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## Sustainable Futures in a Changing World – Reflections from the 5th International Conference on Sustainable Futures: Environmental, Technological, Social and Economic Matters (ICSF 2024)

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# Sustainable Futures in a Changing World – Reflections from the 5th International Conference on Sustainable Futures: Environmental, Technological, Social and Economic Matters (ICSF 2024)

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**Abstract.** This paper presents an overview of the 5th International Conference on Sustainable Futures: Environmental, Technological, Social, and Economic Matters (ICSF 2024), held in May 2024. The conference brought together over 250 researchers, practitioners, and educators from 19 countries to share cutting-edge research and innovative solutions across a wide range of sustainability-related disciplines. The proceedings cover diverse topics, including climate change, disaster risk reduction, sustainable infrastructure, education for sustainability, environmental engineering, and sustainable business practices. Key themes that emerged include the integration of digital technologies in sustainability efforts, the impacts of global crises on



sustainable development, and the importance of interdisciplinary approaches. The conference showcased both theoretical advancements and practical applications, with a particular focus on addressing the United Nations Sustainable Development Goals. This overview highlights the conference's role in fostering global dialogue and collaboration to address pressing sustainability challenges and shape a more sustainable future.

In memory of Serhii M. Chukharev, a  
brilliant researcher and dear friend.

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## 1. Introduction

Welcome to the **International Conference on Sustainable Futures: Environmental, Technological, Social, and Economic Matters (ICSF)** proceedings. This conference serves as a cornerstone for global discourse on sustainable development, providing a peer-reviewed international platform where researchers, scientists, engineers, and practitioners converge to share their latest research findings, innovative ideas, and practical applications. As we delve into these proceedings, we embark on a journey across diverse disciplines, united by a common goal of advancing sustainable practices.

Figure 1 showcases the emblem of ICSF 2024, a symbol of our collective commitment to fostering sustainable futures.



**Figure 1.** ICSF 2024 logo (designed by Andrii M. Striuk).

Since its inception in 2020, ICSF has consistently cultivated a space that encompasses the entire spectrum of sustainable development. With a focus on the intricate intersections of sustainability, environment, and technology, ICSF explores their far-reaching implications for corporations, governments, educational institutions, regions, and societies, both in the present and the future [1–5].

ICSF 2024 is a two-tiered platform comprising pre-conference workshops and the main conference, ensuring an enriched experience for all participants. The pre-conference workshops delve into specific domains of sustainable development.

### *1.1. Geography for Sustainable Development (GSD-2024)*

*Geography for Sustainable Development* (GSD-2024) serves as a peer-reviewed international workshop, offering a platform for researchers deeply engaged with the challenges of sustainable development within the geographical context. Covering an array of topics, including biogeochemical cycles, climate, natural resources, and more, this workshop is a testament to the expansive scope of geography's role in shaping sustainable futures. Dr. Olha Bondarenko guides these explorations through her leadership.

**Workshop URL:** <https://bondarenkoolga9.wixsite.com/gsd-2024>.

### *1.2. Water for the Future: Management, Use, and Technology (WaterManEnvE-2024)*

The *Water for the Future: Management, Use, and Technology* (WaterManEnvE-2024) stands as a peer-reviewed international platform, encapsulating contributions that cover all aspects of water management and environmental engineering, environmental education and modern educational technologies. With a focus on topics including water resources, irrigation, hydraulic engineering, and more, this workshop navigates the complexities of managing our most precious resource sustainably. Dr. Serhii Klimov provides direction for these explorations.

**Workshop URL:** <https://sites.google.com/nuwm.edu.ua/watermanenve-ws2024/home>.

### *1.3. Nuclear Safety and Environmental Protection (IASEI-2024)*

*Nuclear Safety and Environmental Protection* (IASEI-2024) converges as a peer-reviewed international workshop focusing on advancing environmental science research. Covering topics ranging from environmental protection to nuclear safety and technological solutions, this workshop embodies the spirit of pioneering solutions for pressing environmental challenges. Dr. Andrii Iatsyshyn is in charge of cultivating innovative discussions.

**Workshop URL:** <https://iasei.easyscience.education/2024/>.

### *1.4. Infrastructure, Resilience and Sustainable Energy (SEnW-2024)*

*Infrastructure, Resilience and Sustainable Energy* (SEnW-2024) embarks on an exploration of innovative solutions in energy systems. Covering a diverse array of topics, including solar and wind energy, energy policy, climate change, and more, this workshop underlines the essential role of sustainable energy in shaping our resilient future. Guided by Dr. Volodymyr Artemchuk, this workshop paves the way for sustainable energy practices.

**Workshop URL:** <https://ipme.kiev.ua/en/SEnW-2024/>.

### *1.5. Conference sessions*

The main conference unfolded through a series of 12 sessions, each shedding light on different facets of sustainable development. These sessions encompassed topics ranging from sustainable mining, materials and technologies to socio-economic development, energy systems, water management, and beyond.

