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Socio-ecological resilience across Eurasia
innovation for sustainability transition

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Abstract Book

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The abstract book is compiled and edited by Anton Shkaruba (Estonian University of Life Sciences) and Kateryna Husieva (Odessa State Environmental University)

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SHORT-TERM DYNAMICS OF DISSOLVED MAJOR AND TRACE ELEMENTS IN SEMI-CLOSED SHALLOW LAKE

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Key words: lake Kiba-gata, trace elements, distribution of Fe II and Fe III

This study addresses the changes in dissolved major and trace element concentrations of the anthropogenic lake Kiba-gata. Surface water samples were taken between April 2015 and March 2021 in monthly intervals. Parameters (pH, dissolved oxygen, conductivity, and temperature), total suspended sediments, dissolved organic carbon (DOC), and major (ICP-OES) and trace element (Fe, Al, Mn) (ICP-OES) concentrations were measured from 6 points: 5 of them evenly scattered across the lake territory KB1, KB2, KB3, KBG3, KB4, 1 on the flowing river (Hiyou river) for spatio-temporal distribution and change of the main and trace ions in the water of this lake. Also, samples were taken at two points from the bottom of lake KB3, KBG3 to identify the distribution of elements in the cross section of water.

Lake Kiba-gata is normal alkaline with a dominance of Na>Ca>Si>Mg>K in cations. The maximum alkalinity is measured in June and July and the minimum is in December and January. Seasonal variation of trace elements is significantly, While the changes in the concentration of the main ions is not significant. A result of the study, the spatial and temporal distribution, and changes of the major and trace ions in the water of this lake were determined.

Impacts of Climate Change on Baltic Wetland Plant Communities

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Coastal wetlands are considered valuable ecosystems for their biodiversity and the wide range of ecosystem services they supply (Engle 2011, Villoslada et al. 2019, Lima et al. 2020, Ward 2020a). However, coastal wetlands worldwide are also subject to various impacts resulting from natural and anthropogenic drivers, such as urbanization and residential developments, conversion to

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agricultural land and climate change related impacts such as sea level rise, changes in precipitation, inundation, changes in salinity and erosion (Ward 2020b).

The consequences of climate change over recent decades are evident in the Baltic Sea region, with modifications in seawater circulation, temperature and salinity (Omstedt et al., 2004; Räisänen, 2017). In the Baltic Sea, both salinity and water levels have been shown to have a strong influence on coastal plant community composition (Berg et al., 2011; Ward et al., 2016a). In this regard, the Baltic coastal wetlands are expected to be altered due to climate change (Ward et al., 2016b). Regarding the importance of coastal wetlands, it is essential to determine how future conditions will influence coastal plant community functioning. The aim of this study is to evaluate the effects of altered water level and salinity conditions on three different wetland communities (Open pioneer, Lower shore and Upper shore**)** in Estonia using 3 yr. mesocosm experiments. To analyse the differences among treatments in plant communities through time, Permutational Multivariate analysis of variance (PERMANOVA) and species contribution were performed using R software (R version 4.0.3). Bray-Curtis dissimilarity was calculated from species importance values. When a significant ($p < 0.05$) difference between the treatments was detected, a dissimilarity percentage analysis (SIMPER) was used to reveal the contribution of species for the differences between treatments. All factors, year and treatment, influenced plant communities composition and the results showed changes in plant species contribution. For instance, in US, *Poa angustifolia* responded positively to increased water level and salinity compared to control, while *Carex nigra* (*C. nigra*) showed an increase of importance in decreased water conditions. *Festuca rubra* responded with higher importance contribution on decreased salinity conditions. These results demonstrate that, even in a relatively short period, the communities had significant changes under different drives. The results provide an indication of Baltic coastal wetland species composition under an altered climate regime, highlighting the importance of conservation for these areas due to their important ecosystem services and value for biodiversity support.

Valmiera's experience in renovating buildings and using renewable energy resources in multi-apartment buildings

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In Valmiera, 56% (94 out of 167) (01.01.2021.) of multi-apartment residential houses connected to the district heating system have been rebuilt, nominating Valmiera among leaders in Latvia.

There are a number of reasons that have contributed to achieving a good result:

- Energy efficiency as a priority for the environmental sector - since 2004 there were 10 houses renovated before the availability of the EU support programme;
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- an example of the municipality in the implementation of energy efficiency measures (e.g. rebuilding schools);
- local government support programmes for housekeepers;
- active and project management powerful management company;
- Smart, motivated, active, collaborative population community;
- various fundraising programmes.

Challenges preventing energy efficiency measures for multi-apartment dwellings, even if residents have voted "in favour": Increase of costs in the construction sector.

Precautionary of land degradation and Optimum pasture management in the forest-steppe ecological zones in Mongolia

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Land utilization serves human various needs such as increases economic development, provide shelter and foods, ensuring the rights, provide ecosystem services, etc. Mongolian lands are traditionally used for pasture and animal husbandry, but in recent decades, multiple land uses have increased rapidly. However, development of agriculture and mining industries, which supports economic development and product demands, issues of ecological degradation have been increasing. To sustain pasture ecology, we have to use proper way and management for the animal husbandry. The forest-steppe zone of Mongolia is located in northern part; both agriculture and traditional animal husbandry are developed well. The category of agricultural land use occupies 73.76 percent of Mongolian territory and it is over 16 percent of Mongolian gross domestic products, of which livestock sector contributes to almost 90 percent in the agriculture GDP.

I expect that my research could answer does the carrying capacity meet this area and if the carrying capacity is unbalanced what kind of management for it. The paper will attempt to discuss sustainable land uses and optimum pasture management in this area.
From the results, the carrying capacity was overgrazed 2.1 times; herder and farmer have disputes from land use. The main reason of pasture degradation is that lost the traditional pasture rotation; mismatch the livestock number and the carrying capacity.

Key words: Carrying capacity, biomass, livestock, herder, ecology, precautionary

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Research of the green-blue infrastructure of Kharkiv

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The study of green-blue infrastructure reveals broad perspectives for greening urban space and solving a number of environmental problems of cities. The green infrastructure of Kharkiv consists of green areas of the city:

- parks, squares, regional landscape park;
- greenery of house zones;
- linear plantings along highways;
- greenery of private estates within the city;
- landscaping of enterprises, institutions and organizations of various forms of ownership;
- sanitary protection zones of industrial enterprises;
- green roofs (extensive and intensive types);
- green walls.

Maintenance of greenery in the city is carried out by the specialized communal enterprise "Kharkivzelenbud" of the Kharkiv City Council. The landscaping standard for the city of Kharkiv is 11 km^2 of public green spaces within the city. At the same time, this standard increases depending on the presence of industrial enterprises by 15-20% and in the presence of railway junctions by 5-10%. That is, for Kharkiv the standard area of landscaping per capita will be 14,3 km^2.

