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Sustainable development of water management in the context of climate change: Ukrainian experience

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ABSTRACT: Humans need access to clean water and sanitation for overall well-being, yet Ukraine faces significant challenges in meeting Sustainable Development Goal 6 (SDG6). This study examines Ukraine's progress, comparing its performance to that of Central and Eastern European peers and assessing water and climate risks using the World Wildlife Fund (WWF) Water Risk framework. Relevant literature and statistical data from Ukrstat (2015–2023) and the UN (2024) were analyzed to evaluate SDG6 indicators for Ukraine. Comparative benchmarking was conducted against Poland, the Czech Republic, Slovakia, and Hungary. WWF water risk metrics, including Basin Physical Risk, were examined. Ukraine demonstrated limited progress in key SDG6 indicators, including the share of rural and urban populations with centralized water drainage. A comparative analysis revealed that Ukraine underperformed in safely managed drinking water (87.6%) and wastewater treatment (50.2%). WWF data ranked Ukraine 74th globally in Basin Physical Risk, highlighting vulnerabilities in water availability and quality. Findings indicate a need for enhanced water protection practices and robust benchmarking methodologies to accelerate progress toward SDG6. Strengthened monitoring, policy reforms, and international collaboration are crucial for enhancing Ukraine's water security and achieving the SDG6 targets.
Keywords: climate change; sustainable development; water sector; SDG6.

Desenvolvimento sustentável da gestão da água no contexto das alterações climáticas: experiência ucraniana

RESUMO: Os seres humanos precisam de acesso à água limpa e ao saneamento básico para seu bem-estar de forma geral, mas a Ucrânia enfrenta desafios significativos para alcançar o Objetivo de Desenvolvimento Sustentável 6 (ODS6). Este estudo explora o progresso da Ucrânia, comparando seu desempenho com os pares da Europa Central e Oriental e avaliando os riscos hídricos e climáticos usando a estrutura de Risco Hídrico do Fundo Mundial para a Natureza (WWF). Foram analisados dados estatísticos da Ukrstat (2015–2023) e da ONU (2024) para avaliar os indicadores do ODS6 na Ucrânia. Realizou-se uma análise comparativa com Polônia, República Tcheca, Eslováquia e Hungria. Métricas de risco hídrico do WWF, incluindo o Risco Físico da Bacia, também foram examinadas. A Ucrânia demonstrou progresso limitado em indicadores-chave do ODS6, como a proporção de populações rurais e urbanas com acesso a redes de esgoto centralizadas. A análise comparativa revelou baixo desempenho da Ucrânia no gerenciamento seguro da água potável (87,6%) e no tratamento de águas residuais (50,2%). Dados do WWF classificaram a Ucrânia na 74ª posição global em Risco Físico da Bacia, destacando vulnerabilidades na disponibilidade e na qualidade da água. Os resultados indicam a necessidade de práticas aprimoradas de proteção hídrica e metodologias robustas de benchmarking para acelerar o progresso no ODS6. Monitoramento fortalecido, reformas políticas e colaboração internacional são cruciais para melhorar a segurança hídrica da Ucrânia e alcançar as metas do ODS6.
Palavras-chave: mudanças climáticas; desenvolvimento sustentável; setor hídrico; ODS6.

1. INTRODUCTION
1.1. Background

Access to clean water, sanitation, and hygiene is a fundamental human need essential for health and well-being. Without significant acceleration in progress, billions of people will still lack these basic services by 2030. The global availability of freshwater is increasingly threatened by rising demand driven by population growth, the need for greater food and industrial production, pollution from human activities, climate change, and ongoing conflicts.

The number of urban residents facing water stress is expected to rise significantly, from 930 million in 2016 to between 1.7 and 2.4 billion by 2050. By 2022, approximately 2.2 billion people may lack access to safe drinking water, 3.5 billion may lack access to safe sanitation, and 2.0 billion may not have basic hygiene services. Surface water bodies such as lakes, rivers, and reservoirs are under pressure due to rapid global changes. Water pollution has become a significant health concern worldwide, impacting both humans and the environment (UN World Water Development Report, 2023). According to projections, by 2050, at least one in four people will live in a country facing freshwater shortages, primarily due to the depletion of resources and declining water quality. Consequently, one of the United Nations' key goals is to ensure access to and sustainable management of water resources by 2030 (SERBOV et al., 2022).

