2050, from 203 to 232 days in Białystok, from 208 to 233 days in Olsztyn and from 195 to 225 days in Suwałki. The forecast mean data of the start of a vegetation period: 27 March in Białystok and Suwałki and 24 March in Olsztyn, which is 19 days earlier in Suwałki, 13 days earlier in Białystok and 16 days earlier in Białystok than during the period 1986-2005. According to the adopted climate change scenario, mean temperature of the vegetation period will increase from the current 13.2-13.3°C by 1.3°C in Białystok, by 1.5°C in Olsztyn and by 1.2°C in Suwałki. Elongation of the vegetation period by a month will increase the number of days with precipitation by 13 days on average and the total precipitation during the vegetation period, which ranged from 370 to 390 mm during the period 1985-2005, to 420-450 mm. The future minimum values of the parameter may be lower than the present ones by 80 mm in Białystok, by 94.5 mm in Olsztyn and by 43 mm in Suwałki).

FLOATING BEDS: PILOT SCALE TO TREAT SURFACE WATER WITH ACID CHARACTERISTICS

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Keywords: Floating beds, river water, water of drainage mine, *Vetiveria zizanioides*, *Phragmites australis*

Floating beds (floating platforms and rooted aquatic plants) are innovative systems and their processes are still barely known within the methods of phytoremediation that can occur in the river, although they are a technology widely used in wastewater treatment. Surface water treatment using floating beds is an emerging technology, underdeveloped in Portugal.

The surface water in “Baixo Alentejo” region (Portugal), is known to have excess nutrients, due to farming practices and/or excess of metals, as a result of mining activities or/and soil characteristics. This is the case of Água Forte stream (length around 11.7 km), which crosses the mining area (Aljustrel) from south to north. Therefore, reasonable and environment-friendly methods are needed to improve river water quality.

The Água Forte stream is classified on the ecological status as “Bad” and does not comply with the requirements for irrigation. Moreover, it's characteristics have similarities to acid drainage mine (ADM) waters. This study's goal is to test a floating bed at a pilot scale, with two different species of macrophytes (*Vetiveria zizanioides* and *Phragmites australis*) in order to improve the water quality with ADM characteristics.

Two experiments were carried out for 5 months in different years. Both experiments were performed in 4 polyvinyl chloride (PVC) tanks of nominal capacity of 1 m³ each. The tanks were filled with about 0.5 m³ of water coming from Água Forte stream. The floating beds were built with PET water bottles occupying 62% of the total PVC area (1m²) and filled with a plant density of the 150 plants.m⁻².

The results of experiment 1 depict a slight reduction of the contaminants in *Vetiveria zizanioides* leaves. The growth rate in *Vetiveria zizanioides* leaf was 4.0±5.5 cm.week⁻¹ while, in *Phragmites australis* leaf was 4.8±5.8 cm.week⁻¹. In contrast the growth rate of *Vetiveria zizanioides* root and *Phragmites australis* root were 0.6±0.4 cm.week⁻¹ and 1.1±1.1 cm.week⁻¹, respectively.

The results of the experiment 2 show a *Vetiveria zizanioides* leaf growth rate of 3.9 ± 1.3 cm.week⁻¹ and only 0.0 ± 2.9 cm.week⁻¹ for *Phragmites australis*. The growth rate of *Vetiveria zizanioides* root was 0.48 ± 0.4 cm.week⁻¹, while, for *Phragmites australis* was 2.2 ± 2.1 cm.week⁻¹.

The pH and the dissolved oxygen (OD) were practically constant (pH= 3.4 ± 0.3 ; pH= 3 ± 0.05), (OD= 9.1 ± 0.5 mg.L⁻¹; OD= 8 ± 0.2 mg.L⁻¹) in both experiments 1 and 2 respectively. It was also observed a slightly decrease in some heavy metals, namely, cadmium (40% - 45%) and zinc (3% - 10%). During experiment 1, the plants did not show any signs of toxicity although in experiment 2, the plants seemed to be stressed. There were signs of toxicity, namely chlorosis, moreover, leaf and root stopped growing. Contaminant removal was not observed, either in *Vetiveria zizanioides* or in *Phragmites australis*. These results might be associated to the runoff inflow at Água Forte stream, perhaps due to the increase of irrigation area and intensive agriculture practices in the surrounding area.

INTEGRATED APPROACH TO INVENTORY OF LAND AND OBJECTS OF RAILWAY TRANSPORT BY REMOTE SENSING METHOD

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Keywords: railway, DTM, DEM, UAV

Aim: to develop an effective technology for the creation of a cartographic component, which would simultaneously serves for the inventory of land and objects of railway transport, design, construction and reconstruction of roads and infrastructure of the railway.

Relevance of the work. Provision of the growing needs of the economy and the population of Ukraine in transportation requires an immediate reform of the railway industry. An integral part of this action is the reconstruction of existing and active railways and the entire technical infrastructure of the railway industry. This stipulates the development of integrated approach to the creation of cartographic materials for the railway industry using modern technologies and geoinformation solutions. Particular attention deserves the use of images obtained from unmanned aerial vehicles, which would allow creating plans at a scale of 1:100, 1:200, 1:500, necessary for solving engineering problems.

Methods and realisation. The main tasks that could be solved using the integrated approach are:

- inventory of railway land;
- inventory of railway transport objects;
- investment attractiveness of railways activity;
- formation of project optimal solutions for the reconstruction and development of railway facilities;
- implementation of technical projects aimed at increasing the efficiency and safety of rail transport operations.

Recommended scales of maps and plans:

- for cadastral plans of the territory of settlements the scales 1: 2000 , 1: 1000, and for all others 1: 10000;
- for railroad plans the scales 1: 1000 and 1: 500;
- for engineering solutions the scales 1: 100 - 1: 500.

In addition to the purely topographical elements shown on the maps and plans, one can get specific information, which includes the vertices of the turns angles of the tracks, pickets, signs and lines, distance marks; numerical values of curves elements (angles of rotation, radiuses, and others); engineering communications; stations, passing tracks, overtaking points, crossings, crossover switches, track numbers of, etc. (more than 30 items).

The paper presents the general workflow of inventory of land and objects of the railway. It is envisaged that the main resultant documents are digital models covering the territory (DTM), digital elevation model (DEM), digital model of underground communications (DMUC), orthophotos, plans, including cadastral plans in the scales 1:500, 1:1000, plans of railways in the scales 1:500, 1:1000, longitudinal and transverse profiles, engineering drawings.

Conclusions. The proposed approach to the simultaneous application of different type of data such as data obtained from field, photogrammetric and cartographic works, allows to create a universal information platform - the database of cartographic data, which can be used for geoinformation analysis and monitoring of land and objects of the railway, to publish digital cartographic products for execution of project and operational works on the railway. Further researches should substantiate the technical parameters of digital aerial survey for effective creation of geospatial models.

THE STUDY OF RECREATIONAL AREAS USING REMOTE SENSING DATA

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Keywords: recreational area, space image, remote sensing, accuracy

Purpose: to substantiate the recommendations on the use of space images to monitor recreational areas from the point of view of the accuracy of plane position of the main elements specific to recreational territories.

Relevance of work. In connection with the strengthening of the role of local self-government bodies in decision making relating to the state of recreational territories, these bodies should fulfil control functions especially since resort institutions located on recreational areas are a significant financial source for filling the local budget. Nowadays, remote sensing data is freely available, which does not require additional costs for their purchase. However, local experts should know which satellite systems are appropriate to be used for monitoring purposes.

Method and realization. Three categories of land for element by element monitoring are considered: the land of recreational zones within settlements; suburban lands, built up territories and green zones (suburban location); recreational lands outside settlements. Such a division raises various requirements for the accuracy and reliability of the information received from the remote sensing data. There are no clear recommendations on this issue, and therefore it is difficult to find an unambiguous generalization criterion for such requirements. Authors proposed an approach related to the accuracy requirements of cartographic data the same as for land cadastre. The accuracy of the mapping of the territorial elements (building, roads, hydrography, lands, and vegetation cover) for the abovementioned three categories of land is calculated. It varies within 0.4-4.0m. Based on these data, the parameters of the required accuracy of the plane position of the main elements specific for recreational territories, including green areas, green plantations, holiday homes, tourist trails, campsites and others are calculated.

Results. Comparing calculated requirements to the accuracy of the plane position of objects and parameters of space image resolution there were

implemented analysis and made recommendations about choice of appropriate satellite system (IKONOS, QuickBird, OrbView-3, Eros-A, Eros-B and others) for certain type of recreational element by element monitoring

Conclusions. From the data analysis it follows that high-precision mapping of urban areas with buildings is now advisable to implement using ultra-high resolution satellite imagery. In contrast, in all other cases, the precision of thematic mapping (elements of the recreational area) is provided using high-resolution satellite systems.

MATHEMATICAL MODEL OF A PRIORI ESTIMATION OF UAV – PHOTOTRIANGULATION

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Keywords: UAV-survey, phototriangulation, a priori accuracy assessment

The aim: to obtain formulas for the a priori assessment of the accuracy of phototriangulation taking into account the specifics of digital survey from unmanned aerial vehicles (UAVs).

Relevance of research. The current state of aerospace survey has two main features. The first one concerns the use of space images, the resolution of which increases from year to year. This significantly influences the development of new technologies for mapping and monitoring of phenomena and processes, and the scale of mapping is constantly increasing. The second trend is the widespread introduction of UAV-survey, which allows you to create plans at a scale of 1: 500, 1: 200 and even larger. It greatly expands the capabilities of photogrammetry in solving engineering, topographical and thematic problems. Therefore, it is advisable to apply new approaches to the design and implementation of photogrammetric processes.

The content of the work. The UAV-survey in comparison with classical aerial survey has its own peculiarities. This is the application of small-format cameras (often with considerable distortion), flight instability, non-parallelism of routes, significant longitudinal and transverse overlapping of images, influence of high construction, etc. These factors influence the deformation of the photogrammetric model (created on the base of the stereopair), and hence deformation of the route and block model. Therefore, it is necessary to obtain formulas for the a priori estimation of photogrammetric constructions, especially phototriangulation, which will allow to make correct project of aerial survey, to implement image referencing and to obtain high-quality final products (digital models of terrain, relief, coverage of territories, orthophotomaps, etc.). Formulas obtained for the a priori evaluation of the accuracy of constructing a single model, and hence route and block phototriangulation, created by the method of independent models. As input information there was used: the height of survey, the focal length of the camera, the format of the digital image, the magnitude of the longitudinal and transverse overlap, the number of possible imageries of the point of the object on

several images, the number of reference points on the terrain, the accuracy of photogrammetric measurements. The advantages of this approach are shown in comparison with the classical formulas. This should be expected, since the known formulas do not take into account the above-mentioned features of UAV-survey.

Conclusions. The resulting formulas allow to select correctly the UAV-survey parameters and to claim the required density of the reference network. This allows to optimize the obtaining of the final product with the given parameters of the accuracy of spatial modeling of objects.

CAN BIOCHAR APPLICATION IMPROVE NITROGEN REMOVAL IN CONSTRUCTED WETLANDS FOR TREATING AEROBICALLY-DIGESTED SWINE WASTEWATER?

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Keywords: anaerobically-digested swine wastewater, biochar, constructed wetland, dissolved organic matter, intermittent aeration, pollutants removal.

In recent years, the livestock and poultry breeding industries especially pig farms have rapidly increased in China. As a result, swine wastewater, typically characterized by high concentrations of organics and nitrogen, has become a severe environmental problem. Lots of pig farms are equipped with anaerobic digestion tanks to degrade pollutants and to produce secondhand energy. However, the anaerobically-digested liquids from this technique still contain high level of pollutants that can cause eutrophication and deteriorate water quality when discharged directly into water bodies or spread across available land.

In this study, aerated constructed wetlands (CWs) modified with biochar were used to treat anaerobically-digested swine wastewater. Nitrogen removal performance and mechanisms were comparatively investigated by exploring the dynamic transformation of dissolved organic matter (DOM) in water. It was demonstrated that chemical oxygen demand (COD) and ammonium nitrogen (NH₄⁺-N) with removal efficiencies of 63.06%~77.18% and 87.19%~96.54%, respectively, could be achieved in two kinds of aerated CWs under various influent strengths. However, the total nitrogen (TN) removal (30.92%~40.12%) was not enhanced in aerated CWs with biochar application compared that in conventional aerated CWs (40.83%~48.70%), which was related to insufficient carbon sources and lower pH values. Simultaneously, more average N₂O emission fluxes (185.43~443.33 μg m⁻² h⁻¹) were detected in aerated CWs with biochar application for a certain range of influent strengths. Humic-like substances were identified as major components of DOM in water using fluorescence excitation–emission-matrix combined with parallel factor analysis (EEM-PARAFAC). The refractory characteristics of humic-like substances led to insufficient carbon source levels for denitrification. The results showed that the use of biochar in CWs did not increase anaerobically-digested swine wastewater treatment performance under intermittent aeration operations.

PREVENTION AND CONTROL STRATEGIES FOR WATER HYACINTH (*EICHHORNIA CRASSIPES*) IN PISÃO RESERVOIR

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Keywords: water hyacinth, invasive species, Alqueva system, removal, biological control

Prevention strategies against the invasion of exotic species are very important, because the effects derived from the establishment of large populations of alien species can be physical, biological, social and economic. Invasive alien species normally show similar characteristics in terms of high adaptability, very effective reproductive strategies and adaptation to the new environments. Even if worldwide the effort to prevent new alien species to invade ecosystems is on the rise, the problem does not seem to slow down but it actually keeps growing at alarming rates. The aim of this study was to find the way to prevent the spreading of invasive species within the Alqueva system, especially in the Pisão reservoir. It is located nearby Beringel village, naturally supplied by two rivers: Álamo and Galego, and also artificially by the Alvito-Pisão gravity canal. Moreover, it was needed to find the answers for the following questions: How to select the species to monitor? Which ecological, economic and social parameters need to be considered? What is the dispersal range and methods for the selected species and where are the critical locations of possible entry? What are the methods available to control the most dangerous species?

In order to choose the most hazardous invasive species for the Pisão reservoir, risks for 5 invasive species: *Eichhornia crassipes*; *Dreissena polymorpha*; *Arundo donax*; *Procambarus clarkii* and *Corbicula fluminea* were assessed. Some of the factors such as species detection, maximum longevity, etc. were assessed in a scale from 0 (smallest threat) to 10 (highest threat). Water hyacinth received the highest score and became the main subject of this study.

Mechanical methods that are preceded by EDIA (company that manage the Alqueva system) are not highly efficient, so, it is needed to find another solution to fight this invasive species.

Water hyacinth has ability to reproduce in two ways both sexually and asexually. It is considered to be highly invasive, due to the fact that it is capable of spreading fast. Moreover, it has wide ranges of tolerated parameters and is already present in the Guadiana River (Portugal side), which is a natural border. However, it is very unlikely that water hyacinth will naturally disperse to Pisão reservoir due to the complexity of Alqueva pumping and filtering system and the strategic placement of physical floating barriers, but it can still reach the water body via human vectors.

Physical and chemical controls are adopted for short-term goals while biological controls have longer impact and a cost-benefit ratio much higher than the other methods. Only very recently the European Union started to get interested in biological alternatives to fight the non-native species invasion.

The biological method includes the relative long time of implementation, until the population of the controlling agent has reached the level necessary to effectively have an impact on the invasive species. However, the tests in quarantine have to be carried out in an impeccable way reducing to the minimum the potential impact on non-target species and also to prevent the new introduced species to bring along some parasite organisms or diseases.

All the biological agents of control are advised to be used in combination with other agents for an adequate control of the invasive species. For example, the water hyacinth moth (*Niphograptalbiguttalis*) alone can only limit the spread of the plant feeding on the petioles. Combined with a fungal pathogen such as *Cercospora rodmanii* or *Cercospora piaropithe* impact of the invasive species can be significantly reduced, as these species of fungi damage the leaves. Another association of biological agent adopted is the use of fungal pathogen *Acremonium zonatum* in combination with the mite *Orthogalumnatere brantis*.

The environmental impact of such an extensive and complicated measure cannot be done with the instruments available and needs extensive scientific researches on the profound impacts the new introduced species might have on the ecosystem. The balance between the new introduced species has been found in other areas of the world without them to turn into invasive for those ecosystems. In Europe a reform of the present unclear regulation needs to take place soon in order to try to solve a problem that is left without valid alternatives for too long.

BIODIVERSITY OF MICROBIAL COMMUNITIES IN CONSTRUCTED WETLAND

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Keywords: constructed wetland, wastewater treatment, nitrogen compounds

Constructed wetland are based on natural treatment technology that efficiently treat many different type of polluted water. Constructed wetland are engineered system design to optimized processes found in nature to treat various pollutants in as many as possible conditions and processes. The most important are the processes conducted by microorganisms with redox potential fluctuation. Many authors indicating that the type of material constituting the bed layer is also important for the development of various groups of microorganisms.

The main aim of the research was to optimize the processes of removing nitrogen compounds in conditions of deficiency of organic matter, which is the source of carbon. Within the carried out investigation also the microbial community have been indicated.

As part of the project, among others tests on four pilots with vertical flow (SS VF) for the purpose of treatment the outflow from the SBR reactor with the anammox process for the purification of effluents from the dewatering of fermented sewage sludge. Pilot SS VF with dimensions: length x width x height: 40 cm x 40 cm x 80 cm are marked with the following numbers: "I", "II", "III" and "IV". Each bed consists of a filtration layer (45 cm) and thin geotextile, which provides insulation of a 10 cm thick drainage layer made of gravel 16-32 mm. The substrate composition for the bed differ in the main layer. Filling used: for the pilot "II" main layer was sand with equivalent diameter from 0.5 to 1.2 mm, while for "I", "III" and "IV" it was gravel from 2 to 8 mm. Beds were planted with common reed, while the "I" control bed remained uninhabited and all of the beds were fed with synthetic sewage of identical composition given in Table 1.

The efficiency of removing nitrogen compounds was the lowest for a bed not planted with common reed – "I" (about 30% on average) and the highest for a bed filled with reed with gravel filling of the main layer – bed "II" (average approx. 35%). Therefore, the studies confirmed the participation of various processes responsible for the transformation and efficiency of removing nitrogen compounds, depending on the bed substrate and vegetation. Therefore, after a year of exploitation of pilot deposits, samples were taken from the vertical profiles of the

filling material and subjected to genomic analysis to identify bacterial species and biodiversity. The biodiversity of microbial communities in individual trials was estimated using the Shannon H index (Shannon and Wiener, 1963).

Table 1. Working condition of analyzed pilot SS VF

Parameters	Inflow [mg/dm ³]		Load of Ntot [g/m ² d]	Flow [dm ³ / d]	Hydraulic load [mm/m ² d]
	Min.-Max.	Mean $\pm \sigma$			
NH ₄ ⁺ -N	60.4 ÷ 65.4	63.0 \pm 1.51	37.8	96	600
NO ₃ ⁻ -N	23.8 ÷ 28.2	26.0 \pm 1.07	15.6		
NO ₂ ⁻ -N	-	0.00	0.0		
Ntot	86.2 ÷ 92.5	89.0 \pm 1.81	53.4		

Another measure of biodiversity of the microorganism assemblies were the thinning curves showing the potential number of unique OJTs for a given number of sequences obtained from environmental tests, which were obtained from the metagenomic analysis carried out using the SILVA NGS server (<https://www.arb-silva.de>).

On the basis of the archived values of particular indicators, it was determined that the highest level of biodiversity was obtained from the II deposit from the depth of 30-45 cm, for which both Shannon H index values, estimate of the numerous species α and the sharp dilutions showed the highest values. A similar number of species was found in the case of the surface layer in the III range. Slightly smaller species abstraction was observed in a sample from 0 - 15 cm from the IV deposit, for which the H index value was lower on average by 0.1 from the maximum value. The lowest biodiversity was taken into account for samples from deposit I (not settled), for which the average H-value of the Shannon index was lower by a full unit in comparison to other non-collimated deposits. Similar trends showed the values of the α indicator, which showed almost twice lower number of species in the analyzed I. deposit. In the case of deposits I and II for which samples were taken along the profile, depth changes showed changes in biodiversity at individual depths of the deposit. The greatest biodiversity was found in the middle layer of the deposits, the surface layer was slightly poorer, while for samples coming from the deepest layer biodiversity decline was more pronounced. This was particularly evident for the I bed, for which the sample from the deepest layer had, on average, two-fold less-unique DNA sequences.

The obtained results indicate that the fine filtration material could limit diffusion of oxygen to the deeper filter layers and limit the development of hydrophyte rhizosphere, which in turn translated into the reduction of diversity of microhabitats within the deposit. The increase of biodiversity in the central zone of deposits, in turn, should be combined with the growth of hydrophytes. Along with the development of the root system, which most probably was the strongest in the central part of the deposit, conditions were created conducive to the distribution of nutrients and oxygen and the development of symbiotic relationships between reed and bacteria.

THE CONDITION AND DEVELOPMENT NEEDS OF WATER SUPPLY NETWORK AND SEWERAGE SYSTEMS IN THE KRAŚNIK DISTRICT IN POLAND

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Keywords: water supply network, sewage network, collective sewage treatment plants, household sewage treatment plants, septic tanks

The paper presents the current state of water and sewage management in the Kraśnik district in Poland in 2016. The district is located in the south-western part of the Lublin province and consists of 10 communes: the municipality Kraśnik, 2 rural communes Urzędów and Annopol and 7 rural communes: Dzierzkowice, Gościeradów, Kraśnik, Szastarka, Trzydnik Duży, Wilkołaz, and Zakrzówek.

The data used in this work was obtained from a survey conducted in 2016 and concerned: the number of sewage treatment plants with a capacity of more than 5 m³/d, the number of household sewage treatment plants, septic tanks and the length of the water supply and sewage networks. The data show that in the Kraśnik district well developed the water supply network while the state of the sewage infrastructure is unsatisfactory. The largest percentage of the population using the water supply network has the commune of Urzędów - 96.1%, while the smallest commune of Gościeradów - 47.7%. Moving to the sewerage stage, the largest percentage of the population using the sewerage network has the municipal commune of Kraśnik - 80%, and the smallest commune of Gościeradów - 8.7%. In the Kraśnik district, there are also communes that do not have a sewage network, these are the Szastarka, Trzydnik Duży and Wilkołaz municipalities.

The collective sewage treatment plant has 6 communes, all of them are biological sewage treatment plants with capacities from 110 m³/d (Gościeradów) to 12,500 m³/d (Kraśnik city). In addition, 6 communes do not have their own catchment point and they have to transport them, which generates additional costs.

The data show that from 206 household treatment plants located in the communes up to 204 are of drainage-type. Only the city of Kraśnik, the commune of Urzędów and the municipality of Zakrzówek keep records of all septic tanks from all communes. The presented data show that in order to protect the environment, it is necessary to expand the water supply and sewage network in the Kraśnik district.

APPLICATION OF CONSTRUCTED WETLAND SYSTEM WITH MISCANTHUS GIGANTEUS FOR DEWATERING AND STABILIZATION OF SEWAGE SLUDGE

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Key words: sewage sludge, constructed wetland, giant miscanthus

Sewage sludge is an inseparable by-product in wastewater treatment processes. An important feature of all sewage sludge is their high hydration of 95-99%, high content of organic compounds, ease of rotting, occurrence of biogenic compounds (nitrogen, phosphorus), specific compounds and pathogenic microorganisms (bacteria, viruses, fungi, parasitic eggs). In recent years, there has been an increased interest in the issues of sludge - its management, recovery of useful components, while protecting the natural environment from contamination, e.g. soils and waters with heavy metals or pathogens contained in sediments. At present, the most common way to manage sewage sludge produced in household sewage treatment plants is to transport them with the use of slurry tankers to collective sewage treatment plants. This is cumbersome and generate high costs for the user of household wastewater treatment plant. Therefore, sometimes sludge (although this is unacceptable) are discharged in a non-stabilized state to the natural environment, which may cause its pollution and degradation.

The aim of the study is to present the possibility of applying the sludge treatment miscanthus giganteus beds for dewatering and disposal of sewage sludge and effluent from sewage from household wastewater treatment plant.

The process of sludge dewatering in the tested installation was performed by flooding the constructed wetland planted with the giant miscanthus with the raw sludge from the settling tank once a year. The one-time dose was about 4.41 m³. In the samples of drained sewage sludge taken for laboratory tests, the following parameters were determined: pH, dry matter content, organic matter content, total and ammonium nitrogen, total phosphorus, calcium and magnesium, as well as heavy metals: lead, cadmium, mercury, nickel, zinc, copper and chromium. In addition, tests were carried out for the presence of Salmonella bacteria and the number of live intestinal parasitic eggs: Ascaris sp., Trichuris sp., Toxocara sp. in the sediment.

In none of the tested samples of sludge were found exceeding permissible concentrations of heavy metals and no bacteria of the *Salmonella* species were detected and no presence of living eggs of intestinal parasites was found. It was found that sewage sludge from a household sewage treatment plant after dehydration and stabilization in the tested installation can be used in agriculture and land reclamation for agricultural purposes according to the Regulation of the Minister of Environment of February 6, 2015 "On municipal sewage sludge".

The tested installation can with great success be used in practice on a larger scale for dewatering and stabilization of sewage sludge from settling tanks of household sewage treatment plants. Thanks to its application, it is possible to exclude the need to remove sludge from the septic tank by means of slurry tankers, and hence to reduce the operating costs of household sewage treatment plants.

THE IMPACT OF THE TEMPERATURE OF BIOFUELS FROM ANIMAL FATS ON NITROGEN OXIDES EMISSIONS

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Keywords: biofuel, animals fat, nitrogen oxides emission, diesel engine

It is technically possible to replace diesel with biofuels made from fats of different origins. Current research shows that replacing diesel with biofuel will increase nitrogen oxides (NOx) emissions. However, there is no clear answer as to whether the temperature of the fuel feeding the engine has an influence on the level of NOx emission. Therefore, the aim of the study was to analyze the influence of temperature of methyl esters from animal fats (AFME) on the level of NOx emission. The test was carried out on an experimental stand equipped with a diesel engine with a power of 9.5 kW. The engine was controlled by an electric generator from which the generated energy was fed into the electric network. The underfilling was carried out in accordance with the D1 standard for power generators. As a result of the statistical analysis, significant differences were found for the values of average unit emissions of nitrogen oxides obtained for individual phases of D1 tests, i.e. engine loads amounting respectively to 50%, 75% and 100% of the nominal value of engine torque. The use of higher fuel temperature has a slight impact on the reduction of nitrogen oxides emission, because the achieved reduction of specific NOx emission in relation to the emission obtained for the fuel temperature of 20°C reaches the level of only 1%, which makes the practical application of this solution unreasonable in relation to the costs of equipping the engine with an installation allowing the heating of biofuel.

THE IMPACT OF THE TEMPERATURE OF RME ON NITROGEN OXIDES EMISSIONS

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Keywords: biofuel, rapeseed oil, nitrogen oxides emission, diesel engine

Rapeseed oil methyl esters (RME) are commonly used biofuels in European Union countries. They provide environmental benefits such as reduced CO₂ emissions and reduced fossil mineral extraction. According to literature reports, the replacement of diesel by RME results in increased emissions of nitrogen oxides (NO_x). From other to literature wineries that a change in operating parameters may have a significant impact on the composition of the emitted exhaust fumes. The aim of the study was to analyze the influence of RME temperature on the level of NO_x emission. The experiment was carried out on an experimental stand consisting of a 9.5 kW diesel engine controlled by an asynchronous engine. The entire stand was filled with measurements. The result was recorded by means of control and measurement systems in a continuous mode. Exhaust emission measurement was performed in accordance with ISO 8178-4. The increase in the temperature of the test fuel has a positive effect on the reduction of nitrogen oxides emissions from the diesel engine when loading it with 50% and 75% of the maximum torque. When the fuel temperature rises from 20°C to 55°C, NO_x emissions are reduced by approximately 5% for 50% of the maximum engine load and by approximately 2% for 75% of the maximum engine load, respectively. At maximum engine load, raising the fuel temperature will increase nitrogen oxide emissions. When the fuel temperature is increased from 20°C to 55°C, an increase in NO_x emissions of more than 10% has been observed.