The blue infrastructure consists of the main rivers of Kharkiv – Lopan, Kharkiv and Udy which are water bodies of national importance. All of them belong to the Siverskiy Donets' river basin. And also their tributaries Lozovenka and Sarzhynka (Lopan), Nemyshlya (Kharkiv), Zhykhorets (Udy), Studyonok waterstream. Within the city there are Zhuravlivsky hydropark, Osnovyanskoe lake, Oleksiyivsky meadow park, Petrenkivske reservoir.

Artificial water bodies created on the territory of the city parks should be singled out – the artificial lake of the Gorkiy Central Park and the system of artificial lakes of the Shevchenko Garden.

The problems of green-blue infrastructure management are low level of a mechanism for community influence on decision-making, the use of old management practices. For example, it is accepted to cover with a rolled lawn within the park. It requires expensive supervision and mowing, which weakens the root system and consequently reduces of it ecosystem services. While lawn areas are not available for recreation. Other problems are the felling of plantations along highways, because of their expansion; closed data on the inventory of green areas; diseases of tree species,

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namely *Viscum*; pollution of small rivers and absence of programs for their restoration, low level of environmental education and active citizenship.

To improve the situation it is necessary to adopt local policies, cooperation of local authorities with scientists, actively involve citizens.

Plant fund of Khovd inuversity

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For the first university that established in Mongolian western region, many dore of plants which have science and practical importance in respect Mongolian flora collected and saved also plants number in plant fund is changing year after year. In this plant fund involved except territory areas of Khovd, Uvs, Gobi-Altai, Zavkhan, Bayan-Ulgii, Arkhangai province and will involve dried plants that collected from the territory of brieswalld city of republic Germany.

The material of research, methodology. To implement this work used steppe research material more than 11500 pages of dried plants which scientist and researchers collected about 30 years, also used dried plants of our students collected by their steppe practice, and used connected books.

Research work: From this research, we revealed that in total concern 76 family tribes, 363 kinds, 1089 species (more than) 11500 dried plants are saving. In this flora un, double seeds side plants concern 64 tribes, 302 kinds 915 species are collected and saved. We have made a list of double

Result, conclusion

- In Khovd university flora fund, there are concern 76 family 363 genus's 1089 species more than 11500 dried plants are saving.
- In flora fund such as Boraginaceae, Scrophulariaceae, Campanulaceae, Plantaginaceae, Rubiaceae, Caprifoliaceae, Valerianaceae, Oxalidaceae, Polygaiaceae, Malvaceae, Elaeaginaceae, Onagraceae, Hippuridaceae, Cynomoriaceae, Pyrolaceae, Ericaceae concern 16 family 41 genus's 103 species 96 pages dried plants are saving.
- For living condition, multi-aged gassy plants are mos numerous species that are occupying 72 (69.90%), the least one was bush that is occupying 4 (3.89%).
- For the importance, pasture plant gowin 363% mean that it is proving steppe, mountain range, western Mongolian surface, many kind of form and climate.

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COMBINATION IMPACT OF pH AND TEMPERATURE ON THE TOXICITY OF LEAD ON ZOOPLANKTON IN THE CONTEXT OF GLOBAL WARMING

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Heavy metal pollution in Hanoi's urban lakes has become one of the significant environmental issues in the last decades. Research on the toxicity of Pb is necessary due to the extent of its harm to aquatic ecosystems. The toxicity of Pb to aquatic organisms (EC50 values) depends on different environmental conditions. The study was conducted to evaluate the effect of temperature on Pb's toxicity on the test organism *Moina Dubia. Moina Dubia* belonging to the Cladocera group (Cladocera), an indigenous creature collected at Lake Hanoi. Our study conducted zooplankton sampling and analysis in the two urban lakes, Truc Bach lake and Bay Mau lake, which has a function to maintain biodiversity in the freshwater body also drainage water, preventing the flooding for the urban area but suffered the untreated wastewater influence. *Moina Dubia* was cultured under laboratory conditions and has been used to conduct EC50 determination for Pb. *Moina Dubia* grew and developed well in the laboratory and was suitable as a test organism in toxicological studies. A survey from 24 to 28 °C water temperature conditions showed that the EC50 value decreases from 1402 to 775 ug/l. The combination of temperature and pH strongly affects the toxicity of Pb on *Moina Dubia.* In the whole country Viet Nam, according to the Ministry of Natural Resource and Environment scenarios, the average temperature during the period of 1958 - 2014 increased by about 0.6 °C; in the period (1985 - 2014), the temperature increased by 0.42 °C. The rising in temperature and metal pollutants in the water body may cause biodiversity reduction, especially zooplankton, a critical species in the food chain of lakes and rivers in Viet Nam. One urgent question is how temperature and pH can affect the metal toxicology on zooplankton, which is the leading cause of biodiversity reduction. The apparent impact of water temperature and on the toxicity of Pb showed that global warming might gradually lead to potential biodegradation in freshwater ecology.

Keywords: Lead toxicity, metal pollutants, temperature increase

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Green Infrastructure Development to Ensure Sustainability Transition in Odessa

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An unfavourable environmental situation has been formed in Odessa owing to the peculiarities of socio-economic development. The major challenges comprise: increasing air pollution; incompleteness of coastal protection structures; intensification of dangerous exogenous geological processes; sharpening of the issue of waste management; unsatisfactory condition of the historic city centre, etc. In recent years, Odessa, as well as many cities in Ukraine, has been characterized by a decrease in population, and a high sickness rate and mortality. This necessitates the development of green infrastructure to ensure sustainability transition in this urban environment.

The study is aimed at identification of the possibilities to improve green infrastructure in the studied area that eventually will contribute to the sustainable development of the area.

Green areas are a buffer between urban complexes and natural ecosystems. They are effective filters for air purification, reduce wind force, regulate thermal regime, humidify the air, that is of great importance to health. In addition, they refine urban ecotopes and create aesthetic comfort for humans. At the same time, the provision of green spaces for public use in Odessa is only 7.4 m^2 per inhabitant, while the standard is 13.8.

Species composition of the urban flora is determined by both the geographical location (at the south of the Steppe zone of Ukraine) and the planting approaches having been applied. So, while there are less than 10 species of native trees and shrubs among the remnants of ravine forests, about 800 species and forms are used in the city's green open space. The latter originate from other countries and continents. As an example, *Ginkgo bilŏba* is native to China, other representatives of the gymnosperms come from East Asia (juniper, spruce, pine), and the symbol of Odessa - *Robinia pseudoacacia* and other flowering plants (honey locust, Kentucky coffeetree, ashleaf maple, eastern cottonwood, etc.) are natives of America. The latter tolerate the air pollution and paving streets well, capture dust and harmful gases, and are ornamental enough. Among about 900 species of herbaceous urban flora, weeds comprise more than a third. Part of them during flowering is allergenic, although these ruderal species, which are best adapted to the extreme living conditions, are a powerful source of photosynthesis in the city.

In order to neutralize a number of harmful substances in the urban air, according to the research of A.S. Bonetskyi et al., it is recommended to plant such trees and shrubs as horse chestnut, Nanking cherry, American sycamore, Chinese thuja, Atlas cedar, as well as essential oil plants.