Session 1. Sustainable mining. Geophysics, geology, mineralogy and petrology, session 1 (May 21, 2024). Chairs: Serhii Chukharev and Andrii Striuk

Session 2. Technology and materials for sustainability (May 21, 2024). Chair: Serhiy Sakhno

Session 3. Infrastructure, Resilience and Sustainable Energy (SEnW-2024) (May 21, 2024). Chair: Volodymyr Artemchuk

- Session 4. Sustainable use of natural resources. Sustainable transportation (May 21, 2024).  
Chair: Pavlo Nechypurenko
- Session 5. Geography for a Sustainable Future (GSD-2024), session 1 (May 21, 2024). Chair:  
Olha Bondarenko
- Session 6. Green building and sustainable architecture. Sustainable urban planning, cities  
and society (May 22, 2024). Chair: Serhiy Sakhno
- Session 7. Education for sustainability (May 22, 2024). Chair: Tetiana Vakaliuk
- Session 8. Sustainable business practices. Environmental policy, economics, and law.  
Environmental health and sustainable development (May 22, 2024). Chair: Hanna  
Danylchuk
- Session 9. Water for the Future: Management, Use, and Technology (WaterManEnvE-2024)  
(May 22, 2024). Chair: Serhii Klimov
- Session 10. Nuclear Safety and Environmental Protection (IASEI-2024) (May 23, 2024).  
Chairs: Valeriia Kovach, Andrii Iatsyshyn and Teodoziia Yatsyshyn
- Session 11. Sustainable mining. Geophysics, geology, mineralogy and petrology, session 2 (May  
23, 2024). Chair: Serhii Chukharev and Andrii Striuk
- Session 12. Geography for a Sustainable Future (GSD-2024), session 2 (May 24, 2024). Chair:  
Olha Bondarenko

This volume is a repository of the scholarly contributions presented at ICSF 2024. With meticulous reviews conducted by a minimum of three program committee members, the selected papers embody the spirit of rigorous exploration and discovery.

Authors were invited to submit full research papers, including surveys, tutorials, and perspective/colloquia articles on conference topics of interest (<https://www.morressier.com/call-for-papers/6501c5b1cd3f7d001924450d>). With meticulous reviews conducted by a minimum of three program committee members, the selected papers embody the spirit of rigorous exploration and discovery. Out of 304 submissions received, 171 papers were accepted after a rigorous peer-review process.

The unfolding events of the ongoing Russian invasion of Ukraine necessitated a hybrid conference format. By embracing both in-person and online modes, ICSF 2024 extended its reach across borders, allowing more than 250 participants from 19 countries to participate through platforms such as Zoom and Google Meet.

The presentation slots were defined as follows:

- invites talks (25 min): 15 min presentation, 10 min question answering and discussion,
- other talks (15 min): 10 min presentation and 5 minutes question answering and discussion.

The full ICSF 2024 program is available at the <https://icsf.easyscience.education/2024/>, where one or more invited presentations usually head details of the sessions. Video records of talks are available at the *Not So Easy Science* YouTube channel:

<https://www.youtube.com/channel/UCH3gego79m-ofCiNEgEzMuA>

As we present these proceedings, we invite readers to explore the diverse range of topics covered, draw inspiration from the innovative approaches discussed, and consider how these findings can be applied to enhance sustainable practices across various contexts and disciplines. We anticipate that the ideas and findings presented will significantly contribute to shaping a more sustainable future.

## 2. ICSF 2024 program committee

The ICSF 2024 program committee comprised over 100 distinguished researchers from around the world, representing a wide range of disciplines related to sustainable development. Their expertise and dedication were instrumental in ensuring the high quality of the papers presented at the conference.

- *Leon A. Abdillah*, Universitas Bina Darma, Indonesia [6, 7]
- *Khairulla Aben*, CSA Global, Australia [8, 9]
- *George Abuselidze*, Batumi Shota Rustaveli State University, Georgia [10]
- *Rajendran Sobha Ajin*, University of Florence, Italy [11–15]
- *Tetiana Alohina*, Kryvyi Rih State Pedagogical University, Ukraine [16–19]
- *Volodymyr Artemchuk*, G. E. Pukhov Institute for Modelling in Energy Engineering of NAS of Ukraine, Ukraine [20–26]
- *Jozef Bendík*, Slovak University of Technology in Bratislava, Slovakia [27–29]
- *Milan Bělík*, University of West Bohemia, Czechia [30–34]
- *Tetiana Bilan*, State Scientific and Technical Center for Nuclear & Radiation Safety, Ukraine [35–37]
- *Ihor Blinov*, Institute of Electrodynamics of the National Academy of Sciences of Ukraine, Ukraine [38, 39]
- *Olha Bondarenko*, Kryvyi Rih State Pedagogical University, Ukraine [40–47]
- *Liudmyla Burman*, Kryvyi Rih State Pedagogical University, Ukraine [48–51]
- *Matej Cenký*, Slovak University of Technology in Bratislava, Slovakia [52–54]
- *Serhii Chukhariev*, National University of Water and Environmental Engineering, Ukraine [55–59]
- *Giuseppe T. Cirella*, University of Gdansk, Poland [60–63]
- *Hanna Danylchuk*, The Bohdan Khmelnytsky National University of Cherkasy, Ukraine [64–69]
- *Iryna Davydova*, Zhytomyr Polytechnic State University, Ukraine [70–74]
- *Kremena Dedelyanova*, Scientific and technical union of mining, geology and metallurgy in Bulgaria, Bulgaria [75, 76]
- *Viktor Denysenko*, The Bohdan Khmelnytsky National University of Cherkasy, Ukraine [77–82]
- *Tetiana Derkach*, Kyiv National University of Technologies and Design, Ukraine [83–87]
- *Viktoriiia Dmytrenko*, National University “Yuri Kondratyuk Poltava Polytechnic”, Ukraine [88–91]
- *Iryna Dubovkina*, Institute of Engineering Thermophysics of NAS of Ukraine, Ukraine [92, 93]
- *Oleksandr Farrakhov*, Center for Information-analytical and Technical Support of Nuclear Power Facilities Monitoring of the NAS of Ukraine, Ukraine [94–97]
- *Branko Gluščević*, University of Belgrade, Serbia [98–101]
- *Volodymyr Grinchenko*, General Energy Institute of the NAS of Ukraine, Ukraine [102–105]
- *Olena Hanchuk*, Kryvyi Rih State Pedagogical University, Ukraine [106–109]
- *Hermann Heilmeyer*, Technische Universität Bergakademie Freiberg, Germany [110–113]
- *Serhii Honchar*, G. E. Pukhov Institute for Modelling in Energy Engineering of NAS of Ukraine, Ukraine [114–118]