SMART RIVER GOVERNANCE USIUNG RIVER CONTRACT METODOLOGY BY GIS TECHNOLOGY

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Keywords: River contract, GIS layers, flood risk, intake and wastewater discharge points, water resources, and operational tool

The goal of this research is building or creating a management system for hydrographic basin using the "River contract" (RC) methodology and GIS tools. In the same time is provides for an innovative approach for managing water resources based on the **river basin approach** taking into account the natural borders of catchment areas. The RC contributes to the definition and implementation of the district planning tools at basin and sub-basin scale, in particular of the flood risk management plan and water management plan.

The article describes the technological and methodological transfer process through the implementation of the RC instrument applied in the EU countries (Italy, France) for a small river in RM. The methodology included two main aspects: 1) Participatory processes from the bottom to complete identification of problems and definitions of actions, fundamental to achieve concrete and lasting results and 2) the consistency of the RC to the territorial, administrative and social context in which they occur and to the objectives of policies, programmes, plans or other instruments in force on that territory.

Both aspects, especially the second, are realized through GIS tools with the creation of thematic layers and attributes. This provides the ability to view and monitor data / information, including conducting geographic analysis as a support for creating a plan of actions to improve the situation in the river basin.

**ASSESSING SPHAGNUM ACID BOGS HABITATS QUALITY
IN RELATION TO THE THREATS, PRESSURES AND ACTIVITIES
IN CONTINENTAL BIOREGION IN POLAND**

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Keywords: sphagnum acid bogs, biodiversity conservation, environmental threats, Natura 2000

This paper discusses resources of acid bogs habitats of high importance to the European Community in the continental bioregion of Europe, specifically in Poland, as a reference. The study covers four habitats types distinguished in Natura 2000: raised bogs, mires, fen habitats (sphagnum acid bogs: 7110, 7120, 7140, 7150), occurring in 806 Special Areas of Conservation in Poland. The overall state of the habitat types, their threats, pressures, and activities, as well as their potential for restoration, was based on detailed analyses of data from Special Areas of Conservation (SACs) reports for the Natura 2000 network (N2000): Standard Data Forms, management plans, own verification in the terrain, and monitoring from the period 2006–2018. Of the 165 km² total area of peatland habitat covered by N2000 in Poland, only 15.43% represents favorable status (FV), while as much as 84.57% was classified as of unfavorable /inadequate (U1) or unfavorable/bad status (U2). The most significant threats to acid bogs habitats in the continental bioregion result from human-induced changes in hydraulic conditions that have modified whole natural systems. Based on multivariate analysis (PCA), we found that significant differences in the conservation status of the bog habitats resulted from a variety of threats, pressures, and activities, among which the most significant are decreased and unstable water resources (7110, 7120, 7140, 7150), drying up (7120, 7150), peat extraction (7120), changes in plant species composition (7120, 7140), succession of invasive species (7150), and more intense touristic exploration (7140). The most impacted habitats are 7110 active raised bogs. The examined habitats have potential for restoration. Our findings prove that successful conservation programs for peatland habitats of continental type should be undertaken towards the protection and preservation of their direct and indirect surroundings. A list of recommendations for treatments to be included in habitat conservation programs is presented.

**ASSESSING ALLUVIAL FORESTS WITH *ALNUS GLUTINOSA*
AND *FRAXINUS EXCELSIOR* HABITATS QUALITY IN RELATION
TO THE THREATS, PRESSURES AND ACTIVITIES IN CONTINENTAL
BIOREGION IN POLAND**

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Keywords: alluvial forests; biodiversity conservation; environmental threats; Natura 2000

Resources of alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* habitat of high importance to the European Community in the continental bioregion of Europe, specifically in Poland, as a reference have been studied. The most significant threats to alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* habitat in the continental bioregion result from human-induced changes in silviculture, forestry (21.56%, as forest planting on open ground, removal of dead and dying trees, forestry clearance, thinning of tree layer), transportation and service corridors (20.82%, as roads, motorways, paths, tracks, cycling tracks, bridge, viaduct, suspended electricity and phone lines), natural system modifications (13.20%, as human induced changes in hydraulic conditions), natural biotic and abiotic processes (11.7%, as biocenotic evolution, succession, interspecific floral relations), invasive, other problematic species and genes (8.74%, as invasive native and non-native species), pollution (8.36%, as pollution to surface waters), agriculture (7.81%, as cultivation and grazing), urbanisation, residential and commercial development (5.95%), mining, extraction of materials and energy production (0.93%), human intrusions and disturbances (0.56%), climate change (0.38%). The examined habitat have potential for restoration. Our findings prove that successful conservation programs for alluvial forests habitats of continental type should be undertaken towards the protection and preservation of their direct and indirect surroundings. A list of recommendations for treatments to be included in habitat conservation programs is presented.

APPLICATION OF KRIGING IN THE ANALYSIS OF SPATIAL VARIABILITY OF PRECIPITATION IN POLAND

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Keywords: kriging, water resources, precipitation, moderate climate

The aim of this work is to present the application of the geostatistical methods in the assessment of the possibility of utilizing rainwater in the moderate climate in Poland. The country was divided into regions with homogeneous precipitation amounts by means of method kriging.

The study uses meteorological data regarding average monthly precipitation values from 53 meteorological stations from the years 1981-2010. The station selection was dictated by the necessity to consider the variability of the amounts of annual precipitation in the whole country. The obtained data provided the basis for the calculation of mean annual precipitation totals, as well as precipitation totals in the summer half-year (May to October) and in the winter half-year (November to April) in the years 1981-2010 for the territory of Poland. The spatial distribution of mean precipitation totals for the entire year, the winter and summer half-year in the territory of Poland were estimated based on the source data.

Analyses of spatial variability of precipitation have been conducted since the beginning of the previous century. Various methods have been applied for this purpose: Thiessen polygons, inverse distances, triangulation, isohyets, and polynomial interpolation. A GIS software package ArcGIS 10 extension were used for the ordinary kriging estimations in this study. The maps were produced with the ArcMap module of ArcGIS.

The positive side of the water balance of Poland expressed in total annual atmospheric precipitation from meteorological stations equals 607 mm. Atmospheric precipitation in Poland is characterised by high spatial and temporal variability. The lowest precipitation totals were recorded in the central part of the country, where they equalled 500 mm. The highest annual precipitation totals were determined in the south, equalling 970 mm. Annual precipitation shows an uneven distribution in

a year. The average precipitation total in the summer half-year is 382 mm (63% of the annual total). The accurate estimation of the precipitation pattern in complex areas requires a very dense network of instruments. In the case study, cross-validation was used to compare the prediction performances of the three period. Kriging gave the best performance in the statistical sense. Their application is justifies especially in areas where landform is very complex. In accordance with the assumptions, the ME and MSE values are approximate to 0.

ASSESSMENT THE SPATIAL AND TEMPORAL VARABITY OF WATER QUALITY INDEX IN THE BYSTRZYCA RIVER BASIN

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Keywords: Bystrzyca River Basin, water quality index, correlations, cluster analyses, principal component analysis

The paper present research environmental variables a four year monitoring period (2015–2018). Analyze research chemical and physical parameters obtained during is subjected on assessing the spatial and temporal changing trend sand classifying of water quality in the Bystrzyca River Basin. To investigate the use water quality index (WQI) a Principal Component Analysis, correlation and cluster analyses are conducted. The analyze identify the statistical significant in the water quality and the correlated parameters. The method some redundant variables can be deleted and reduce the analytical costs. The WQI calculation is more adequate to reflect the seasonal changes of water quality, we have tried to quantify the impact of human activities on the water quality.

The Bystrzyca – a left-bank tributary of the River Wieprz, has its source in Sulów (at 227 m a. s. l.). The total length of the river is 70.3 km, and the area of the river basin 1315.5 km². Below Spiczyn (at 152 m a. s. l.) it flows into the River Wieprz. In Osmolice the River Kosarzewka flows into the Bystrzyca. Within the Lublin urban area three more tributaries flow into the river: Krężniczanka from the west, Czerniejówka from the south and Czechówka from the northwest. The last tributary outside the urban area is Ciemięga. The storage reservoir Zalew Zemborzycki is situated on the river in the southern part of Lublin – a place for leisure and recreation, with a base of tourist and sports services.

The paper presents the analysis of physicochemical and biological parameters in water samples taken from the Bystrzyca river and its tributaries: Kosarzewka, Krężniczanka, Czerniejówka, Czechówka, Ciemięga. The water quality index (WQI) was calculated to assess spatial and temporal variability and to determine the water quality classification in the river.

Weighted arithmetic water quality index (WQI) was used to assess the water quality of the river. Multivariate statistical techniques used in the work are cluster analysis (CA), correlation analysis (C) and main component analysis (PCA) that

allowed to determine the sources of water quality variability and determine the cause of pollution in the river. WQI values indicated a high level of pollution in the Zemborzyce reservoir, which makes it unsuitable for any purpose. The test results showed very good water quality at the place of inflow of watercourses, good water quality in the upper course of the river and average water quality in the lower reaches of the Bystrzyca river. This suggests that urban wastewater from the growing population and industry in the middle course has led to a deterioration of water quality along the river. The results of statistical analyzes have shown that sources of river pollution can be divided into four groups: mineral impurities, organic pollutants, heavy metals, fecal contamination. It was shown that the deteriorating water quality of the river comes from various sources of anthropogenic activity: municipal sewage discharge from the cities of Lublin and Świdnik, wastewater discharge from large industrial activity in Świdnik, Osmolice and Motycz, agricultural activity, storage of solid waste in Rokitno. Selected measurement stations are characterized by statistically significant temporal and spatial variability. This study successfully demonstrates the use of WQI and multivariate statistical techniques.

PRODUCTION OF MICROALGAE BIOMASS USING AN AQUACULTURE WASTEWATER AS GROWTH MEDIUM

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Keywords: microalgae biomass, wastewater treatment, nitrogen / phosphorus removal

Aquaculture is one of the fastest growing sectors in food production. Fish farming in closed systems brings a number of benefits, however, it is not indifferent to the environment. The biggest problem is the presence in the sewage of large amounts of nitrogen and phosphorus, which cause the phenomenon of eutrophication. The amount of generated wastewater is significant, and it is proportional to the increase in fish production, so it is necessary to undertake actions aimed at reducing the negative impact of aquaculture sewage (AWW), mainly on eco-water systems. A good solution is the biological treatment of these wastewater, and due to the possible additional environmental and economic benefits, the use of algae in these processes. Thanks to these organisms it is possible to remove biogenic elements from wastewater with the simultaneous production of their biomass, which has a significant energy potential, and the components it contains can be used, *inter alia*, for the production of advanced biofuels.

The purpose of the presented study was to determine the potential of microalgae from the *Chlorella minutissima* species in the area of removing nitrogen and phosphorus from saline wastewater from the pro-ecological salmon breeding and using these components as food substrates necessary for the production of algae biomass. The tests were carried out in tubular photobioreactors for 10 days. The cultures were illuminated with LED light in the cycle of 16 h light/8 hours dark. As part of the analysis, cell density in culture, biomass growth and its productivity as well as nitrogen and phosphorus content were determined. In addition, the amount of lipids in biomass was also determined. The optical density (OD) was determined by

spectrophotometric method at 680 nm, while the amount of biomass in the culture by gravimetric method. The total content of nitrogen and its individual forms (N-NH₄, N-NO₂, N-NO₃) as well as total phosphorus and orthophosphates (PO₄) was determined by spectrophotometric method. Lipid content in biomass was determined after its extraction by the Soxhlet method using hexane.

It was found that the optical density of cells in the culture increased almost 5-fold compared to the initial values (OD₆₈₀ 0,502). The biomass concentration is 4,77 g L⁻¹ and maximum productivity 1,73 g L⁻¹ day⁻¹. The content of total nitrogen in sewage was reduced by 88%, and the total phosphorus by over 99%. Analyzing individual forms of nitrogen, it was found that the reduction of N-NO₃ was 88.6%, N-NO₂ - 74.3%, and for dissolved in water orthophosphates (V) - 99%. The N-NH₄ content in the sewage from the beginning to the end of the experience remained below 0.05 mg L⁻¹. The lipid content in the biomass was 46.4% (w/w).

It was found that the *Chlorella minutissima* algae used in the tests showed high efficiency in removing nitrogen and phosphorus from wastewater. These elements have been used by microalgae to produce their own biomass and lipids collected in their cells. The results of the presented experimental research may be the basis for the creation of an integrated system of saline water treatment with simultaneous production of microalgae biomass for energy purposes.

METHODOLOGY OF THEMATIC MAP CREATION FOR FORMATION OF SOLID HOUSEHOLD WASTE AND THE CREATION OF BUFFER ZONES

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Keywords: solid domestic waste, classification map, localized card scheme.

Purpose. Familiarity with modern methods of creation of the thematic maps and the analysis of the formation of solid waste in the territory of the Lviv region.

Problems with the accumulation and utilization of solid household waste arise and need to be solved in each civilized country. Ukraine is no exception.

Solid household waste is a waste produced as a result of human life and activity in residential and non-residential buildings, as well as remains of substances, materials, objects, etc., and can not subsequently be used as intended (according to the "Service Provision Rules" on collection and removal of solid and liquid household wastes).

In the Lviv region, the issue of solid waste is very acute, especially after the catastrophe in Gribovychy, because the waste disposal is reduced to mere dumping in landfills. The vast majority of them works in violation of all requirements regarding the amount of accumulation, that is, we have overwhelmed landfills that pose a great danger to the environment. Soils, underground and surface waters, and residents of surrounding settlements suffer the most.

Methodology and scope of a research. To create a map for placing solid waste containers there is need in the information about the location (address) and their number. To solve this problem, authors appealed to local governments, such as Lviv District Administrations, and the Department of Housing and Communal Services. In the final analysis, data was obtained on the location and condition of container platforms in the following areas: Zaliznychny, Lychakivskyi, Sykhivskiy, Shevchenkivskyy and Halychskiy.

To get the map scheme of Lviv, the Digitals software was used to download the basis of WGS 84 (Fig.1).

Due to the expanded capabilities of QGIS, the classification was established on the basis of the density of the location of solid waste containers, called "thermal map" (Fig. 2).

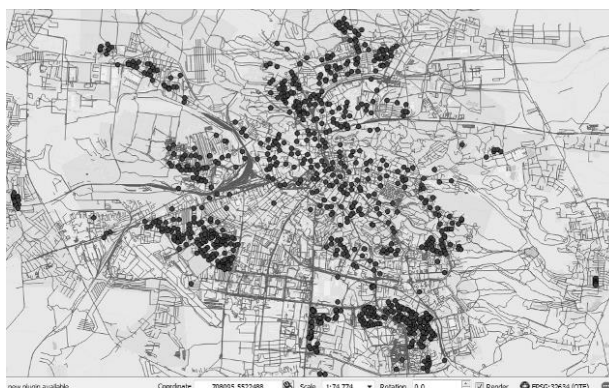


Fig.1 A general view of the road network map and the shape-file of the Solid household waste container

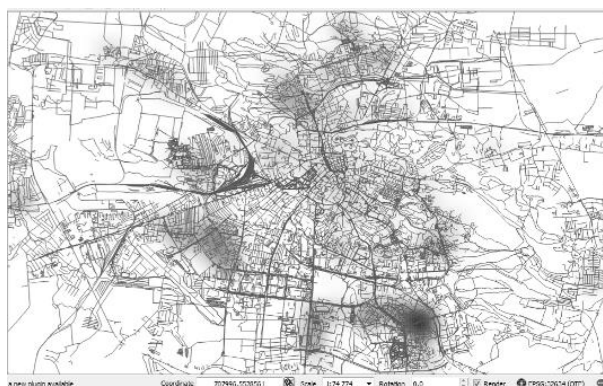


Fig.2 Thermal map of garbage containers clutches

Result and conclusions. Comparing the experience of management of solid waste in Ukraine with the experience of the EU, we came to the conclusion that the volume of domestic waste generation is significantly higher compared to foreign countries. Also, the article analyses obtained data on collecting garbage containers on the territory of Lviv. Using the "Google Tables" the data and coordinates of the placement of solid waste containers were received

By means of QGIS software, a map for placing solid waste containers on the territory of Lviv in such areas as: Zaliznichny, Galitsky, Lychakivsky, Shevchenkivskyi, Sykhivsky was created. A map of classifications was created and buffer zones for the placement of trash cans were founded.

AUTOMATED GENERATION OF DIGITAL MODEL OF OBJECT MICRO SURFACE FROM SEM STEREO PAIR BY AREA-BASED IMAGE MATCHING

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Keywords: SEM stereo pair, image matching, accuracy, 3D model.

The goal of this work was the development and research of a method of automatic constructing a digital model of the micro surface of an object using a stereo pair SEM digital images taking into account the specifics survey SEM and evaluating the accuracy of digital modeling.

For research, we have used two stereo pairs of digital SEM images. Digital images of the deformed surface chrome steel specimen were obtained from the JSM 7100F (JEOL) with magnification 750x. Images of a specimen of loess soil were obtained from the SEM "Hitachi" S-800 with magnification 1000x, recorded on photographic film with a possible measurement accuracy of 0.03-0.05 mm and scanned at a resolution of 1200 dpi by a photogrammetric scanner. In both stereo pairs, the left SEM images were obtained in the horizontal position of the specimens, and the right images were obtained by tilting them along the x axis. To evaluate the accuracy of micro surfaces simulation test models were created by manual coordinate measuring feature points of the digital stereo pairs both specimens. For a specimen of chrome steel, 250 points were measured, and for a more complex micro relief of the surface of a specimen of loess soil - 626. The search for the matching points of the stereo pair was carried out by the levels of the image pyramid using the correlation algorithm. For the image of a specimen of chrome steel, a more detailed zero level of the Gaussian pyramid with a resolution of 0.5 pixel was created. Four levels of the Gaussian pyramid from low to fine resolution were created to image a specimen of loess soil. To improve the image quality of a specimen of loess soil, a histogram equalization method was used, by which the number of successfully identified points increased by 2.6%. The input points were generated in the left top-level image of the pyramid using the gradient method and global Otsu threshold to obtain respectively, the points of the edges and on the borders of the regions. The results of these two operations were combined into one array. First, for the generated points, the corresponding points were determined taking into account the displacement due to the tilt of the right image. Secondly, the

points in the right image were sequentially displaced along the x axis by a shift parameters, which were selected from the range of possible x -parallax values caused by the surface relief. In the right image in the obtained points were centered search windows whose size was determined depending on the interval between the adjacent shift parameters. For each point in the left image a normalized coefficient of correlation between the template window and a similar region was calculated, the center of which moved from point to point in the search window in the right image. Points for which the maximum correlation coefficient did not satisfy the acceptance criterion were displaced on the next shift parameter from a given set. After the displacement procedure, all points that satisfy the correlation criterion, passed to the next level of the pyramid for clarifications. When calculating the spatial coordinates of the points of the surface micro relief, the values of geometric distortions inherent in the SEM image were taken into account. The developed algorithm was implemented in program for micro surface simulation written in MatLab system. Construction of the 3D models and visualization of micro surface of research objects were performed in the Surfer package. To eliminate some anomalous values of the heights of the 3D model, an adaptive median filtering procedure was applied. Accuracy created digital micro relief model was evaluated by the differences between the heights of test points and heights interpolated at the same points using the constructed grid model. For a chrome steel specimen micro surface about 79% of the points, and for a micro surface specimen of the loess soil about 70% of the points were within tolerance $\Delta Z \leq \pm 2 \text{ } \mu\text{m}$. Comparison of 3D models created for a specimen of chrome steel at the 0th level of the image pyramid before and after adaptive median filtering showed their similarity. Comparison of the same models obtained at the 1st level of the pyramid, revealed in about two times an increase in the number of ΔZ values in the range $[-4 \div 2] \text{ } \mu\text{m}$. It should be noted that the speed of calculations in the Matlab system in the interpretation mode for the 0th level of the pyramid decreased by almost 4 times compared to the 1st level. Using pixels size windows at the pyramid levels: 1st: 17x17 template, the search window 5x5; 0th: 25x25 template, the search window 21x21. Comparison of 3D models obtained from scanned images of a specimen of loess soil at the 1st and 2nd levels of the pyramid showed that scanning the film with the above properties with a resolution of 1200 dpi (1st level) did not increase the accuracy of the simulation.

The ability to reproduce the surface micro relief of an object automatically using a stereo pair of SEM digital images was established in accordance with the requirements of both the accuracy of determining the spatial coordinates of points and the structure of the micro surface of the object. The greatest differences between the micro surfaces of the test models and constructed models were observed near the boundaries of the models and in areas with a complex micro relief. Such areas should be complemented by the coordinates of points measured directly by the operator.

THE IMPORTANCE OF PERMANENT GRASSLANDS IN AGRICULTURAL ECONOMY

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Key words: grasslands, economic and environmental functions, organic farming, synergy effect

The location of permanent grassland is related to the physiographic conditions of the area. Due to the waterlogging and the location marked out by the river line, grasslands often occupy extreme habitats where other plants can not be grown. Yields of hay from meadows or grazing sward can range from 1-2 to 10 and more t from ha. They are one of the cheapest roughage, about 2.5 times cheaper than forage from arable land.

The basic economic function and natural form of use is the production of roughage for ruminants. The content of feed ingredients is determined by the content of nutrients, minerals and so-called specific substances as well as digestibility and palatability. Unlike concentrated feeds, they are enriched with biocatalysts: carotene, vitamins, enzymes and microelements. Thanks to multi-species, natural feed from meadows and pastures affects the good quality of meat and dairy products obtained from the animals fed to them.

The economic importance of permanent green uses in agriculture depends on habitat and physiographic factors that determine their share in the structure of agricultural land, as well as their productivity and the possibility of use in animal production. The methods of using the sward, pasture or mowing are determined by inputs and factors such as the distance between the three-point system from the shed, expanse, terrain, soil conditions, stocking, machine park, the possibility of feeding the feed.

The use of grouse and pasture is associated with the ruminant stock. In Poland, the number of ruminants in recent years has been decreasing, which does not ensure receipt of the produced biomass. Degradation of plant communities is taking place and their utility value is reduced.

Roughages account for 50 to 90 % of all feeds in ruminant nutrition, which is why their quality plays an extremely important role. Therefore roughages production requires compliance with all agrotechnical recommendations, starting from mowing the meadow sward in the right development phase. The best way to

feed cattle and use meadow and pasture sward is grazing. Animals eat green fodder with the highest biological value. It guarantees even 18-20 dm³ of milk per cow per day or 0.8-1.0 kg·head⁻¹ daily weight gains of fattening. There is no loss of harvest, maintenance and storage. Due to the climate, part of the harvest from grassland must be preserved for the winter. The production of hay for the winter still prevails in Poland, but the best way to preserve the sward is to ensnare it. Better nutritional value and greater independence from weather conditions are obtained.

The natural meaning and functions of meadows and pastures are a derivative of the process of sodding grassland ecosystems, which is associated with their beneficial impact on the resources of the natural environment of agricultural areas: water, soil, air and biodiversity. Grasslands are the only "agricultural crop" that combines production functions with protective ones in relation to the natural environment.

Properly used meadows and pastures stabilize the processes of changes in the natural environment. On the farm, they enable the use of synergy, i.e. benefits from the cooperation of grassland and arable land. Practically impossible is rational management in meadows and pastures in isolation from arable land and vice versa. In integrated / sustainable agriculture, these lands complement each other, a large part of the ingredients from the fodder returns with manure to the field. And then "the meadow feeds the field." Due to the lack of possibility of other management of meadows and pastures, they are included in the basic forage area on the farm. As the share of grassland in the structure of arable land on the farm increases, the arable land begins to fulfill a supplementary function. The correct organization of farms should result from their share in the structure of agricultural land. Also in an organic farm a large share of meadows and pastures in the structure of agricultural land has a positive effect on the organization of their use. It is possible to maintain a certain stock of cattle, even in conditions of slightly lower yields of hay and forage forage, resulting from limitations imposed on ecological farms.

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EFFICIENCY AND RELIABILITY OF SEWAGE PURIFICATION IN LONG-TERM EXPLOITATION OF THE WASTEWATER TREATMENT PLANT WITH ACTIVATED SLUDGE AND HYDROPONIC SYSTEM

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Keywords: wastewater treatment, activated sludge, hydroponic system, efficiency and reliability of operation

In typical collective wastewater treatment plants with activated sludge and hydroponic system there is used not only a classic system for wastewater treatment (I° mechanical treatment, II° biological treatment) but we can also find the third stage which is hydroponic lagoon. The most often hydroponic lagoons look like artificial rivers to which wastewater after biological treatment inflows. Pollutants removal occurs due to the functioning of organisms that float either on wastewater surface or on some supports made from chemically neutral materials. The abovementioned organisms can be various macrophytes, algae, minor aquatic invertebrates, protozoans and bacteria that develop in plant root systems. Preservation of constant flow, providing sewage aeration in some chosen parts of the bed and light access enable to create appropriate conditions which are essential during self-purification processes that are similar to the ones that occur in rivers.

The aim of the work was to analyse the efficiency and reliability of pollutants removal (total suspended solids – TSS, BOD₅, COD) in a collective wastewater treatment plant with activated sludge and hydroponic lagoon during its long term operation. The tested object was designed to treat sewage influent through the sewerage system and sewage delivered by the septic trucks. The projected capacity of the treatment plant was 1200 m³·d⁻¹. The technological system for wastewater treatment consisted of a mechanical part, a flowing biological reactor working according to the BARDENPHO process, a secondary settling tank and a hydroponic lagoon.

The efficiency and reliability of pollutants removal in the analysed treatment plant were assessed on the basis of the data concerning influent and effluent wastewater collected during the years 2009-2018. The samples were collected

seasonally in two points of the wastewater treatment plant: 1) raw sewage from the pumping station, 2) treated sewage outflowing to the receiver.

On the basis of the measurements results, there were determined characteristic values of the selected pollution indicators in wastewater and the average efficiency of pollutants removal. The technological reliability of the wastewater treatment plant was assessed for the basic pollution parameters (BOD₅, COD, TSS) in accordance with the elements of the Weibull's reliability theory, with regard to normative values of the indicators specified in the Regulation of the Minister of Environment. The analysis was carried out using the Statistica 13.1 software. It was proved that in the wastewater treatment plant with an active sludge and hydroponic lagoon the level of organic pollutants removal expressed by BOD₅ was on average 99,4%, COD – 98,0% and TSS – 99,2%. The technological reliability of the system was 100% in terms of the removal of pollutants from the basic group, which means that during the long term operation (10 years) it provided failure-free operation and guaranteed the fulfilment of the requirements that can be found in the law regulations concerning the analysed pollutants.

THE CONDITION AND DEVELOPMENT NEEDS OF WATER SUPPLY NETWORK AND SEWERAGE SYSTEMS IN THE RYKI DISTRICT IN POLAND

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Keywords: water supply network, sewage network, collective sewage treatment plants, household sewage treatment plants, septic tanks

The paper presents the condition and development needs of the water supply network and sewerage systems in the Ryki district in Poland in 2016. The district is located in the north-western part of the Lublin province and consists of 6 communes: 2 municipalities: Dęblin and Ryki, and 4 rural communes: Kłoczew, Nowodwór, Stężycza, and Ułęż. The paper presents data obtained from a survey conducted in 2016 in the Ryki district and concerning: the number of sewage treatment plants with a capacity of more than 5 m³, the number of household sewage treatment plants, the number of active septic tanks and the length of the water supply and sewage networks. The data show that the district has a well-developed water supply network, while the condition of the sewage infrastructure is unsatisfactory. The largest percentage of the population using the water supply network has the municipality of Ułęż – 100%, while the smallest municipality Stężycza – 9.77%. The most significant percentage of the population using the sewerage network has the municipal commune of Dęblin – 89.59%, and the lowest municipality Kłoczew – 1.51%. The presented data show that in order to protect the environment, it is necessary to expand the water supply and sewage network in the Ryki district.