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The most effective way of expanding green areas is to form a green belt of Odessa, i.e., a system of ecological corridors around the city centre that would connect green space at the coastal slopes with all existing parks, gardens and squares by green links, stripes of boulevards and streets, and through establishment of new recreation zones instead of abandoned industrial areas.

Municipal waste governance in Latvia: overall assessment

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The waste sector has been assessed through the role of municipalities, as the author has concluded that municipalities in Latvia are responsible for the full cycle of municipal waste management, including “liquidation”. This, in turn, is a traditional environmental as well as health task. It follows that municipalities in Latvia are responsible for the governance of the most complex waste streams, moreover, the efficiency of systems developed by municipalities will affect the national economy. The topicality of the topic is confirmed by the fact that the waste governance system is one of the most important directions in the EU and Latvian legislation in the field of environmental protection, as well as in the context of the circular economy. On 11 December 2019, the EC issued a new Communication on a European Green Course, which also aims to protect, preserve and strengthen the EU's natural capital and protect the health and well-being of its citizens from environmental threats and impacts. Since regaining independence, Latvia's waste governance system has been gradually designed to adapt to the requirements of the European Union and to achieve its defined objectives, although developed in accordance with the European Union waste management guidelines and based on its priority objectives set out in Council Directive 2008/98. / EC on waste is rather complex, fragmented, with some shortcomings in its operation.

Municipalities have a central role to play in waste governance, given that it is an autonomous function and have an important role in organizing the management and governance process at the lowest level, as they are closest to waste generators . In addition, it is the municipality that selects and concludes contracts for the collection of municipal waste with waste managers. So far studies has focused on waste management. As management is part of the governance, it has been taken into account and in the research the waste sector is seen more broadly in the context of governance. The study describes main challenges and opportunities in waste governance sector in the context of the “Waste management national plan 2021.-2028”. Challenges has been determinate trough governance instrument assessment.

Challenges has been determinate trough governance instrument assessment The study also reviews assessment of the EU requirements for waste management in the context of the

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institutional model and in the context of all groups of waste governance instruments such as – communication, planning, economical and financial, political and legislative, administrative and institutional and infrastructure. In order to assess topicalities in the context of the waste governance sector and promote understanding of the requirements and goals, several sociological research methods were used to obtain qualitative and quantitative data on the research area, information on the current situation, identified problems and possible solutions.

Identification of affecting factors of urban heat islands by means of UAV data

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In the presentation I will give an overview of our work to assess the impact of heat waves and the role of green and blue infrastructure in mitigating the Urban Heat Island (UHI) effect in different regions of Tartu, Estonia. The relationship between urban land cover and its effects is analyzed using a combination of unmanned aerial vehicles equipped with thermal, RGB and multispectral cameras. The study was carried out in Tartu, Estonia.

The data required for the research was collected in six differently characterized regions in Tartu, during three heat waves in July and August 2020 and June 2021. Data was collected using SenseFly and DJI unmanned aircraft carrying RGB, thermal and multispectral cameras. Ground temperature control measurements were performed simultaneously with the thermal camera flight. Thermal data is used to identify potential heat islands, RGB data is used for creating a 3D-model and evaluating the effect of building density and multispectral data is used to assess the presence and vitality of vegetation. Using this methodology in areas of different characteristics, we were able to analyze the mitigating and amplifying effects of different elements on urban heat islands. As the resolution of the data is very good, the results of the study can be used to provide recommandations for future urban planning.

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Municipal Lake Management in Latvia: Management Approaches and Instruments

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In Latvia, as in other countries of the northern hemisphere, there are many lakes, many of which are subject to eutrophication. Eutrophication is not the only threat, as in many parts of northern Europe lakes are also threatened by increased beach littering by swimmers and tourists, landslides, and inappropriate / inefficient lake management, which can adversely affect the lake environment and its surroundings.

As a result of climate change, as well as other factors, the population's interest in lake management and quality has increased, as have the issues affecting lakes. It is therefore necessary to study lake management, its methodology and the tools used in it in order to assess its effectiveness in different areas and to improve it, with a view to making it more sustainable and effective in the event of increased pressures and unforeseen situations. In Latvia, the situation with lake management is very complicated, as management is performed by local governments, and the system is not yet fully developed - the law does not specify which organization is the executor of the management, nor is there a national management program for lakes.

The aim of this study is to study lake management in the northern regions of Latvia, emphasizing the communication resources and other environmental management tools that are used to manage lakes and their associated territories in Latvia.

The study identified five governance approaches used by municipalities. These approaches are the Utilities management approach, environmental and natural resource management approach, water sector management approach, non-governmental organization (NGO) approach and combined management approach using two or more management approaches, or even all other approaches simultaneously. The study also revealed that the studied municipalities have insufficiently developed and used environmental communication instruments, as well as most municipalities do not have enough resources to manage all lakes in their territories - especially smaller rural municipalities, where municipalities can manage only the most important lakes, and even then maintain lakes or their coastal infrastructure equally well. Only public or state-owned lakes are managed. Private lakes have a limited number of regulations and are only the responsibility of their owners if they are not located in at least partially protected areas or do not contain protected values (eg rare birds).

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Keywords: Lake governance, water resources, governance dimension, municipalities, governance instruments, communications instruments

EFFICIENCY OF INNOVATIONS FOR SUSTAINABLE SOIL MANAGEMENT

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Soil quality is declining in many parts of Eurasia, including Ukraine, where degradation continues, primarily of agricultural land. This paper studied the efficiency of financing of innovations for sustainable soil management (on the example of innovations for amelioration of acidic and saline soils in Ukraine). As a result of the study, the effectiveness of the following measures was determined and analyzed: (1) the financing of measures to improve the ecological and agro-amelioration status of irrigated, withdrawn from irrigation and alkaline soils in the area of the Steppe (on an example of maize for grain); (2) financing the liming of acid soils in the Polissya area and in the area of the Forest-Steppe; (3) financing the project of reclamation plowing of solonetz chestnut under non-irrigated conditions; (4) financing the project of organization of agricultural production under the conditions of drip irrigation. Different levels of efficiency of the analyzed measures and projects are stated. For example, on strongly acidic soils, the investments in liming can be paid back in four years, on medium acidic soils – in five years, in general in Ukraine – in six years, on slightly acidic soils the liming was economically ineffective. The results of the study can be used in making management decisions to implement innovations for sustainable soil management.

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Environmental runoff as indicators of social resilience of South of Ukraine to global climate change

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Due to global climate change, urbanization, and economic activity, primarily runoff regulation (dams, shore fortifications, hydroelectric power plants, etc.), the number of rivers with the radically changed regime in Ukraine is increasing from year to year. All this leads to significant environmental damage and hurts living conditions and social resilience of areas to change. On the other hand, in recent years the most acute problem, in particular in the South of Ukraine, is the hydrological situation of a natural nature - low water or hydrological drought.