- *Teodora Vassileva Hristova*, University of mining and geology “St. Ivan Rilski”, Bulgaria [119, 120]
- *Pavlo Hryhoruk*, Khmelnytskyi National University, Ukraine [121–125]
- *Andrii Iatsyshyn*, Center for Information-analytical and Technical Support of Nuclear Power Facilities Monitoring of the NAS of Ukraine, Ukraine [126–130]
- *Anna Iatsyshyn*, State Scientific Organization “Ukrainian Institute of Scientific Technical and Expertise and Information”, Ukraine [131–134]
- *Nataliia Ivanenko*, Institute of General Energy of the NAS of Ukraine, Ukraine [135–138]
- *Mykola Kharytonov*, Dnipro State Agrarian and Economic University, Ukraine [139]
- *Ihor Kholoshyn*, Kryvyi Rih State Pedagogical University, Ukraine [140–142]
- *Liubov Kibalnyk*, The Bohdan Khmelnytsky National University of Cherkasy, Ukraine [143–146]
- *Arnold Kiv*, Ben-Gurion University of the Negev, Israel [147]
- *Serhii Klimov*, National University of Water and Environmental Engineering, Ukraine [148–153]
- *Elena Komarova*, NitrosData, LLC [154–156]
- *Valerii Korniyenko*, National University of Water and Environmental Engineering, Ukraine [157–160]
- *Valeriia Kovach*, Center for Information-analytical and Technical Support of Nuclear Power Facilities Monitoring of the NAS of Ukraine, Ukraine [161–164]
- *Oksana Kovtun*, University of Educational Management [165–168]
- *Andrey Kupin*, Kryvyi Rih National University, Ukraine [169–172]
- *Olena Kuzminska*, National University of Life and Environmental Sciences of Ukraine, Ukraine [173–176]
- *Evgeniy Lavrov*, Sumy State University, Ukraine [177–181]
- *Olena Lavrova-Manzenko*, The Bohdan Khmelnytsky National University of Cherkasy, Ukraine [182]
- *Tetiana Lazarieva*, Ukrainian Engineering Pedagogics Academy, Ukraine [183–185]
- *Cristina Leonelli*, University of Modena and Reggio Emilia, Italy [186–188]
- *Nadiia Lobanchykova*, Zhytomyr Polytechnic State University, Ukraine [189–193]
- *Oleh Lysak*, Institute of Renewable Energy of the National Academy of Sciences of Ukraine, Ukraine [194–196]
- *Nataliia Maksyshko*, Zaporizhzhia National University, Ukraine [197–201]
- *Svitlana Malchenko*, Kryvyi Rih State Pedagogical University, Ukraine [202–205]
- *Anatolii Matsui*, Central Ukrainian National Technical University, Ukraine [206–208]
- *Oleksii Merkulov*, Iron and Steel Institute of Z.I. Nekrasov of NAS of Ukraine, Ukraine [209]
- *Bård Borch Michalsen*, UiT The Arctic University of Norway, Norway [210]
- *Iryna Mintii*, Kryvyi Rih State Pedagogical University, Ukraine [211]
- *Roland Iosif Moraru*, University of Petrosani, Romania [212–214]
- *Victor Mutambo*, University of Zambia, Zambia [215–218]
- *Oleksii Mykhailenko*, Kryvyi Rih National University, Ukraine [219–221]
- *Tetiana Nazarenko*, Institute of Pedagogy of the National Academy of Educational Sciences of Ukraine, Ukraine [222, 223]