The 2030 Agenda for Sustainable Development was adopted by all United Nations Member States in 2015 with 17 Sustainable Development Goals (SDGs) (United Nations, 2024). Among these, Goal 6 (clean water and sanitation) and Goal 13 (climate action) are particularly interconnected. In this context, ensuring universal access to sustainable water and sanitation services is a crucial strategy for mitigating climate change in the years to come. Limiting global temperature rise to 1.5°C, rather than 2°C, could significantly reduce the number of people facing water scarcity, although regional disparities exist (IPCC Sixth Assessment Report, 2021). Research (Snizhko et al., 2019; Hapich et al., 2024b) indicates that Ukraine has relatively limited water resources compared to much of Europe. The country's internal river runoff is about 50 km³, and its available groundwater reserves total just 5 km³. With an internal renewable water resource of 1,200 cubic meters per person per year, Ukraine ranks 37th out of 50 European countries (Hapich et al., 2024b).

1.2. The Water Crisis in Ukraine: Structural Factors

Ukraine's internal water resources are constrained. Statistics show that only 31.4% (55.1 km³) of the country's total renewable water resources originate domestically, and the remaining 68.6% (120.2 km³) is sourced from neighboring countries (FAO, 2017). Furthermore, it is estimated that 97% of Ukraine's water resources come from river runoff, with groundwater contributing only 3% (KHILCHEVSKY, 2021). Additionally, water resources are distributed unevenly across the country. The study by Snizhko et al. (2024) focuses on the southern, eastern, and central regions of Ukraine, where water resources are critically scarce. It highlights that the Danube basin, located in Ukraine's border regions, contributes the largest portion of water resources, accounting for about 50%. In comparison, the water demand in this area is approximately 5% of the total available water resources.

The water stress index, which measures the ratio of water withdrawal to average annual water resources, is notably high in southern and southeastern Ukraine, ranging from 40% to 80%. In certain areas, such as the Donetsk-Mariupol industrial region, it exceeds 80% (SNIZHKO et al., 2024). An analysis of the water stress index across Ukraine's regions from 2006 to 2017, conducted by Fedulova et al. (2021), yielded similar findings to those of Snizhko et al. (2024).

Global studies (Caparrós-Martínez et al., 2020; Qasemipour et al., 2020; Wu et al., 2020; Khan et al., 2021) emphasize that the reduction in Ukraine's water supply is a key factor driving the country's increasing import of virtual water, reaching critical levels (ARUNRAT et al., 2020; OBAJANA et al., 2020).

1.3. The Impact of Armed Conflict on Water Security

Ukraine's water security is under significant threat from climate change-related factors, including droughts and floods, which can result in substantial economic losses. However, the most immediate concern is the potential impact of military actions on the country's water security. Russia's occupation of southeastern Ukraine and the annexation of Crimea in 2014, along with the full-scale invasion that began on February 24, 2022, have further exacerbated the state of Ukraine's water resources.

Between February 2022 and 2024, it is estimated that Russian forces destroyed approximately one-third of Ukraine's freshwater resources, equating to around 18-20 km³ (HAPICH et al., 2024). This damage has had a severe impact on water supplies for drinking, industry, and agriculture, particularly in the southern and eastern regions. The total social, economic, and environmental losses are estimated to amount to tens of billions of US dollars, with recovery costs for Ukraine projected at around $600 billion (HAPICH et al., 2024).

Researchers, including Snizhko et al. (2024), have noted that the destruction of the Kakhovka Reservoir alone may have led to a loss of 10% of Ukraine's water resources, significantly affecting agriculture and industry in the southern regions and limiting access to safe drinking water for approximately 6 million people. Furthermore, up to 13 million people could face limited access to water for sanitation purposes.

The ongoing conflict has also resulted in extensive damage to Ukraine's water infrastructure, including the destruction of 1,947 kilometers of water supply networks, 23 sewage treatment plants, and several other critical water systems (Kyiv School of Economics, 2024). Restoring this infrastructure is a central focus of Ukraine's recovery efforts, as emphasized by Mahats (2023) and Kitowski et al. (2023). However, the continued conflict presents long-term challenges, not only for Ukraine's sustainable development but also for global efforts to achieve clean water, sanitation, and food security.