In the period of modern climate change, this part of Ukraine is in a zone of significant risk due to the shortage of water resources, which according to the forecast climate trends will increase in the next 30-50 years. Under such conditions, the rational use of water resources becomes increasingly important, in particular, the definition of ecological runoff, which determines the characteristics of river runoff needed to support the functioning of freshwater ecosystems and provide conditions for prosperous living and social sustainability.

The Ukrainian Hydrometeorological Center has developed a normative document "Regulations on the procedure for assessment and information on low water (hydrological drought) on water bodies of the land of Ukraine." This Regulation establishes and regulates the activities of hydrometeorological organizations, including the observation network, during the period of the threat of occurrence and formation of low water (hydrological drought) on water bodies of the land of Ukraine. An auxiliary criterion for assessing the onset of low water is the ecological flow of water, which is a critical indicator for the functioning of the river ecosystem.

The authors of the study analyzed modern approaches to quantifying the estimated environmental flow. It is shown that different authors, both in Ukraine and abroad, have proposed different methods, some of which determine the environmentally acceptable final runoff, as some share of river runoff (annual, minimum) that remains in the river after water intake.

For the rivers of the southern part of Ukraine, the calculation of environmental flow and comparison with the lowest observed discharges of the summer-autumn limit from the beginning of observations to 2018 inclusive was performed.

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Analyzing the obtained results, we can conclude that the rivers of the South of Ukraine during the study period in some years there were water discharges, which were less than ecological, i.e. in this period on the rivers were observing significantly decreased of water content and stopped the functioning of the ecosystem.

MONITORING THE CHANGE OF SEA SURFACE SALINITY IN THE BIEN DONG OF VIETNAM 2011-2015

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The process of analyzing sea surface salinity (SSS) in the East Sea of Vietnam using NASA's Aquarius/SAC-D satellite image source and data from non-fixed Argo drift buoys to build the function correlation and mapping of sea surface salinity by season average from 2011 to 2015, an analysis of changes. The results show that the fluctuations of SSS over the years are not significant. However, seasonal fluctuations have quite clear differentiation in space and time.

Key words: Sea surface salinity-SSS, Argo drift buoys, Aquarius/SAC-D, the East Sea of Viet Nam.

The application of unmanned aerial systems and automated machine learning systems in sustainable smart farming

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Unmanned Aerial Systems (UAS) are considered one of the most substantial technologies for the further progress of precision agriculture and sustainable smart farming. UAS are regularly employed for the surveillance of cultivated lands, providing efficient solutions for accurate decision support, enhancing farming productivity, reducing environmental impacts, and driving further technological innovation. Furthermore, the recent trend of automated machine learning (AutoML) has been driving additional significant technological innovation in the application of artificial

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intelligence from its automated algorithm selection and hyperparameter optimization of the deployable pipeline model for unravelling substance problems. Therefore, we employed a state-of-the-art (SOTA) and open-source AutoML framework, to focus particularly on the recognition and adoption of UAS-derived multispectral vegetation indices (VI) data across a diverse range of agricultural management practices. Demonstrate fast, high-precision non-destructive agricultural land classification technology and biomass prediction methods in several common grains and forage crop categories in Estonia. It further illustrated the automatic system would become an important tool in furthering the understanding for future sustainable smart farming and field-based crop phenotyping research across a diverse range of agricultural environmental assessment and management applications. The core value of our research lies in introducing the concept of agricultural sustainability into agricultural production and supporting food security, reducing the application of chemical fertilizers and pesticides, and monitoring crop health and water supply in real-time productions.

MODELING OF SPATIO-TEMPORAL CHANGES IN AIR POLLUTION IN KHARKIV

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One of the urgent problems of the city's environment is air pollution, which has a negative impact on public health. There is a worldwide practice of online monitoring of pollutants content in the air of settlements and informing the population about the periods of high pollution concentrations especially dangerous for certain categories of diseases and the population as a whole. There are now more than 20,000 well-known air quality monitoring stations in the world, of which more than 10,000 are published in the draft World Air Quality Index (AQI). Data published in AQI in real time cannot be adjusted at the time of publication, which ensures the objectivity of the information. Officially, Ukraine is represented there by only one meteorological center in Kyiv, although air quality research is conducted in different cities of the country.

Kharkiv Hydrometeorological Center monitors air pollution in Kharkiv at 10 stationary observation points equipped with complete laboratories "POST-1" and "POST-2". However, the information received by the Centre is not communicated to the population, it only enters the Regional Report after appropriate statistical processing, which reduces its value for city residents and the possibility of using the entire urban system in Kharkiv.

The use of geoinformation systems is possible for timely informing the population of the city. With their help it is possible to carry out on-line processing and analysis of certain information data sets on air pollution and to introduce mathematical models of pollution distribution, using modern means of visualization calculations.
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The study is based on observations of Kharkiv Regional Center for Hydrometeorology on air pollution in the city of Kharkiv for 2014 - 2020. The analysis includes only the substances monitored at the majority of points: dust, carbon monoxide, nitrogen dioxide, sulfur dioxide, formaldehyde.

The dynamics was studied in terms of changes in concentrations both during the year and year-on-year changes in annual averages.

Analysis of data on the content of pollutants in the air of Kharkiv for 2014-2019 showed that the concentrations of all substances from 2014 to 2016-2017 increased, and from 2018 began to decrease. Mathematical and statistical processing of numerical series of concentrations of each substance during the year allowed us to identify specific patterns.

Using GIS, we have developed mathematical models of pollution propagation with visualization of calculations. The Spline algorithm is used for cartographic data visualization.

Analysis of cartographic materials showed that, in general, lower concentrations of almost all substances are confined to elevated areas of relief. High concentrations of all pollutants are observed in the low-lying areas and in the floodplains of the Lopan and Kharkiv rivers, namely:

- in the north-western part of the city there are the highest concentrations of dust, nitrogen dioxide and sulfur dioxide;
- in the southern part of the city - dust, carbon monoxide, sulfur dioxide.
- in the central part of the city (floodplains of the rivers Lopan and Kharkiv) there is a high average concentration of formaldehyde, etc.
- The south-eastern part of the city of Kharkiv is mostly affected by carbon monoxide, nitrogen dioxide and formaldehyde. This is due to the large area of industrial facilities.

The developed models and information of Kharkiv Hydrometeorological Center allow us to inform the population about air pollution in the region.

SEWAGE TREATMENT PLANTS IN SMALL TOWNS OF UKRAINE

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The problem of drainage and wastewater treatment of small towns in Ukraine is extremely relevant even today. Only about 57% of small towns and urban settlements have centralized sewerage systems. Also, less than 5% of rural settlements are connected to sewerage systems [1].

This problem is extremely relevant due to the pollution of rivers and groundwater by insufficiently treated or untreated wastewater.

It is important to identify whether there is a dependence on the geographical location of small towns in Ukraine, or whether this is a common problem common throughout the country. The authors propose such an analysis on the example of small towns, such as Yaremche located in Ivano-Frankivsk region, Vilkove (Odessa region), Chuguiv (Kharkiv region) and Skole (Lviv region).