THE MINIMUM REQUIRED LANDSCAPE DISCHARGE

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Keywords: landscape change, water availability, environmental change, restoration ecology

The Minimum Required Landscape Discharge serves as a decisive factor to restore, preserve or develop specific landscape conditions. The parameters dependent on the water availability determine the condition of flora and fauna as well as the climate, area topology and anthropogenic impact.

In order to determine the Minimum Required Landscape Discharge, the basic nature and human factors (e.g., landscape constraints, historical reference conditions, climate change, spatial dependencies, land-use legacies) and their relations within a defined catchment area have to be described and the essential parameters defined.

The hydro-ecological relations in the landscape are described through the certain measurement methods and interpretation algorithms. The aim is these procedures and the interpretation thresholds concerning the objectives to recognize and optimally adapt and apply.

HYDROCHEMICAL EFFECTS OF WATER RETENTION IN FOREST CATCHMENT

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Keywords: Forest catchment, water quality, small retention.

In recent years, as a result of increased awareness of the deepening negative impact of drainage of the wet woodland habitats, interest in small catchments and the associated small retention has increased. Many activities at various levels of the state organizational structure, aimed at increasing retention of forest habitats, have been carried out. The hydrochemical study of a small catchment, to assess the link between spatial soil distribution and heterogeneity of surface and groundwater chemistry, was undertaken in NE Poland. To estimate effects of technical solutions regulating water retention along small forest streams, four forest experimental catchments were selected, diversified in terms of hydrological, physiographic, soil, habitat conditions.

Determination of the hydrogeological and hydrological effects of water damming and quantitative changes in water resources was based on the periodic control of the groundwater level within the reach of the damming. In the samples the nitrate nitrogen (V) concentration, Kjeldahl nitrogen, magnesium, phosphate phosphorus, total phosphorus, sodium, potassium, sulphates, carbonates were determined according to commonly accepted methods. The average concentrations of components dissolved in the water of the watercourse showed significant spatial variability throughout the catchment. Although there were links between hydrochemical properties of groundwater and soil types. The predominant types of soils did not always determine the properties of water. Concentrations of the constituents in related river waters have not always been correlated with the quality of the water flowing in the streams. The share of groundwater in the supply of streams was included in the calculations of water balances and showed different concentrations of solutes relative to the watercourse, which increased the heterogeneity of hydrochemical attributed to the drainage of surface soil, and thus indicated the complexity of subsurface flow paths. Small sub-basins of the basin can have a decisive influence on the outflow balance of components dissolved by the watercourse. The assumptions of hydrochemical modeling approaches that define small basins as homogeneous units may treat them too broadly. Too detailed approach, however, complicates holistic approaches in making decisions at the level

of the administration of water for the protection of water resources. The study was supported from the EU ERANET 2017 Water JPI Joint Call project “Water Harmony - Closing the Water Cycle Gap With Harmonised Actions for Sustainable Management of Water Resources”.

DETERMINATION OF DIVERGENCES IN MEASURED AND SIMULATED FLOWS BASED ON THE CONCEPTUAL RAINFALL- RUNOFF MODEL FOR A SMALL FOREST CATCHMENT

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Keywords: forest catchment; retention; runoff modelling; SCS-CN.

The paper presents an analysis of suitability of the conceptual rainfall-runoff model by Nash for simulation maximum flows in two small forest catchments located in the NE Poland. The parameters of the Nash model were determined for 9 rainfall-outflow events. This model compares hydrological phenomena occurring in the basin river system with a cascade of N linear tanks with a retention time K . Determination of spatial-temporal conditions of forming the outflow in spring sections of forest catchments enclosed by the damming infrastructure. These structures differ from typical hydrotechnical and reclamation constructions. They include wooden weirs, ground dams, stone and fascine artificial rapids, water gates made of natural, local, environment-friendly materials. Objects of this kind, located in forests, normally do not deliver the typical water management function, considering the limited controllability of the flow. The water-balance is regulated automatically; the stabilization of hydrological extremes occurs to a limited degree. The conformity between measurements and simulated flows as well as the time delay of outflow and parameters of the Nash model in the catchment were assessed. An estimation of the influence of afforestation on flooding was calculated based on the SCS-CN method. The main parameter of the curve number is a function of land use. The parameter combines land cover and soil properties, including the preceding soil moisture conditions preceding the run-off event. The analysis was conducted for catchment area of 855 ha and 176 ha. Pine and spruce are the dominant tree species in the forest stands. The field measurements comprised. Field measurements included continuous recording of water levels in the course of the Thompson's overflow and constant measurements of the groundwater level using electronic units to automatic registration of groundwater level in 12 piezometers. Additionally 2 comparative units (Baro) to compensation atmospheric pressure were installed. Average rainfall for 9 precipitation episodes were 12.6 and 16.2 mm. The compatibility between these flows is much greater in simulations with a shorter time step than with a longer time step.

The study was supported from the EU ERANET 2017 Water JPI Joint Call project “Water Harmony - Closing the Water Cycle Gap With Harmonised Actions for Sustainable Management of Water Resources”.

ASSESSMENT OF THE POSSIBILITY OF BUILDING AN AGRICULTURAL BIOGAS PLANT ON A CHOOSING FARM

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Key words: biogas plant, substrates, location, technical conditions, infrastructure

An increasingly popular method of obtaining energy from biomass is the production of biogas, generated under controlled conditions, in the anaerobic digestion process. Biogas can be obtained from waste from agriculture, forestry and various branches of industry, as well as from biomass from target crops. When planning the construction of a biogas plant, the sources of substrates, their composition, availability, storage capacity, price volatility and transport costs should be identified in detail.

The aim of this research is to evaluate the possibilities of building an agricultural biogas plant and calculating its size on the basis of available raw materials in a selected farm, based on the methods presented in the literature. The studied farm specializes in pig fattening and produces plant production mainly for fodder. Animal production generates a large amount of waste in the form of slurry, which is suitable for the production of biogas.

It was assumed that one of the thickening substrates would be silage from grass from own land. In addition, it will be bought and imported from several places, a bakery waste, which will consist mainly of stale bread. It is not planned to allocate arable land for special crops. It was estimated that the amount of daily feed will be 16.44 m³, of which 13.81 m³ is manure, 1.37 m³ will be bakery waste, and the remaining 1.26 m³ will be silage. Within a day, 807.9 m³ of biogas will be produced with a biomethane content of 56.8%. It was assumed that from 1 m³ of such biogas, 5.31 kWh of electricity can be obtained. The total daily electricity production will be 1577,12 kWh. The generated energy and heat will be fully utilized by the farm.

The sizes of the individual elements of the biogas plant were selected based on the amount of daily charge and biogas arising from it. The calculated capacity of the fermentation chamber will be 500 m³, and the aggregate that will be installed for biogas combustion will be 66 kW and will operate in the cogeneration system. The entire facility will be equipped with the necessary control, control and measurement equipment.

The logistics of raw materials supply has been designed in such a way as to minimize the costs and transport time of individual substrates and to use already existing machines, buildings and structures. The slurry will be transported directly from the livestock buildings, the silage will be prepared with its own equipment and stored directly in the vicinity of the biogas plant, and the bakery waste will be purchased if possible by individual suppliers and stored in a dry warehouse. The post-fermentation substance resulting from the methane fermentation process will be collected in a container tightly covered in order to recover residual biogas that is still being formed in the post-fermenter. It was calculated that about 4930 m³ of this substance will be produced during the year. The farm will be able to fully use the digestate on its own land.

The construction of a biogas plant in the surveyed farm will allow the management of onerous wastes of animal production and biomass from grassland, which is unnecessary in the current animal breeding. In addition, it will allow for the management of local bakery waste, which may be problematic for the baking industry in utilization. In addition, there will be a valuable organic fertilizer with a much smaller odor nuisance and more environment-friendly than slurry.

ASSESSMENT OF THE APPLICABILITY OF DIGESTATE FROM AGRICULTURAL BIOGAS PLANTS

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Keywords: digestate, agriculture biogas plant, natural fertilizers

Currently, in Poland, due to environmental reasons, the number of biogas installations is slowly increasing. In addition to the primary product, which is biogas, a large amount of digestate is also produced. Therefore, the problem becomes its proper management.

The aim of this work is to assess the possibility of using digestate from agricultural biogas plants, its impact on the natural environment state and effects on agriculture. Particular attention has been paid to the use of fertilizers and energy. To this end, laboratory tests of chemical, physical properties of digestate samples were carried out.

These studies have shown that digestate is a valuable product suitable for agricultural use. Due to the content of a large amount of organic matter and minerals, it increases plant yield and soil quality and is similar to natural fertilizers. Digestate in various forms is an excellent alternative to natural fertilizers and allows reducing the amount of mineral fertilizers used in agriculture. Digestate also has a high energy potential. The calorific value of pellets obtained from separated solid fraction, is comparable to wood pellets (up to 18.5 MJ/kg), which makes it a good alternative. The research results indicate that rational digestate management can bring tangible benefits to the environment and local society. Digestate recycling can undoubtedly bring significant economic benefits to units dealing with waste management, agriculture, or energy, but also environmental benefits relevant to the whole society. It has to be also underlined that usage of digestate in agriculture instead of natural fertilizers (manure, slurry) decrease strongly the odor emitted during spreading which increases the welfare of local societies.

**THE STATE AND THE PERSPECTIVES OF THE ECOENERGY
INFRASTRUCTURE DEVELOPMENT IN BIAŁA PODLASKA COUNTY
PART II. THE BIOMASS RESOURCES**

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Keywords: renewable energy sources, biomass, wood, straw, resources estimation

The research aimed to estimate the resources of the biomass, possible to acquire for the energetic purposes in Biała Podlaska County (Lublin Voivodeship, Poland). The studies were carried out, according to the regional biomass resources estimation methods, practiced in planning works and strategic elaborations. The abilities to acquire wood, straw, hay, and solid biomass from the dedicated cultivations were determined. The wood resources for energetic purposes were estimated in accordance with its different sources: woods, orchards, stockings, roadside plantations and wood-processing factories (sawmills, furniture factories, etc.). The estimation of the straw potential was based on the assumption that its energetic usage is reasonable as long as it fulfills the agricultural needs for this kind of stock, as litter, feed or to plow. On the contrary, the potential cultivations area of energetic plants was estimated in accordance with the area of marginal and uncultivated lands, occurring in the researched area.

The estimation of the biomass potential, possible to acquire in Biała Podlaska County indicates that the most energy may be gained from the straw (approximately 51% of the calculated potential). Due to the significant area of the marginal lands, the next resource is the biomass of plants possible to grow in this region. This resource is theoretical since currently, there are no energetic plantations, and the cultivation of its is dependent on the biomass market and its price. The wood derived from forests, orchards or stockings and the litter biomass from the wood processing makes a less part of the estimated potential. The aggregated potential of the solid biomass, available for the energetic purposes, was estimated on a level of approx. 460 thousand tonnes a year, that corresponds to approx. 6.7 PJ of energetic value (tab.1).

In accordance to the researches carried out, it was proved that the most of communities in Biała Podlaska County have tremendous possibilities to acquire the

solid biomass, suitable for using as energetic purposes without encroaching the food security of the region or the country. The fundamental condition of development of this production is creating the installations, processing the biomass into fuels (briquettes, pellets, biocoal) or providing the energy for local purposes.

Table 1. The potential of the solid biomass in Biała Podlaska County

Biomass source	Technical potential	Energetic potential	Share in energetic potential
	[Mg]	[GJ]	[%]
Wood	48 945	443 298	6.63
Straw	243 501	3 395 375	50.76
Hay	17 096	238 888	3.57
Perennial energetic plants	113 595	2 044 703	30.57
Annual energetic plants	35 499	567 275	8.48
Total	458 636	6 689 539	100

A reasonable solution is a local biomass usage: for heating the public buildings, individual residential or industrial buildings and for local boiler rooms. Long-distance transport of the biomass is associated with fuel consumption and consequently – with the environment pollution and the rise of energy production costs. The usage of the agriculture resources for energy and energetic stocks production provides opportunities for a region development, i.a. new workplaces for local populations, improvement of the income of the rural society, local resources usage, increase of the energetic security and the independence or also for sustainable development of the rural areas and the agriculture.

RELIABILITY AND STABILITY OF THE SEWAGE TREATMENT PLANT OPERATION WITH THE BIOREACTOR POLMILTEK MANN TYPE

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Keywords: sewage, active sludge, bioreactor, effectiveness, pollution indicator.

Goal of a research:

The aim of the study is to assess the reliability and stability of organic pollutants removal expressed in BOD, COD and total suspended solids in wastewater treatment plant with the bioreactor Polmiltek Mann type.

Methodology and scope of a research:

Scope of a research includes the result of organic pollution indicators in the raw and treated wastewater noted in the period between 2003 and 2014. During this period, collected and analyzed the 38 samples of raw and treated sewage. The analysis was performed for the following pollutants indicators: BOD₅, COD_{Cr} and total suspended solids. For each of them descriptive statistics, percentage reduction the pollutants indicators and treatment plant reliability factors (WN) were calculated. The assessment of the stability of work of sewage treatment plant was performed by using control cards X for the simple test. The assessment of reliability of pollutant removal in the treatment plant was determined using elements of Weibull's reliability theory.

Highlight of results:

Table 1. Values of main descriptive statistics of pollutants indicators in raw sewage and treated sewage

Raw sewage				
	Unit	BOD	COD	Total suspension
Minimum	mgO ₂ · dm ⁻³	100,00	268,00	120,00
Average	mgO ₂ · dm ⁻³	543,83	1228,08	579,94
Maximum	mgO ₂ · dm ⁻³	2200,00	6117,00	2958,00
Standard deviation	-	352,17	1075,44	580,80
Coefficient of variation	-	0,65	0,88	1,00
Treated sewage				
Minimum	Unit	2,70	25,50	3,20
Average	mgO ₂ · dm ⁻³	28,48	86,60	25,02
Maximum	mgO ₂ · dm ⁻³	103,00	225,00	106,00
Standard deviation	mgO ₂ · dm ⁻³	22,05	45,69	21,89
Coefficient of variation		0,77	0,53	0,87

Table 2. Values of treatment plant reliability factors of sewage treatment plant

Reliability indicators			
Indicators	η [%]	WN	Psw
BOD	94	0,95	0,82
COD	89	0,58	0,92
TS	94	0,50	0,92

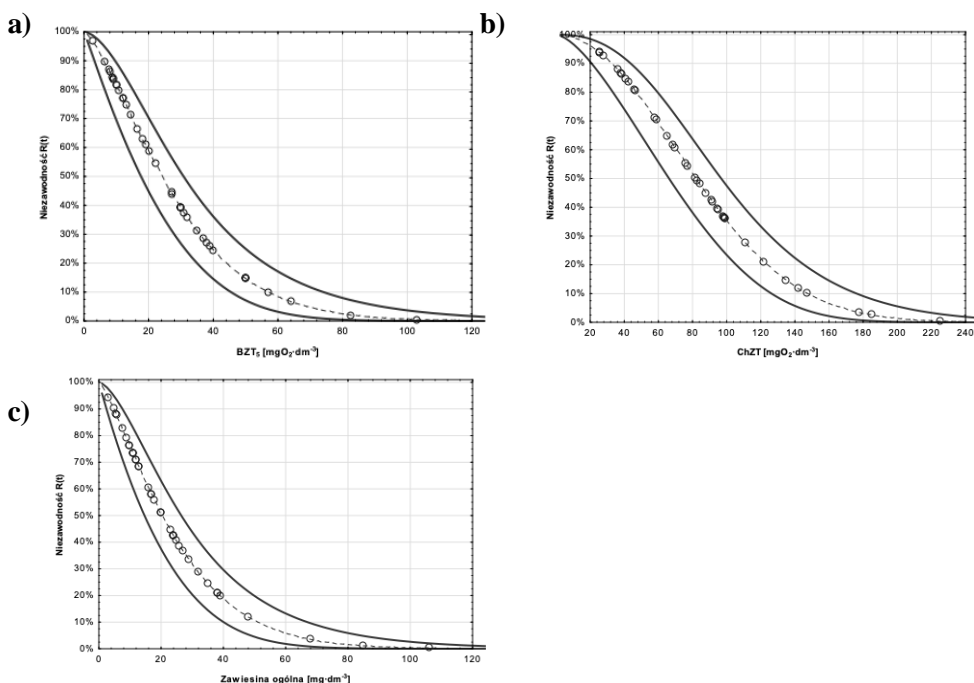


Fig. 1. Weibull cumulative distribution functions and the technological reliabilities determined for a) BOD b) COD c) Total suspended solid indicators

Main Conclusions:

1. In the period of analyses between years 2003 and 2014, according to the water-law permission in the treated sewage noticed of 7 exceedance have been noticed for the BOD₅ limit value, and 3 cases for COD and suspended solid.
2. In the period of 12 years of study the average effectiveness of pollution reduction was equal of 94% for BOD₅ and 89% for COD, for the total suspension was create on 94% level.
3. Based on the reliability analysis by the Weibull method, it was found that the probability of exceeding the limit value in treated sewage of BOD indicator was on 26%, for COD was equal 9%, and for the total suspension solid create on 11% level.

COMPLEX THEMATIC MAPPING USING GEOGRAPHICAL MAPS, SPACE IMAGES AND STATISTICAL DATA

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Keywords: thematic maps, GIS, statistical sources, attributive database, administrative reform.

Goal of research is to develop and create a set of thematic maps that reflect the current natural and socio-economic situation of the Ternopil region in Ukraine, as well as the assessment of the situation on maps, the choice of the main factors of influence on the system, their analysis and comparison, the identification of interrelations, potential threats, the impact on the environment and on the development of the territory as a whole.

Methodology and scope of research. The administrative map of the Ternopil region has been used as basis for the research and its geographic reference has been carried out. Update of thematic maps and localization of some spatial objects was carried out by the means of a space shot. From statistical sources of information, thematic variables were obtained for 17 administrative districts of the oblast - data on the population, human diseases, objects of the forest and nature reserve fund, pollution of areas, the share of the ecological network in relation to the total area of the district, etc. This data was organized into an attributive database. The database became the basis for creating a set of thematic maps in the GIS Mapinfo software environment. Thematic mapping and distribution of thematic variables involves the use of ranked ranges, the dimensional character method, the column and circular diagram method and the ranges method. To create icon maps in Adobe Illustrator, the graphic editor has designed and eliminated a number of special map symbols that mapped spatial objects and their characteristics on maps. The research used a mapping and GIS analysis method.

Highlight of results. As result of the research, 15 interdisciplinary thematic maps - cartograms, map diagrams, zoning maps, maps of areas and symbol maps that reflect the current state of the socio-economic and ecological situation in the Ternopil region and serve for the analysis of information were created. The correlation between social, economic and environmental indicators is clearly observed in some areas. Such cartographic studies help identify problem areas and require further in-depth special analysis and rational management.

Main conclusions. When it comes to presenting certain thematic information on a geographic basis, thematic mapping applies to all industries without exception. In recent years, environmental and socio-economic projects that use special industry maps have become particularly relevant. They are created by means of GIS-technologies on the basis of graphically-attributive databases.

The obtained research results are objective and relevant. They should be taken into account during the administrative reform in Ukraine, which envisions a significant reduction of the number of districts. Redistribution of administrative territorial units can lead to the loss of important system-based factors and connections in society and nature. In order to maintain the integrity of the system, ensure its functioning and sustainable development, a scientific, integrated approach must be followed, and recommendations based on GIS analysis and forecasting based on accurate cartographic and statistical data should be taken into account.

SHAPING SPACE IN AN OPEN LANDSCAPE USING A MULTI-VALUED METHOD IN SOUTHERN POLAND

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Keywords: landscape, multi-valued method, spatial development, Dobczyce

Polish agriculture, in accordance with the adopted development strategy and requirements, will be subject to quite profound changes. The condition for their implementation is the rationalization of the use of agricultural production space and taking into account in its shaping new needs and programs for the development. The aim of the analysis of city Dobczyce is to identify areas that may be the most convenient place for agriculture development. The term "most convenient" is understood as those areas where the functional and spatial solutions adopted will allow to fully use the values and to avoid difficulties in the analyzed environment. The following methods steps have been distinguished: determination of the type and scale of the map and division of the analyzed area into measurement sectors, determination of the purpose of the area and selection of conditions for its evaluation, selection of features for the area assessment and their quantification, determining the matrix of the values of the features and matrix of values of the weights, selection of measuring sectors that meet the assumed values of the destination and comprehensive evaluation of the research area (selection of areas requiring preparation of local plans).

It is based on cartographic studies and detailed analysis of information contained in them. The area under consideration is divided into individual measuring sectors. Then, the goals of the given area and conditions for their evaluation are specified. The sets of features and their quantification are selected for them. Each feature has a rating scale with three degrees of freedom 0; 0.5 and 1. The collected values are used to determine the matrix of the values of features and the matrix of values of weights. The matrix consists of:

- rows corresponding to fourteen features,
- columns corresponding to the purpose of the assignment,
- selected conditions are recorded on individual layers of the matrix.

The purpose of the features is to expose the most important elements and factors of a given space that will significantly affect specific conditions. The general assessment of each sector, taking into account all the aforementioned conditions to

an adequate degree, indicates the existence, in the city of Dobczyce of areas predisposed to perform the functions sought. The final comparison of the results obtained with the existing spatial development plan for the city made it possible to notice that the vast majority of areas in the plan are intended to perform agriculture function. The greater the number of interpreted functions, the more complex and detailed selection of materials and documents illustrating the existing state of the studied area, the more reliable results of the given method. The consequence of using the multi valued method are complex proposals and solutions that can fully use the features of the analyzed environment.

DETERMINATION OF THE POSSIBILITY OF REDUCING THE SALINITY OF ROADSIDE SOILS WITH THE USE OF MINERAL AND ORGANIC MATERIALS

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Keywords: rendzinas, easily soluble salts, coconut fibres, poplar shavings, salinity reduction

The paper presents the results of the conducted research, which involved the use of coconut fibres, poplar shavings as well as fine sand and medium gravel to reduce the amount of easily soluble salts entering the soil environment as a result of winter road maintenance. For the study purpose, rendzinas were selected, i.e. soils formed on the basis of Cretaceous marls characterized by a shallow humus level with a high content of skeletal parts, as well as the lack of homogeneity of the material within the soil profile. All research areas have been selected within the road lane of the main streets of Opole.

The reduction of the salinity in the investigated soils may result from the sorption of readily soluble salts by the organic material, which was particularly evident in the plots with the top layer of coconut fibres.

In the experiment, an attempt was made to determine the optimal method of application of the analyzed material on the soil surface. The use of organic materials mixed with the soil (mix) has a positive effect on the properties of rendzinas but only in a layer of 10-30 cm depth. This is revealed by lower values of electrical conductivity or a reduced amount of Na^+ and Cl^- ions in the deeper layer of the soil profile.

The use of fine sand and medium gravel does not measurably improve the chemical properties of the analyzed soils within the whole profile, including the reduction of salinity. This was evidenced by the loosening of the soil structure, and thus by the limitation and even lack of salt sorption in the surface layer, thus supporting the free migration of Na^+ and Cl^- ions deep into the soil profile.

The conducted research is experimental with the focus on the possibility of coconut fibre application in roadside zones as well as in other areas exposed to soluble salts.

The subject discussed in the research should inspire to search for other new methods of neutralization of the salinity of roadside areas, contributing to the improvement of the quality of the natural environment.

THE USE OF THE IGeo INDEX AND GEOSTATISTICAL METHODS IN THE ASSESSMENT OF FOREST SOIL CONTAMINATION BY HEAVY METALS IN THE BABIA GÓRA NATIONAL PARK

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Keywords: forest ecosystem; site condition; soil properties; heavy metals; topography

The aim of this investigation was to determine the content of heavy metals in forest soils of the Babia Góra National Park. For this research, 59 research plots were selected. Soil samples were taken from the surface horizon. The content of carbon and nitrogen, pH, acidity, the cations and heavy metals content were determined in the soil samples. The degree of soil contamination was determined by calculating the Igeo index. The tested soils are characterized by strong contamination by heavy metals, especially by lead. The concentration of heavy metals in the surface horizons of the tested soils exceeds allowable concentration. The content of heavy metals was related to the content of soil organic matter, soil acidity and altitude. Higher altitudes are dominated by coniferous tree stands, which are accompanied by acidic, poorly distributed organic horizons. Geostatistical methods were used to generate maps of accumulation of heavy metals. Our study has confirmed the impact of local streets and pollutants transported from industrial areas on the amount of heavy metals in soils of the BNP.

EFFECT OF THE TEMPERATURE OF WASTE COOKING OIL METHYL ESTERS ON THE VALUE OF NITROGEN OXIDES EMISSION FROM THE SELF-IGNITION ENGINE

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Keywords: biofuel, waste cooking oil, diesel engine, nitrogen oxides emission

Combustion of diesel oil and liquid biofuels in self-ignition engines is related to the emission of harmful gases to the atmosphere (is nitrogen, carbon or sulfur oxides). These compounds, emitted in significant quantities, pose a threat to human life and health, as well as the natural environment. The goal of our research was to investigate the influence of temperature of the waste cooking oil methyl ester on the nitrogen oxides emission in the self-ignition engine. This is to help determine if the use of biofuel thermal activation can be used to reduce nitrogen oxides emissions. Experiments carried out on the test bench in relation to harmful nitrogen compounds (NO_x). The emission of exhaust gases from a diesel engine fed with methyl esters of the cooking oil was measured. The measurements were made in accordance with ISO 8178-4. Bearing in mind that the research stand constituted a model of a cogeneration aggregate, the tests were carried out by the D1 test procedure used for engines operating at a constant rotational speed.

In total, three tests were carried out for three different fuel temperatures, which were 20, 40 and 70°C respectively. During the measurements, the air temperature ranged from 19.9 to 24.8°C, and the atmospheric pressure was 1020 hPa.

From the obtained test results it can be concluded that it is worth equipping the engine with installation for preheating the fuel before its injection, but the optimal value of fuel temperature reducing emissions is at least 70°C.

THE ASSESSMENT OF THE USEFULNESS OF *MISCANTHUS X GIGANTEUS* TO ESTABLISH PROTECTIVE EROSION BELT AND ENERGETIC MANAGEMENT OF ITS BIOMASS

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Key words: erosion, giant *Miscanthus*, biomass, eroded soil

The study aimed to assess the usefulness of giant *Miscanthus* (*Miscanthus x giganteus*) for planting in erosion belts and the use of its biomass for energy purposes.

The research was carried out in Czesławice on the Lublin Upland (Poland). On the slope of the eroded field, an erosion belt measuring 15 x 2 m from the giant *Miscanthus* was put on. Qualitative and quantitative studies of the intensity of erosive processes were carried out against the background of the meteorological and soil conditions. Samples of waters flowing down the slope were collected, in which the following concentrations were determined: total nitrogen, ammonium nitrate, nitrate nitrogen as well as phosphorus and potassium. The mass of the eroded soil was also determined. The studies of *Miscanthus* biomass included: biometric measurements of aboveground and underground plant parts, biomass yield and its structure, biogas yield, energy parameters, and ash chemical composition. The crop yields were measured in the vicinity of the erosion belt.

