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EUROPEAN ASSOCIATION OF GEOSCIENTISTS & ENGINEERS

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VENUE **ONLINE** **Institute of Geology** **Taras Shevchenko National University of Kyiv** **90, Vasylkivska Street** **Kyiv**	**МІСЦЕ ПРОВЕДЕННЯ** **ОНЛАЙН** ННІ «Інститут геології» Київського національного університету імені Тараса Шевченка м. Київ, вул. Васильківська, 90

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GEOGRAPHIC INFORMATION SYSTEMS AND TECHNOLOGIES ГЕОІНФОРМАЦІЙНІ СИСТЕМИ І ТЕХНОЛОГІЇ Session Chair: *PhD Demidov Vsevolod*	
9.00	**Morning coffee**
9.30	[Mon23-004] **Estimation of carbon sequestration potential by soils of the Forest-Steppe of Ukraine based on the use of geoinformation technologies and remote sensing data** ***A. B. Achasov** (V. N. Karazin Kharkiv National University), **A. O. Achasova** (Research Institute for Soil and Water Conservation), **A. O. Siedov** (State Biotechnological University)*
9.45	[Mon23-050] **Software for field research: QField** ***T. Kupach** (Taras Shevchenko National University of Kyiv), **O. Gryniuk** (Taras Shevchenko National University of Kyiv), **S. Demianenko** (Taras Shevchenko National University of Kyiv)*
10.00	[Mon23-058] **Geographic information systems and technologies in establishing the boundaries of territorial communities in practical terms** ***O. Dorosh** (National University of Life and Environmental Sciences of Ukraine),* ***R. Kharytonenko, A. Dorosh, R. Derkulskyi, Y. Riabova** (Land Management Institute of National Academy of Agrarian Sciences of Ukraine)*
10.15	[Mon23-071] **Technological features of the assessment ecosystem services control of erosion rates** ***N. Korohoda, O. Kovtoniuk, O. Halahan, T. Kupach** (Taras Shevchenko National University of Kyiv)*
10.30	[Mon23-193] **A multi-temporal assessment and mapping of lake recreation ecosystem services: an example from Trakai region (Lithuania)** ***M. Inácio, M. Das, Y. Shuhani, L. Pinto, K. Bogdzevič, M. Kalinauskas, P. Pereira** (Mykolas Romeris University, Vilnius, Lithuania)*
10.45	[Mon23-161] **Geology monitoring information system for the protection service in Ukraine** ***Yu. Starodub, B. Mykhalichko , A. Havrys, S. Yemelynenko** (Lviv State University of Life Safety), **O. Kozionova** (Taras Shevchenko National University of Kyiv), **H. Lavrenyuk** (Lviv State University of Life Safety)*
11.00	**Coffee Break**
11.15	[Mon23-101] **Monitoring the Potential of the Ecosystems by GIS Facilities for the Sustainable Development of the Tourist and Recreational Destination's Attractiveness** ***V. Udovychenko** (Taras Shevchenko National University of Kyiv)*
11.30	[Mon23-115] **The use of GIS and remote sensing data for the assessment of ecosystem services for hydrological cycle and water flow regulation** ***O. Pochaievets, N. Korohoda** (Taras Shevchenko National University of Kyiv)*
11.45	[Mon23-135] **Multispectral index change detection for groundwater monitoring borehole localisations using Google Earth Engine interactive application (by the example of San River basin)** ***L. Davybida** (Ivano-Frankivsk National Technical University of Oil and Gas), **M. Worsa-Kozak, J. Górniak-Zimroz, A. Michalak** (Wrocław University of Science and Technology)*