In a study of small towns, it was determined that in all selected cities there are problems with drainage, wastewater treatment and storm sewer systems. Wastewater treatment plants in small towns have been in operation since the 1970s and 1980s.

Local authorities are trying to solve these problems, but they lack the funds.

Yaremche is a mountain town where the organization of treatment facilities is a separate problem.

In 2017-2018, a complete modernization of treatment facilities was started in Yaremche. Construction and modernization are now suspended, the city still uses an outdated biological wastewater treatment system in ponds.

Vilkove also has a similar problem. The city is situated on Danube River delta and built on a network of canals. It is quite difficult to plan such a sewerage system to cover all buildings. In 2018, a new modern wastewater treatment system was built in the city. The project envisaged a large number of pumping stations. Unfortunately the sewerage system also did not cover the entire city. And in 2021 the system is working intermittently due to debt for electricity.

The existing treatment facilities in Skole were put into operation in the 1970s. The percentage of obsolescence of technological equipment is currently over 90%.

In Chuguiv, the same situation is observed with the obsolescence of treatment facilities.

Analysis of the international experience of solving this problem allows us to identify four areas of solution:

1. Connection of small cities to sewage treatment plants of large cities.
2. Connection of several settlements to one sewer system with joint treatment facilities.
3. Construction of individual treatment facilities for each settlement

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4. Construction of autonomous treatment facilities for individual buildings [2].

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The modern method for calculating the maximum river runoff on the Vistula River Basin within Ukraine

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An important step in the implementation of the EU Water Directives - EU Water Framework Directive (2000/60 / EC) and the EU Flood Directives (2007/60 / EC) is the identification of the flood risk areas, and therefore arises the task of study of the maximum runoff of rivers, especially the rare probability of excess.

The Vistula river basin is cross-border and located in Poland, Ukraine, Belarus, and Slovakia. The Polish part of the Vistula River basin, now assessed the flood zones and built flooding maps, so similar studies for the Ukrainian part of the basin are an urgent problem.

One of the main problems for today is an insufficient hydrological study of river basins, in particular, this problem exists in the Vistula River basin within Ukraine, where the number of the water gauging stations (WGS) is insufficient and they are unevenly distributed, that, in particular, creates statistical instability of parameters, which can be effectively compensated by additional information about the spatial patterns of distribution of the considered characteristics of runoff. Background for the spatial generalization of the characteristics of maximum floods runoff is the study of the influence of zonal and azonal factors on the studied characteristics

To study the characteristics of the maximum runoff of rain floods and spring floods in the territory of the Vistula basin, long-term observation data for 14 WGS were selected for the period from the beginning of observations to 2015. Since the number of hydrological posts in the studied area is rather limited, the data used for generalizations also 5 WGS in the Pripyat River basin, which borders on the studied basin.

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One of the first stages of the work was the study of the cyclicity of the maximum runoff of spring and rain floods of the Vistula river basin. If the water cycles coincide with each other, which indicates that the selected observation points have synchronous fluctuations of the annual runoff, so they can be used for further calculations and compare with each other.

The second stage of the research was to perform statistical processing of series of data of maximum runoff of rain floods and spring floods. As a result, standard statistical parameters of theoretical distribution curves, as well as rain and spring floods depths of runoff and a rare probability of excess are calculated.

• For the future study authors proposed to use a new modified version of the operator model for determining the maximum runoff of spring floods, which allows taking into account the possible impact of climate change on the estimated values of the maximum modules 1% probability of exceeding .

• The next task is to assess the risks from the passage of floods of a rare probability of exceeding in the study area.

VIDEOECOLOGICAL PROBLEMS OF URBAN SYSTEMS

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In the process of development, humanity significantly changes its habitat. Solving the problems of urban infrastructure has exacerbated the problems of visual comfort. Therefore, taking into account the current pace of urbanization, it is important to take into account public opinion on the impact of commercial infrastructure on the quality of the visual environment. Citizens were asked: "What do you think can improve the visual environment of your area?". The results showed that a significant proportion of respondents are dissatisfied with the number and location of SAFs and suggest "their destruction".

Therefore, there is a problem of interaction of the formed urban space with the attributes of modern life, which are SAFs for commercial purposes. After all, now the problem of oversaturation of urban space with small architectural forms of the commercial purpose of low aesthetic level is very acute, and a certain conceptual approach to solving this problem does not yet exist, except for simple demolition. Therefore, it is very important when designing an urban space to take into account the requirements of video-environmental aspects. In our opinion, the approach should be methodical, gradual, meet certain criteria, and the solution to this problem should be scientifically sound.

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Thus, to solve this problem, we propose to integrate SAFs with elements of green infrastructure, because the presence of landscaping in the urban environment is a means of harmonization by increasing the color and variety of textures of architectural surfaces.

The lack of territories makes an interesting proposal to interpret the designs and technologies of vertical landscaping to create permanent and temporary SAFs for different functional purposes. Now it is a generally accepted world practice to move parks, gardens, boulevards from the ground level to the roofs or facades of buildings. Thus, the green architecture makes the city not only environmentally friendly but often hides the vagueness of architectural facades behind the "mask" of vegetation.

Green infrastructure`s important elements are not only the greening and existing buildings landscaping but also the introduction of new natural elements in the urban environment. These can be greenery along roads, streets, and railways; small urban green areas and green playgrounds; parks and city lawns; green routes; recreational and urban gardening facilities; providing easier access to city parks, forests, and natural wildlife areas.

Actual socio-economic problems with water resource management of Black Sea estuaries on climate change condition

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In the north-west area of the Black Sea (as part of the Odessa region in Ukraine) are known closed estuaries-reservoirs - Khadzhibey and Kuyalnik. They are unique in origin of a natural formation. These estuaries were formed when the wellhead areas of the rivers Small Kuyalnik (Hadzhibey) and Big Kuyalnik (Kuialnitsky estuary) were flooded due to the lowering of the coastal strip of land. Estuary separated from the sea bay the pour 7 km long, so that they:

- Have little or no connection with the sea,
- Characterized by slow water exchange,
- Receive minimum inflow of fresh water from small rivers.

We also know that the Kuyalnitsky estuary is an important recreational and spa subject to state and global significance.

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Modern hydrology regime of the Hadzibeevsky and Kuyalnitsky estuaries is due to natural and anthropogenic factors and characterized by their intense economic use. For Hadzhibey, since the beginning of the last century, there was an intensive discharge of municipal waters from Odessa (biological treatment plant "North"). This led to a significant increase in the levels of water in the estuary, which threatened to destroy the dam that separates the estuary from the sea, with the possible flooding of residential areas and enterprises of the Peresip area (total area of 25 km2), as well as the road, on the dam, especially in disastrously high water years.

The ecological crisis of the Kuyalnitsky estuary is caused by the regulation the water flow r. Large Kuyalnik (since 1960) a significant number of ponds and reservoirs now. They are designed to provide water to irrigation systems and management needs. This led to a catastrophic shoaling and silting of the reservoir estuary, reducing the water level and the depth, as well as an associated increase in water salinity.