- *Pavlo Nechypurenko*, Kryvyi Rih State Pedagogical University, Ukraine [224–230]
- *Borya Orkhontuul*, Mongolian University of Science and Technology, Mongolia [231]
- *Kateryna Osadcha*, Norwegian University of Science and Technology, Norway [232–235]
- *Viacheslav Osadchyi*, Borys Grinchenko Metropolitan Kyiv University, Ukraine [236–240]
- *Marinela Ivanova Panayotova*, University of Mining and Geology “St. Ivan Rilski”, Bulgaria [241–245]
- *Natalia Panteleeva*, Kryvyi Rih State Pedagogical University, Ukraine [246–249]
- *Andrii Peremetchyk*, Kryvyi Rih National University, Ukraine [250–253]
- *Mykhailo Petlovanyi*, Dnipro University of Technology, Ukraine [254–257]
- *Olha Pinchuk*, Institute of Information Technologies and Learning Tools of the NAES of Ukraine, Ukraine [258]
- *Oleksandr Popov*, Center for Information-analytical and Technical Support of Nuclear Power Facilities Monitoring of the NAS of Ukraine, Ukraine [259–261]
- *Vasyl Porokhnya*, Classic Private University, Ukraine [262–266]
- *Oleg Pursky*, Kyiv National University of Trade and Economics, Ukraine [267–269]
- *Olena Remezova*, Institute of Geological Sciences of the National Academy of Sciences of Ukraine [270–274]
- *Olena Rubanenko*, Vinnitsa National Technical University, Ukraine [275–277]
- *Ivan Sakhno*, Donetsk National Technical University, Ukraine [278–281]
- *Serhiy Sakhno*, Kryvyi Rih National University, Ukraine [282–284]
- *Myroslav Sanytsky*, Lviv Polytechnic National University, Ukraine [285, 286]
- *Tetiana Selivanova*, Kryvyi Rih State Pedagogical University, Ukraine [287–289]
- *Serhiy Semerikov*, Kryvyi Rih State Pedagogical University, Ukraine [290–292]
- *Volodymyr Shamrai*, Zhytomyr Polytechnic State University, Ukraine [293–296]
- *Yevhenii Shapovalov*, National Center “Junior Academy of Science of Ukraine”, Ukraine [297–302]
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- *Vadym Shkarupylo*, National University of Life and Environmental Sciences of Ukraine [306–310]
- *Sergii Skurativskyyi*, Institute of Geophysics National Academy of Sciences of Ukraine, Ukraine [311–313]
- *Valentyna Stanytsina*, Institute of general energy of NAS of Ukraine, Ukraine [314–318]
- *Andrii Striuk*, Kryvyi Rih National University, Ukraine [319–322]
- *Izabela Barbara Sztangret*, University of Economics in Katowice, Poland [323–327]
- *Radomir Timchenko*, Kryvyi Rih National University, Ukraine [328–330]
- *Mihaela Toderaş*, University of Petrosani, Romania [331–333]
- *Krzysztof Marian Tomiczek*, Silesian University of Technology, Poland [334–337]
- *Vitalii Tron*, Kryvyi Rih National University, Ukraine [338–341]
- *Iryna Trubavina*, Kryvyi Rih State Pedagogical University, Ukraine [342–344]
- *Illia Tsyhanenko-Dziubenko*, Zhytomyr Polytechnic State University, Ukraine [345–347]
- *Tetiana Vakaliuk*, Zhytomyr Polytechnic State University, Ukraine [348–353]
- *Iryna Varfolomyeyeva*, Kryvyi Rih State Pedagogical University, Ukraine [354–356]



- *Kateryna Vlasenko*, National University of Kyiv-Mohyla Academy, Ukraine [357–361]
- *Yuriy Vynnykov*, National University “Yuri Kondratyuk Poltava Polytechnic”, Ukraine [362–366]
- *Petro Vyshnivskyyi*, National University of Life and Environmental Sciences of Ukraine, Ukraine [367, 368]
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- *Ievgen Zaitsev*, The Institute of Electrodynamics of the National Academy of Sciences of Ukraine [378–382]
- *Oleksandr Zgurovets*, Institute of General Energy of NAS of Ukraine, Ukraine [383–386]
- *Iryna Zinovieva*, Kyiv National Economic University named after Vadym Hetman, Ukraine [387–391]
- *Valerij Zvaritch*, Institute of Electrodynamics of the National Academy of Sciences of Ukraine, Ukraine [392–395]

### 3. ICSF 2024 organizer

The 5th edition of ICSF was meticulously coordinated by the Academy of Cognitive and Natural Sciences (ACNS, <https://acnsci.org>), a non-governmental organization dedicated to nurturing the growth of researchers' expertise in the cognitive and natural sciences arena. ACNS's mission encompasses enhancing research, safeguarding rights and liberties, and catering to professional, scientific, social, and various other interests.

ACNS is engaged in a spectrum of activities, including:

- Spearheading research initiatives within the cognitive and natural sciences domain and fostering collaborative ties among researchers.
- Orchestrating conferences, workshops, training sessions, internships, and other platforms for the exchange and dissemination of knowledge in the realm of cognitive and natural sciences.
- Publishing scientific journals, conference proceedings, collections of scholarly works, and related materials (<https://acnsci.org/cms/journals/>).

Among ACNS's prominent publications is the Diamond Open Access *Journal of Edge Computing* (JEC) that covers a broad range of topics aligned with the Sustainable Development Goals (SDGs). Here are select articles from *Journal of Edge Computing* categorized by SDG goals:

#### SDG 3 (Good Health and Wellbeing)

- Non-contact photoplethysmographic sensors for monitoring students' cardiovascular system functional state in an IoT system [396].
- Model of an automated biotechnical system for analyzing pulseograms as a kind of edge devices [397].
- A system for monitoring the microclimate parameters of premises based on the Internet of Things and edge devices [398].
- An IoT system based on open APIs and geolocation for the prevention of human health disorders [399].
- Responding to challenge call for machine learning model development in diagnosing respiratory disease sounds [400].

#### SDG 4 (Quality Education)

- Design and implementation of an IoT-based educational model for smart homes: a STEM approach [401].
- Investigating the effect of virtual machine migration accounting on reliability using a cluster model [402].

#### SDG 9 (Industry, Innovation, and Infrastructure)

- Graph theory methods for fog computing: A pseudo-random task graph model for evaluating mobile cloud, fog and edge computing systems [403].
- Analysis and protection of IoT systems: Edge computing and decentralized decision-making [404].
- A new approach for dispatching task flows in GRID systems with inalienable resources [405].
- Introduction to doors Workshops on Edge Computing (2021-2023) [406].
- ImpalaE: Towards an optimal policy for efficient resource management at the edge [407].
- Reliable distributed systems: review of modern approaches [408].
- Empowering the Edge: Research advances from doors 2024 [409].
- Efficient model of PID controller of unmanned aerial vehicle [410].
- Design and implementation of an edge computing-based GPS tracking system [411].
- Telemetry to solve dynamic analysis of a distributed system [412].
- Advancing IoT interoperability: dynamic data serialization using ThingsBoard [413].
- Ambience: an operating system for IoT microservices [414].
- Use of wireless technologies in IoT projects [415].