12.00	[Mon23-162] **Land & Water: An interactive web cartography platform for hydrological research in Ukraine** ***V. Osypov** *(Ukrainian Hydrometeorological Institute)*, **Y. Matviienko** *(Taras Shevchenko National University of Kyiv)*, **A. Bonchkovskyi, N. Osadcha, H. Mossur, Y. Ahafonov** *(Ukrainian Hydrometeorological Institute)*
12.15	[Mon23-170] **Study of dynamics of changes in the Kakhovka reservoir based on remote sensing data** ***I. Tsiupa, L. Plichko** *(Taras Shevchenko National University of Kyiv)*
12.30	[Mon23-246] **Example of GIS application for urban water management. Case study of Trebišov, Slovakia.** ***K. Sokolchuk** *(Institute of Hydrology, Slovak Academy of Sciences; Institute of Landscape Engineering, Faculty of Horticulture and Landscape Engineering, Slovak University of Agriculture in Nitra)*
12.45	[Mon23-077] **Geoinformation technologies for monitoring forest protection plantati** ***V. Trysnyuk** *(Institute of Telecommunications and Global Information Space, NASU)*
13.00	**Lunch Break**
13.45	[Mon23-076] **Geo-information technology research of the impact of agricultural processes on the environmental safety of the territory** ***T. Trysnyuk, V. Shumeiko, D. Mosiichuk, Ye. Pashchenko** *(Institute of Telecommunications and Global Information Space, NASU)*
14.00	[Mon23-237] **Assessment of the state of bridge crossings and geoinformation spatial analysis of regional engineering geological conditions of their operation** ***A. Haidechuk, I. Chepurnyj, S. Bagriy, E. Kuzmenko** *(Ivano-Frankivsk National Technical University of Oil and Gas)*
14.15	[Mon23-010] **Research of earthquake series in Turkey using InSar data** ***H. Ostapenko, V. Zatserkovnyi** *(Taras Shevchenko National University of Kyiv)*, **M. De Donatis** *(Universita degli Studi di Urbino Carlo Bo)*, **L. Ilyin** *(Lesya Ukrainka Volyn National University)*, **O. Nikolaienko** *(National Aviation University)*
14.30	[Mon23-041] **Analysis of hydrological conditions for the comfortable life of fish populations in the Uzh River of Zakarpattia Oblast** ***V. Rusyn** *(Lviv Polytechnic National University)*, **M. Moskal, I. Feketa, V. Leta** *(Uzhhorod National University)*
14.45	[Mon23-070] **System for continuous 2D modeling of flood zones of the Uzh River** ***V. Rusyn** *(Lviv Polytechnic National University)*, **M. Moskal, I. Feketa, V. Leta** *(Uzhhorod National University)*
15.00	[Mon23-086] **A study of urbanization of Kyiv city by calculating impervious surface indices using Landsat 5 and 8 OLI/TIRS satellite imagery** ***S. Sakhniuk, O. Derkach, V. Zatserkovnyi** *(Taras Shevchenko National University of Kyiv)*, **L. Ilyin** *(Lesya Ukrainka Volyn National University)*, **I. Tsiupa** *(Taras Shevchenko National University of Kyiv)*

15.15	[Mon23-100] **Visualization of three-dimensional geoelectric models using Python** ***V. Dobrov** (Taras Shevchenko National University of Kyiv)**, A. Kushnir** (Subbotin Institute of Geophysics of the National Academy of Sciences of Ukraine, Kyiv)*
15.30	[Mon23-127] **Study of the influence of aquifer lithology on the development of landslide processes with the help of GIS in the management of the territories of the Chernivtsi region** ***N. Tuz, L. Shtohryn, D. Kasiyanchuk** (Ivano-Frankivsk National Technical University of Oil and Gas)*
15.45	

Mon23-161

Geology monitoring information system for the protection service in Ukraine

***Yu. Starodub** *(Lviv State University of Life Safety)*, **B. Mykhalichko** *(Lviv State University of Life Safety)*, **A. Havrys** *(Lviv State University of Life Safety)*, **S. Yemelynenko** *(Lviv State University of Life Safety)*, **O. Kozionova** *(Taras Shevchenko National University of Kyiv)*, **H. Lavrenyuk** *(Lviv State University of Life Safety)*

SUMMARY

This work presents a developed environmental geo-information system that allows the identification and elimination of emergencies of natural and man-made nature at the stage of preventing their occurrence, which relates to possible cases of destruction or flooded areas, where there are construction sites and roads pass on mountain slopes, built bridge structures, tunnels and dams on soils, which are characterized by their geological and geophysical characteristics. In the process of project implementation, it is planned to use the existing and purchased licensed software in order to create convenient algorithms and solve practical problems of civil rescue services on the territory of Ukraine. The geoinformation system was developed in order to coordinate the actions of civil protection services and increase the effectiveness of rescue measures through the use of the developed methodology. The geoinformation system developed and tested is planned to be transferred for use in the civil rescue services in Ukraine. The work also informs on the development of a new type of wood sawdust (WS) composite material based on CuSiF6-modified epoxy-amine polymers with reduced combustibility, the wide application of which allows preventing fires in objects and structures made of wood.