The mild course of meteorological conditions in 2018 did not favor the occurrence of erosive phenomena, and it is difficult to determine unambiguously (on the basis of annual observations) the depth-protective function of the erosion belt from giant *Miscanthus*. Concentrations of nutrients, especially phosphorus and ammonium nitrogen, contained in waters flowing out of the slope, exceeded the limit values corresponding to a good class of surface water (max: 3.069 mg/dm³ P, 4.912 mg/dm³ N-NH₄). In the year of research on the production field, winter wheat was grown. The average grain yield of winter wheat in the vicinity of the erosion belt was 7.416 Mg/ha. The eroding belt from giant *Miscanthus* did not significantly affect the wheat yield in its vicinity. The reason for this could be meteorological conditions, particularly low precipitation, which adversely affected the growth and development of giant *Miscanthus* seedlings, which did not develop abundant aboveground and underground parts. This was confirmed by studies on the biometric parameters of *Miscanthus* plants as well as the yield of its fresh and dry biomass

(respectively 1.7 and 0.66 Mg/ha). Elemental analysis of *Miscanthus* biomass showed that the share of coal was 48.96% d.m. and hydrogen was 5.98% d.m. These elements determine the calorific value of fuel, which was 18.06 MJ/kg d.m. The low coalification of the biomass studied had a high volatile content (82.0% d.m.). The content of unfavorable elements was not high and amounted to: N - 0.20% d.m., S - 0.03% d.m., Cl - 0.045% d.m. In the biomass of giant *Miscanthus*, 2.76% d.m. it was an ash in which acidic acids prevailed: silica (SiO_2) and aluminum oxide (Al_2O_3), while basic oxides: calcium (CaO), potassium (K_2O), magnesium (MgO) and iron (Fe_2O_3), found themselves in a minority. Fusibility temperatures the ash from giant *Miscanthus* was comparable with other types of biomass. The yield of biogas from giant *Miscanthus* silage was 547.0 m³/Mg o.d.m. with a biomethane content of 56.88%.

The research did not allow to fully determine the usefulness of *Miscanthus x giganteus* in the protection of eroded arable soils against water erosion, while minimizing its adverse impact on adjacent farmland and crop yields. Soil protection against further erosive degradation will result in preserving the production potential of soil erosion threatened and increased crop yields, which will translate into an economic effect of crop production. However, the produced giant *Miscanthus* biomass can be used for energy purposes in thermochemical and biochemical conversion processes, which should additionally increase the cost-effectiveness of such a solution. Preliminary results of the research, obtained in the first year of the experiment, are promising and allow to suppose that their continuation will allow an unambiguous assessment of the suitability of this new method of soil protection against water erosion.

PRELIMINARY RESEARCH ON SEWAGE SLUDGE AND STRAW FERMENTATION AND COMPOSTING WITH VARIOUS STRUCTURAL MATERIALS BASED ON EXTRUDED CORN STARCH

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Keywords: extrusion-cooking, methane fermentation, biogas, composting, lignocellulosic materials

Biomass treatment has become a prominent technology for agricultural waste utilization. One of the limiting factor is a presence of lignocellulosic, hemicellulosic and cellulosic matrix within the treated material. Those characteristics are attributed to most of the agricultural flora biomass contributing to a large portion of agricultural waste. Most common technique of overcoming this situation is a chemical and physical hydrolyzation. Those technologies are expensive and require a lot of energy or chemicals. Different approach to this subject is a implementation of technique known in food production. Extrusion-cooking technique is a process mainly used for the production of breakfast snacks such as snacks or instant noodles. It is also one of the methods of pre-treatment of lignocellulosic materials used in agricultural biogas plants. Therefore is also one of the methods of pre-treatment of lignocellulosic materials. Subsequently this method could be applied as a biomass pretreatment for methane fermentation, and as a structural material in composting. Potentially depolymerization of cellulosic matrix should improve both methane and biogas yield, as well as compost properties.

The aim of this research was to analyze the influence of extrusion-cooking technique on methane fermentation and composting to determine best condition of extrusion for biogas generation pretreatment and composting process. The biogas efficiency tests were made in Ecotechnologies Laboratory at Institute of Biosystems Engineering, Poznan University of Life Sciences within the European standard procedures DIN 38 414/S8 and VDI 4630.

The results have shown the significative influence of extrusion process on methane yield as well as CH₄ concentration in produced biogas. In consequence it

has to be underlined that extrusion of lignocellulosic material has positive influence on both, biogas production and growth of methane concentration in biogas. Extrusion also improved compost properties. The composting with such structural additive as extruded corn starch shows good benefits too.

THE USE OF VARIOUS TYPES OF CONTROL ALGORITHMS TO DETERMINE THE OPERATION OF SEWAGE FACILITIES

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Keywords: control algorithms, sewage treatment, on-site wastewater treatment, optimization, activated sludge

The article describes the use of various algorithms for controlling sewage objects. The solutions dedicated to the whole sewage systems as well as to on-site systems of household wastewater treatment have been presented. The application of control algorithms based on artificial intelligence solutions for dynamically determining the operation point and simulation models for simple systems were subjected to analysis. The layered structure of the control system was presented, individual layers were characterized and examples of current and future use of the system based on dynamic determination of operating point for sewage facilities were given. It shows how to decompose control tasks on the example of a biological sewage treatment process using activated sludge with the removal of carbon and nitrogen compounds. The complexity of the problems of control and optimization of wastewater treatment installations is described, and its solution is given using a dynamic work point system enabling the integration of many different sources of information depending on the implemented stage of the undertaking. The advantages and disadvantages of individual solutions were indicated, depending on the complexity and costs of implementing a given control system based on advanced solutions using artificial intelligence as well as simple and inexpensive algorithms for private users that do not require continuous supervision and technical knowledge.

UPDATING THEMATIC MAPS ON ROAD ACCIDENTS IN CHISINAU MUNICIPALITY

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Keywords: Geographic Information System, maps, roads, accidents, standards, laws and instructions

The description of the online road accidents record system in Chisinau Municipality, the capabilities and characteristics of a geographical informational system in the field of road accidents, the ways and procedures of querying a database, spatial analysis and interoperability of GIS, representation of the data collected on road accidents, detailed description of the traffic accidents record procedure, initial data for map development and updating, sources of information used to complete the map, the actual case study analysis and the applications used for the analysis, as well as the presentation and description of the final product.

Accident is an unforeseen event in time and space that occurs due to an unintentional happening / action and that has visible effects, affecting the bodily integrity of individuals and / or causing material damage.

In order to highlight and subsequently prevent road accidents, an interactive road map GIS map was created in ArcGIS Online, which allows the introduction of data on road accidents at any time.

The data entered on the map is available to the general public on the site www.accidente.iharta.md. Anyone with good internet connection can view real-time data about the most frequent road accidents, who is most often involved in accidents, how many accidents occurred on a particular day and even at what time of day.

THE INFLUENCE OF ATMOSPHERIC PRECIPITATION ON THE VOLUME OF FLOWING WASTEWATER TO THE TREATMENT PLANT IN NOWY TARG

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Keywords: wastewater, atmospheric precipitation, rainwater, treatment plant

The study presents the influence of atmospheric precipitation on the amount of flowing wastewater and on the variability of concentrations of pollutants contained in them in the treatment plant in Nowy Targ. The research period covered the years 2016 and 2017, in which the amount of atmospheric precipitation, average daily inflows of wastewater and the temperature of wastewater inflowing the analyzed treatment plant were analyzed. Based on the analysis, a significant influence of accidental (rainwater) waters resulting from atmospheric precipitation on the increased volume of wastewater flowing into the treatment plant was found. A very strong correlation was found between the annual sum of precipitation and the value of the share and the addition of accidental waters flowing into the treatment plant. Calculated parameters of regression equations allow to predict the hydraulic load of the tested sewage systems with accidental waters. The obtained test results should be a signal for the operators of sewerage networks to undertake intense and effective actions aimed at eliminating illegal connections of roof gutters or rainwater runoff from the estates area to sanitary collectors and liquidation of the combined sewer system in the city for the distribution system.

AN ATTEMPT TO EVALUATE CHANGES IN A RELIEF BASED ON PHOTOGRAMMETRIC DATA IN AREAS EXPOSED TO WATER EROSION

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Photogrammetric techniques and laser scanning (TLS) are more and more often used to track changes in terrain surface layout while maintaining high spatial resolution and precision. These techniques are used to study erosion of river banks (O'Neal and Pizzuto, 2011), seas (Olsen et al., 2011) or landslides (Wawrzyniec et al., 2007, Abellán et al., 2010).

The study of changes in the terrain surface structure can be made by comparing two point clouds acquired at different dates. Two types of measurements can be used for this purpose: determining the surface displacement based on the identification of homologous elements in the compared point clouds or measuring the distance between the clouds of points used in detecting changes and in calculating the volume. The second approach does not assume consistency between point cloud elements.

The aim of the work is to assess changes in the terrain surface shape in areas threatened by soil water erosion based on clouds of points acquired with photogrammetric techniques at various dates.

For the study, an area located in the town of Karwów (in the Opatów commune) was selected. This area is a vast, agricultural valley, located in the right-bank part of the middle course of Opatówka, below the town of Opatów. Despite the relatively small fragmentation of ravines, which is characteristic of the lower and middle parts of the Opatówka basin, it is characterized by a significant carving.

The landscape of the Opatówka river basin is characterized by a rich sculpture, although about 70% of the total area has mild decreases - up to 5% and is generally a high plateau; slopes with slopes exceeding 15% occupy about 6% of the area. The absolute heights of the area are about 200 - 280 m in the western part and about 170 - 180 m in the eastern part. The width of denivelation is within 100 m, while the valley of the main watercourse is cut into the surrounding area to a depth of 20 - 50 m (valley elevation of the slopes). The river itself, with springs on the eastern edge of the Świętokrzyskie Mountains at an altitude of 325 m above sea level. and the estuary to the Vistula above Zawichost at 143 m above sea level. (281.9 km of the Vistula), has all the features of an erosive watercourse.

Varied sculpture, low forest cover, soil water erosion and the morphology of the river itself have a significant impact on the rhythm of the annual outflow, which is diverse. The upper part of the Opatówka drainage basin lies in the belt with average rainfall of 550 mm and the lower part - 600 mm per year. From the agricultural point of view, such high rainfall is a favorable phenomenon, however, due to the low retention capacity and soil protection of forests resulting mainly from their small share in the catchment, the occurrence of very wet springs, years and autumn creates potential conditions for water erosion. The climatic period, equally conducive to erosion, are spring thaws, their share in soil degradation is estimated at about 40-50% of annual losses.

Soils occurring in the basin are soils made of loess. The chernozems formed about 4,000 years ago, covering almost the whole catchment area, currently occupy about 11% of the area, and the most important part is occupied by podzolic soils with variously degraded properties. Lessons are characterized by good physicochemical properties, but they are very susceptible to erosion and therefore the soils formed from them are exposed to strong degradation. The area is richly carved, which is further compounded by a powerful system of erosional dissections.

The M3C2 algorithm, implemented in the CloudCompare program (Lague and others 2013), was used to assess the changes in the relief. The algorithm is characterized by the fact that it works directly on the clouds of points without the need to create triangles. Determines the local distance between two clouds of points along the normal direction to the surface, and estimates for each distance measurement the confidence interval depending on the roughness of the point cloud and registration error.

The analysis was based on point clouds acquired by terrestrial and air laser scanning, as well as generated on the basis of aerial photographs and obtained by a drone. The obtained results allowed for a quantitative assessment of changes in the relief of the soil occurring under the influence of water erosion. The algorithm used was helpful for this type of research. It allowed not only to determine changes in the area of the site but also confidence intervals for these changes.

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FORECAST FOR THE STABILITY OF CHEMICAL COMPOSITION OF THERAPEUTIC GROUNDWATER IN PIWNICZNA-ZDRÓJ

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Keywords: groundwater, therapeutic water, stability, carbonated water

Goal of a research

The basis for the water supply of the existing bottling plant of the company "Piwniczanka" in Piwniczna-Zdrój are openings captivating therapeutic waters. Water from the boreholes is used for bottling purposes in the Bottom Mineral Water Bottling Plant in Piwniczna-Zdrój. The analysis covered hydrogeological wells named P-1, P-2, P-5, P-6, P-7, P-8, P-9, P-11 and P-14. The aim of the analysis was to assess the stability of the chemical composition of the groundwater in terms of maintaining the status of therapeutic waters in accordance with the Geological and Mining Law.

Tab. 1. Characteristic of analyzed boreholes

Name	Chemical type of groundwater / TDS
P-1	szczawa HCO_3 - Ca - Mg - (Na) / 2 239 – 3 970 mg/dm^3
P-2	szczawa HCO_3 - Ca - Mg - Na / 2 424 - 3 370 mg/dm^3
P-5	woda kwasowęglowa HCO_3 - Ca - Mg - (Na) / 890 -1378 mg/dm^3
P-6	szczawa HCO_3 -Ca-Mg - (Na) / 1 450 - 2 319 mg/dm^3
P-7	szczawa HCO_3 - Mg -Na-Ca / 3 868 - 5 578 mg/dm^3
P-8	szczawa HCO_3 - Na - Mg -(Ca) / 5 893 - 7 153 mg/dm^3
P-9	szczawa HCO_3 - Ca - Mg – Na / 2 488 -3 576 mg/dm^3
P-11	woda kwasowęglowa HCO_3 - Ca – Mg / 816 - 1 283 mg/dm^3
P-14	woda kwasowęglowa HCO_3 -Ca -Mg -(Na) / 764 - 978 mg/dm^3

Methodology and scope of a research

The basis for the analysis was the results of stationary observations for 9 hydrogeological wells that include therapeutic waters for the needs of the "Piwniczanka" company. The analyzes were carried out in the accredited laboratory of the AGH University of Science and Technology in Krakow, sample for P-1 borehole is presented in Table 1.

The database used for the analysis covered the years 2008-2018 and concerned the content of HCO_3 , Ca, Mg, Na, Ba, Fe, Cl, F, SO_4 ions as well as mineralization (TDS) and CO_2 content measured by the carat in the area.

Highlight of results

For each of analyzed boreholes the analysis of the variability of the content of main and secondary ions as well as carbon dioxide and mineralization for selected years was performed.

Borehole P-1

Analyzing the results of physical and chemical research of therapeutic water from the P-1 well in the period from 2011 to 2018, it can be noted that the mineralization of captured water ranges from just over 2.5 g/dm^3 (2018) to almost 4 g/dm^3 (2015) (Tab. 2). The chemical type of groundwater exploited from P-1 borehole did not change and it was a carbonated water HCO_3 - Ca - Mg - (Na). The CO_2 content in water from the P-1 well in the years 2010-2019 has a similar course and ranges from 1055 to 3173 mg/dm^3 with an average of 2166 mg/dm^3 (Fig. 1). The content of HCO_3 ions changes significantly during the operational period: in the initial and final observation period (up to July 2011 and from September 2018) it is definitely lower than in August 2011 - August 2019, where HCO_3 concentrations are on a relatively constant level, but about 1000 mg/dm^3 higher. This change is visible in the attached graphs (Fig. 1).

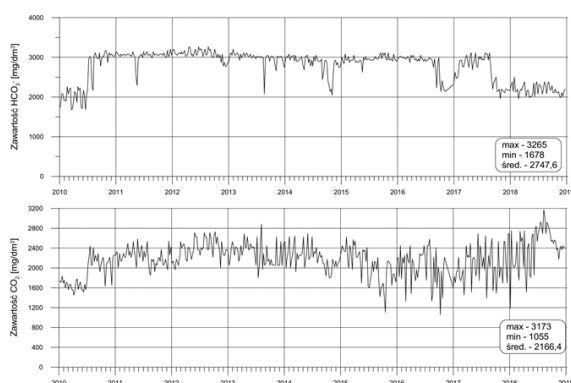


Fig. 1. Variability of selected components.

Statistical analysis of the variability of observed ion contents indicates a small variability of their concentrations (Fig. 2). The relatively highest variability

is characterized by the content of fluoride ions, where their content is very low and the observed variability does not affect the classification of the water taken. Ions that form the basic type of water (HCO_3 , Ca, Mg) show little variability and thus the type of water captured in this range is unchanged. Some changes in concentrations visible on the graph result in the appearance of this ion in the water type or its absence.

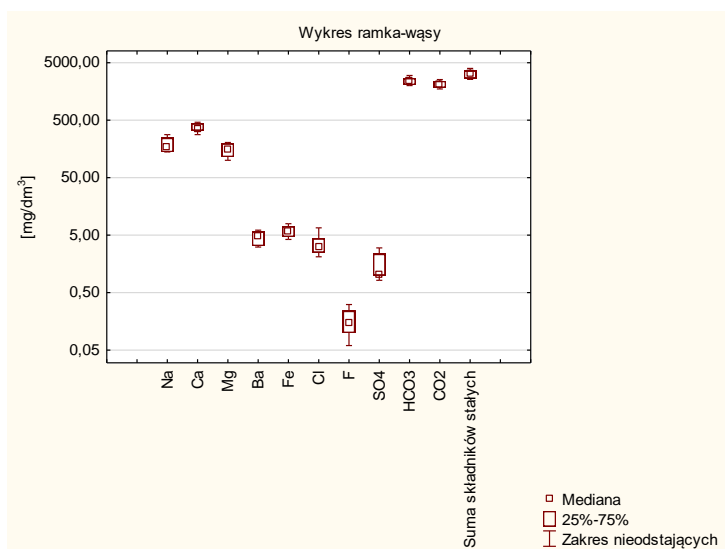


Fig. 2. Variability of selected components.

Main conclusions

Summing up the analysis, it can be clearly stated that the content of basic ions of the exploited water show little variability and does not threaten the loss of therapeutic water status (according to the mineralization criterion $> 1000 \text{ mg/dm}^3$, and CO_2 content $> 1000 \text{ mg/dm}^3$ classifying water as carbonated water). Variable content of sodium ions causes changes in the type of water without affecting the maintenance of the status of therapeutic waters.

HYDROPOWER OF LARGE CITIES - A CASE STUDY FROM NOWY SĄCZ IN POLAND

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Keywords: effective potential of hydropower, technical potential, theoretical potential, hydropower potential, renewable energy sources, technological water

Hydropower is an important type of renewable energy source. Most often associated with the possibility of energy management of run-of-river power plants. An interesting solution, but usually unappreciated, is the use of waste water, utility or industrial water, which is very often generated in industrial centers, which are large cities. Technological processes related to the paper, chemical and food industry as well as refrigeration processes related to metallurgy require a large amount of water that can be used in the context of its energy potential. Hydropower plants located on artificial channels are much more efficient than those located on natural watercourses. It results directly from the characteristics of the variability of disposable flows for electricity generation. Unfortunately, such projects often do not receive the status of a renewable energy source due to unclear provisions in the law and their unfavorable interpretation. Consistency is the lower economic balance, often completely blocking the investment. The article recognizes the problems of hydropower plant implementation on natural watercourses and those using the processed waters. Their potential, limitations and formal and legal basis for their implementation were indicated. The course of action aimed at determining the hydropower potential is shown on the example of the city of Nowy Sącz in southern Poland.

STUDY OF THE EFFECT OF WATER REGIME AND NITROGEN FERTILIZATION ON SOFT WHEAT GRAIN TECHNOLOGICAL QUALITY GROWN IN THE ALENTEJO STEPPE REGION

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Keywords: Irrigation; Nitrogen fertilization; Grain quality; Alentejo steppe; *Triticum aestivum* L.

1 - Introduction and objectives

The landscape in the Alentejo region, in southern Portugal, has Mediterranean characteristics, recognizable in the large variety of landscape elements that compose it: cork oak and holm oak forests, vineyards, olive and almond groves, irrigated field crops such as corn and sunflower and, until recently, vast areas of rainfed cereal steppe dedicated mainly to the cultivation of soft wheat. However, the low profitability of this crop and the expansion of irrigated areas, where it is possible to grow more profitable crops, has led to a severe retraction of the cereal steppe, compromising its future existence.

The preservation of this valuable landscape, and the biological and social heritage associated with the cereal steppe, depends on the economic profitability of wheat. Irrigation and the selection of high-quality grain varieties for the baking industry are good options for enhancing soft wheat profitability. Its quality depends mainly on the cultivated variety and on the crop fertilization. On the other hand, irrigation can affect the baking quality and will also require some adaptations especially in nitrogen fertilization strategies.

In this context, a field trial was carried out in 2018 to evaluate the effects of irrigation and fertilization on the baking quality of soft wheat in the southern Portugal region of Alentejo.

2 - Methodology

In a trial performed in Beja, Portugal, (38°02'10"N; 7°53'10"W) three irrigation treatments and eight type/splitting treatments of nitrogen fertilization were tested. The irrigation treatments were: R0 (without irrigation); R1 (irrigation with

100% of crop evapotranspiration (ET_c); R2 (irrigation with 100% ET_c only in four stages: start of stem elongation, booting, anthesis, grain filling). Nitrogen fertilization treatments included 4 types of fertilizers (classic, with nitrification inhibitor, controlled release, and with urease inhibitor) applied totally at sowing or fractionated throughout the plant cycle. The trial was carried out during 2017/2018 on a Vertisol, and according to the Koppen classification the climate is type Csa, with a hot and dry summer. The soft wheat high-quality variety 'Antequera' was used for the study. The following quality parameters were evaluated: grain protein content, dry gluten, Hagberg Falling Number Index, and, from de Alveogram, the dough balance (P/L) and the dough strength (W).

3 - Results

Regarding the grain protein and dry gluten content, a highly significant effect ($p \leq 0.001$) of the fertilization was observed. The highest protein and gluten contents were recorded in the treatments in which the enhanced efficiency fertilizers were applied and the fertilization was distributed in equal doses between the sowing and the booting stage. The water regime did not have a significant effect on the protein and gluten content. The Falling Number Index was significantly affected by water regime and fertilization ($p \leq 0.01$). The Index was higher without irrigation and when classic fertilizers were applied and fertilization was fractionated.

Concerning dough balance (P/L), a highly significant effect ($p \leq 0.001$) of fertilization was observed. The values of P/L ratio were higher when the fertilization was less fractionated or when it was all carried out at sowing. On the contrary, the type of fertilizer and the water regime did not affect the results. Regarding dough strength (W), a highly significant effect ($p \leq 0.001$) of fertilization was also observed. For all types of fertilizer, the W values were higher when fertilization was made at booting and lower when the fertilization was not fractionated. The type of fertilizer and the water regime did not significantly affect the dough strength.

4 - Conclusions

The "Antequera" medium values for protein content (12.8%), P/L ratio (1.02) and W (287) indicate that, since a high-quality variety of soft wheat is selected for sowing, grain production with quality parameters that meet the requirements of the baking industry can be achieved. It can also be concluded that protein content and dough strength, and, therefore, baking quality, here higher when nitrogen fertilization was fractionated. On the contrary, the type of fertilizer and the water regime did not influence baking quality. Finally, we can also conclude that wheat irrigation, thanks to the predictable gains in productivity, and higher grain baking quality, will be a solution that will allow to preserve wheat cultivation and, therefore, to preserve the Alentejo typical steppe landscape.

ASSESSMENT OF SOIL USES ON ITS QUALITY: PHYSICAL, CHEMICAL AND BIOLOGICAL PROPERTIES

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Keywords: Water, pesticides, fertilizers, Alqueva, irrigation, sustainability of agriculture practices

The use of pesticides and fertilizers play an important role in the quality of agricultural crops, providing benefits for the increase of productivity, reducing weeds, pests or diseases. Notwithstanding, their massive use may decrease the quality of agriculture soils, surface and groundwaters, resulting in a potential risk to the ecosystems and public health.

The construction of the Alqueva reservoir (South of Portugal) allowed the increase of irrigated area and the intensification of irrigation crops, changing the types of crops and the agricultural techniques used from extensive to intensive practices, with the intensification of olive groves and vineyards. This change of land use led to the increase of application of pesticides and fertilizers with the possible loss of water and soil quality, and the correspondent unbalance of terrestrial and aquatic ecosystems.

This study is integrated in the FitoFarmGest project, developed in the Brinches-Enxoé hydro-agricultural area, subsystem of Ardila (Alqueva reservoir). The aims of the project are developing tools for assess the increment of sustainability use of pesticides and fertilizers, in irrigation agriculture, contributing to the improvement of the quality of production, protection and conservation of soil and water resources.

The present study tried to assess the correlation among the fertilizers applied at crops and the quality parameters of the soils. During the annual irrigation campaign of 2018, soils of three crops of partners farmers of the FitoFarmGest Project (olive grove, vineyard and corn crops) were collected in the begin and the end of the cultural-cycle of the plant, and were analyzed for: (i) physic-chemical

parameters: pH; electrical conductivity; total nitrogen (TN); organic matter content (OM) and extractable P and K; (ii) enzymatic parameters: dehydrogenase activity, acid phosphatase activity, β -glucosidase activity, urease activity.

Results showed soils with slight alkalinity (pH of 7.5-8.9; in the 1:2.5 extract with deionized water), which may be dangerous for the vineyard crop, once this plant is very sensitive to pH. The soils presented values of electric conductivity among the limit's proposal for agriculture soils (300-600 $\mu\text{S cm}^{-1}$). Further, vineyard crop soil presented concentrations of TN of 0.10%, due probably to the application of inorganic nitrogen fertilizer. All soils presented high extractable concentrations of potassium and phosphorus. The enzymatic activities indicated that some enzymes may be committed with the excessive use of fertilizers. Hence, the acid-phosphatase activity was very influenced by the application of high amounts of phosphorus fertilizers, with values of 0.83-1.09 $\mu\text{mol PNP g}^{-1}\text{h}^{-1}$ at the corn crop, indicating the inhibition of its activity by the use of fertilizers, as well as by the pH of the soils.

The results highlighted the excessive use of fertilizers and its correlation with the chemical and biological proprieties of the soils, which will allow, further adjust of the agriculture practices for a better sustainability of the agriculture system.

TREATMENT OF WASTEWATER WITH HIGH AMMONIUM NITROGEN CONCENTRATION

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Keywords: Motor Rest Area (MRA), activated sludge, organic matter, ammonium nitrogen, wastewater treatment

Goal of research: The paper deals with the problem of wastewater treatment with specific physicochemical composition (increased ammonium nitrogen concentration) which were generated in Motor Rest Areas (MRA). Conventional biological wastewater treatment systems with activated sludge were used to purify wastewater from sanitary equipment used in MRA. Based on research conducted on four MRA, an attempt was made to determine the impact of the wastewater quality on biological wastewater treatment processes.

Methodology and scope of a research: The influence of the wastewater quality generated in MRA on efficiency of biological wastewater treatment processes, was estimated based on physicochemical analysis of wastewater. Samples of raw sewage were collected directly from initial settling tank. Samples of treated wastewater were taken from secondary settling tank. The following parameters such as: pH, organic matter (BOD, COD), total suspension, alkalinity, nitrogen forms (total nitrogen, ammonium nitrogen, nitrate nitrogen, nitrite nitrogen) were determined.

For selected parameters, basic descriptive statistics were specified and statistically significant relationships were determined.

Highlight of results: In classical systems with activated sludge used for treatment of specific wastewater with high concentration of ammonium nitrogen, in case of insufficient amount of organic matter carrying out the nitrification process is a complicated problem. The wastewater flowing into the bioreactor did not show the typical composition of domestic sewage. The pH of the wastewater sample before biological treatment was high (alkaline), what was related with the main component of this sewage – urine.

Two-stage system with activated sludge used in treatment of wastewater with high concentration of ammonium nitrogen shows measurable effectiveness in case of organic matter reduction, average 53 – 56 % for COD and BOD and 39 %

for total suspension. This is mainly due to the sedimentation processes and it is not connected with the biological transformation of ammonium nitrogen. In variable inflows and high irregularities of nitrogen load (high pH and ammonium concentration) conditions, systems with activated sludge have low reduction of ammonium nitrogen (average 9%).