#### SDG 11 (Sustainable Cities and Communities)

- Edge computing in environmental science: automated intelligent robotic platform for water quality assessment [416].

#### SDG 15 (Life on Land)

- Enhanced deep learning model architecture for plant disease detection in Chilli plants [417].

#### SDG 16 (Peace, Justice, and Strong Institutions)

- A long short-term memory based approach for detecting cyber attacks in IoT using CIC-IoT2023 dataset [418].

## 4. Proceedings structure

### 4.1. Atmospheric science, meteorology, and climatology

The papers in this section cover topics related to atmospheric science, meteorology, and climatology. [419] investigates methane degassing within Ukraine using satellite data. [420] analyzes patterns of PM10 particles change in the atmospheric air of Ivano-Frankivsk city. [421] explores the application of remote monitoring tools in the educational process by studying the content of water vapour in the atmosphere. [422] explores the use of FEM technology in analyzing the stability of the design concept of a residential building “Flower of Life” under explosive load conditions.

### 4.2. Biodiversity conservation and environmental impact

[423] assesses below-ground carbon stock of mangrove stands at a mining site in Hinatuan Island, Philippines. [424] investigates the accumulation of heavy metals by different biota representatives in the operation zone of the Prydniprovsk thermal power plant. [425] proposes spatial optimization models of socio-natural interaction as a way to sustainable development.

#### *4.3. Climate change, disaster risk reduction, and environmental policy*

Climate change and its impacts are addressed in [426], which proposes ML-ERV, a machine learning-based CO<sub>2</sub> emissions model for rental vehicles. Disaster risk reduction is the focus of [427], a hermeneutic phenomenological study of motivations, challenges, and resilience in a landslide-prone environment in the Philippines. [428] assesses seismic hazard in the Shamkir-Mingachevir reservoir region through ground response analysis. Environmental policy is represented by [429], which explores stakeholders' awareness and perception of bio-economic transformation in Ukraine. [430] evaluates green flood mitigation measures in urban areas within the sustainable city concept. [431] investigates the physical and mechanical properties of burnt-out coal mine waste heaps. [432] assesses the risks for Ukraine's infrastructure under war conditions. [433] focuses on the resilience of systems for public protective actions under wartime.

#### *4.4. Education for sustainability*

Several papers address education for sustainability from various angles. [434] models the digital ecophilic tendencies of university students' consciousness. [435] explores the use of digital technologies in education in the context of sustainable development. [436] discusses inclusive culture in Ukrainian higher education institutions for sustainable development. [437] focuses on nanoeducation for a sustainable future and attracting Ukrainian youth to nanotechnological specialities. [438] investigates collaborative learning in training future IT specialists as a strategy for sustainable education. [439] explores transforming education and navigating the human-AI ecosystem in psychological training and beyond. [440] discusses ensuring sustainable development through digital educational hubs for teaching civic education at school. [441] presents a case study of students and plagiarism, focusing on plagiarism checker use at a university in North Sumatra. [442] investigates cultivating intercultural competency and the role of sustainability in pre-service teacher professional development. [443] provides a literature review on the educational dimension of sustainable development from 2019-2023. [444] explores the intersection of artificial intelligence, the labour market, and education for sustainable development. [445] explores the use of ICT by teachers for developing students' critical thinking in the context of sustainable development in Ukraine. [446] investigates transformational leadership in higher education for implementing sustainable development goals, using Ukraine as an example. [447] presents a case study of a school preparing for sustainability management, focusing on the Palau simulation model. [448] explores blended learning, its definition, concept, and relevance to education for sustainability. [449] proposes AI tools for sustainable primary teacher education, focusing on literary-artistic content generation.

#### *4.5. Environmental engineering and green technology*

Several papers represent environmental engineering and green technology. [450] evaluates green flood mitigation measures in urban areas within the sustainable city concept. [451] investigates increasing biogas production energy efficiency through vibration activation of heat and mass exchange in the bioreactor. [452] focuses on sustainability and resilience, exploring digital technologies for GHG Scope 3. [453] presents a geoinformation assessment of solar plant potential in the Ivano-Frankivsk region for effective decarbonisation and energy stability. [454] uses canonical correlations to assess the relationship between economic growth and environmental threats. [455] forecasts the development of the circular economy in Ukraine. [456] improves municipal wastewater treatment technology in towns and villages. [457] explores the prospects of using composite preparations based on silica nanosols. [458] provides a review of the current state and prospects of red mud utilization. [459] proposes technological solutions for the population under existing challenges.