The general task of study is estimation of filling the closed estuaries-reservoirs in north-west area of the Black Sea, and long-term forecasting condition of during the spring period of year.

The first stage was an analysis of conditions of the Hadzhibeysky estuary in the presence of an exceptional the spring flood and rain floods of exceedance probability (P = 1%).

The second task - was to develop a methodology for the long-term forecasting of filling of the Hadzhibeysky and Kuyalnitsky estuaries during the spring flood, which is the most abundant phase in the hydrological regime into the territory.

During the study, these problems were solved and method of long-term forecasting was realized by the authors in operational work at the Hydrometeorological Centre of the Black and Azov Seas.

Structural development of environment governance system in Latvian municipalities

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Introduction of the environmental governance system in Latvian municipalities is optional and municipalities are free to choose which components should be introduced in a specific place to address certain needs and problems. Nor does it determine what the enforcement body needs to be in order to introduce it. At the same time, the achievements in the development of municipal and local governments also increase the scope and specificity of environmental governance, and climate change management issues are also increasingly demanding:

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- new qualifications and higher administrative capacity,
- the involvement and involvement of the public, all target groups should be substantially improved in new circumstances.

Structures for introduction of the environmental governance system in Latvian municipalities are very different – it can be separate department, division in other department, or separate individual specialist. However, for many municipalities (almost half of them before 01 June 2021) still there it is impossible to find a separate person responsible for environment management issues in the local government.

As a result of the administratively territorial reform following the local government elections on 5 June 2021, there will be 42 administrative territories in Latvia instead of the previous 119. The reform will result in more acreage, more population, and increased diversity of environmental problems in every new administrative territory. Local government expenditures on environmental issues will increase, but there will be room for optimal use of the common infrastructure following the merger of municipalities, increasing investment opportunities.

CYCLING GOVERNANCE DEVELOPMENTS IN LATVIA municipalities USING DISCIPLINARY GOVERNANCE INSTRUMENTS

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Considering, that in today's modern world cycling as one of the daily transports is becoming more popular among all kind of interest groups of our society, municipal activities for local cycling developments are already substantial part of municipal development in Latvia too and that needs adaptive governance application, based on socio-ecological system approach and stakeholder's participation and collaboration, and must be properly integrated within necessary sustainable municipal mobility approach. The aim of this research is to study the cycling governance system in the municipalities, going through complementary set of cycling governance instruments in terms of their development, implementation and impact evaluation. Within this research cycling transportation governance have been studied, using as the main research case study area Valmiera township municipality (case of medium and small size town municipalities), where mobility studies have been step-wise continuing from 2016 to 2020, participatory documenting the cycling

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development and governance as sub-system of municipal mobility governance. The research methodologies included both research-and-development framework, being realized in active collaboration with municipal administration, and, case study research, allowing to provide integrative contextual analysis of the case phenomenon, including document studies and infrastructure observations with photo documentation, followed by semi-structured in-depth interviews with main stakeholders. The study outlines necessity of the systematic governance approach and complementary use and administration of all governance instruments mentioned, esp. developing adaptive governance based disciplinary instruments for cycling as mobility sub-system governance. Studies results and recommendations may be used to the other local municipalities starting to expand cycling mobility.

Keywords: mobility, cycling, governance, governance instruments, infrastructure, communication.

The potential value of drones as tools for improved and sustainable forest management

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Recently, unmanned aerial systems (UAS) have been complementary to traditional forestry frameworks for data collection, minimizing spatial and cost limitations of the latter approach, and offer opportunities for accurate landscape-scale estimation of forestry inventory variables. In this perspective, it benefits some management activities such as mapping and assessing forest structural properties and functions provided by these environments. This study aimed to demonstrate the potential of UAS data for estimating and describing structural and functional properties of forest plots located in Lahemaa National Park (Estonia), linking data collected with UAS to ground data from forest inventory. For this, we used ground data from the Estonian Forest Register, and multispectral and height data obtained using a fixed-wing UAS. For modeling, we developed Random Forest Regression models for estimating: height index, tree cover, tree density, and basal area. Lastly, the models were assessed according to their coefficient of determination (R^2) and RF variable importance. The results indicated the variable performance of the models for estimating these parameters. For example, the model for height index explained 55.7% of the
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validation dataset, and 66.6% of the calibration dataset, while the model for basal area explained 4.7% of the validation dataset and 10.3% of the calibration dataset. The results suggest that drone data is adequate for estimating tree canopy data, but further research must be conducted for improving under-canopy metrics. In conclusion, 3D information showed good predictive performance when estimating forest parameters, suggesting that forest management can be carried out using consumer-grade cameras. On the other hand, the traditional NDVI was not a good index for modeling stand parameters, indicating the need for selecting a more appropriate index for forest evaluations. Altogether, we demonstrated that drones are useful tools for supporting collection and prediction of some parameters, but it may provide better and more meaningful results when applied synergistically within other tools and approaches.

DEVELOPMENT OF TOOLS FOR FORECASTING OF MAXIMUM SPRING RUNOFF TO THE BLACK SEA ESTUARIES REQUIRED FOR DECISION-MAKING

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The possibility of assessing the filling degree surface water from melting snow and rainfall every year of the closed estuaries- reservoirs of the Black Sea areas' was reviewed.

To accomplish the task proposed by the scientific method of the long-term forecasting revenue of spring water in the reservoirs of the Black Sea estuaries. The main problem of scientific study was that the hydrological observation network in the basins of the estuaries, and rivers in the whole north-western Black Sea region were basically absent. Therefore, the methodological framework forecasting of the characteristics of spring floods and rain floods hardly developed. No recommendations, on how to estimate the probability of forecasting values in the long-term perspective.

Sequence of forecasting of the layer of the spring flood.

1) Typification of spring floods in accordance with their water content according to the model – discriminant function *DF*, which takes account of the complex of factors having an influence upon conditions of spring flood formation.
2) Determination of the forecast modular coefficient of the spring flood.
3) Setting the probability of occurrence of the forecasting flow layers in the long -term period.
4) Derivation of the forecasting value for flow layers of the spring flood.

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The income of surface waters at the Hadzhibeysky and Kuyalnitsky estuaries in the spring, are determined by:

a) the initial water level in the pond at the date of the forecast;
b) the volume of the curve set the initial volume of water in the estuary;
c) determining the volume of water flow into the pond during the period of the spring flood;
g) calculating the expected volume of water in the reservoirs for the spring flood according to the water balance equation of the lake.

It is assumed that the rainfall in the water area of the estuary offset evaporation with its water surface;

e) the largest forecasting volume of water in the estuary during the period of the spring flood W ' curve volume is set to the maximum level of water.

Diagram of the convergence between the calculated and observed values of volumes of water of the spring flood Hadzhibeysky and Kuyalnitsky estuaries (2005-2020) showed satisfactory results (correlation coefficient r = 0,95). The accuracy of testing forecasting maximum spring water levels in estuaries is about P= 93%.