Introduction

Modernization of the environmental geoinformation system for the prevention of natural and man-made emergencies is today one of the priority and promising global trends, the inclusion of which is now strategically appropriate for civil protection services in Ukraine.

In connection with technical progress in the world, the development of technological base in the units of civil protection indicates the urgency of improving software products that support the storage and exchange of cartographic data in management decisions in forecasting and emergency response, assessing the effectiveness of rescue measures, sets the task of developing and improving software products and technologies for their operation (*Vyzhva et al., 2008; Doltsinis, 2018; Starodub, Havrys, 2018; Starodub et al., 2020; Karpenko et al., 2021; Kochubei et al., 2022*).

There is a need to ensure reliable data exchange and application of software methods and tools, in particular, the development of geographic information systems, and applied mathematical modeling of hazard forecasting for natural and man-made endangered objects, which together will increase the assessment of operational and rescue results.

From the above follows, in particular, the need to develop methods and algorithms for software that, based on the use of field observations, will predict the consequences of emergencies and fires in civil protection tasks before their elimination in the early stages of detection.

From the description of the current state of the problem, there are tasks of the project, which are to create a geographic information complex (system) that would support the following functions:

• Analysis, forecasting of emergencies and assessment of fire risks for objects in the studied areas and public facilities for potentially dangerous objects, high-risk objects for the purpose of prompt decision-making: mapping of endangered objects, accounting, and classification of facilities, sources of fire water supply (including the location of fire hydrants, shelters, and other facilities).

• Accounting for natural hazards and man-caused loads, statistical processing of data on emergencies and fires, modelling the development of fires and emergencies in endangered areas, studying the processes of flooding, emissions and discharges of pollutants with the release of hazardous substances, fires in natural ecosystems, their distribution, threats of dynamics of soils and fires of objects for services of civil protection providing information for the development of contingency plans.

Method and Theory

- Development of a methodology for preventing the risks of environmental emergencies in accordance with the tasks of civil protection at facilities and on a national scale was carried out with the hierarchical and relational access to information obtained.
- Elaborating the chemical technology of metal-coordinated epoxy-amine composites creation with reduced fire hazard and improved performance characteristics for preventing the risks of fire initiation.
- The method includes the development of a new geographic information system that quickly predicts the consequences of natural and man-made emergencies at the stage of preventing their occurrence, which relate to possible cases of destruction in areas threatened by flooding or flooding, where shore protection is required. Constructions, roads on mountain slopes, built bridge structures, tunnels, and dams on soils, which are characterized by their geological and geophysical characteristics, pollution by hazardous substances of air, water resources and soils, fires, and others.
- In the process of the method implementation it is used existing and purchased licensed software (the main thing is ARCGIS, ENVI, COMSOL programs, the necessary scripts are developed for use in software packages) in order to create convenient algorithms and solve practical problems of civil protection services on the territory of Ukraine.
- In the case of developing layers of a geographic information system, the unique relationships between the data are expressed in separate layers, and in the case of supplementing such links by calling separate procedures, such layers represent the user interface. The interface moderator fills in the layers of connections between databases.
- Developed geographic information system to prevent risks of emergencies using software products, in particular, the creation of databases for mapping high-risk objects, potentially dangerous

objects, and water reservoirs, serving as an aid in rapid response and guidance for civil protection services during emergencies and firefighting. This will contribute to the creation of orienteering atlases using GPS receivers, route planning, route control, track analysis, measurement, and calculations, as well as representation by users of the operational environment.