1.4. Significance and aims of the study

The 2024 progress report highlights that the world is not on track to meet the SDGs by 2030. As shown in Figure 1a, out of 135 targets with available trend data and insights from relevant agencies, only 17 are expected to be achieved by 2030. Nearly half (48%) of these targets have deviated significantly from their expected progress, with 30% showing only minimal progress and 18% indicating moderate progress. Worryingly, 18% of targets have stalled, and 17% have regressed compared to the 2015 baseline.

The indicators for SDGs 6 and 13, which are particularly relevant to this context, are especially concerning. As shown in Figures 1b and 1c, these goals have made the least progress toward their 2030 targets. For Goal 6, 64% of instances show only minimal to moderate progress, while 36% have either stagnated or regressed. Similarly, for Goal 13, 66% exhibit marginal or moderate progress, and 34% have either stalled or declined (UN DESA, 2024).

The importance of achieving the SDGs in Ukraine's agricultural sector is emphasized by Rudevska et al. (2024), who advocate for promoting agricultural processing in line with the Green Deal and supporting the sector's transition to more sustainable practices. It is also important to acknowledge that Ukraine's economic growth, which is largely driven by the agricultural sector, may face limitations due to water availability. Consequently, experts suggest that the most effective path to sustainable economic growth may involve implementing water-saving technologies and intensifying water conservation efforts in the region (FEDULOVA et al., 2021).

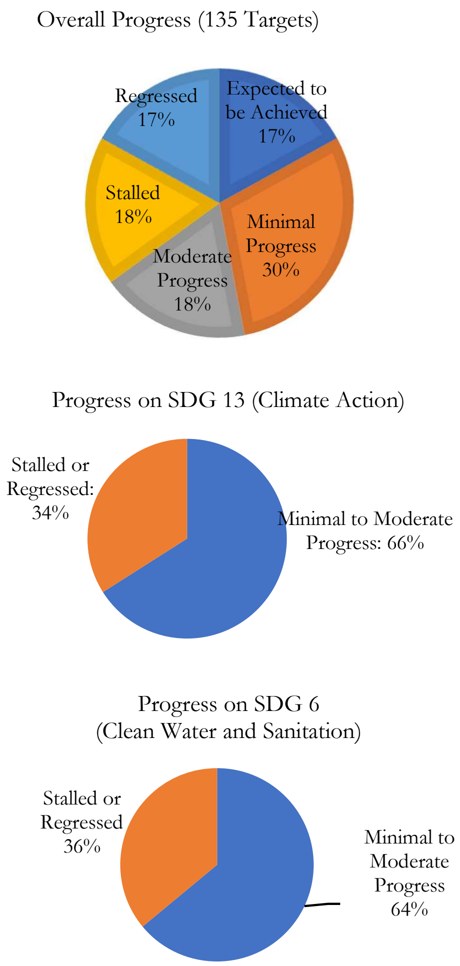

Figure 1. Progress towards SDGs targets by 2030 – 135 targets (A), SDG 13 (B) and SDG 6 (C). Source: Based on data from UN DESA (2024).
Figura 1. Progresso em direção às metas dos ODS até 2030 – 135 metas (A), ODS 13 (B) e ODS 6 (C). Fonte: Com base em dados do UN DESA (2024).

Gunda et al. (2019) observed that many water security studies tend to concentrate on water quantity, often neglecting the evaluation of water quality and its adequacy for meeting essential societal needs, which are key components of water security. It is crucial to understand that even when there is an adequate supply of water, its quality may still be insufficient. The combination of diminished water availability and poor water quality, exacerbated by climate change in various regions, can lead to water stress and significantly impact water security.

Water quality is a particularly critical issue for Ukraine, where surface water resources, primarily river runoff, make up 97% of the total water volume (SNIZHKO et al., 2019). In light of this, the water strategy for Ukraine, which is set to guide policies until 2025, highlights the considerable negative effects on water bodies caused by diffuse runoff from agricultural, urban, and industrial waste areas, as well as landfills (DOROSH et al., 2023).

Agriculture is a major diffuse source of water pollution. As suggested by the authors above, establishing water protection zones with regulated economic activities and coastal protection strips with limited economic use and specific agricultural land conditions may be an effective approach. However, it is worth noting that the previous procedure for allocating water protection zones, which was introduced in 1966, did not adequately address the requirements of EU Directives, such as Directive No. 91/676/EC, which aims to protect waters from nitrate pollution caused by agricultural sources (DOROSH et al., 2023).