Conclusions:

- For the first time, the method of the long-term forecast of surface water during the spring period for the closed estuaries in North -West area of the Black Sea was substantiated.
- This method was realized by the authors in operational work at the Hydrometeorological Center of the Black and Azov Seas.

Ecological management and administrative-territorial structure: experience of practical application of the concept of noosphere ecosystems

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The concept of noosphere ecosystems has been developed by the author since the late 1980s and is aimed at the practical solution of environmental problems at the local level by "inscribing" nature management into ecosystem dynamics.

The essence of the concept is as follows. All countries, ethnic groups, communities are participants in one global process - noospherogenesis, the ascending logic of which logically and clearly unites them on the way to expanding the ecological niche of the entire population. From ecosystem

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positions on any territory of the globe in the process of development of the species *Homo Sapiens* forms its ecotope, the structural and functional features of which are, first, a radical change in the material and energy flows of natural ecosystems; secondly, a profound change in the spatial features of the ecotope, which is limited by the most significant component of the natural landscape - relief.

Such an ecotope (primary noosphere unit) is the agroecosystem - a form of spatial existence of Man, saturated with ecological content. Thus, the human population in terms of bioecology has its own habitat / ecological niche, which can be traced both in space and time. Such an area is the agroecosystem. In our case, agroecosystems that are formed in the Kharkiv region and those that have a dual character of borders can be "found" in space. For a constructive solution to the "global environmental problem" it is necessary to find such areas of space in which the difference between the speeds of nature and society is reflected and, in the future, gradually reducing them, to bring them into optimal proportions.

It has been 35 years since the first identification of agro-ecosystem boundaries. Their repeated study was compared with the modern administrative-territorial system (where instead of 27 administrative districts in the region there are only 7). These are Bohodukhiv, Izium, Krasnograd, Kupyansk, Lozova, Kharkiv, Chuguiv. This number and, most importantly, the spatial configuration of these areas are most correlated with the spatio-temporal dynamics of agroecosystems. This will make it possible in the future to "fit" the process of nature management into the spatial units of noosphere genesis and make it more tolerant of the biosphere.

Evaluating the impact of upstream sediment change on the deposition and erosion processes of the Hau River

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The study focuses on simulating the bottom morphology under the influence of river currents and tides in Hau Estuary during the flood season according to the scenarios in 2017 and reducing sediment by using MIKE 21FM. Four scenarios were simulated, including the current condition in 2017 in the dry season, the current condition with a 50% decrease of sediment concentration upstream boundary in the dry season, the current condition in 2017 in flood season, the current condition with a 50% decrease of sediment concentration upstream boundary in flood season. The study results include spatial and temporal distributions of water level, velocity, suspension concentration, and bed thickness change. The results show that the erosion process in the flood season was more significant than that in the dry season. However, the erosion and deposition distribution tendencies were similar in both seasons. Erosion occurred in the middle of the river bed and middle of the estuaries. Deposition mainly occurred at the Dung islet. The most remarkable erosion appeared in the middle of the estuaries in the dry season, ranging from 0.01 to 0.03m over three months. In the flood season, erodes in the estuaries and the middle of the inland river, changing between 0.02 and 0.04 m over three months. Under the scenarios of reducing sediment concentration condition of the upstream boundary, the erosions were estimated to be more significant than those of the current condition. The study could be helpful as a scientific reference for researchers interested in erosion-deposition modeling as well as for the stakeholders to have strategies to limit the damages from river erosion in the future, especially in the condition that the upstream sediment is decreasing under the influence of the dam constructions in the upper of Mekong river.

Keywords: Bottom morphology, Soc Trang estuary, sediment transport, MIKE 21, reducing sediment.

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Pathway and experience of building sustainable community in An Giang Province, Vietnam

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The cooperation project between An Giang and Piteå, Sweden has established since 2010, and granted by ICLD from 2012. The project is addressed on development of An Giang as a sustainable province with the green rice and agricultural communities and sustainable agriculture production based on grass root democracy and quality life improvement. After 10 years of implementation, both sides have achieved lots of succeeds from three project phases: "An Giang and Piteå - Sustainable Communities"; "Action plan for utilizing rice waste" and “Implementation of action plan for a sustainable An Giang province”.

Building capacity and changing mind set are the key factors brought the project success. The project conducted: 02 international trainings organized by ICLD in Sweden and Indonesia and 01 online training on project planning and management; 04 international trainings conducted by Swedish experts; and annual meetings for experience exchange for 114 managers at all levels in Sweden, India, Thailand, Korea; 12 study tours for 240 people in Vietnam for learning new techniques, experiences and 18 trainings on new techniques for rice waste programs with more than 270 participants. More importantly, the project brought an increase of income for the poorer and people in rural areas through utilizing rice waste programs and adding the chain value of by-products, such as: incomes from rice straw in the field increase 500,000 - 600,000 VND/ha; from selling the straw rolls of 20,000 -26,000 VND per roll of 12kg; from selling the rice husk as fuel from 500 VND to 900 VND/kg, and from selling the rice husk ash of 120,000 VND - 200,000 VND/ton (compared to values in 2016). The project supported 360 models of utilizing rice waste to produce mushroom, cow feed, fertilizer and straw rolls in An Giang. More than 1,228 farmers, 50 enterprises, 50 Steering Committee, provincial decision-makers, civil servants and staff from departments, sectors in the localities and 200 staff and students from An Giang University. It also helps to reduced 4 % GHG emission due to the effective management and utilization of rice biomass for energy production in climate change context for An Giang province to 2030.

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Distribution and chemical speciation of molybdenum in river and pond sediments affected by mining activity in Erdenet city, Mongolia

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Rivers and ponds near the Erdenet mine, among the world's largest copper–molybdenum mines, exhibit high concentrations of molybdenum (Mo). This study was conducted to evaluate the distribution and chemical speciation of Mo in sediments from ponds and rivers in Erdenet city to elucidate the mobility and solubility of Mo in the aquatic environments in the area. The waters and sediments were collected in two ponds connected to the tailing pond and three rivers flowing through Erdenet city. The distribution and chemical speciation of Mo in the sediments were examined using five-step sequential extraction and X-ray absorption fine structure (XAFS) analyses. The XAFS spectra of the sediments showed that large amounts of Mo in the river and pond sediments are molybdate or polymeric molybdate, weakly adsorbed onto ferrihydrite. Sequential extraction consistently showed a large amount of Mo distributed in the labile fraction. Results suggest that the pond and river sediments play a role as a secondary contamination source of Mo rather than as a sink of Mo in the area.

Keywords: Erdenet mine molybdenum sediment, chemical speciation, XAFS; sequential extraction

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INTENSE Doctoral School at Karazin University: key outputs

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Erasmus+ project "Integrated Doctoral Program for Environmental Policy, Management and Technology – INTENSE" started in 2017 and will finish in 2021. Karazin University together with other INTENSE partners have made a great job and developed very unique Doctoral Prorogram.

At Karazin University all necessary document and methodological materials were developed, agreed and signed. PhD program "Earth Science" has successfully passed accreditation.