Main conclusion: The main component in wastewater stream flowing into systems applied in Motor Rest Areas (without additional dining options) is urine (uric acid and urea) which determine high concentration of ammonium nitrogen as well as high pH. The lack of organic matter susceptible to biological decomposition makes it difficult to develop the biocenosis of activated sludge, and the limits of ammonium nitrogen concentration inhibit the nitrification processes. Difficult to balance of wastewater inflow as well as the extreme conditions of hydraulic and pollution load are not favourable for conventional solutions of wastewater treatment in MRA. One of the most appropriate solution for wastewater treatment generated in MRA would be connection of these places to the central sewage systems or the use of urine separation systems to avoid high ammonium concentrations.

PROTECTION OF THE MEDICINAL WATERS OF THE RESORT SHIDNYTSYA - COMMON CHALLENGE AND CHANCE TO PRESERVE AND USE THE NATURAL HERITAGE

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Key words: medicinal waters, natural heritage, sustainable development

Actuality. Skhidnytsya Resort is located in the Carpathians at a distance of 120 km from the city of Lviv and 20 km from the city of Truskavets. Therapeutic peculiarities of the Skhidnytsya Resorts are created by mild climate, clean environment, picturesque mountain landscape with large forest areas. Significant reserves of medicinal mineral waters determine the balneotherapeutic profile of the resort. The area of Skhidnytsya Resort includes 38 springs and 17 wells. Now there are implementing active researches on composition, quality, properties and reserves of different types of waters. The State Commission on Mineral Resources has approved explored water of the "Naftusya" type, whose flow rate is 64.5 cubic meters per day, which in 1.5 times exceeds the reserves of the resort Truskavets.

At the stage of study are: chalybeate water with flow rate - 12.9 cubic meters per day; hydrocarbonate-sodium (soda) water of the type "Borjomi", with flow rate - 10 cubic meters per day; chloride-sodium brines containing bromine and iodine; other mineral waters with a total flow rate of more than 200 cubic meters per day. Over the past four years, more than 10,000 children who have suffered from the Chornobyl catastrophe have made healthier in Skhidnytsya.

The aim of the research is to analyze current situation and to determine directions for the development and purposeful use of the Skhidnytsya mineral water reserves for treatment and rehabilitation.

The implemented investigations allow underline the main tasks for sustainable development of the resort:

- creation of conditions for the further development of the resort Skhidnytsya as an all-Ukrainian health resort;
- preservation and development of resort and recreational complex;
- development of infrastructure (engineering, social and general resort);
- provision of ecological and sanitary-hygienic conditions, further integrated study of the hydro-mineral composition of the resort waters for preservation and recreation of therapeutic resort resources.

There were defined the main ways for realization of activity:

1. Execution of survey and urban-planning project works: updating of geodetic, gas and soil surveying of territories under the influence of operating and non-operating oil wells; adjustment of the development plan and the project of sanitary protection zones of the Skhidnytsya resort; continuation of complex studies of the hydro-mineral base of the resort.

2. Design of treatment facilities and the sewage drainage and sewerage purification systems, reconstruction of the Rybnik water intake, water, power, and gas supply facilities, access roads.

3. Construction of engineering facilities.

4. Realization of measures provided for by the project of sanitary protection zones of the resort.

5. Creation of a fund of development of resort Skhidnytsya, design of investment projects for the construction of individual resort objects, search of national and foreign investors and attraction of charitable contributions of private and legal entities.

The realization of all planned activities will be done in two main stages. During the first stage it is planned: to implement survey works and carry out town-planning design; to elaborate the town development plan for the resort and to coordinate principle decisions concerning the engineering provision of the resort; to correct the project of sanitary protection zones of the resort; to design investment projects; to conduct tenders for the right to obtain a special permit for the operation of the Skhidnytsya mineral water deposit and the determination of the contractors; to begin construction of engineering and transport infrastructure objects;

During the second stage the following events are planned: carrying out works on improvement and protection of the hydro-mineral base of the resort; regulation of the zones of sanitary protection; implementation of complex studies of the hydromineral base of the resort

Results. The implementation of these measures will enable: to increase the level of resources use of the balneotherapeutic resort Skhidnytsia; to create conditions for a healthy rehabilitation and rest of more than 25 thousand people per year, including 10 thousand children; to create about 3 thousand jobsites; to create conditions for the further development of the resort as an all-Ukrainian children's sanatorium.

ANALYSIS OF THE REAL ESTATE MARKET IN THE CITY OF LUBLIN (POLAND) FROM THE PERSPECTIVE OF SPATIAL DEVELOPMENT

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Keywords: real estate market, GIS, cartographic visualization, spatial development, Lublin

In cities course of the spatial development mostly depends on local government laws. Resolutions made with the local spatial development plans or lack of those effect on behave of entities whose participate in the real estate market, for instance, housing developers. An individual pays attention for things such as localization of the property, prospect of development, neighborhood, the shape of the plot. Furthermore, for some people, essential things are local trends or even fashion. All those features reflected in prices of properties sold in the studied area.

The author decided to reveal the undeveloped properties due to analyzing and latter cartographic visualization of the data of the register of notarial deeds of estate sales and purchases. The main plaintiff to do so were terms of spatial development in the city of Lublin. Into consideration had been taken only transactions which represent a free market of real estates. Data from the real estate market have a spatial reference, therefore it is realizable to visualize them through the use of tools of Geographic Information Systems. By dint of spatial reference of estates, it was possible to display unit prices in individual districts of the city by using the quantitative method of visualization of the data – quantitative signatures. It was done this way in order to a preliminary analysis of the data. The division of the city into two parts is noticeable – ‘expensive’ north-western and ‘cheaper’ south-east. Maps helped to portray a number of transactions of a given type and intended use in respective districts. Majority of single-family housing transactions were reported in the north-western part of the town (Sławin, Szerokie, Czechów Północny, Węglin Północny) which may explain the higher unit prices in this part of the city. On the other hand, the bulk of transactions with the agricultural intended use of land were observed in southern districts such as Zemborzyce and Głusk. The number of transactions taking place on the outskirts of the city was far more significant than in the central part of the studied area. Relationship between the unit price of the property and its area was also noticed.

CARTOGRAPHIC METHODS IN THE ANALYSIS OF LOCAL REAL ESTATE MARKET AS EXEMPLIFIED BY KONOPNICA COMMUNE

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Keywords: real estate market, cartographic visualization, Konopnica

The article focuses on the use of cartographic methods in the analysis of local real property market. The study covered the area of Konopnica Commune. Data were obtained from the register of notarial deeds of estate sales and purchases led by the Department of Geodesy, the Starost's Office of the District of Lublin in a TXT format. The register contains detailed information on every single transaction, including a property and plots numbers, its price, type of land-use, area, etc. The data was manually converted into a spreadsheet table form and prepared to be used in GIS software on two levels – cadastral unit level and individual level related to a single property. The database consists of plots of undeveloped land traded between 2012-2018.

The performed research allows us to find out the reasons for the occurrence of land prices differences and show the possibilities of using the Geographic Information System in the process of analyzing the real estate market. When performing a cartographic presentation of real estate prices, the scope of work is a multi-stage analysis process consisting: obtaining data, creating a database from these data, giving them spatial character by indicating the location on the map, and then performing a cartographic visualization using GIS tools.

Four kinds of transactional properties can be single out in this research: single-use agricultural land, multi-use agricultural land, properties intended for development and forests. The total number of sale transactions of this kind in the Konopnica commune over a 6 years amounted to 911. A total of 1603 registered plots were sold. After the rejection of transactions, which did not meet the assumed criteria, the analyzed set included 479 sales, which were subjected to the further part of the study.

The single-use and multi-use agricultural land sales prevailed in all units. The cartographic presentation of price differentiation showed that the highest unit prices were recorded in the eastern part of the commune bordering directly with the

city of Lublin, while the lowest prices occurred in the south-western and western part of the analyzed area. Areas located in the vicinity of the city center, are more attractive for investors, which affects the higher price of land in this area. Based on the analyzes it was found that location is the main factor affecting the prices in the suburban commune of Konopnica. The drop in prices was observed as the distance from the urban center to the south-west increased.

Cartographic visualization in the form of a map and the possibilities of using geographic information systems are a useful tool in the process of real estate market analysis. They allow us to find answers to investors' questions about the accuracy of their investments and indicate the most attractive locations of plots of land. A very significant benefit of using GIS is the ability to quickly perform a map visualization and adapt it to the research problem.

CLASSIFICATION OF THE FORESTS OF CARPATHIAN REGION USING HIGH RESOLUTION SPACE IMAGES

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Keywords: space image data, forestry, hybrid classification, postclassification image processing.

Goal of a research. Forests carry out economic, ecological, water protection, protective, sanitary, sanitary, recreational, aesthetic, educational and other important functions. Therefore, the damage caused to forests can lead to very significant negative consequences and even environmental catastrophe. The purpose of the work is the use and classification of space image data and application them for solving the main forestry tasks

Methodology and scope of a research. In the research the basic forestry tasks solved using remote sensing aerospace systems of various resolution and spectral range are systematized, the frequency of obtaining information, the scale of observation and the main characteristics of the objects are set.

Existing mathematical models of object classification are considered and a model of hybrid classification of forests is proposed. The main stages of this model are the following: determining of the optimal number of classes based on the results of uncontrolled classification, creation and analysis of educational standards and implementation of controlled classification.

To assess the effectiveness of the proposed method, testifying information is obtained from field studies and measurements with fixing forest taxation parameters of selected polygons and coordinates of boundary points are determined. Implementation of a hybrid classification is made by space images from satellites Ikonos (the winter of 2002) and QuickBird (the summer of 2010). Through sophisticated luminance distribution of pixels, especially in the summer photo, an error in determination of areas, calculated according to testifying information and the method of controlled classification, may reach 35-45% for certain classes. Therefore, the procedure of postprocessing is used, which means that in the selected neighbourhood the value of the majority pixels will be set to all the pixels of the class. The difference among various class areas, derived from postclassification image processing and test areas, is generally 2-14% and for some classes with a significant impact of underlying surface it is about 20%. The area of cutting is determined by the pictures taken in different periods: Ikonos-2 in 2002 and 2007,

QuickBird-2 in 2010 and WorldView-2 in 2014, which makes it possible to evaluate changes in forest clearings areas in specified time period. Thus, the results of the investigation make it possible to assert that by high resolution satellite images deforestation can be identified, the time of cutting can be set and the area can be determined.

Results. A hybrid classification technique based on combining and analyzing the results of uncontrolled and controlled classifications is proposed. The method is implemented in the images of the winter landscape, obtained from the satellite Ikonos, and in the images of the summer landscape from the satellite QuickBird. By the results of uncontrolled classification, the criterion for determining the optimal number of classes has been worked out.

Conclusions. The application of postclassification image processing allows to significantly improve the results of controlled classification of different classes of objects, which allows by-turn to determine their area more accurately. Based on the analysis of the areas received from the credential information and obtained from the postclassification, it was established that the difference in the determination of the areas of different classes of objects is from 2 to 20%.

THE CONTENT OF HEAVY METAL IONS IN ASHES FROM WASTE INCINERATED IN DOMESTIC FURNACES

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Keywords: ashes from wastes, wastes, heavy metals, ICP-MS

The article presents the results of tests obtained from the analysis of ashes coming from the combustion of various types of waste in household furnaces. The aim of this work was to examine the influence of various types of waste burning in household furnaces on the elemental composition of the generated ashes.

Waste management is mainly aimed to protect human health and, secondly, to protect the environment. Humanity has been producing waste for centuries, however along with the rapid civilization development, the amount of generated waste has drastically risen. A lot of legal regulations have been introduced to reduce waste generation as well as a rational management of already generated waste, e.g. separate collection of waste and recycling, thermal utilization with energy recovery, and natural use, thus avoiding the inadvisable storing. The rise in the living costs (increased fuel and energy prices) and, consequently, impoverishment of the society and low ecological awareness caused the common usage of high-calorie waste as fuel in household furnaces, thus causing environmental pollution with uncontrolled emission of hazardous substances and producing dangerous furnace waste (ash / slag). Such waste utilization is carried out in uncontrolled conditions, as opposed to utilizing in professional energy, cement or waste incineration plants. Incineration of waste in specially adapted equipment, endowed with exhaust aftertreatment devices, reduces dioxin emissions by over 700 times more than during the combustion of waste in a domestic furnaces. The combustion process in a domestic environment takes place at low temperatures, which results in high emission of toxic gases into the environment, including: carbon and sulfur oxides, hydrogen chloride, hydrogen fluoride and hydrogen cyanide, as well as metals such as cadmium, thallium, mercury and others. Waste such as polyvinyl chloride (PVC), from which liners, bottles, cable casing, foils, shoes, clothing, furniture, plywood or chipboards are made, is burnt in the home furnaces in an uncontrolled way. It is also extremely unhealthy to incinerate PET plastics, rubber waste or varnished materials. As a result of domestic thermal utilization of this group of products, carcinogenic dioxins are introduced to the atmosphere, which toxic effects on health are manifested only after

several dozen years, for example in the form of cancer. All these aspects have recently led to an increase in the interest of authorities that control the emission of pollutants over the possibility of identifying incineration in waste furnaces basing on the chemical composition of furnace waste (ashes).

As part of the research, analyses of ashes generated from the incineration of mixed waste, plastics, wood, textiles, rubber waste and paper were made. The content of selected metal ions was determined in the tested samples. From the collected waste, ashes were prepared in laboratory conditions by burning each of the waste samples at a temperature of $550^{\circ}\text{C} \pm 25^{\circ}\text{C}$ in such a way as to obtain samples of ashes from total combustion and from combustion with limited oxygen access. The analytical samples prepared in this way were then mineralized in an Anton Paar microwave oven. After mineralization, the samples were subjected to multi-elemental analysis by ICP-MS technique, according to PN-EN ISO 17294-2: 2016-11 standard. The analysis of the content of such elements as: Mn, Cu, Mo, Zn, Cd, Tl, Cr, Co, Ni, As, Sn, Sb, Pb was conducted in the samples.

The highest concentrations of zinc, copper and lead were found in the tested samples. The highest concentrations for elements such as copper, lead, cobalt and chromium were recorded for samples of rubber and large-sized waste containing e.g. varnished furniture boards. The obtained results showed that depending on the waste incinerated, the content of selected metals was significantly different, and the highest concentrations were noted for samples of large-sized waste, waste from segregated plastics and waste from rubbers. Basing on preliminary research, it can be stated that it is possible to identify waste utilized in household furnaces on the basis of chemical analyses of ashes coming from incinerated waste.

EXPERIENCE OF LVIV POLYTECHNIC UNIVERSITY IN TRAINING BACHELOR AND MASTER STUDENTS IN THE FIELD OF GEODESY, PHOTOGRAMMETRY AND GEOMATICS

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Keywords: curricula; major, competence, learning outcomes

The aim of the work is to analyse development and current state of the main study programme (major) for training bachelor and master students in the field of geodesy, photogrammetry and geomatics in Lviv National Polytechnic University and to consider perspectives of their development and modernisation according to future challenges and world wide experience in this field.

The method. During the work there were analysed the history of development graduated specialities at the department of photogrammetry and geoinformatics in Lviv National Polytechnic University beginning since 1945 when first student started to study on program “Aerial photo geodesy”. In 18 years there was established the department with same name which now is called the department of photogrammetry and geoinformatics. Authors considered historical changes in cycle of studies, subject areas, contents of main study programmes, volume of programmes, workhours, etc., and factors which influenced on these changes. Next step was to analyse worldwide experience relating to student training in our field, especially positive and negative features of introduction of Bologna processes and Tuning projects in foreign and national universities. On 2015 the Ministry of education and science of Ukraine approved new list of fields of knowledge and specialties, which are training students of higher education. According to this list there two fields of knowledge dealing with geodetic specialties: 10. Natural Sciences (including 103.Earth sciences) and 19. Architecture and construction (including e193. Geodesy and land management). At the same it was decided to apply for development of study programmes and curricula the student centric approaches and evaluate quality of education using obtained by students competences and learning outcomes.

Results. Analysing the development and current state of education on geodetic speciality in Lviv Polytechnic University and considering experience of developed countries in this field there were defined the positive and negative features of various approaches in education in the field of geodesy, photogrammetry and geoinformatics.

Conclusions. The obtained results show the importance of introduction of student centric education. Other important challenge is establishment of proper competences and learning outcomes keeping correspondence between generic competences of curricula and competences of included courses. For this authors recommend to involve representatives from industry and production as most interested parties in the qualitative and modern education of students. Additionally during last years the student's worldwide mobility and studying on the programme of double diploma become very active. So it important to consider the current study programmes of foreign universities when development of national study programme. In this process according to the new approaches the main attention should be paid to the competences and learning outcomes of courses and curricula that will allow student exchange and facilitating recognition of qualifications.

LIDAR BASED URBAN VEGETATION MAPPING AS A BASIS OF GREEN INFRASTRUCTURE PLANNING

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Keywords: LIDAR data, vegetation mapping, urban greenery planning, green infrastructure, spatial analysis, point cloud analysis, green governance and planning

Planning green infrastructure in the cities is a challenging task for planners and city managers. Developing multifunctional green space systems provide many benefits including: increasing water retention, mitigating urban heat island effect, microclimate regulation, reducing air, water and noise pollution and conservation biodiversity. The greenery in the city also have an impact on human health. The paper presents the possibilities of using LiDAR data mapping vegetation density in urban areas on the example of Gorzów Wielkopolski (Poland). Maps made as a result of processing the point clouds obtained from airborne laser scanning represents the most accurate, comprehensive and detailed assessment of Gorzów Wielkopolski vegetation cover to date and establishes the baseline for greenery governance and planning of green infrastructure in the city.

**PRESENTATION OF RESEARCH INSTITUTE OF GEODESY,
TOPOGRAPHY AND CARTOGRAPHY, V. V. I.**

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Keywords: geodesy, surveying, mapping, cadastre, library, dictionary

- Goal of a research
 - Basic and applied research in the field of geodesy, surveying, mapping and cadastre
 - Development and testing of new methods, processes and program solutions and expert consultations in the following areas:
 - creation and management of the Information System of the Cadastre of Real Estate (ISKN)
 - creation and management of geographic information systems
 - geodesy, geodynamics and engineering geodesy
 - metrology and standardization in the fields of geodesy and cadastre
 - creation and maintenance of maps
 - quality of geospatial data according to CSN EN ISO 19157
 - development of user applications over data of digital surface model of the Czech Republic
 - photogrammetry and remote sensing
 - development, production of tools, equipment and measurement systems for geodesy and cartography.
- Scope of a research
 - The Cadastre of Real Estate – supporting renewal of the cadastral document
 - Development, management and training of software products MicroGEOS for renewal of cadastral documentation for the Czech Office for Surveying, Mapping and Cadastre (CÚZK) and surveying companies
 - Development and management of software systems using ISKN data
 - Consultancy and training courses in the field of the Cadastre of Real Estate
 - Geodesy and geodynamics and the Geodetic observatory Pecný
All activities performed at the Geodetic observatory Pecný at Ondřejov, equipped especially for:
Scientific experimental and theoretical research focused on:
 - scientific aspects of GNSS positioning

- description of detailed structure of the Earth's gravity field, mathematical methods of physical geodesy
- periodic temporal variations of the Earth's gravity field (terrestrial tides)
- recent Earth's surface movements in local and regional scales
- study of the Earth's rotation
- GNSS applications in metrology and study of the troposphere
- Applied research
- reference coordinate systems in the Czech Republic
- Metrological aspects of positioning and determination of gravity acceleration
- Metrology and engineering geodesy
- Operation of Accredited Calibration Laboratory (AKL)
- Administration of the National measuring standards for long distance measurements (1.5 km), for calibration of electronic distance meters, measuring standard for azimuth angles, for calibration of measuring instruments (theodolites, gyrotheodolites and aeronautical compasses), measuring standard for laser scanning systems, National measuring standard for gravity acceleration (Geodetic observatory Pecný at Ondřejov) and the measuring standard for reference position for calibration of GNSS equipments
- Laser tracker for precise works in engineering and construction and for control measurements (assessment activities). It enables measurements of lengths with an accuracy characterized by standard deviation of 20 microns and determines the position of the point with coordinate accuracy characterized by standard deviation of 40 microns
- Own enterprise measuring standard - laser interferometer with length measurement accuracy of 1 micron for metrological traceability of other standards
- Own mechanical workshop for the development and production of special measuring systems and equipment (in the past e. g. circumzenithals, now measuring systems HYNÍ for monitoring of vertical displacements at power plants and at other strategic objects)
- Normalization, standardization and terminology
- Activity in the technical standardization committees
- Administration of the Web application Terminological Dictionary of Geodesy, Cartography and Cadastre
- Surveying Library
- The largest specialized professional public library for surveying, mapping and cadastral in the Czech Republic and neighboring countries.
- Accredited Training Centre of the Ministry of the Interior of the Czech Republic

Digitalization centre

- Highlight of results

Solution of the project

- H2020 „EPOS – Implementation Phase“
- GSA „Galileo-Reference Center – Member States“

- Main conclusion

With regard to international activities the specialists of our institute are active in many high-esteemed The European Council of Geodetic Surveyors – CLGE and International Federation of Surveyors – FIG.

TECHNOLOGY AS A TOOL TO ENHANCE MOTIVATION AND LEARNING

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Keywords: Motivation, Learning, technology

Nowadays, being a teacher is a matter of being focused on learning rather than teaching in a classical point of view. With so much and so good information available and easily accessible, the figure of the "*self made man*" can even lose meaning once it is easier to learn outside school. School as institution must be equated as a space to promote learning and motivation to learn which is often absent.

In order to respond to the necessary shift paradigm school faces resulting from a different way of life in a very recent past, the use of technology proves to be a powerful ally, ensuring student's ability to respond to technical and scientific questions as well as creating an environment of trust and security since, for example the mobile phone, is a tool of permanent use in the student's life.

Even "*the extent of change caused by recent and unexpected events like Brexit (Britain's departure from the European Union) will be insignificant compared to the impact of an avalanche of technological change that can reshape the very essence of humanity and life in the our planet*" (Leonhard, 2017). And if, as Leonhard (2017) says, the mega changes we are confronted with will re-draw trade, culture and society, biology and ethics, what shall we say about school still working in a model created in the nineteenth century? And considering that we are at a critical turning point in technological evolution and where change seems irreversible, what new challenges does the teacher also face in this field?

The aim of this work is to think about how technologies can have or not a role on motivation to learning and academic success. As teachers, we defend we must adjust methodology so it can serve learning. Same methods and technics may prove to be excellent or lousy according to multiple and various factors. We often think we have the best class ever prepared, able to impress all students and this just does not happen. Why? What mechanisms can make an activity be remarkable and impactful?

The methodology used in the classes is diversified and according to the goal, participative techniques of active learning, simply active listening, informal

dialogue, apps or a quick research on google, in all of them technologies are welcome. Even so, sometimes it seems to not be enough.

Results from different sorts of conversation with students (interview, focus group and small questionnaire) shows the mobile phone is the most requested in class and even for research, it is preferred in deterring the computer. Technology (eg some apps for identification of wildlife species) can also make no sense to the student if the contents are not pleasant for students but in general, answers show us that technology helps students to feel confident since it doesn't expose individual (un)knowledge, to learn with pleasure, to create group dynamics and in general, to create happy moments that increase motivation and improve learning and knowledge.

Our lessons learned tell us that today students lack meaning, they need to give meaning to their existences. And of course, technology can be exploited for this, not just in a content-oriented sence but existential sense, without the two together, everything will remain inadequate.

THE KINETIC OF MANGANESE (II) SORPTION ON POWDERED BASALT AND ZEOLITE – ORDER AND DIFFUSION MODELS ANALYSIS

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Keywords: manganese removal, aluminosilicates, tuff materials

The goal of research

Sorption is practical method for water treatment and natural materials can remove metals from the water, although the process is diverse and complex. The aim was to study of possible sorption mechanism of manganese(II) on basalt tuff in kinetic system, as well as compare the results to the commonly used material – zeolite.

The scope and methods

The basalt tuff from Ivanodolinsky quarry (Rivne region, Ukraine) was investigated. The zeolite tuff from Sokyrnytsia deposit (Zakarpattia region, Ukraine) as comparative mineral sorbent was used. The both raw materials were used in the form of powder.

The kinetic experiment was carried out by batch method at a temperature of 10 °C. Two litres of a manganese chloride solution in double-distilled water with manganese concentration of 10 mg/L and a pH 6.0 were prepared. Then 2.0 g of the mineral material was added to the solution and it was kept mixed. At set time intervals the samples of 10 mL were taken to analyse the manganese concentration. The mineral powder was separated from the solution by a two-minute centrifugation (10 000 rpm). The manganese concentration in solutions using atomic absorption method was measured. Data were analysed using pseudo-first- (PFO) and pseudo-second-order (PSO) kinetic models as well as the liquid film and intraparticle diffusion kinetic models. The models' adaptation to experimental data was evaluated using the coefficient of determination (R^2) and standard deviation Δq .

Highlight results

The basalt tuff consisted mainly of andesite and a small amount of saponite, whereas the clinoptilolite predominated in the zeolite. The structure of each rock

includes aluminosilicates, which possess ion-exchange properties, names generally the ability of sorption.

Main conclusions

It was found that the adsorption process of Mn(II) onto basalt tuff and zeolite tuff followed pseudo-second order kinetics with intraparticle and film diffusion mechanisms.