The importance of assessing the quality of groundwater (well water quality), which is polluted by the aforementioned diffuse sources of pollution and then used for drinking in developing countries, can be judged from the work of Gelsanda et al. (2024). To achieve SDG 6, effective facilities for urban and industrial wastewater treatment are crucial, but as shown by Mykhailenko et al. (2023), biological wastewater treatment plants may, in some cases, contribute to environmental pollution through the release of persistent organic pollutants. This has been observed in the Odesa industrial and urban agglomeration.

The importance of using green bonds for energy security and sustainable development is described by Sembiyeva et al. (2023). They demonstrated that over the last five years, green bonds have been widely utilized to finance environmental improvement initiatives, including sustainable infrastructure for clean and drinking water, wastewater treatment, and adaptation to climate change, which align with SDG 6 and SDG 13.

Research shows that the threat of climate change worries not only scientists, politicians and public figures, but also the general population. Thus, in a three-year (2020-2022) experimental survey of 346 Polish households nationwide through computer-assisted web interviews, it was found that the threat of climate change was of great concern to 12.5% of respondents in 2020 and 20.2% of respondents in 2022. In terms of the growth rate of respondents over three years, the threat of climate change (+7.7%) was in fourth place after the nuclear threat and use of mass destruction weapons (+16.5%), energy shortages (+9.7%) and local conflict (+8.3%) (SAPIŃSKI; SZYDŁOWSKI, 2022).

Water security is becoming more vulnerable due to climate-related factors, such as droughts and floods, which can result in significant economic damage (LEVKOVSKA et al., 2020; SNIZHKO et al., 2019; POKHREL et al., 2021; QUANDT et al., 2022; LEVKOVSKA et al., 2023).

Demydenko (2020) explores the Global Water Partnership's experience in integrating risk-based Integrated Water Resources Management (IWRM) into Ukraine's water policy. He critiques the outdated post-Soviet "rational use" concept, which aims to meet specific standards and ensure water security. This concept, however, focuses only on human water risks and neglects the broader environmental context. Demydenko argues that effective environmental management is impossible without measuring its parameters. He therefore supports replacing the outdated model with a measurable, goal-driven approach that integrates risk management into water policy. It is essential to note that this modern concept closely aligns with the principles of the Sustainable Development Goals.

The Eastern Partnership countries of the European Union, including Armenia, Azerbaijan, Georgia, Moldova, and Ukraine, are currently adopting this approach. Belokurov et al. (2024) outline the progress and challenges these nations face in aligning their water management practices with EU and international standards, such as the EU Water Framework Directive, the United Nations Water Convention, and the Sustainable Development Goals. The authors emphasize that this approach should involve integrated water management across various water users, economic tools for resource management, funding strategies for the sector, participatory planning at the river basin level, comprehensive water monitoring that includes ecological factors, data sharing on water resources, and strengthened cross-border cooperation on shared waters.

The management of freshwater resources, based on monitoring the achievement of quantitative SDG6 indicators, is discussed in the works of Sebrov (2021) and Serbov et al. (2022). These research efforts underscore the importance of considering the balance among the three core aspects of sustainable development: economic, environmental, and social.

An analysis of the key challenges in water management, such as non-compliance with European standards, outdated infrastructure, and the absence of effective planning, monitoring, and control systems for water resource usage, indicates that these issues primarily stem from the shortcomings of the state's water resources management system.

To tackle these challenges, Diegtiar et al. (2020) proposed an algorithm designed to establish an efficient water resource management system at the state level. This approach would entail the creation and execution of public-private partnership initiatives that adhere to the principles of effective water management.

Cherkashyna (2024) suggests that a new version of the Water Code of Ukraine could be beneficial, as the current law has not undergone significant updates since its adoption in 1995. The existing code contains outdated provisions and contradictions that simple amendments cannot fully address. Uberman; Vaskovets (2020) propose that Ukraine's water protection strategy may need to evolve, shifting from an economic focus to a more environmental one, in line with EU principles. An alternative to revising the Water Code could be the creation and adoption of a new Law of Ukraine "On Water Protection."

Fedulova et al. (2020) discuss the need to classify water infrastructure as a critical sector of infrastructure in Ukraine and its regions. Their findings have contributed to new ideas on securing the economic stability of regional socio-economic systems, particularly those prioritizing the development of engineering and technical infrastructure.