Results

The paper aims to create map layers by different users using the ARCGIS map editor specially designed scripts and the use of existing maps. The developments are based on the algorithm of data processing of remote sensing of the Earth using a set of software packages ARCGIS, ENVI, own development of scripts using the algorithmic language Python and programs for the packages used to process monitoring data and predict the consequences of natural and man-made emergencies.

It is used the digital terrain model SRTM (Shuttle Radar Topography Mission). The digital model of the relief is obtained by radar topographic survey of the earth's surface. The model for the territory of Ukraine is selected based on data from the official CGIAR-CSI website. Terrain database digital data - the conversion of radar data into a digital terrain model are used based on CGIAR data.

On the website of the EarthExplorer, the organization USGS "U.S. Geological Survey" available for download are hypsometric data in ArcGIS format. Data is searched and downloaded, after which high-altitude data is allocated to the contours of the Ukrainian border, resulting in the SRTM model, which is presented in the database: the USGS site selects the area where you want to download data, expands the list "Digital Elevation" and the SRTM terrain selected. The parts to be downloaded are selected and the data are downloaded.

The boundaries of regions, districts, endangered areas and other objects are obtained by creating a digital map in accordance with the technological scheme of creating digital maps based on raster maps. Sequence of operations: first, a map of the administrative structure of the territory is scanned, with the help of a digital classifier, a passport of the map and the mathematical basis of the topographic map, the map is linked. Next, create a shapefile media using the command "New> Shape file> Obl.shp". The shapefile was used as content to perform the operation of vectorization of the boundaries of the study area. Using the tools of the ArcGIS package, the Obl.shp file is translated into MapInfo and ENVI formats.

The developed set of scripts is used to perform calculations in the form of a set of tools ArcGIS, written in the Python programming language using the library "arcpy".

An example of this technology is described below: To perform the described actions, the following sequence was followed: running routines (ArcMap, Catalog window, creating a folder to place the future map, copying data from a previously created DataBase folder to a folder with a future map. Database, which contains all the necessary and available information, makes the necessary signatures on the map (objects, symbols, indicate the scale, directions of the world of the study area and save (print) information file with a map of the model of ecological and geophysical state of the territory.

Digital models of engineering structures are used. The trend in the world is to solve problems related to emergencies at engineering facilities in the field of civil protection. At the same time, the task of civil protection services is to quickly assess the emergency condition of the facility. An important cause of accidents is the stress-strain state of the object. In such cases, which relate to stresses and strains in bridges, viaducts, landslide slopes of mountains and river banks, and dams, determine the geological and geophysical parameters of objects, in particular, the existing geometric geophysical characteristics, personal computers for calculations possible deformations and stresses in them are used (*Gnyp, 2022*). The calculations are based on the theory and methodology of complex interpretation of geophysical monitoring data of dangerous geological and geophysical processes and modeling of objects by the finite element method (COMSOL software package). The approach consists in model discretization of objects into separate rather small elements-particles in which deformations and stresses are modeled in interaction. Digital models assess the endangered condition of objects (*Lu et al., 2020; Moravej et al., 2019*).

Thus for a physical body consisting of particles with a given density, Young's modulus, the Poisson's ratio; values of specific adhesion in the soil, the angle of internal friction, modeling in the environment depending on the influence of externally applied force on the object for the used

Drucker-Prager model (*Doltsinis, 2018*) the state of the object is described as an equation finite element method:

$$\mathbf{KU = R},$$

where **K** is the stiffness matrix of the object, **U** is the vector of generalized displacement, **R** is the vector loads on the simulated object.

By conducting numerical experiments, model results are obtained, which makes it possible to theoretically calculate and determine the critical allowable stress-strain states of the soil mass in the vicinity of engineering structures, bridge structures, to prevent the destruction of the massif due to excess stresses and deformations under the action of loads.

An emergency situation for a soil massif with certain predetermined physical and mechanical characteristics is investigated, analyzed, localized and prevented.

Information processing on the basis of the mentioned software packages makes it possible to quickly process large amounts of information, reduce the level of poor processing and distortion of data.

The project analyzes the legal and methodological support of geographic information systems, uses empirical research methods: forecasting the possible consequences of floods and forecasting the spread of fires in the open and during man-made accidents, pollution due to emissions of hazardous substances and more.