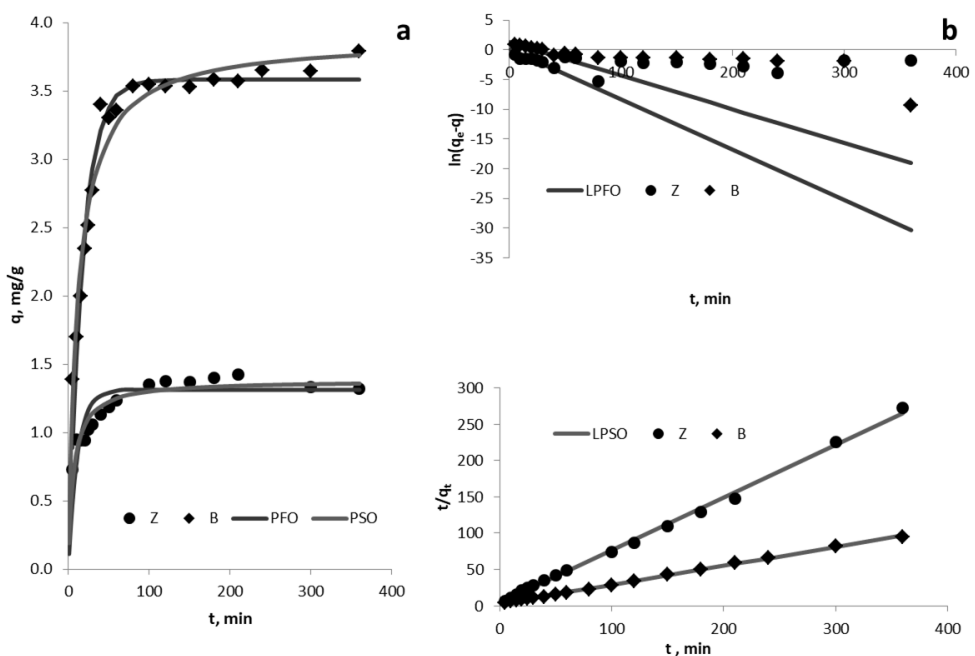


Figure 1. Linear (b) and nonlinear (a) PFO and PSO models for the adsorption kinetics of Mn onto basalt tuff (B) and zeolite tuff (Z)

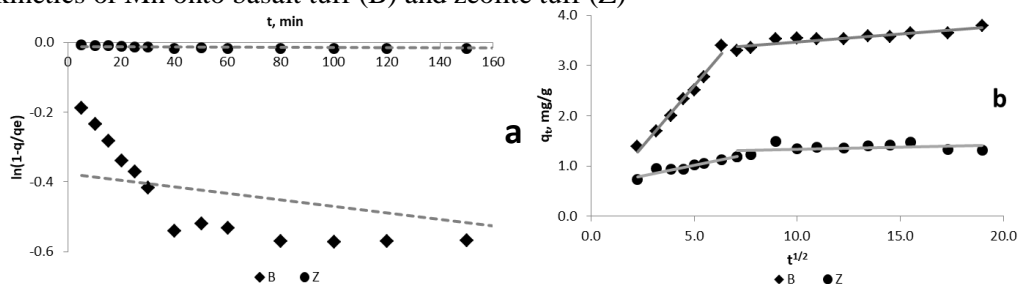


Figure 2. The liquid film diffusion plot (a) and the intraparticle diffusion kinetic plot in fragmented form (b) for the adsorption kinetics of Mn onto basalt tuff (B) and zeolite tuff (Z)

EFFICIENCY OF FUNCTIONING SOLAR COLLECTORS IN SELECTED HOUSEHOLDS

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Key words: renewable energy, solar collector, hot utility water, alternative energy sources

The increase in the population demand for energy in many countries contributes to the search for its alternative sources, and one of them is solar radiation. The most common devices for converting solar energy into usable energy are solar collectors. The paper presents the efficiency of solar collectors used for heating utility water in a single-family house, inhabited by 4 people, located in the Płonka village (Lublin province, Poland). The tested solar installation consists of three collectors with an area of 2.1 m² each (total 6.3 m²) was completed in 2014 thanks to the support under the project "Solar energy in the Communes of Gorzków and Rudnik", co-financed from the funds of the Regional Operational Program of the Lubelskie Voivodeship. In addition to the collectors, the installation includes a 300-liter water tank with a heat exchanger, a pump that distributes water from the collectors to the tank, and a controller for the entire system.

Data regarding thermal power and generated energy includes detailed annual, monthly and daily reports, stored in the device's memory to verify the performance of the set. The generated data allow to track the variability of device performance, depending on weather conditions. The number of days in which the cloudiness was too large was determined so that the installation could function even at the lowest parameters, and when the intensity of solar radiation, and thus the amount of generated heat were the greatest. The obtained results allowed to draw up daily diagrams and annual cycles of solar radiation. The amount of fossil raw materials (coal, oil and natural gas) needed to generate the energy that was produced in the tested installation and the reduction of pollutant emissions that was achieved due to the use of solar energy were also calculated.

The highest efficiency of the tested solar collector installation was found in the period from March to October, and its work significantly reduced the costs of water heating by the traditional boiler, which was the main source of heat for the installation in the household. Collectors produced the least energy in December,

while the highest installation efficiency was achieved annually in July. Depending on the insolation conditions during the year, the amount of energy produced by the collectors changed; it fluctuated significantly even within a few days from 0 to even 15 kWh/day.

An effective heating system, based on a renewable energy source, which is a solar installation, decisively reduces household expenses incurred for heating water by up to 60%. The use of a modern, high-efficiency heat source brings not only economic but also ecological effects in the form of reduction of atmosphere pollution.

COMPARISON OF ELECTRIC POWER CONSUMPTION AND CURRENT EFFICIENCY OF ROTATING ELECTROCHEMICAL AND ROTATING ELECTROBIOLOGICAL CONTACTORS TREATING WASTEWATER FROM SOIL-LESS CULTIVATION SYSTEMS

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Keywords: rotating electrochemical contactor, rotating electrobiological contactor, electric power consumption, current efficiency, soil-less cultivation

The aim of this study was to compare the performance of rotating electrochemical and rotating electrobiological contactors, based on current efficiency (CE) values and electric power consumption during phosphorus removal (E).

The study was conducted in a one-stage electrobiological contactor (REB) and an electrochemical contactor (REC). In the REB, the cathode consisted of discs with immobilized biomass. In the REC, the cathode consisted of rotating discs, from which biofilm was periodically removed. An aluminum anode was placed in the flow chamber of each contactor. The study employed synthetic wastewater with characteristics similar to wastewater from soil-less cultivation of tomatoes, which is the dominant cultivation method.

The experiments were divided into two stages. The goal of the first stage was to calculate the current efficiency, which determined the denitrification efficiency in nitrogen compounds removal, and the electric power consumption for removal of a defined amount of phosphorus compounds in the REC with discs without immobilized biofilm. Nitrogen compounds were removed during electrochemical reduction of nitrates, and phosphorus compounds were removed during electrocoagulation. The second stage determined the current efficiency and electric power consumption for removal of a defined amount of phosphorus compounds in the REB with discs with immobilized biofilm. Nutrient compounds were removed during hydrogenotrophic and heterotrophic denitrification, electrochemical reduction of nitrates, electrocoagulation of phosphorus compounds and biomass growth. In each stage, four hydraulic retention times were tested: 4 h, 8 h, 12 h and 24 h. With each retention time, the following densities of electric current were used: 0.63 A/m², 1.25 A/m², 2.50 A/m², 5.00 A/m² and 10.00 A/m², which were selected based on the literature.

The study showed a decrease in the current efficiency of the electrochemical contactor with an increase of the electric current density and hydraulic retention time. The current efficiency was the highest in the contactor operated at a hydraulic retention time of 4 h and a density of 0.63 A/m^2 ($61.17\% \pm 4.59\%$). It was the lowest in the contactor operated at a hydraulic retention time of 24 h and a density of 10.00 A/m^2 ($3.4\% \pm 0.03\%$). The study also indicated that the electrical power consumption for removal of a defined load of phosphorus compounds depended on the current density and hydraulic retention time. At $J = 0.63 \text{ A/m}^2$ and $\text{HRT} = 4 \text{ h}$, power consumption was the lowest (0.12 kWh/gP). At $J = 10.00 \text{ A/m}^2$ and $\text{HRT} = 24 \text{ h}$, it was the highest (9.43 kWh/gP).

Similar tendencies were observed in the electrobiological contactor. In the contactor operated at a density of 0.63 A/m^2 and an HRT of 4 h, the current efficiency was the highest ($80.2\% \pm 6.5\%$). In the contactor operated at 10.00 A/m^2 and an HRT of 24 h, it was the lowest ($4.6\% \pm 0.5\%$). An increase in electric energy consumption in the process of phosphorus compounds removal along with increasing the density of electric current and hydraulic retention time was observed in the electrobiological contactor. At $J = 10.00 \text{ A/m}^2$ and $\text{HRT} = 24 \text{ h}$, power consumption was the highest (9.46 kWh/gP). Conversely, at 0.63 A/m^2 and an HRT of 4 h, it was the lowest (0.10 kWh/gP).

The study showed that, in both the electrochemical and the electrobiological contactors, increasing the current density and hydraulic retention time increased electric power consumption during phosphorus compounds removal and simultaneously lowered current efficiency.

The current efficiency values were higher in the electrobiological contactor than in the electrochemical contactor. Combining biological processes with electrochemical processes in the electrobiological contactor resulted in almost 20% higher current efficiency in the contactor operated at a density of 0.63 A/m^2 and $\text{HRT}=4 \text{ h}$.

TREATMENT OF WASTEWATER CONTAINING AIRPORT RUNWAY DE-ICING AGENTS IN BIOFILTERS

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Keywords: airport de-icing agents, wastewater treatment, biofilter, light weight aggregates

Large quantities of pavement de-icing and anti-icing fluids, collectively termed de-icing agents, are used at airports to facilitate wintertime safe air travel. On average, the maintenance of a medium-sized airport may consume several hundred tons of fluid over the entire winter season. After use, most of the de-icing and anti-icing agents get typically mixed with storm water runoff and may enter grounds and waters near the airfield pavements. The de-icing agents are the principal source of airport pollutants entering surface and ground waters, and the soil. The wastewaters resulting from airports' winter operations (de-icing agents mixed with storm water runoff) are contaminated mainly with nitrogen and carbon compounds, while the average total phosphorus levels do not exceed the limit values.

Research results has shown that the use of biofilters filled with light weight aggregates prepared from fly ashes from sewage sludge thermal treatment (FASST LWA) can be an effective method of removing nitrogen and organic compounds from wastewater containing airfield deicing fluids at low temperatures, i.e. 0-8 °C. For this to be possible, it is necessary to maintain a proper relationship between the amount of carbon and nitrogen in the treated wastewater, through the simultaneous application of de-icing agents containing urea and easily biodegradable carbon compounds.

Based on the results of the study, technological systems of wastewater treatment plants for wastewater containing airport runway de-icing agents with the use of biofilters were proposed, treated wastewater discharging into natural waters, soil and sewerage network (common, sanitary, storm water sewers).

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**POSSIBILITIES OF PERFORMING AN APPROPRIATE ASSESSMENT
OF THE IMPACT ON WASTE ON THE ENVIRONMENT,
ON THE EXAMPLE OF ASH FROM LIGNITE**

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Keywords: heavy metals, fly ashes, sequential extractions, lignite

The problem of the migration of metal ions in the environment, remains a current problem in the light of the quality of obtained crops. The necessity of more and more frequent use of alternative sources of biogens in the form of waste substances, poses a threat of loading significant amounts of metals into the soil - including heavy metals harmful to human health and life.

The article was discussed a significant problem, which is the comparison of the results of the environmental impact of waste, obtained on the basis of legally authorized leaching tests (three-stage leaching test according to PN-Z-15009), with results obtained from sequential chemical extraction (performed in 4-step chemical extraction developed and recommended in European Union countries by Communities Bureau of References - BCR).

The study covered investigation the industry fly ash from the combustion of lignite, in which Cu, Zn, Cd, Ni, Pb, Cr, Na, K, Li, Mn. These tests confirm that the leaching tests used for their application in the natural environment indicate at most such concentrations as we obtain at the first or second stage of sequential chemical extraction, and thus we do not know their proper full environmental impact.

EXPLORING SPATIAL ORDER OF NATURAL VALUABLE SUBURBAN AREAS WITH GIS - CASE STUDY

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Keywords: spatial order, suburbanization, environmental protection, cultural landscape

There is increasing awareness of the human population growth accompanied by the decrease in natural areas and their fragmentation. Natural valuable areas located in suburban and peri-urban areas are particularly prone to intense and chaotic development. Lack of integrated spatial plans for foregoing areas as well as lack of mandatory environmental protection plans (EPPs) can impede sustainable development.

To enhance the effectiveness of environmental protection and spatial planning reflected by spatial order in suburban areas evaluation and monitoring are needed. But it is impossible without measurable indicators. The aim of the paper is to develop a method to measure and monitor spatial order. Moreover, natural valuable areas located in Polish suburbs are identified and quantified in the paper. Taking the suburbs of Krakow as a case study, we propose an indicator for the evaluation of spatial order in natural valuable areas using the point bonitation method and Geographic Information System (GIS). As indicators we have used: forestation rates, landscape diversity level, density of the total road network, type of built-up area, as well as the building intensity.

ENVIRONMENTAL EFFECTS OF REDUCING LAND FRAGMENTATION IN LAND CONSOLIDATION AT WEST ROZTOCZE AT THE SLOPE SCALE

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Key words: land consolidation, eroded areas, protection of land against erosion

The purpose of land consolidation understood as a set of project and technical activities, is to create more favorable farming conditions by improving the area structure of agricultural holdings, rationally shaping land plots, adjusting property boundaries to the water melioration system, roads, and land relief. The scope of work performed in the management process may be different from the classic land consolidation to the comprehensive development of the area, made on the basis of a consolidation process.

In the case of upland areas located in the south-eastern part of the country, due to the varied sculpture of terrain, the occurrence of inner-slope valleys and slopes with different exposures, suffusion drench, and other erosion wastelands, the project of land consolidation can be complicated. At the same time, land fragmentation and the occurrence of balks and scarps, trees, sods and mosaics of crops, makes that the intensification of water erosion is limited. In the case of classical consolidation works without erosion control rules, erosion processes are triggered, and the losses caused by erosion of soil degradation can often exceed the consolidation effects resulting from the improvement of land configuration. Therefore, land consolidation in such areas besides of enlargement of plots must also take into account the principles of protection of the land against erosion.

The work aims to assess the impact of land consolidation on the risk of erosion on the example of a selected fragment of the Latyczyn village on the West Roztocze (Radecznica commune, district of Zamość). Land consolidation was carried out in 2012-2014. The effects of consolidation of 11 small plots into one big plot located on a slope with a gradient of up to 18% were studied.

On the studied part of the slope, all the plots before consolidation had an across-slope arrangement with the same direction of agrotechnical operations. The same layout has remained after consolidation. Creation of one large plot (4.59 ha), however, was associated with the liquidation of several sodded balks, including transverse sodded scarp. The width of the newly separated plot is up to 130

m. Carried out research showed both the advantages and disadvantages of this solution. Apart from creating the plot suitable for mechanical cultivation, an advantage is the liquidation of many longitudinal balks dividing individual plots before consolidation. Along those balks, rainwater runoff was concentrated, causing a groove erosion. Thus, consolidation has eliminated this problem.

Disadvantages of this consolidation decision were proved by the simulation results using the WEPP model (Water Erosion Prediction Project). As a result of the liquidation of two sodded scarps located crosswise to the slope in the upper and middle part of the slope, the risk of water erosion increased. For the pre-consolidation state (the simulated crop was winter wheat), the expected annual soil loss as a result of water erosion was $3.713 \text{ kg} \cdot \text{m}^{-2}$, and the outflow of soil outside the slope during the year may amount to $34.88 \text{ Mg} \cdot \text{ha}^{-1}$. Currently, after the consolidation, despite the across slope direction of cultivation, the expected losses of soil amount to $190.32 \text{ kg} \cdot \text{m}^{-2}$, and the outflow of the sediment – $894.50 \text{ Mg} \cdot \text{ha}^{-1}$. To protect soils against erosion without increasing the difficulty in carrying out agrotechnical procedures, at least one sodded scarp should be reconstructed across the slope in the place of the most significant decline.

EFFECT OF THE QUALITY OF SHALLOW GROUNDWATERS ON THE OCCURRENCE OF SELECTED RELIC PLANT SPECIES OF PEATLANDS IN THE ŁĘCZNA-WŁODAWA LAKELAND

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Keywords: groundwater quality, physical-chemical parameters, relic species, peatlands

The chemical composition of waters is therefore a resultant of the geochemistry of landscape depending on its geological and topographic features – overland flow and landscape retention; specific climatic conditions – temperature, humidity, atmospheric pressure; chemical composition and distribution of atmospheric precipitation; regional and local water management; type and intensity of land use in a given area; as well as type of vegetation. In the case of seminatural and natural ecosystems, namely peatlands, the vicinity of agricultural areas constitutes the primary source of biogenic substances and post-production pollutants for this type of environment, causing a change in its fertility towards eutrophy. This condition affects the qualitative reconstruction of the biocenotic composition of phytocoenoses and the possibility of occurrence of rare and protected plant species. This is essential in planning the strategies and methods of their active protection, because on the effectiveness of such activities have an equivalent impact: stabilization of the hydrological system of the habitat, restitution of biocenotic systems, extensive management inhibiting the succession of shrub and forest vegetation, correctly carried out methods of reintroduction of the species and basically - optimal features habitats shaped by the quality of peat groundwater.

In the years 2010-2014, in the aspect of planning the strategy of active species protection (reintroduction and species restitution), research was conducted to determine the optimal values of the examined physical and chemical parameters of shallow groundwater, relevant for the proper functioning of boreal protected plant species in the Łęczyńsko-Włodawskie Lakeland (their higher percentage share in phytocoenoses): downy willow (*Salix lapponum*), swamp willow (*Salix*

myrtilloides) and dwarf birch (*Betula humilis*). For this purpose the representative locations were selected in the Łęczna-Włodawa Lakeland for different types of regional ecological research (seminatural places with potentially limited human pressure and regulated hydrological relations): lake-peatland complexes: Lake Bikcze (B), Lake Karaśne (K), Lake Długie (D), Lake Moszne (M), Lake Lubowierz (L); forest peatland Blizionki (BZ), and wilderness Dekowina (DK). Depending on the object, study sites were designated with the natural character confirmed by the research and the procedure was conducted (sampling water from mounted piezometers soil). It included certified laboratory analysis (Central Agroecological Laboratory of the University of Life Sciences in Lublin) of 14 physico-chemical properties such as: reaction (pH), electrolytic conductivity (EC, dissolved organic carbon (DOC), nitrogen fractions: total nitrogen (N_{total}), ammonium nitrogen (N-NH₄), nitrite nitrogen (N-NO₂), nitrate nitrogen (N-NO₃), phosphorus fractions: total phosphorus (P_{total}), phosphate phosphorus (P-PO₄), concentration of sulphates (SO₄) and selected cations: sodium (Na), potassium (K), calcium (Ca), and magnesium (Mg). Results of the laboratory research were analysed in statistical permitting the determination of the ecological tolerance of the analysed object in reference to each physico-chemical parameter of shallow groundwaters (inter alia non-parametric competent Kruskal-Wallis test).

Based on the conducted research, it is stated that the late-glacial boreal relics, on the natural sites of peatlands in Central-Eastern Poland are characterized by a broad spectrum of ecological tolerance with reference to the majority of the analysed physical-chemical habitat parameters of water. In the case of *Salix myrtilloides*, low level of values of nitrogen fractions, phosphorus fractions, studied cations, and DOC can be considered a group of conditions favouring the functioning of its population, whereas for the simultaneously studied *Salix lapponum*, such conditions were met by: low level of TN, phosphorus fractions and DOC, as well as a high level of Ca, pH, and EC. For *Betula humilis*, values of statistically significant, favourable for its occurrence abiotic properties of groundwaters were provided in more detail also providing ranges of their values based on boxplots for which the upper and lower quartile referred to the Kruskal-Wallis test provide information on the range of values of physical-chemical water properties significant for the species. They included: TP: 0.08-0.32; P-PO₄: 0.1; TN: 2.2-21.2; N-NH₄: 0.1-0.46; DOC: 24.6-56.9 (mg·dm⁻³), as well as higher than average pH values, in a range of: 5.34-5.95; Ca: 5.67-28.1; Mg: 0.56-2.41 (mg·dm⁻³) and EC in $\mu S \cdot cm^{-1}$: 72.1-142.3. It should be stated that the occurrence and the permanence of measures related to the restitution of selected boreal relics, however, depends on the preservation of habitat conditions that are approximate to natural, including the proper level and appropriate physical-chemical specification of peatland waters.

APPLICATION OF UAV SURVEY FOR UPDATING CARTOGRAPHIC INFORMATION OF THE RESORT SHIDNYTSYA

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Keywords: UAV, map updating, control points, image processing

Actuality. During last decade Skhidnytsya Resort is rapidly developing. New constructions such as motels, hotels, restaurants and cafes, private and office buildings, gas stations, new building quarters, roads, bike and pedestrian tracks are constructed around the village. Availability of updated cartographic information is very important for many concerned parties. Tourists are interested in information about availability and location of objects of tourist infrastructure. For local authorities such information is very useful to plan development of the village.

Modern remote sensing methods, especially, application of UAV for aerial survey allow to get updated information about terrain quickly and cost effectively.

The aim of the research is to analyse possibilities of application of UAV survey data to update different type of cartographic information, to develop workflow and consider advantages and disadvantages of this method.

The method and realisation. For obtaining updated cartographic information with use of UAV there should be done following stages:

- preliminary works, which includes the analyse of available cartographic data, considering requirements to new information, recognisance of existed geodetic networks, investigation of camera, creation of project of survey, a priory accuracy assessment, etc.

- planning and implementation of survey using UAV TRIMBLE UX5 equipped with camera Sony Alpha ILCE-QX1;

- implementation of referencing of control points by means of GPS-receiver S82-T/S82V.

- image processing and cartographic information updating.

When application of processed images for updating cartographic information it was used different software depending of the type of updated cartographic data. For topographic maps there was used software “Digitals”, for tourist maps additionally software “Mapinfo” and “ArcGIS” as there is need to update the attributive data as well. The advantages and disadvantages of application of UAV survey for map updating were considered.

Results. The implemented studies show effectiveness of application of UAV survey for obtaining updated cartographical information about terrain. Especially it is useful for not large settlements. Such way local authorities can get precise and actual information about changes of the settlement territory and use the data for effective planning and sustainable development. The analysis of a prior and a posterior accuracy, cost effectiveness and timetable confirm possibility and effectiveness of application of UAV survey for assigned tasks.

EFFECT OF RAINBOW TROUT (*ONCORHYNCHUS MYKISS*, WALBAUM 1792) CULTURE IN A CASCADE WATER FLOW TECHNOLOGY

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Keywords: trout; fish ponds; water quality; pollution; WQI_{CCME}

Aquaculture may have a negative effect on the water environment, mainly due to fish metabolites, undigested feed residues or chemical production means as well as pharmaceuticals, which increase the pool of biogenic substances in water. The optimal conditions for the survival and growth of fish necessitate not only adequate amounts of water but also the right temperature and high quality of water. The objective of this research has been to evaluate the influence exerted by the rearing of rainbow trout in four-stage cascade system on the quality of water in ponds and discharged from fish farm. A fish farm selected for the study comprises concrete fish ponds fed water by gravity in a constant-flow system. Spent water, prior to being discharged from the farm, was pretreated by flowing through a treatment ditch, which is 450 m long.

As a result of the flow through the fish ponds, arranged in a cascade system, the quality of water deteriorated to the lowest class on a five-degree scale, denoted as poor. However, it was evidenced that changes in the quality parameters of water after passing through ponds A and B were not large, whereas a drastic decrease in the water quality occurred once it flowed through ponds C and D. The threshold values of nitrite and ammonia nitrogen as well as BOD₅ were exceeded constantly, while the concentrations of the other substances analysed were above the quality norms periodically. The nitrogen balance determined in the analysed waters showed a gradual increase in the concentration of ammonia nitrogen at the expense of the organic nitrogen share. The research did not confirm the intended positive influence on the quality of water discharged from the fish farm effected by the 450-meter-long ditch situated between the lowest fish pond in the cascade (pond D) and the outlet of water from the farm. After water had passed through the ditch, its quality class remained in the poor category. Thus, it was demonstrated that water discharged from the fish ponds, despite the implemented system for its pretreatment, creates a risk of polluting water in the receiving water body.

SEWAGE AND SLUDGE MANAGEMENT IN A SMALL SEWAGE TREATMENT PLANT

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Keywords: wastewater treatment plant; wastewater; nitrogen; phosphorus.

Wastewater treatment becomes an increasingly complex and complicated process. This is caused by the intensive development of the industry and technologies used in it and the greater wealth of the society. This affects the high concentrations and diversity of chemical compounds contained in the used water supplied to the sewage systems, and then to the wastewater treatment plant. The aim of the work was the analysis and assessment of wastewater and sewage management in the municipal sewage treatment plant in Braniewo. A municipal wastewater treatment plant was located in the town of Braniewo, serving about 17 thousand inhabitants residents. The technological system used in the municipal sewage treatment plant in Braniewo consists of a mechanical part (mechanical cleaning) and a biological one using activated sludge working in the technological system A2/0.

The conducted research showed that the sewage treatment plant in Braniewo was characterized by high efficiency of organic matter removal, and treated wastewater discharged to the receiver should not pose a threat to it. The analyzed wastewater treatment plant was characterized by high efficiency of nitrogen and phosphorus removal, however, periodically, the permissible values of their concentration in treated wastewater were exceeded by the water permit. In order to increase the efficiency of pollution reduction in sewage, it was proposed to modernize the sewage treatment plant under which the simultaneous phosphorus precipitation was designed, the denitrification capacity was increased, and the recirculation level was increased. The proposed technological system will ensure in the outflow from the sewage treatment plant in Braniewo the concentration of nitrogen and phosphorus at the level specified in the water permit. The study was supported from the EU ERANET 2017 Water JPI Joint Call project "Water Harmony-Closing the Water Cycle Gap With Harmonised Actions for Sustainable Management of Water Resources".

DIFFERENTIATION IN THE PROFILE OF ATMOSPHERIC CARBON DIOXIDE AND METHANE CONCENTRATIONS ALONG SELECTED SECTIONS OF EUROPEAN ROADS

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Keywords: greenhouse gases atmospheric concentration, carbon dioxide, methane, transport emission sources

Increasing concentrations of atmospheric greenhouse gases are considered the main cause of observed climate change. It is estimated that over 20% of anthropogenic CO₂ emissions originate from transport-related sources. Measurements of ground-level concentration of greenhouse gases are carried out at reference stations, allowing assessment of the situation on a global scale, but there are less information about local conditions and spatial variability of distribution of these pollutants in the atmosphere. The research aimed at recognizing the variability of concentration of two greenhouse gases: CO₂ and CH₄ along car communication routes in selected parts of Europe. The measurements were performed in June 2018 by cavity ring-down spectroscopy technique (CRDS) using a Picarro GasScouter 4301 portable spectrometer equipped with a GPS module. In order to compare the local variability of greenhouse gases occurrence, within the route with a total of about 3000 km, 11 zones were distinguished in the following locations: France - east, central and southern part; Italy - area along the Mediterranean coast, central lowlands and mountain areas (Dolomites); Austria - south-western area and northern lowlands; The Czech Republic - the eastern part, and Poland - the south of the country and the section between Warsaw and Olsztyn. As a result of the mobile measurements carried out, a set of data was collected, after selection including 150,600 individual samples. The research showed differentiation of the concentration of both measured gases on a regional basis. Average CO₂ concentrations in individual regions ranged from 414.36 ppm (Dolomites) to 513.89 ppm (Mediterranean coast). For methane, average concentrations were found from 1899 ppb (eastern France) to 2028 ppb (central Italy lowlands). The maximum measured values of both gases were often incidental (small, point or linear emission sources), especially those related to CO₂ concentrations; the minimum values were arranged in much more stable sequences, reflecting the values of the geochemical background in a given area. The variability of CO₂ was local, while the difference in CH₄ was clearly supralocal (regional).

LONG-TERM TRENDS IN RIVER DISCHARGE – A CASE STUDY OF WARTA RIVER BASIN, POLAND

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Keywords: discharge, long-term trends, climate change, Mann-Kendall test, Sen's test

The aim of the study was to analyse the long-term river discharge changes. The analysed data were taken for the rivers located in the Warta basin, Poland. The paper presents the following research hypotheses: 1) minimal and mean river discharges in the Warta basin decreased, 2) maximum discharges in the rivers of the Warta basin increased, 3) human activity has greater impact on the changes in river discharges than climate changes.

The analysis was carried out for 20 rivers on the basis of data from 1951-2017 for 32 water gauge stations. The data on minimum, mean and maximum discharges from summer and winter half-years and the hydrological year were used.