#### *4.6. Sustainable infrastructure, mining, transportation, and urban planning*

Sustainable infrastructure is the focus of [460], which explores the automated trolleybus park system as part of sustainable city infrastructure. [461] proposes neural network methods for searching additional functions in information-driven permutation operations to increase critical infrastructure sustainability. Sustainable mining is represented by [462], considering multifactorial geomechanical-technological factors in determining rational parameters for site outgassing technology in Western Donbas mines, Ukraine. [463] models the soil erosion process during amber mining. [464] investigates the influence of stress-strain evolution in the immediate floor before and after excavation face on floor heave origin in coal mines roadways. Sustainable transportation is addressed by [465], analyzing prospects and peculiarities of autonomous and cyber-physical systems development for vehicle control at mining enterprises. [466] proposes a strategic approach to sustainable railway transport development and optimizing empty car use in organizing dangerous goods transportation. [467] presents a flight situation advisory system for uninterrupted and efficient air transportation. Sustainable urban planning is the focus of [468], which applies geoinformation systems in developing a city's intelligent transport network. [469] discusses problems in developing urban planning solutions for the restoration of deoccupied cities in eastern Ukraine. [470] explores the sustainable development of the Pirnovo community in the Kyiv region, focusing on problems and perspectives. [471] reviews smart city trends, achievements, and challenges in Ukraine in the context of Sustainable Development Goals. [472] applies geometrization to estimate mineral deposit reserves. [473] investigates the degree indicators of coal metamorphism for predicting hazardous properties of coal seams during mining. [474] explores predictive calculation of blasting quality as a tool for estimating production cost and investment attractiveness of mineral deposit development. [475] proposes a tool for management and planning of the fuel and energy complex, considering the production potential of coal-mining enterprises. [476] investigates the management of resource potential in European countries in the context of "post-coal mining". [477] researches the selection of optimal instrumentation for mine surveying and software for processing field results. [478] presents a methodology for the operative setting of mass crystallization parameters of gas hydrate in reservoir systems. [479] proposes an integrated approach to forecasting and managing emergencies in the working faces of coal mines, focusing on technical, organizational, and safety measures with subsequent assessment of potential consequences. [480] explores the application of prefabricated retaining walls with increased shear resistance to ensure tailings dam stability. [481] develops a method for estimating the carbon footprint when transporting grain by road. [482] predicts CO<sub>2</sub> emissions during multimodal grain transportation. [483] proposes an improvement technique for surveying observations of displacement. [484] analyzes quantitative and qualitative parameters of the gas mixture in thermal processes of mine medium. [485] applies GIS in the retrospective analysis of the territorial organization of the Kryvyi Rih settlement. [486] explores the geography of the COVID-19 pandemic in Ukraine and the world, focusing on similarities and differences. [487] investigates the features of functional zoning of esports arenas, considering the concepts of sustainable development of territories. [488] proposes the FUTURE 5.0 multi-goal decision-making framework for sustainable university governance in the Industry 5.0 era and beyond.

#### *4.7. Agriculture, food systems, and natural resources*

Several papers represent sustainable agriculture and food systems. [489] proposes a resource-saving method for extracting cucumber and melon seeds. [490] conducts experimental research on spray opening and closing time in flat and injector nozzles. [491] explores areas of nature reserve fund used in the context of sustainable development. [492] investigates consumer perceptions and determinants of millet milk consumption as a sustainable choice. Natural resources are the focus of [493], assessing changes in forest ecosystem structure using the example of sanitary

woody plantations in the Steppe Dnipro. [494] generates a geospatial database of forest growth using the QGIS software package. [495] explores the peculiarities of using statistical data for the mass valuation of agricultural lands in Ukraine, focusing on the Kharkiv region. [496] investigates the structural and functional content of xerophytic plants of the *Elytrigia repens* L. genus. [497] assesses trends in the functioning of the grain industry of EU countries using ARDL modelling. [498] explores the application of polymer flooding to increase oil recovery. [499] investigates the influence of organic agriculture development processes on Ukraine's economic security components. [500] assesses the bioenergetic efficiency of growing miscanthus with sewage sediment. [501] discusses the prerequisites for improving crop irrigation regimes based on resource optimization.

#### *4.8. Business, economics, and sustainable development*

Sustainable business practices and economic aspects of sustainable development are addressed in several papers. [502] proposes a mathematical model of the business process of higher education institutions based on ontological analysis. [503] explores creditworthiness management as a tool for ensuring sustainable, self-sufficient business development in Ukraine. [504] focuses on managing the economic security of food industry enterprises as a direction for ensuring sustainable development. [505] transforms the business ecosystem model into an energy enterprise's strategy. [506] analyzes the motivational profile of personnel directed at achieving sustainable enterprise development. [507] investigates sustainable consumption in times of war, focusing on needs, values, and possibilities. [508] proposes complex socio-economic solutions for the sustainable ecological development of Ukrainian regions. [509] discusses Ukrainian social sector development in contemporary conditions, highlighting problems and areas for their solution. [510] provides a comprehensive review of green accounting practices in India and global perspectives for advancing sustainable development. [511] identifies key competencies for post-war recovery and sustainable development of Ukraine's economy. [512] explores the interconnected roles of human capital, employment, and sustainable development in EU countries. [513] analyzes the income, consumer spending, and well-being of Ukrainian households. [514] explores project sustainability and sustainable project management in times of crisis, focusing on the context of the Russian-Ukrainian war. [515] models the energy security of the country in the context of sustainable development, using Ukraine as a case study.

#### *4.9. Technology, materials, and modelling for sustainability*

Various technological and material aspects of sustainability are addressed in the papers. [516] develops a dephosphorization technology for iron ores with high phosphorus content. [517] investigates melamine-doped TiO<sub>2</sub> as a perspective photocatalyst for hydrogen evolution. [518] studies the effect of sodium metasilicate on the early-age hydration and setting behaviour of alkali-activated common cement-containing slag. [519] explores the electrospark method of obtaining metal nanoparticles for creating antifungal drugs (fungicides). [520] designs rapid-hardening cementitious repair mixtures for increasing the sustainability of concrete structures. [521] investigates thermo-responsive hydrogels based on gelatin-alginate composition with humic acids intended for controlled drug delivery. [522] focuses on sustainable web API evolution and forecasting software development efforts. [523] conducts a comparative analysis and models safe variability areas of power for VVER-1000 and AP-1000 power units. [524] calculates electricity losses using neural networks for retrospective data with the presence of anomalous values. [525] forecasts air pollution by leveraging traffic modelling techniques. [526] applies chatbots to support indoor temperature control. [527] investigates the raw material base of crushed stone and rubble stone in the Khmelnytskyi region. [528] studies the influence of deformation degree on the efficiency of thin sheet cold rolling. [529] models cone crusher steady-state operation modes. [530] proposes modelling the process of ensuring the environmental