For the proper functioning Karazin University team has developed or updated the following courses:

1. Philosophy of Science
2. Science Methodology
3. Natural Resource Science
4. Environmental Policy and Management
5. Geomatics and Modelling
6. Practice Learning in University Teaching
7. Environmental Projects Development and Management
8. Models for Environmental Risk Assessment
9. Sustainable Development
10. Environmental Management Practices

For each course the following documents were developed: working program (according to UA requirements), syllabuses, presentation of the course, reviews (2 national and 1 international one), Teaching and Learning Materials, QA of the course. All these documents are uploaded to the INTENSE web-site (http://intense.network) and on INTENSE web-page at Karazin University (http://ecology.karazin.ua/mizhnarodna-dijalnist/intense-integrated-doctora/navchalno-metodichnij-komponent/).

All courses are developed also for online on Karazin University Karazin University - https://moodle.karazin.ua/.

Another big output is MOOC "Precautionary Principle and Sustainability Transition". The structure of the MOOC is as following:

Module 1 - Sustainability concept and precautionary principle
Early warnings and the precautionary principle
Sustainability indicators

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IT tools - Geoinformation technologies in planning sustainable development of territories

Sustainable land management and climate change

Module 2 - Sustainable consumption and production

Special protected area management and its sustainability

Sustainable agriculture

Sustainable Fisheries

Sustainable Transport

Sustainable Forestry

Sustainable Tourism

Delta Challenges

Social conflicts during econetwork creation and development

For each topic, partners have provided lectures (moreover, in most cases video-lecture also), syllabus, presentation, list of questions for self-control, references.

After testing and polishing MOOC "Precautionary Principle and Sustainability Transition" will be opened on the INTENSE project web-site: http://intense.network/ on Chamillo platform.

Karazin University team has prepared contributions to three other MOOCs: Energy MOOC, MOOC "Nature-Based Solutions and Green-Blue Urban Infrastructure" and MOOC "Water Management and Policies under the Growing Uncertainties in Biophysical and Socioeconomic Systems".

Such strong educational and methodological basis will assure high quality and proper functioning of new Doctoral School and national and international levels.

ANALYSIS OF METHODS OF ASSESSMENT OF ECOSYSTEM SERVICES OF FOREST LANDSCAPES

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V.O. Voronin

The development of the ecosystem forest services market consists of three stages: the emergence of the market, its formation and the functioning itself. At the first stage, the essence of ecological forest services and the circle of persons interested in obtaining this service is determined. Information about existing problems and possibilities of their solution is also reported to stakeholders. Thus, the willingness to pay for protection from problems is formed and a basis is created for the desire of interested persons to enter into negotiations. The second stage determines the structure of the market. Compile instructions that determine the type of service,

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contain the rights and obligations of stakeholders, and provide a basis for contractual payments. The market begins to exist at the last stage, when transactions occur and funds are moved between stakeholders. For the development of the ecosystem forest services market, one should first consider the methods of resource assessment.

According to the method of determining the ecological and economic efficiency of forest cultural measures:

$$\sum_{i=1}^{I}(П_i - C_i - p_i + Ф_i)\times K_д^i \geq 0$$

where:: I – the duration of the felling of planting;

$П_i$ – revenue from the sale of products;

C_i – the cost of creating plantations;

p_i – the amount of taxes;

$Ф_i$ – financial assistance;

$К_д{}^i$ – discounting coefficient of cash flows.

This equation allows you to compare the cost of creating forest crops with the turnover of chopping up to 20 years. The efficiency of growing forest plantations can be considered successful if the result is not less than 0.

Calculation of specific current (annual) assessment of ecosystem services for forest ecological systems is carried out by the formula:

$$R_i = \frac{Ц \times K_R}{1 + p + K_R} \times К_{вых} \times К_{хцп} \times К_{пп} \times К_э \times Р$$

where:: Ц - market price of the main product of nature use;

$К_R$ = 0,3 - efficiency factor of reproduction of the main product of nature use;

Кхцп coefficient of economic value of the main wood on the estimated site;

Кпп = 1,25 coefficient, reflecting the cost of by-products of forest use;

Квих = 0,7 output coefficient of the final main products of nature use from a unit of natural raw materials (for sawn timber);

Кє = 2 coefficient of ecological significance of forest ecological systems is established for rare forest biotopes;

Ке = 1;

Р - annual resource productivity of the main product of nature use.

Thus, the calculation of the current (annual) assessment of ecosystem services for forest ecological systems, requires modernization, and improvement.

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FEATURES OF THE VEGETATION COVER OF FOREST ECOSYSTEMS OF YAREMCHE (CARPATHIAN NATIONAL NATURE PARK)

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Carpathian National Nature Park (Carpathian NNP) is located on the northeastern slopes of the Ukrainian Carpathians, along the Prut River and the western tributaries of the Black Cheremosh. The length of the Park from northwest to southeast is 55 km, and from west to east - 20 km. The Carpathian NNP has been operating since 1980.

The main purpose and task of the Carpathian NNP is the preservation, reproduction and effective use of natural complexes that have a special ecological, health, historical and cultural, scientific, educational and aesthetic value.

The territory of the park has the following functional zones: protected, regulated and stationary recreation, economic, security and recreational, recreational, recreational and economic, which are assigned to 12 departments of environmental research (PONDV).

Virgin forests have the greatest scientific and landscape-aesthetic value. In the structure of the forest fund of the Carpathian NNP beech old forests (age 150 and more) are 368.9 ha (6.9%), in the natural environment of which there is a slight anthropogenic impact, but provided that the age and coenotic structure of these plantations is not disturbed. Such forests have been preserved in the form of separate plots, of which three forest plots with a total area of 157.5 ha are located in the vicinity of Yaremche. There are 3 forest-forming species: *Picea abies* (L.) H.Karst. – 77%, *Fagus sylvatica* L. – 17% and *Abies alba* Mill. – 6% [1].

In particular, the first largest continuous plot (86.5 ha) is located in the Mezhizvirna tract and the Pasika tract on the slopes of (mostly) northern exposures in the basin of the Yavirnyk river (left tributary of the Prut river).

The second largest small continuous plot (41.0 ha) is located on the north-eastern slope of the Bereza tract, on the right bank of the Bagrivets river (right tributary of the Zhonka river).

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The last, smallest, plot (30.0 ha) is located on the northern slope of the Mezhyzvirna tract, also on the left bank of the Prut river. These areas are part of a large continuous massif of natural beech forests with remnants of virgin forests, located on the left bank of the Prut river in the interfluve of its tributaries - Yavirnyk and Bagrivets [2].

Afforestation has a regulatory effect on the hydrological regime of rivers. For example, at 14% afforestation of forests, the amount of runoff will be three times greater than at 80% afforestation, according to a study by BV Kindyuk

At present, at all water arteries observing autumn low-flow, which are characterized by low water content, but the flow velocity is quite brisk, and therefore it is difficult to imagine their strength during floods, when the flow velocity is higher than today, and the level rises by 2-5 meters. It is possible that in such situation, more than half of the city's territory of Yaremche can be flooded.

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