Long-term changes in water discharge were analysed using Mann-Kandall and Sen's tests. The non-parametric Mann-Kandall test enabled to determine the direction and significance of the changes. The Sen's test allowed to determine the magnitude of changes in discharges in the period of 1951 - 2017. Based on the results of the Sen's test, the rivers were divided into groups with the highest similarity in terms of discharges changes. For this purpose, the cluster analysis (CA) was carried out. In order to highlight the factors determining the changes in river discharges, the following parameters were determined for each of the catchment: drainage density, lake index, average slope, average altitude, land use and soil type. The data obtained were used in the principal components analysis (PCA). The obtained results indicate that the changes in the discharges in the rivers located in the Warta basin in the period 1951-2017 are multidirectional. Changes in water discharges in rivers are caused by anthropogenic factors and changes in thermal conditions and precipitation. The impact of these factors depends on the natural conditions of the river basins. The greatest changes occurred in the case of minimum discharges both in summer and winter half-years and maximum discharges in winter half-years. Significant changes were recorded in 13, 15 and 19 gauge station respectively. In the case of minimum discharges in summer half-years, in 6 gauge

station decreasing trend was recorded, and in 7 rising trend. Minimum discharges in winter half-years showed a rising trend in 11 gauge station and only in 4 - a decreasing trend. In the case of maximum discharges in winter half-years, 19 gauge station showed a significant decreasing trend. The largest changes in discharges were recorded in the Mała Noteć, Gąsawka and Widawka (Rogoźno gauge station) rivers, whereas in the case of the Kanał Mosiński (Mosina), Mogilnica, Wełna, Sama and Noteć rivers (Nowe Drezdenko) the Mann-Kandall test showed no significant changes.

CAN WATER MANAGEMENT IN DRAINAGE SYSTEMS CONTRIBUTE TO MITIGATE THE EFFECTS OF CLIMATE CHANGE IN AGRICULTURE?

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Keywords: agriculture, climate change, drainage water management, control drainage, DRAINMOD

The paper presents the potential impact of water management in the drainage network on the dynamics of groundwater table and the surface and subsurface outflow. The research was carried out on the example of two drainage sections located on arable land of Ostrowo Szlacheckie, located in Wielkopolskie Voivodeship, Poland. The results of the simulation answer the question of how water management in drainage systems will contribute to adapting agriculture to climate changes.

The analysis of different scenarios of water management in the drainage network on soil water balance components was carried out using the DRAINMOD model. In the first stage, on the basis of field measurement from the years 1994-2000, the model parameters were identified. In the second stage the model was calibrated and validated. The first series of simulations included calculations for the years 2014, 2017 and 2018, characteristic in terms of precipitation, assuming various initial conditions and variants of control drainage. In order to present the functioning of drainage networks in the conditions of future climate change, seasonal changes in precipitation and temperature were applied for the RCP4.5 emission scenario for two time horizons: 2012-2050 and 2071-2100. The simulations used data from 2014, 2017 and 2018, in which temperatures were increased by 1.2 and 2.1 °C respectively and total precipitation from March to September by 5.7 and 7.6%, respectively. Moreover, due to the predicted increase in the number of rain-free periods and the increase in the frequency of high intensity rains, the daily precipitation recorded in the studied years was summed up for the ten-day periods. The values have been assigned to the last day of the decade.

The obtained results indicate that the regulation of the outflow from the drainage network allows to increase the groundwater table and to stabilize it. The obtained results showed that intensive precipitation may increase surface outflow. At present, controlled drainage practice, depending on the initial groundwater table depth, allows to reduce the subsurface outflow from the drainage network from 56 to 100%. The average reduction in subsurface outflow will be between 80 and 100% (2021-2050) and 83 to 100% (2071-2100) respectively. Analysis of the functioning of drainage systems in the face of climate change has shown that the water balance of drained arable land can be improved with simple devices to control outflow.

This study was done within the project “Technological innovations and system of monitoring, forecasting and planning of irrigation and drainage for precise water management on the scale of drainage/irrigation system (INOMEL)” under the BIOSTRATEG3 program, funded by the Polish National Centre for Research and Development. Contract No. BIOSTRATEG3/347837/11/NCBR/2017

APPLICATION OF 3D GRAPHIC SOFTWARE AND GIS IN VISUAL IMPACT ASSESSMENT OF HIGH-VOLTAGE OVERHEAD TRANSMISSION LINES

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Keywords: LIDAR data, GIS, 3D graphic software, Blender, high voltage overhead transmission lines, visual impact assessment

The paper presents the possibility of using GIS tools and 3D graphic software to assess the impact of high voltage overhead transmission lines on the landscape. The paper uses a digital elevation model developed on the basis of airborne laser scanning data. In addition, potential locations and high voltage overhead transmission lines tower heights have been used. The Viewshed tool available in the ArcGIS software made it possible to calculate the visibility range of tower. To limit the spatial range of the analysis 3D simulations were carried out in Blender version 2.79. Visibility range analysis was performed in the range from 250 m to 3000 m in steps of 250 m. The render analysis in relation to the percentage of the area occupied by the HVOTLs tower in the total field of view, allowed to limit the range of the analysis. Calculations have shown that the range of the HVOTLs tower impact assessment should be limited to 2 km. The very strong and strong visual impact of the tower range from 0 to 250 m. In contrast, there is a significant impact between 251 m and 750 m and a moderate and weak impact above 750 m.

MAPPING OF LVIV IN THE SOVIET PERIOD

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Keywords: mapping, topographic plan, Lviv Tourist Atlas.

The goal of a research is to define the peculiarities and patterns of mapping of Lviv city for the state and public needs in the Soviet period.

Methodology and scope of a research. The theoretical and methodological basis of the research includes the modern concepts of significance of a map as an important instrument of geospatial information and of cartography as a paramount tool for recording the developments and phenomena. We consider the development of social and historical process as a set of many constituents.

Highlight of results. In the USSR, the cartographic and geodetic activity was absolutely and exclusively monopolized by the state. The responsibility for providing topographic, geodetic and cartographic information to the Military Department – the Soviet Armed Forces – was conferred on its Military Survey Service; it was responsible for mapping of the USSR territory (the topographic maps from a scale of 1:50 000 (local scale) and smaller, the topographic plans of military sensitive cities), delimitation and demarcation of the state boundaries and mapping of the territories of foreign states. The civil state cartographic and geodetic service represented by the Main Office of Geodesy and Cartography of the Council of Ministers of the USSR (MOGC) ensured the development of the topographic maps of a scale of 1:10 000 (the largest scale) and 1:25 000 (the local scale) in the USSR, conducted the local (detailed) survey of urban settlements, and edited the public maps for people. After the MOGC was integrated into the USSR Military and Industrial Complex in 1967, the air of mystery about the geodesy and cartography realm became thicker, especially from the beginning of 1970s.

The first topographic plan of Lviv city was edited by the Military Survey Service of the Soviet Armed Forces at Saratov Military Cartographic Factory in February 1944 (prior preparations for the city liberation). The plan of a scale of 1:15 000 was worked out as of January 1944 with usage of the 1941 office deciphered controlled mosaics of a scale of 1:20 000 and of some other materials. The list of the military and industrial objects and determined city buildings was given as of 1939.

In September 1947, the subsequent edition of the military topographic plan of Lviv city was carried out, although it was of a scale of 1:10 000. The plan was

worked out upon the 1936 Polish plan of a scale of 1:5 000 with reconnaissance in 1944-1945 and was edited at Kyiv Military Cartographic Factory.

The latest edition of the topographical plan of Lviv city for military purposes of a scale of 1:10 000, in two pages, was made in 1987.

Such military topographic plans were intended for survey of the cities in detail and the approaches and access to them, navigation, performance of the precise measurements and calculations while planning and conducting the defense actions. They displayed the sites of the locations adequately and accurately, provided the rapid detection of the important objects and landmarks, highways, obstacles on the approaches and access to the cities; ensured the possibilities of quick detection of rectangular and geographical coordinates, absolute and relative heights; included the information statement and list of the signed names of the streets. The plans of the cities for the Defense Department were developed by usage of Gauss Transverse Mercator projection calculated upon the parameters of Krasovsky ellipsoid in the coordinate system of 1942 and of the Baltic height system.

For the purposes of the postwar reconstruction and city renewal, it was needed to elaborate the topographic basis for the development and drawing up the Master Plan of the City, projects of placement of the high-priority housing and industrial construction, highway utility systems and communication lines, transportation routes, etc. The edition of the large-scale topographic plans of the cities for business purposes was conducted on the basis of the materials of the pre-war survey by plane-table reconnaissance technique. After 1944, the Soviet government authorities revived the preliminary advances of The Master Plan of Soviet Lviv worked out upon the plan "Królewskiego stołecznego miasta Lwów" of a scale of 1: 10 000 by E. Wilczkiewicz (1936).

The Voluntary Fire Community issued the Schematic Map of Lviv City in 1947 which was intended to be used by people. The Map displayed almost all streets and squares of the city, included their names being the main advantage of the present publication. However, in the context of cartography, it was quite elementary schematic map.

In the course of 1950s -1960s, a few plans of Lviv for the guests of the city and its citizens have been edited. Generally, they were the city schematic maps with routes of public transport for tourists which were edited by other than cartographic enterprises. Prior to the beginning of 1970s, Kameniar, Lviv Publishing Office, had been publishing such maps of little information in Ukrainian language.

Only since 1974, the MOGC Factory No.1, the Main Cartographic Enterprise of Ukraine (currently Kartographiia National Scientific and Production Enterprise) has been editing the Lvov Tourist Schematic Map in Russian on a regular basis (1974, 1976, 1977, 1979). In 1979, it was separately published in English, German, French languages. The main drawback of these schematic maps of

the city was distorted and idealized geographical base being worked out by specifically elaborated guidelines (different scales of the plan in the central and peripheral parts of the city, distortion in angles of intra-city buildings and North-South direction, etc.) The subject scope of these editions was adequately full (the tourist agencies, cultural and educational establishments, historical and cultural monuments, hotels, food outlets, etc.), although the selection of these alluring sites was conducted on the basis of the Soviet ideological factors. The schematic maps were published without any scale indication.

In general, the subsequent editions of Lvov Tourist Schematic Map (1982, 1984) of the modified form and with updated design did not change low-level cartographic scope.

In 1970s – 1980s, Lviv Schematic Maps of Passenger Transport had been published.

In 1970s, the MOGC divisions performed great amount of work on development the large-scale topographic plans being necessary for different types and stages of engineering. The main approaches to elaboration, the main requirements for the content and execution of the plans of the cities of a scale of 1:5 000, 1:2 000, 1:1 000 and 1:500 were laid down by the respective technical guidance documents. In 1978, the topographic plans of Lviv of a scale of 1:2 000 (in 133 pages) and of 1:5 000 (in 50 pages) were edited under the materials of the surveys and were classified as Confidential. The latest plan was updated and published in 58 pages in 1985. Such large-scale monochrome plans of the city were developed upon the local coordinate system and the Adriatic height system used to be employed in Austria-Hungary.

The effort to carry out democratic reforms in the Soviet society of the late 1980s favorably contributed to development of mapping. When the rigidly regimented restrictions on display of the geographical base were lifted, the level of detail, accuracy and quality of the plans of the cities, in general for different social groups, were substantially enhanced. The edition of Lvov Tourist Schematic Map in 1986 (reedited in 1988) with significantly improved cartographic basis (the number of the streets displayed was increased, the basis became more accurate) is a conspicuous instance of it. In 1987, Lviv City Tourist Schematic Map was published in Ukrainian language for the first time ever (under the Tourist Plan of 1986).

The tourist atlases have become the new mapping direction for the purposes of tourism and have been published in the USSR since the middle 1980s. Lviv Tourist Atlas (1989) displayed the historical and cultural attractiveness of the well-known tourist capitals of Ukraine. The Atlas had quite detailed and accurate geographical base, displayed a considerable amount of the streets of the city that have never before appeared at the maps. Page 27 of the Atlas contained the City

Plan with its central part being displayed in a larger scale. The Plan was supplemented by the list of the outstanding monuments and city infrastructure facilities. The Atlas also provided the tour routes, the park plans in detail, and the passenger transport route maps.

Main conclusions. The mapping of Lviv in the Soviet period was first and utmost defined by the preponderant trends of development of mapping in the whole USSR. Among the particular features of this period we may single out the unsubstantiated mystery of the cartographic information and security classification related to the elaboration and usage of different maps. The military topographic plans and large-scale city plans for business purposes were published only as Confidential ones. In the late 1970s, the city was provided with the topographic multipage plans of a scale of 1:2 000 and of 1:5 000. The elementary, extremely simplified plans of Lviv for the guests of the city and its residents have been edited by publishing offices prior to the beginning of 1970s. Since 1974, in the context of complete and full monopolization by the state of performance of the topographic and geodetic activities as well as of the cartographic ones, the MOGC cartographic enterprises have been publishing on a regular basis the tourist plans of the city with distorted and dramatically simplified basis. Only in the late 1980s, the cartographic quality of Lviv Tourist Plans has been enhanced and improved.

IMPACT OF IRRIGATION AND VARIOUS NITROGEN FERTILIZATION SCHEME ON THE CHEMICAL COMPOSITION OF SOIL SOLUTION UNDER WARM TEMPERATE CLIMATE CONDITIONS

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Soil solution play crucial role in plant feeding, as it constitutes the main source of water and available elements for plants. The study was carried out to assess the impact of water irrigation and various nitrogen fertilization on chemical composition of soil solution. Furthermore we focused on the nitrogen forms remains in the soil solution after plants harvesting. A field experiment was conducted at the Poznań University of Life Sciences experimental field (potatoes) in 2009, 2010 and 2011 growing seasons. The experimental plots (three replications) were established on soil classified as Haplic Luvisol (WRB 2015). Irrigation was the main treatment, starting when soil moisture was below 70% of field water capacity. Nitrogen fertilization (0, 60, 120, 180 kg N ha⁻¹) was used as the sub-treatment in this study, while the fertilization with K and P was equal for every experimental plots. The soil samples (ca. 1 kg) for laboratory analysis were collected from 0-30 cm soil layer, three times during the growing season: a) just before plants planting, b) during plants flowering, c) after plants harvest. Soil samples were frozen just after sampling to avoid nutrient loss. The soil solutions were obtained using the vacuum method from soil saturated paste. In soil samples the following properties were determined: texture, pH, TOC, TN, P, K and Mg. In soil solutions the concentrations of following compounds and elements were determined: NO₃⁻, NH₄⁺, Cl⁻, Ca²⁺, Mg²⁺, K⁺, Na⁺ and PO₄³⁻. Results showed that N fertilization did not significantly affect the chemical composition of soil solution. We found that the main factors shaping the concentrations of each compound and element were irrigation and soil sampling time. Irrigation had significant negative impact on NO₃⁻, NH₄⁺ and PO₄³⁻ concentrations. The highest amounts of nitrogen forms (NO₃⁻, NH₄⁺) were found in soil solutions obtained in samples collected from not irrigated plots. In the case of Na⁺, Cl⁻ and Ca²⁺ irrigation had significant negative impact. Among all of analyzed elements only for Mg²⁺ no effect of irrigation was found.

ANALYSIS OF THE SPATIAL STRUCTURE IN THE VILLAGES OF THE PUCHACZÓW COMMUNE AS AN INDICATOR OF THE URGENCY OF LAND CONSOLIDATION AND EXCHANGE

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Keywords: land consolidation, exchange of land, environmental protection, spatial planning

The spatial layout of today's village is the result of centuries-old human activity. In order to provide himself with means of maintenance, he changed the natural landscape adapting it to his own needs, without taking into account the negative effects of his activity. The decisive influence on the change of the village structure was caused by the settlement, which led to the division of settled space according to specific rules. As a result of this division, various forms of land use arose. The consequence of the economic development of the rural community was the constant transformation of the land structure, the pace of which was dictated by the stages of development and economic conditions. The excessive fragmentation of land, that is, their distribution in many, usually small plots, is characteristic for agriculture in south-eastern Poland. This is an element hindering the conduct of profitable agricultural production. The occurrence of this phenomenon is a prerequisite for the implementation of consolidation works in this area, which will enable the improvement of the spatial structure of the land.

The purpose of the work is to determine the needs of works for the consolidation and exchange of land in the villages of the Puchaczów commune, located in the Łęczna district, Lublin Voivodship. The zero unitarization method was used to determine the ranking. The basis for the calculations were the diagnostic features adopted for each town. The obtained results in the form of a synthetic measure for each village, allowed to create a hierarchy of urgency for the implementation of land consolidation works.

SUBURBANIZATION AS A PROBLEM OF RURAL DEVELOPMENT

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Keywords: suburbanization, development of rural areas, land fragmentation

Polish agriculture is currently struggling with many problems. One of them is land fragmentation. It has its historical background. Farmers wanting to distribute their property among their children, they gave to everyone on a certain part of the farm. The willingness of a fair division of property for heirs resulted in increased land fragmentation. The nuisance of this phenomenon manifests itself in the fact that too small or too narrow plots and their irregular shape make it difficult to conduct profitable agricultural activity. Another negative factor that affects the spatial arrangement of rural areas is the suburbanisation process. During the suburbanization process between the city and rural areas, specific connections are created, such as the flow of people, goods and capital. They play an important role in the transformation of these areas, and in particular in the way of managing these areas and the location of particular activities. Suburbanisation has meant that the population density in the city center has decreased, and has increased in its suburbs. The phenomenon of emigration of indigenous inhabitants of cities to the suburbs has become popular. The result of this process is the growing fragmentation of parcels in order to extract smaller and smaller building plots. In many cases, plots used for agriculture but intended for local plans for housing construction are divided into many smaller parcels and change over time into suburban housing estates. The incoming urban society, and thus the spread of buildings in the villages, causes it to lose its identity. In this way, the agricultural character of the village changes, where the farms withdraw from agricultural activity.

The aim of the article is to conduct research on selected spatial factors such as analysis of the ownership, use and fragmentation of land of individual farms, as well as the analysis of the suburbanisation process in the villages of the Konopnica commune, located in the Lublin powiat, Lubelskie Voivodeship. Obtained results of the research will allow to determine the direction and scope of changes in land fragmentation in the villages of the analyzed commune.

EVALUATION OF THE QUALITY OF WOOD PELLETS AVAILABLE ON THE MARKET

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Keywords: solid biofuels, quality, methane fermentation

1. Aim of research

There is a constant increase in interest in various types of solid biofuels, mainly pellets, which can be burned in individual, automated combustion systems. Pellets are considered the best substitute for heating oil, gas and coal. The main raw material for the production of pellets available on the market is wood waste - sawdust, shavings. The attractiveness of pellets as a biofuel is determined by their properties such as: low humidity, low ash and sulfur content, high heating value as well as easy storage, transport and distribution.

The aim of the conducted research was to assess the quality of wood pellets available on the market. This assessment was made on the basis of their calorific value and the contents of moisture, ash, C, H, N, S. Fourteen different types of wood pellets available on the market were tested, each from a different producer. In addition, an attempt was made to assess the organic matter content in the studied pellets based on methane fermentation.

2. Methodology and scope of research

The subject of the research were wood pellets of deciduous and coniferous wood available on the market. Fourteen different types of this biofuel from different manufacturers were tested. The TGA701 thermogravimetric analyzer from LECO was used to determine moisture content and ash. The carbon, hydrogen and nitrogen content tests were performed using LECO CHN 682 analyzer. The determinations were made in triplicate. The calorific value was determined using an automatic, isoperibolic LECO AC600 calorimeter. The result was the average of three measurements, the results of which did not differ from each other by 200 J·kg⁻¹. The research on biomethane production potential was carried out with the help of The Automatic Methane Potential Test System (AMPTS II) Bioprocess Control Sweden AB. On-line measurements of biomethane formed during methane fermentation

from a biodegradable substrate were carried out. The experiment was carried out under thermophilic and mesophilic methane fermentation conditions.

3. Highlight of results

The calorific value of the tested pellets was high and ranged from 17.18 [MJ·kg⁻¹] of P8 pellets to 18.84 [MJ·kg⁻¹] of P12 pellets, which defines them as attractive renewable fuels. Moisture content ranged from 3.91% in P12 pellets to 7.65% in P6 pellets. Moreover, the ash content in all the tested pellets was low and ranged from 0.26% to 1.32%. The carbon content ranged from 47.21% in pellets P14 to 49.92% in P8 pellets. The hydrogen content ranged from 5.61% in P11 pellets to 5.84% in P8 pellets. The hydrogen content ranged from 5.61% in P11 pellets to 5.84% in P8 pellets. The N content was varied and ranged from 0.021% in P13 pellets to 1.77% in P4 pellets. The sulfur content ranged from 0% in P13 pellets to 0.011% in P2, P5, P11 pellets.

The highest biomethane production potential during mesophilic and thermophilic fermentation was found for P7 pellets: 79.38 [Nml·g⁻¹ VS] and 139.62 [Nml·g⁻¹ VS], respectively, which may indicate their highest content of organic matter and the best quality. The lowest biomethane production potential during mesophilic and thermophilic fermentation was found for P3 pellets: 71.46 [Nml·g⁻¹ VS] and 23.35 [Nml·g⁻¹ VS], respectively, and P5 pellets: 20.74 [Nml·g⁻¹ VS] and 21.28 [Nml·g⁻¹ VS], respectively, which may indicate their content of contaminants (paints, resins, adhesives from waste wood) that could impede anaerobic decomposition, which may indicate poor quality of these pellets.

4. Main conclusions

The parameters characterizing the studied pellets in terms of energy did not differ significantly. High calorific value as well as low ash and sulfur content indicate that the initial biomass was of good quality and contained a small amount of impurities.

Differences in biomethane production potential of the studied pellets were found, but the use of this method to assess the quality of solid biofuels and their organic matter content requires further verification tests.

SOLUTION OF THE PROBLEM OF INVASIVE SPECIES IN CINCO REIS RESERVOIR

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Keywords: Asian clam, Red swamp crayfish, invasive species, Cinco Reis reservoir

The work was created for the needs of the Integrated Project International Aquatic Ecosystem Analysis (3rd edition), organized in Portugal, by Instituto Politécnico de Beja, Aeres University of Applied Sciences and EDIA (Development and Infrastructure Company of Alqueva, S.A.). The duration of the study was 5 weeks. The basic goal of the project was to fight with invasive species.

The subject of interest was the Cinco Reis reservoir, which is part of a larger system of Alqueva. It is located in the south of Portugal, in the agricultural region of Alentejo. Its primary purpose is to irrigate fields. In the future, it is also planned to create a beach, with water sports and recreation areas.

The aim of this study was to find if the invasive species are in the Cinco Reis reservoir and also to assess their impact on the environment including the infrastructure of the reservoir in order to advise same solutions to minimize their reproduction.

For this purpose, the structure of the entire system of Cinco Reis reservoir (dam and canal) was examined. The analysis of the 5 - S Model was performed, providing a thorough understanding of the connections between the elements of the environment. To understand the problem was organized a meeting with stakeholders (representatives of local authorities, EDIA organization, farmers and employees of the water supply company in Beja). For the solution the impact assessment using the Matrix method was evaluated.

During the observation of the reservoir, two invasive species were found: Asian clam (*Corbicula fluminea*) and Red swamp crayfish (*Procambarus clarkii*).

The knowledge gathered allowed to put up three questions that were to be answered: (1) what are the negative influence of invasive species?; (2) how to reduce a population of Asian clam and Red swamp crayfish?; (3) how to stop their reproduction in Cinco Reis reservoir?.

Asian clam and Red swamp crayfish pose a threat to both the environment and human activity. The main problems caused by invasive species are clogging of pipes both inside and at the inlet as well as changes in the natural environment. Both Asian clam and Red swamp crayfish cause serious problems for water reservoirs. First of all, competition should be exchanged for environmental resources with native species, by taking nutrients for their own development. At the same time, as a result of their metabolism, large amounts of inorganic nutrients are formed, in particular nitrogen, which can stimulate the growth of algae, which leads to water pollution. This study also considered the effects resulting from the construction of the beach in the eastern part of the Cinco Reis reservoir. The beach can be a big attraction for local residents, especially those from Beja. On the other hand, bringing sand can increase the number of Asian clam who likes this environment.

In order to reduce the population of invasive species and stop further reproduction, several methods, organized by 3 groups (educational, biochemical and technical) were analyzed. The solutions related to educational group, covers lessons in schools for children and adults, information boards on the reservoir, but also species monitoring. The second group, biological and chemical methods analyzed, includes the use of chemicals: potassium chloride, Zequanox (product composes of dead cells of bacteria: *Pseudomonas fluorescens*), natural biocide and predatory fish. The third group includes technical methods, such as, periodic cleaning of pipes in relation to Asian clam and the use of traps for Red swamp crayfish.

In the last part of the study, conclusions have been formulated which are advice for EDIA namely: education can be applied always, regardless of others; for biochemical solutions, it is recommended to use them in combination with technical methods, in order to get better results. Therefore, it is recommended to use the: Zequanox with cleaning the pipes at the same time for Asian clam; predatory fish with traps, in a large area, simultaneously for Red swamp crayfish.

THE ROLE OF BOTTOM SEDIMENTS ACCUMULATED IN THE DRAINAGE DITCHES IN THE PROCESS OF SELFPURIFICATION OF WATER

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Keywords: drainage ditches; bottom sediments; self-purification of water

Poland is one of the countries lying in the basin of the Baltic Sea, whose waters are currently in poor condition regarding purity. The poor quality of waters significantly limits the economic development and life quality of the local population. It is also a cause of degradation, eutrophication and accelerated disappearance of water bodies in the Masurian Lake District, starting from the smallest, most severely threatened small ponds and moving on to the largest lakes. The ongoing programmes mostly involve technical actions carried out in larger urban centres, such as construction of new or refurbishment of existing wastewater treatment plants. Obviously, this contributes to reducing the number of point sources of pollution. However, degradation processes affecting the natural environment and resources also occur over more widespread rural areas, which simultaneously serve as the sites where natural resources are being formed and renewed. Consequently, the nature conservation actions carried out in rural areas will largely influence the availability of these resources to the whole population. The purpose of this article is to assess the impact anthropopressure on the quality of waters flowing off from rural areas, including their self-purification potential and the chemical composition of bottom sediments. It is an important problem because here, as well as in other similar cases encountered across Poland and elsewhere in the world, drainage networks (ditches, canals and rivers) often receive both runoffs from farmlands and wastewater that has been treated to different degrees. The latter usually meets the standards set out in the water permits but their lasting influx, often under variable meteorological conditions, may lead to a variety of changes in the environment. Rather than being a continuous process, self-purification proceeds through many stages. In the chain of these transformations, it is necessary to distinguish physicochemical processes that occur naturally in rivers as well as in aquatic organisms, which convert complex organic compounds into simple mineral compounds through specific biochemical reactions in their bodies. Depending on the kind of pollutants which have entered or been discharged to water, the rate of reactions involved in water self-purification is varied.

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DEVELOPMENT OF INNOVATIVE MATERIALS BASED ON IRON HYDROXIDE FOR REMOVAL OF MICROPOLLUTANTS FROM PROCESS WATER AND SEWAGE WATER

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Keywords: iron hydroxide, micropollutants removal, process and sewage water treatment

Successful circular economy requires new technologies in selective product enrichment and an efficient recirculation into the material cycle.

The topic of "iron hydroxide" has a high relevance for the development of new materials and for new strategies in environmental technology.

The subject of the study is the development of an innovative process and product for the removal of pollutants and the recovery of reusable materials from process and waste water using novel adsorption materials based on iron hydroxide combined with membrane separation processes.

Research aspects:

- Availability of the residue as raw material
- Technologies transforming the properties
- Applications areas and utilisation strategies.

RESEARCH OF METHODS OF CLASSIFICATION TEXTURE FEATURES DIGITAL SEM IMAGES MICRO SURFACES OBJECTS AND THEIR SEGMENTATION

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Keywords: digital SEM image, texture features of the SEM image of the object's micro surface, classification, segmentation, equalization.

The goal of this work was to develop and study the method of texture classification of SEM images of micro surfaces of research objects based on the results of calculations of their statistical, spectral and geometric features of regions, as well as a comparative analysis segmentation methods of SEM images.