sustainability of the airport as a functional component of socio-technical systems. [531] conducts experimental tests of the over-columned plates of the precast building frame. [532] investigates the effect of electrochemical impact on copper-molybdenum flotation separation. [533] conducts an experimental study of the effect of hydraulic gradient on soil hydraulic conductivity. [534] explores vegetation zone segmentation in multispectral imagery. [535] improves the evaluation of gamma radiation from cylindrical bodies with spatially inhomogeneous source activity distribution. [536] calculates round foundation slabs subjected to non-uniform base deformation under complex loads. [537] researches the effectiveness of using steel reinforcement for strengthening products made of natural stone. [538] investigates reducing the risk of power equipment failure when using information from the information measurement system of vibration diagnosis rotating units of auxiliary engines of power plants. [539] reviews the collapse behaviour of double-layer pipes. [540] proposes a technology for casting restoration by casting alloyed thermite melt onto the surface. [541] investigates changes in the intensity of polished surface glow of natural stone depending on the intensity of its heating. [542] presents a comprehensive approach to calculating operational parameters in hydraulic fracturing. [543] develops the modelling system core for severe plastic deformation processes. [544] explores harmful emissions of welding aerosol during pulse-arc welding of structural aluminium alloy D16. [545] investigates the propagation of elastic waves in cross-sectionally heterogeneous rods. [546] compares the seismic loading of points on the surface of the Earth during a massive explosion in a mine.

#### 4.10. Hydrology, water management, and sustainable tourism

Hydrology and water management are the focus of several papers. [547] assesses the aesthetic and ecological functions of the urbanized part of small watercourses using the indicator of the visual quality of the environment. [548] investigates the issues of technological modelling of physicochemical iron removal from deep groundwater at the rapid filter. [549] explores the influence of war on the content of some components in the rivers of Ukraine. [550] analyzes trends in the variability of particulate organic carbon distribution in the north-western part of the Black Sea. [551] presents geoinformation modelling of the geocological state of the floodplain-channel complex of rivers in the Turka city community of the Lviv region. [552] assesses the distribution and population characteristics of *Musculium lacustre* in anthropogenically altered aquatic landscapes of the northern right bank of the Dnipro River in Ukraine. [553] investigates the groundwater level dynamics in rice systems under different irrigation and drainage network parameters. [554] focuses on improving the efficiency of saline soil flushing under conditions of water resource scarcity. [555] analyzes the impact of water use and consumption for a nuclear power plant on alterations in the hydrological and temperature regimes of a river through a case study. [556] explores the regulation of water flow on the foothills of Ukrainian Carpathian rivers using flooded groynes. [557] applies numerical modelling for the interpretation of piezometric data on earth dams, considering uncertainties specific to dam operation. [558] analyzes current trends in water runoff of the Sluch River in terms of extraterritorial impacts of hydrotechnical construction. Sustainable tourism is represented by [559], which explores concession as a tool for improving budget and tax incentives for the investment attractiveness of the tourist complex in Ukraine. [560] proposes a new vision for ecological tourism in the industrial environment. [561] investigates sustainable development strategies in the field of tourism and recreation under war conditions in Ukraine. [562] identifies approaches to developing a response plan for potential emergencies caused by external water contamination. [563] investigates the influence of the accident at the Chernobyl nuclear power plant on the condition of pine plantations in Ukrainian forests. [564] designs a variable-structure controller for electric drives with ventilator torque.

#### *4.11. Geology, mineralogy, and petrology*

Geological aspects of sustainability are addressed in several papers. [565] proposes a concept for synthesizing the digital twin of a rock massif based on the stability criterion. [566] studies and analyzes amber deposits using ArcGIS techniques. [567] explores the features of mineral composition of garnet-bearing shales of the Kryvyi Rih basin and provides recommendations for further processing. [568] investigates the paleogeomorphological amber traps of the Prypiat amber-bearing basin in Ukraine, focusing on the theory and methodology of searches. [569] applies the geophysical method of NPEMFE for the preliminary geological outline of deposits of technological iron-containing raw materials. [570] studies the impact of low-molecular carboxylic acids on carbon dioxide corrosion of steel in underground gas production equipment in the Dnipro-Donetsk basin fields. [571] assesses the risks of soil foundation stability losses at the Kyiv-Pechersk Lavra Dormition Cathedral due to urban activities.