As a result, the application of the proposed approach reduces the possible consequences of emergencies in the practical tasks of civil defense units.

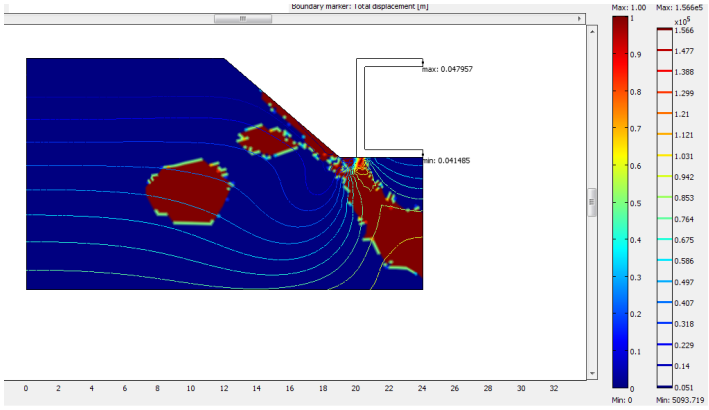

Figure *This is an example of the stress-strain state of the 5*10**4 N/m**2 pressing on the ground tunnel effect calculated: left column – deformation, right column – stress with the same scale in horizontal and vertical directions*

The study also reports the development of a new type of wood-sawdust (WS) composite based on CuSiF6-modified epoxy–amine polymers (EAPs) with reduced combustibility. The thermo-oxidative behavior of the obtained WS/EAP-CuSiF6 and WS/EAP specimens was studied using complex thermal analysis. Thermal analysis data show that incorporating CuSiF6 (flame retardant) into WS/EAP increases the thermal oxidation resistance of WS/EAP-CuSiF6. It is shown that for WS/EAP-CuSiF6 and WS/EAP, thermo-oxidative destruction ends at 571oC and 625oC, and the maximum temperature of this exothermic process is 435ºC and 499ºC, respectively. The combustibility of WS/EAP-CuSiF6 and WS/EAP was studied by the "ceramic tube" (CT) method. The CT results obtained demonstrate impressive differences in the combustibility of these two composites; the maximum temperature of gaseous combustion products for WS/EAP-CuSiF6 is 265ºC, and for WS/EAP, it is 910ºC. Flammability tests for WS/EAP-CuSiF6 and WS/EAP were carried out in accordance with ASTM D635-18 and ASTM D3801-19a. According to the results of vertical burning tests, the WS/EAP-CuSiF6 composite material was classified as V-0.

Conclusions

The paper presents a developed environmental information system that allows quick identification and eliminates emergencies of natural and man-made nature at the stage of preventing their occurrence, which relate to possible cases of destruction or flooded areas, where there are located construction sites and pass roads on mountain slopes, built bridge structures, tunnels and dams on soils, which are characterized by their characteristic geological and geophysical characteristics. In the process of project implementation, it is planned to use the existing and purchased licensed software (main -

programs ARCGIS, ENVI, COMSOL development of necessary scripts in PYTHON language) in order to create convenient algorithms and solve practical problems of civil rescue service on the territory of Ukraine.

The geoinformation system was developed in order to coordinate the actions of civil protection services and increase the effectiveness of rescue measures through the use of the developed methodology, which is expected to be tested in Ukrainian Kyiv, Lviv, Ivano-Frankivsk, Zakarpattia regions. It is planned to develop maps for the civil rescue service with the help of ARCGIS, ENVI, COMSOL, PYTHON software. The geoinformation system developed and tested will be transferred for use by the civil rescue service of other regions and oblasts of Ukraine.

The practical value of the planned results of the project for the economy and society will be to increase the level of public safety related to civil protection and fire safety through the use of a geographic information system to solve existing problems. Improving information, efficiency, reliability, and as a result of effective decision-making. Preservation of protected objects in modern natural and man-made threats.

The data obtained allowed us to classify the WS/EAP-CuSiF6 composite as a hardly combustible material. Based on the results of the flammability tests, the WS/EAP-CuSiF6 composite material was classified as the highest category of burning resistance (V-0).

Acknowledgements

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