The studies were based on the processing of a series of SEM images of soils, metal surfaces and erythrocytes obtained with SEM "Hitachi S-800", SEM JCM (JEOL, Japan) and SEM "Stereoscan S4-10" in the range of magnifications from 1,000x to 3,000x; the frame sizes were 55×55 mm. The images were scanned at the resolution of 300 dpi and saved in JPEG format with image sizes on the order of 650x650 pixels. The determination of statistical texture measures of SEM images was based on the statistical moments calculated from the brightness histogram, as well as on the values of their homogeneity and entropy. The classification of soil type images was performed using histograms of distributions of texture measures of their SEM images and according to the values of their homogeneity and contrast. Spectral texture measures were based on properties of the Fourier spectrum. The parameters of the amplitude and axial functions, such as maximum value, maximum location, average value, standard deviation and the difference between maximum and average values, were chosen as the spectral texture features of the SEM images of objects. The segmentation of SEM images of objects was performed in four ways, namely: global thresholding technique (threshold selection by the Otsu method), region growing by pixel aggregation, region splitting and merging, a watershed method with a choice of markers. Determination of the geometric characteristics of the regions were performed in the following order: noise reduction by image averaging, generation a segmented binary image, use of morphological filters, regions boundary detection and calculation of their sizes and shape parameters. Statistical characteristics calculations were performed for pairs of visually similar soil images before and after histogram equalization on each of the images. Analysis

of the results showed that the values of homogeneity, and entropy is almost not changed before and after histogram equalization images. Compared to the original image, the average brightness, contrast, symmetry characteristics and homogeneity have changed significantly in the equalized image. However, after the equalization procedure, these characteristics became more similar for different SEM images of the same soil type, and the boundaries of the classes selected by their histograms of the distribution of homogeneity and contrast values practically coincide. Similar histograms were also analyzed for SEM fragments of various types of metals. To determine the spectral measures of the textures of SEM images of metals, graphs of spectral functions were constructed, which revealed their regular structure. The experiment showed that the parameters of the amplitude and axial functions differ for images of various types of metals and, thus, are applicable for their classification. The distribution of classes was carried out taking into account the location of the maximum value axial function. To compare the segmentation methods SEM image of each type were selected, namely: images of erythrocytes, soils and metal surfaces. Segmentation with automatic threshold selection is most effective in the case of a bimodal histogram (erythrocytes image). Automatic technique to determine the threshold of unimodal distributions led to the selection of an excessive amount of small fragments in the SEM images of the soil and metal surface. The result of the segmentation of region growing depended on the selection of starting point that properly represent regions of interest and the selection of the similarity criterion for including points in the various regions during the growing process. The similarity criterion was selected based on the intensity or texture of regions of a SEM-image in an interactive mode. The obtained segmentation results were similar to the previous case. The procedure split and merge the regions requires specifying the condition under which the region is subdivided into smaller quadrant regions. To define the region subdivision conditions, its statistical features of the texture were used: average brightness, average contrast, uniformity, entropy, and combinations thereof. The experiment confirmed that the split and merge procedure is suitable for the selection of regions with the specified texture characteristics in the image. The application of the watershed method with markers makes it possible to most clearly detect on SEM image the boundaries of erythrocytes and dark fragments of the metal surface. As a result of applying the above method to the SEM image of the complex structure of the soil surface, excessive segmentation has occurred. For selected objects (erythrocytes), their areas (in pixels) and the shape roundness parameters were determined. Calculation programs using the above methods were written in MatLab system.

The possibility of classifying SEM images of micro surfaces of objects by their texture features using statistical and spectral measures has been established. It was shown that SEM-image segmentation using the “split and merge” method

allows to select regions with specified texture features. A comparative analysis of the four segmentation methods showed that the best result of detecting the boundaries of objects in an SEM-image was obtained by a watershed method using markers.

FISH PASS AS A TYPIFY ECOLOGICAL HYDROTECHNICAL STUCTURES

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Keywords: Ecological continuity of river, seminatural fish passes, technical fish passes, hydraulic model, laboratory investigation

Hydraulic structures on rivers are often an obstacle that the migrating fish cannot overcome. Ecological continuity of river ecosystems is disrupted. Fish passes are of increasing importance for the restoration of free passage for fish and other aquatic species in rivers as such devices are often the only way to make it possible for aquatic fauna to pass obstacles that block their up-river journey. The fish passes thus become key elements for the ecological improvement of running waters. Their efficient functioning is a prerequisite for the restoration of free passage in rivers. Fishways can be constructed in a technically utilitarian way or in a manner meant to emulate nature. Bypass channels and fish ramps are among the more natural solutions, while the more technical solutions include conventional pool-type passes, slot passes, fish lifts, hydraulic fish locks and eel ladders (WWF-Poland, FAO&DVWK, 2016) Complex and multivariate research of various types regarding technical (also prototypical) fish passes has been carried out in the Institute of Environmental Engineering (IEE) in Wrocław for many years now. They include: 1) hydraulic laboratory test on physical models, 2) models and numerical simulations, 3) ichthyological tests (with the use of fish), 4) field research. The transport of river sediment present in the fishways is a separate problem. Sometimes it causes erosion of the river bottom or silting up the fishway. In the water laboratory of the IEE a number of model test were carried out for the following types of fishways: 1) nature mimicking fishways: a) inclined passes with increased roughness (ramps with rocks), b) bypass channels with vegetation development; 2) technical fishways a) step-pool rock ramp fishways, b) vertical slot fishways, c) meander fishways, fishways for high slopes. For established construction solutions and geometrical dimensions of the fishways the following elements, among others, were tested: hydraulic conditions (including the fish attracting water stream inside the device, distribution of velocity, turbulences and repletion, maximum differences of water levels and volume dissipation of energy (E) in fishway chambers, and also utilization problems (e.g. silting up fishways, control over the upper water level in

the fishways and more) related to the compliance with the requirements of the migrating ichthyofauna. This work presents selected examples of conducted laboratory tests.

References: WWF-Poland, FAO&DVWK, 2016, Fish Passes - Design, Dimensions and Monitoring (in Polish), Polish edition, Warsaw, 128 pp.

STUDY OF MAGNETIC WATER TREATMENT MECHANISM

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Keywords: wastewater, magnetic treatment, aqueous solutions, magnetic induction

The main problem of widespread introduction of magnetic water treatment (MWT) in the processes of water and wastewater treatment is the lack of modern research aimed at studying the mechanisms of MWT effects, in particular the influence on the physicochemical properties of aqueous solutions. A comprehensive analysis of the existing hypotheses of the MWT mechanism suggests that different interpretations of the MWT effects do not determine the general principles of the process. Known hypotheses consider MWT effects independently of each other and remain ineffective when attempting to explain all the known MWT effects. The aqueous solution remains the only treatment object in practice. This study was made the first attempt to explain the effect of MWT taking into account the physical and chemical properties of aqueous solutions due to the presence of quantum differences in water molecules.

Goal of the research is the study of determinant MWT parameters, taking into account the quantum differences of water molecules and the nature of the distribution of hydrogen bonds in supramolecular formations due to the presence of librational oscillations of water molecules. It allows the development of general requirements for MWT equipment.

Methodology and scope of a research. Since all of the MWT effects are related to the change in the physicochemical properties of aqueous solutions, in research was used a comprehensive analysis of the current data on the physicochemical processes in aqueous solutions due to the presence of two types of water molecule isomers and their librational oscillations, while taking into account constructive and mode parameters of MWT devices.

Highlight of results. The MWT mechanism is based on the effect of a non-uniform magnetic field on synchronous librational vibrations of water molecules (para-isomers) in ice-like supramolecular formations. The synchronism of the librational vibrations of the para-isomers under normal conditions leads to a shift in the equilibrium ratio of the ortho-para-isomers to the para-isomers, and the aqueous solution is a nonequilibrium system. MWT is a "catalyst" of sequential processes, where the only result of MWT is a violation of the synchronism of para-isomers vibrations, with the subsequent destruction of ice-like structures due to the receiving

of energy from collisions with other water molecules (ortho-isomers). The establishment of an equilibrium ortho/para ratio is due to the conversion of the para-isomers into the ortho-isomers caused by the collisions of water molecules. So the number of ortho-isomers increase, which explains changes in density, viscosity, in the infrared spectrum of water, hydration of dissolved substances that are registered after MWT. One of the most important MWT effects are the change in the nature and speed of the physicochemical processes in aqueous solutions by increasing the number of more physically and chemically active ortho-isomers. It can explain most of the MWT effects and may use in different areas of water and wastewater treatment.

It is proved that the motion of an aqueous solution in a non-uniform magnetic field is a prerequisite of MWT. The velocity of aqueous solution in a non-uniform magnetic field and the duration of the MWT are one of the main MWT parameters. The rate of change in magnetic induction plays a decisive role and is more important than the magnitude of the magnetic induction. In addition to these parameters, the intensity of the manifestation of the MWT effects is influenced by the output physicochemical properties of the aqueous solution.

Main conclusions. The MWT parameters specified in the work allow to explain the nature of most MWT effects and require to develop scientific and methodological principles for the implementation of the MWT process and mathematical modeling of the MWT process in water and wastewater treatment.

HYDROLOGIC AND HYDRAULIC GUIDELINES FOR PRE-DAMS IN POLAND

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Dammed storage reservoirs – due to their location in the lowest parts of the catchment and river valleys – are the areas of accumulation of organic and mineral matter carried out by the supplying watercourses. This results in silting and water quality deterioration. In many cases, water stored in the reservoirs undergoes degradation processes and loses its usable values. Increased eutrophication of water environments causes many changes in ecosystems, which are unfavourable from the point of view of an economic operation. Nutrient enrichment of surface waters results in abundant development of plant communities, mainly plankton, with all side effects diminishing the usable value of water and aesthetic values of the reservoirs. Under favourable meteorological conditions – usually in late summer – on the surface of the fertile reservoir waters, Cyanobacteria Blooms, in the form of a blue-green scum, can be observed. This is not only an aesthetic problem but also – and first and foremost – a health problem due to the production of acute toxins.

The eutrophication process is a serious obstruction in the efficient water management, particularly in the case of impounded water. Therefore, the aim should be to improve the water quality and remove nutrients from the water system with a simultaneous reduction in their inflow from the outside.

Methods aimed at water eutrophication prevention have been worked out for many years. One of them is based on the use of what is known as pre-dams.

The studies carried out on the purity of the waters of both the rivers feeding the reservoirs and the reservoirs located in the Upper and Central Odra basins showed that these waters are characterised by significant content of pollutants, especially nutrients. The biggest threat to dam reservoirs is the eutrophication process. Increased eutrophication of water environments causes many changes in ecosystems, which are unfavourable from the point of view of an economic operation. Throughout the country, there are many examples of places with significant eutrophication of impounded water. As an example of reservoirs where eutrophication of the retention water took place, the following reservoirs in the Odra river basin, among others, can be enumerated: Turawa on Mała Panew, Słup on Nysa Szalona, Nysa and Otmuchów on Nysa Kłodzka.

These facilitate:

- Stopping suspended loads, bed loads and fertilising substances;
- Biodegradation of organic pollutants supplied from the catchment;
- Protection of the main reservoir from emergency discharge of pollutants, which is particularly important in the case of water supply reservoirs;
- Protection from uncovering a part of the reservoir in backwater zones;
- Creation of water reserves.

The main goal of the pre-dams with plant filters is to stop pollutants transported in the river and take over most of biochemical processes responsible for eutrophication. As a result, water flowing to the main reservoir contains smaller loads of fertilising substances as well as smaller suspended sediment loads and bed loads.

In Poland, only a few retention reservoirs located in the Odra river catchment have a pre-dam and those include the following: Turawa reservoir on Mała Panew, Mściwojów reservoir on Wierzbiak, Brzózki on Pratwa and Włodzienin reservoir on Troja. Moreover, on the left-hand tributary to the Michalinka reservoir on Widawa River, there is a small reservoir acting as a pre-dam reservoir.

The paper presents hydrological and hydraulic criteria for the dimensioning of pre-dams. The design stages of the pre-dam will be discussed in detail, taking into account its capacity, flood area, depth, flow rate and retention time. The matter of great importance is the gradual clogging of the pre-dams with sediment, which should be periodically removed and, consequently, the frequency of the sediment removal should be determined.

The paper concludes that one of the ways to counteract poor quality of water impounded in retention reservoirs may be the use and utilisation of pre-dams. Research carried out in the area of pre-dams indicates their positive role in improving and protecting the quality of impounded water in dam reservoirs.

The use of pre-dams, which main advantage is the transfer of a significant part of biochemical processes causing eutrophication from the main reservoir to a separate initial reservoir is justified by the relatively low cost and short period of construction of such reservoirs.

The studies carried out on the purity of the waters of the rivers feeding the reservoirs and water impounded in the reservoirs showed that these waters are characterised by significant content of pollutants, especially nutrients. Therefore, hydrological and water quality studies should be carried out on both existing and new water reservoirs, and the advisability of building pre-dams should be considered in each case.

ANALYSIS OF A WATER MANAGEMENT OF A TURAWA WATER RESERVOIR IN THE ASPECT OF FUNCTIONAL ASSOCIATIONS

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Turawa water reservoir located on the Mała Panew river at km 18.900 in the Opolskie Voivodeship. The main function of the reservoir is the flood protection of the Mała Panew river valley below the reservoir, water retention, supply of the hydroelectric power plant and maintenance of the Odra River for the needs of navigation.

The paper involved analysis of water inflows and outflows from the Turawa reservoir, water levels in the reservoir and the quality of water retained in the reservoir. Particular attention was paid to the important, from the point of view of the proper use of the tank, usable water qualities: assessment of eutrophication of the water of the reservoir, classification of waters for living fish and for bathing.

The analysis of flows was carried out on the basis of data received from the The State Water Farm Polish Waters Regional Water Management Board in Wrocław. The analysis of water quality was made on the basis of data obtained from the Voivodeship Inspectorate of Environmental Protection in Opole. For the analysis of flows, the period from 2010 to 2017 was adopted, while the year 2011 was taken into account for the assessment of water quality.

Based on the obtained results, the water management for the reservoir was presented in 2010-2017. The retention time and the average water retention time were determined and the water level in the reservoir for individual years was described. The characteristic flows from the years 2008-2016 were compared to long-term flows. The Turawa reservoir is covered by the Natura 2000 program, which affects the water management of the reservoir, which depends on protected species of birds and the existence of fish. The following water quality indicators were analyzed: water temperature, total suspended solids, dissolved oxygen, BOD₅, reaction, ammonium nitrogen, total nitrogen, phosphates and total phosphorus. The assessment of water quality in accordance with the Regulation of the Minister of the Environment on the classification of the surface water bodies is presented.

It was found that the Turawa reservoir reduces the risk of flooding below the reservoir and creates limited possibilities for fish recreation and breeding. The article provides suggestions for the correct principles of water management on the tank.

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FACTORS AFFECTING CHANGES IN WATER LEVEL AND QUALITY IN A RURAL FARMSTEAD WELL

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Keywords: well, weather conditions, water table level, water contaminants, rural areas

The aim of this study was to analyse the factors that affect changes in the water level and quality in a dug well at a farmstead situated in the catchment area of Lake Wydmińskie. The experiment was conducted between June 2016 and May 2018 at a farmstead in the village of Sucholaski (Warmińsko-Mazurskie Voivodship). Changes in the water level and quality were examined in a 3.75 m deep dug wall. In the past, it was used as a drinking water intake; now it is only an extra water source, used for the farm's needs (watering plants and cattle). The study showed that changes in the well water level and physicochemical properties were affected to the greatest extent by the weather conditions at the moment (precipitation and air temperature). The quality of water in the well was affected by the amount and distribution of rainfall as well as by the farm buildings, especially by the cow shed and its surroundings. The amount and distribution of rainfall did not always have a direct impact on the water level in the well and the intensity of impurity migration within the soil profile, which was associated with a temporal shifting of groundwater resource replenishment relative to the time of rainfall. High concentrations, mainly of nitrates (V) and potassium ions in the well water, indicate that it is poorly protected against impurity influx from the immediate surroundings, with the cow shed being their main source.

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REMOVAL OF NITRATES AND ORGANIC COMPOUNDS FROM SURFACE WATER BY ZERO VALENT IRON REDUCTION COUPLED WITH COAGULATION AND AOPs

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Keywords: nitrates, zero valent iron, coagulation, advanced oxidation processes, reduction processes

Nitrates are an increasingly common pollutants of both underground and surface waters treated for drinking purposes. Because presence of nitrates in drinking water can pose harmful health effects, WHO and US EPA set a nitrate standard of 50 mgNO₃⁻/L. Removal of nitrates in water treatment plants is cumbersome because of their high solubility in water. Under technical scale the most frequently used methods are the biological ones (heterotrophic or autotrophic denitrification). Also some chemical and physicochemical processes such as ion exchange, reverse osmosis, electrodialysis and adsorption can be used. Costs constitute a barrier that makes chemical methods less often used in water technology.

Use of zero-valent iron (ZVI) for reduction of nitrates as an alternative method to the ones mentioned previously, is tested in recent years. However most studies are limited to the laboratory scale. Zero-valent iron is cheap, easy to produce and easy to use, because technology of nitrates reduction by its requires little maintenance. Moreover ZVI is non-toxic. The previous studies were mainly focused on nitrates removal efficiency, nitrates reduction products and factors affecting the process. It is well known that the process is pH depended. Part of nitrates is reduced to NH₄⁺ or NO₂⁻, not to N₂. It means that process for individual waters may need second stage including e.g. use of amides.

Less attention has been paid to the final by-products of iron oxidation, which can be both Fe²⁺ or Fe³⁺ depending on the reaction balance and environmental conditions. Meanwhile both Fe²⁺ and Fe³⁺ can be used as a substrate in coagulation of organic compounds. It can be a possible way of final products of nitrates reduction.

The aim of the study was to evaluate the effectiveness of nitrates removal from surface water by using one and two stage process – ZVI and ZVI coupled with amides. The process was coupled with coagulation by using by-products of nitrates reduction as a coagulation agent.

The doses of ZVI used in the study were lower than 400 mg/L. The first part of the experiment was focused on the effectiveness of nitrates removal and was conducted in 500 mL conical flasks. Initial concentration of nitrates was equal to 75 mgNO₃⁻/L. ZVI was added in powdered form. The flasks were mechanically agitated on a shaker with horizontal motion. All experiments were conducted under room temperature (20±1°C). Effect of pH and kinetics of nitrates removal (for 0 to 24 hours), as well as nitrogenous by-products were investigated. The results indicated that nitrates reduction by ZVI was the most effective under acidic conditions (pH < 4.0) and was relatively quick (less than 3 hours). Depending on the process conditions various quantities of nitrites and ammonium nitrogen were generated. Concentration of Fe in water was also monitored.

Even using one-stage ZVI process nitrates were completely reduced (and as a result removed from water). One-stage process however resulted in formation of nitrates(III) and ammonium nitrogen ions. They were effectively reduced by using CO(NH₂)₂ (urea) in the two stage ZVI plus amides process. Two stage (ZVI plus urea) allowed to improve the effectiveness of N₂ formation during the process.

The by-product of nitrates reduction have been successfully used in coagulation. The experiments were conducted under laboratory conditions by using natural surface water. The coagulation was performed in 1 L beakers as a classical process. The doses of by-products were chosen experimentally and the effectiveness of the process was compared to the ones conducted by using FeSO₄ and FeCl₃. The effectiveness of organic compounds removal as well as turbidity removal was comparable to the one obtained by using classical Fenton's process and coagulation under optimal conditions.

The results obtained in the study indicate that ZVI can be effectively used in surface water treatment and the by-products of the process could be further applied in coagulation. The use of by-products is especially important in water technology and gives an advantages over others methods of nitrates removal. This is e.g. because during biological denitrification biomass of bacteria occurs which should be further processed off-site.

Based on the results nitrates reduction by the processes described above should be advisable as a promising alternative to the technologies used nowadays under technical scale.

EFFECT OF THE SPECIFIC ENERGY OF ROLLING ON THE AGGREGATE STRUCTURE AND SOIL SUSCEPTIBILITY TO EROSION

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Keyword: integrated soil tillage, tillage energy, soil erosion, soil conservation

The integrated soil tillage developed in the Institute of Biosystem Engineering is based on a single pass of basic tillage, secondary tillage and sowing or planting. The integrated soil tillage allows a relatively high mechanical strength of the soil. An important element of the technology is the use of tillage roller sets which significantly influence the obtained aggregate structure and its eolic resistance. The aim of the study was to determine the influence of roller speed in various soil moisture conditions on the aggregate structure of the soil arable layer.

The research was carried out on the production field in Dziećmierowo, Wielkopolskie Voivodeship, on medium soil with mechanical composition of light clay. During the research, cultivation sets with two units of Campell + Crosskil and Campbell + studded roller were used. For two actual soil moisture levels and five speeds within the range of 3-7 km/h, the influence of unit tillage energy at three levels of the cultivating layer (0-5 cm, 5-10 cm and 10-15 cm) was analyzed on the aggregate structure of soil and the content of aggregates with the highest resistance to wind erosion.

The studies showed a differentiated influence of the speed and type of rollers on the aggregate structure of soil in all the studied depths. The results of the work lead to conclusions on the possibility of controlling the unit energy of cultivation through the selection of the type of rollers to the current soil conditions in order to obtain an optimal aggregate structure with the participation of aggregates with the highest eolic resistance.

THE USEFULNESS OF THE PROXIMAL VIS-NIR SPECTROMETRIC FIELD PROBE FOR THE DETERMINATION OF THE TEXTURE OF AGRICULTURAL SOILS

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Keyword: proximal soil sensor, soil spectroscopy, soil management

Remote and proximal soil sensing have recently become the basic methods to assess the spatial variability of agricultural production area. More and more often the processing and analysis of data obtained by remote and proximal methods become complementary methods for each other. The development of these technologies is however determined by the development of sensors and measurement platforms, among which the greatest shortage concerns ground-level platforms for proximal sensing. In order to meet this need, the Institute of Biosystem Engineering has developed a field measurement platform for dynamic measurement of the topsoil layer properties.

The aim of the study was to evaluate the usefulness of VIS-NIR spectrometric probe to assess the texture (sand, silt and clay fractions content) of agricultural soils and to develop calibration models using small set (below 50) samples with different moisture content (natural and air-dry moisture). The second objective was to validate soil measurement platform in field conditions and to assess its interoperability. The proximal soil measurement system included VIS-NIR spectrometer (AgroSpec, Tec5, Germany) mounted in the tractor cab with optical soil probe mounted through four-bar linkage on the frame of the platform. The material for the laboratory study and for calibration models development was intact soil samples collected on the stubble after maize production, taken from the bottom of the soil probe track. Using the Unscrambler X version 10.1 software the obtained data was processed and then several PLS models were developed and tested.

As a result of the research, it was found the calibration that has been carried out and the method used to create the calibration models enables the determination of the main granulometric fractions content of sand and clay (best validation models $R^2=0,77$, RMSEV=2,03) and with accuracy sufficient for the determination of uniform production zones of arable fields. The models developed

for the assessment of the silt fraction content were characterized by low accuracy ($R^2 < 0,5$, $RMSEV > 4,27$). It was found that by creating models based on dry air samples, calibration models with better prediction than those based on natural moisture were obtained. The operation of the measuring platform in the field was assessed as satisfactory, but the need to improve the quality of the obtained spectra in the field conditions has been observed.

HYDRAULIC EFFECT OF VEGETATION ZONES IN INTER-EMBANKMENT OF RIVERS

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Keywords: hydrodynamics, vegetation, LIDAR, flood hazard, modelling

The goal of the research is to build a hydrodynamic model and to compare the methods of roughness determination in the inter-embankment zone. The research area was the section of the Ślęza River in Wrocław, about 2 km long. The river has a relatively simple geometry, has a regulated riverbed and embankments, which allows for an accurate interpretation of the results. The research material was LIDAR data with a resolution of 12 pts/m². Different configurations of the use of LIDAR data for the reclassification and obtaining spatial roughness distribution of Manning n parameter were investigated. The methodology included preliminary determination of Manning's roughness n parameter and simulation of flows at this roughness. For specific water depths in the spatial distribution, the density and height of plants were determined from the LIDAR point cloud. The R packet tool was used for this, where roughness was reconfigured for the appropriate depths spatially. The vegetation coverage property was defined as the density of point clouds below the previously defined altitude (where the depth on the HD model is the height in the LIDAR data). The obtained values of Manning's roughness n parameter were simulated in subsequent steps until the optimum roughness distribution in the analyzed area was obtained. The hydrodynamic model was built in the Nays2DH software in the IRIC environment. Hydrological data were characteristic flows and flows with a given probability of occurrence determined on the basis of data on daily flows from the Ślęza station from the IMWM-NIR resources. The obtained results indicate the necessity of using the Manning roughness n parameter not only in the horizontal spatial distribution, but also the definition of roughness at height, which is allowed by LIDAR data. The feedback of the model allows definition of the Manning roughness n parameter after the water depth and thus accepts roughness values for different flows.

THE INFLUENCE OF ANTHROPOGENIC POLLUTION ON WATER QUALITY OF THE CIEMIĘGA RIVER

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Keywords: anthropogenic pollution, river, water quality, eutrophication

The purity of water in rivers depends on many factors. However, the amount of pollutants is associated with the type of catchment. Pressure caused by human activity (anthropopressure) is the biggest hazard to the quality of surface waters. Agricultural catchments and rural areas are believed to be among the main sources of pollution and eutrophication of surface waters. The largest share in deteriorating the quality of water in rural areas are the substances penetrating from the surface of the ground, so-called diffuse pollutants and household sewage. By penetrating into surface waters they cause adverse changes leading to a decrease in natural values, and sometimes even to the destruction of water ecosystems.

The purpose of this work is to assess the impact of anthropogenic pollution on the quality of water of the Ciemięga River flowing through the Jastków Commune (Lublin Voivodeship, south-eastern Poland). Water samples used during the research were collected 4 times in 2019 from 6 characteristic points of the Ciemięga, located in the Commune in the following towns: Ożarów, Moszenki, Sieprawice, Jastków, Snopków, Jakubowice. The following parameters were analyzed in the water: pH, electrolytic conductivity, BOD₅, COD, total nitrogen, ammonium, nitrate, nitrite, general phosphorus and phosphate, dissolved oxygen, total suspended solids, chloride, sulphates, iron and potassium. Physical and chemical analyzes of water were made according to commonly used methods. On the basis of the conducted research there was found an increase in the content of total suspended solids and biogenic compounds in the analyzed water along with a course of the river. The concentrations of the other analyzed indicators were at a similar level. Probably surface runoff from eroded fields and sewage from leaky cesspools has a direct impact on the increased content of general slurries and biogenic compounds in the river. In order to improve the quality of water in the river, it is necessary to take appropriate measures that will limit or eliminate the inflow of anthropogenic pollution.

VISUAL IMPACT ASSESSMENT OF RIVER REGULATION STRUCTURES

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Keywords: LIDAR data, GIS, 3D graphic software, Blender, river regulation structures, visual impact

The paper presents the quantitative methodology for visual impact assessment of river regulation structures such as non-submerged groins and longitudinal dams. The method integrates LIDAR data, GIS tools, 3D graphic software and 360° panoramic images. Digital Surface Model (DSM) developed on the basis of LIDAR data and imported to 3D graphic software allows one to render images from any location of 3D scene. This feature was used for rendering 360° panoramic images from the perspective of the observers located on the study site in designated with the viewshed analysis area. Renders were verified against panoramic photographs taken during the field inspection. The proposed methodology was tested on two locations of Kostrzyn nad Odrą and Ślubice cities where modernization of regulation structures on Oder River is planned. Calculated percentage values of river regulation structures occupying the full field of view of the observer for 25 locations in Kostrzyn nad Odrą and 19 locations in Ślubice shows insignificant visual impact. The maximum values of 0.94% and 0.26% for Kostrzyn nad Odrą and Ślubice respectively, were obtained. Additionally the visualization method in the form of “Little Planet” projections was presented, which allows for full documentation of the visual impact of the structures on the landscape.