#### *4.12. Sustainable energy solutions and waste management*

Sustainable energy solutions are the focus of several papers. [572] explores the prospects for autonomous low-power renewable energy communities. [573] models and forecasts the production potential of renewable energy sources in the context of sustainable development. [574] proposes an electric drive of coordinated rotation for mechanisms of flow-transport systems. [575] determines the operating parameters of accumulative electric heating systems. [576] studies double short circuits on earth in 10 kV power grids with isolated neutral and high-level penetration of renewable energy sources. [577] discusses the postwar perspective of ammonia production in Ukraine. [578] analyzes the current state and prospects of renewable energy in heating and cooling systems in Ukraine. Waste management is addressed by [579], which focuses on the utilization of vegetative waste from the green infrastructure of cities “in-situ”. [580] explores the prospects of recycling metallurgical waste. [581] investigates the natural phytomelioration of coal mine waste heaps in the context of increased radiation background, focusing on the case of the Nadiya mine in the Lviv-Volyn coal basin, Ukraine. [582] proposes increasing the level of an ecologically oriented logistics system in waste management for territorial communities. [583] explores gypsum recycling using an inclined chamber vibrating jaw crusher. [584] explores radioecological monitoring as a critical factor in food quality management. [585] discusses the methodology for improving the concept of maximum security of a nuclear facility at minimum costs. [586] investigates the features of designing systems for the formation of an internal microclimate of a high class of cleanliness in operating rooms of medical institutions. [587] explores climate factors and their role in the development of wind energy in the Lviv region. [588] analyzes the current state and development prospects of the graphite industry in Ukraine. [589] revisits the mathematical model of the process of self-destruction of outburst-prone coals under hydrodynamic effect.

## **5. Conclusion**

The vision driving ICSF 2024 is to establish a paramount interdisciplinary platform, uniting researchers, practitioners, and educators to showcase and deliberate upon the latest innovations, emerging trends, concerns, practical challenges, and adopted solutions in the realm of sustainability.

We extend our sincere gratitude to the authors who submitted their papers and to the delegates for their enthusiastic participation and interest in ICSF as a conduit for sharing ideas and innovation. Our heartfelt appreciation also extends to the program committee members, whose unwavering guidance, dedication, and the invaluable contributions of peer reviewers have elevated the quality of the papers. The constructive critiques, improvements, and corrections they provided have significantly enriched the success of this conference. We also recognize the pivotal role of Morressier’s developers, whose robust conference management system facilitated

every stage of the process, from soliciting papers to coordinating peer reviews and crafting the conference proceedings volume.

A special acknowledgement goes to the session chairs, whose steadfast commitment to shaping the conference and its program has been exceptional. Their role has contributed significantly to the cohesive and productive flow of the conference sessions.

Furthermore, we express our gratitude to IOP Publishing for their generosity in waiving the APC payments for corresponding authors based in Ukraine. This initiative enables authors to publish open access without charge in the prestigious *IOP Conference Series: Earth and Environmental Science* journal (<https://iopscience.iop.org/journal/1755-1315>). Additionally, the submission extensions offered by IOP Publishing are a testament to their understanding of researchers' challenges and constraints, underscoring their dedication to fostering a supportive academic environment.

As we move forward, we anticipate exceptional presentations and insightful discussions that will expand our professional horizons. We hope that all participants find immense value in this conference and eagerly anticipate the prospect of reconnecting in a more convivial, light-hearted, and harmonious setting at ICSF 2025. The next instalment in the series, the 6th International Conference on Sustainable Futures: Environmental, Technological, Social, and Economic Matters, is set to take place in May 2025 in Kryvyi Rih, Ukraine (<https://icsf.easyscience.education/2025/>).

Thank you all for being an integral part of ICSF 2024, and here is to a brighter, more sustainable future that we collectively strive to build.

### Acknowledgments

We want to acknowledge the contributions of our late colleague, Serhii Mykhailovych Chukharev, a distinguished scholar and dedicated educator who passed away before this work was published.



**Figure 2.** Prof. Serhii Mykhailovych Chukharev (04/17/1958 – 08/30/2024).



Born on April 17, 1958, in Kropyvnytskyi (formerly Kirovohrad), Serhiy Mykhailovych was a beacon of knowledge and inspiration in the field of mining engineering.

Serhii Mykhailovych graduated from Kryvyi Rih Mining Institute in 1981, earning his degree as a mining engineer-builder. His academic journey continued with the defence of his PhD thesis in 1989, marking the beginning of a prolific career in academia and research. In 1996, he furthered his education by obtaining a second degree in finance and credit, showcasing his versatile intellect and commitment to lifelong learning.

Throughout his career, Serhii Mykhailovych held esteemed positions, including Associate Professor at the Department of Underground Mining of Mineral Deposits at Kryvyi Rih National University and later at the National University of Water and Environmental Engineering. His contributions to the field are immortalized in over 100 scientific and methodological works, including five patents.

Serhii Mykhailovych's research focused on developing innovative technologies and methodologies for the sustainable and efficient extraction of mineral resources. His early works explored the application of vibration mechanisms for forming asymmetric draw figures and the feasibility of this process. He also contributed to the development of a method for mining mineral deposits.

In the 1990s, Serhii Mykhailovych's research expanded to include the development of self-propelled equipment in the mining industry, the technology of extracting under-quarry ore reserves and improving the technology for extracting ore from the underground tier. He also investigated the patterns of formation of the drawing figure for ores with different physical and mechanical properties and the possibility of increasing the stability of the receiving horizon.

In the 2000s, Serhii Mykhailovych's research focused on using communication technologies to improve the efficiency of working with corporate bank clients and applying marketing to the creation and implementation of scientific and technical products.

In recent years, Serhii Mykhailovych's research has centered on the development of resource-saving mining technologies, the enhancement of the stability of mine workings during their excavation and operation in complex mining and geological conditions, and the selective mining of complex-structured ore deposits of the Kryvyi Rih basin.

Serhii Mykhailovych was not only a respected academic but also a mentor and guide to many students and colleagues. His dedication to advancing mining technology and resource-saving methods has left an indelible mark on the industry.

He is survived by his family, friends, and countless students who will remember him for his wisdom, kindness, and unwavering dedication to education and research.

May his soul rest in peace, and may his legacy continue to inspire future generations.

Serhii Mykhailovych was a valuable member of our research team and significantly contributed to this project. We miss him dearly.

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