Iskakova (2024) addresses the role of lifelong learning and e-learning in achieving the Sustainable Development Goals, emphasizing the importance of education in this context. Pazos et al. (2023) similarly highlight education as a fundamental pillar of sustainable development.

1.5. Research questions and contribution

Thus, this literature review revealed a notable absence of publications on the quantitative analysis of SDG6 indicators for Ukraine, including their comparison with those of other countries, as well as a lack of publications on the quantitative assessment of water and climate risks for Ukraine.

Since Ukraine is participating in the SDGs programme) As goals 6 and 13 fall within the proposed research topic, it is essential to determine what is being done to achieve the 2030 goals in this country. This will be the focus of the literature review. It will identify unexplored challenges within the quantitative analysis of the SDGs and WWF Water Risk indicators. The following research questions are posed:

1. To study the dynamics of time series of values of indicators of Sustainable Development Goal 6 "Clean water and sanitation" based on Ukrainian statistics, and to show for which indicators Ukraine is far behind in achieving the 2025 and 2030 goals;
2. To make a comparative analysis of the current values of indicators of Sustainable Development Goal 6 "Clean water and sanitation" of selected countries of Central and Eastern Europe, including Ukraine, based on UN statistics, and to show in which indicators Ukraine lags far behind its competitors.
3. To make a comparative analysis of the current values of the World Wildlife Fund Water Risk (WWF Water Risk) for Ukraine and its closest competitors and to study the structure of values of this indicator against the background of values for other countries of the world;
4. To disseminate these comparative analyses within the framework of internal and competitive benchmarking.

2. MATERIALS AND METHODS

The procedure for searching for relevant publications for writing a literature review was as follows (October 5, 2024). In the advanced search of Google Scholar, in its first line (search for articles in which all words occurs), the term "water sector" was written in quotation marks so that the search occurred by the exact phrase, in the second line (search for articles in which the exact phrase occurs), the term sustainable development was written without quotation marks, in the third line (search for articles that contain at least one of the words), the word Ukraine was written.

Through an advanced Google Scholar search, 1,100 responses (publications) were received. In the process of the search settings, the term "water sector" was entered in the first line, "sustainable development" in the second line, and "Ukraine" in the third line. And the option "anywhere in the article" was selected for all search terms. The most relevant publications with good metadata and full texts were located on the first five pages (50 publications).

We selected 32 journal articles from the initial pool of 50 that met predefined inclusion criteria, specifically full-text availability, publication in English, relevance to the intersection of the water sector, sustainable development, and Ukraine, and publication in peer-reviewed journals indexed in Scopus or Web of Science. Additionally, the relevance was assessed through a careful reading of titles and abstracts to ensure a substantive thematic focus. The selected set included leading journals such as *Sustainability*, *Science of the Total Environment*, *Water International*, *Global Ecology and Conservation*, *Water Security*, *Water Policy*, *Nature Climate Change*, *Ecohydrology & Hydrobiology*, *Frontiers in Water*, *Regional Environmental Change*, and *Ecological Economics, among others*. A total of 47 publications were used in the article, comprising 32 journal articles and additional reports from international organizations that included statistical data. Approximately 40 publications informed the Introduction and Literature Review of this work.

The analysis of these publications revealed issues that had not yet been explored in the literature.

This analysis reveals that the quantitative analysis of SDG6 indicators for Ukraine, including their comparison with those of other countries, as well as the quantitative assessment of water and climate risks for Ukraine, has been largely unexplored. In the first case, statistical data from Ukrstat (Sustainable Development Goals, 2024) and the UN (United Nations, 2024) were used to study these issues. In the second case, statistical data and methodology from the World Wildlife Fund (WWF, 2024a, b, c) were utilized.

When analyzing the time series of values of selected SDG6 indicators for Ukraine, their target values for 2025 and 2030 from the Sustainable Development Goals (2017) were used, and for comparison with the values of current SDG6 indicators for Ukraine, Poland, the Czech Republic, Slovakia and Hungary were taken (United Nations, 2024). These countries were selected based on their geographic proximity to Ukraine, similar post-socialist development trajectories and availability of comparable SDG6 data. This makes them suitable regional benchmarks for reference in this work.

In the first case, it is proposed to consider and develop this time series analysis within the framework of the internal benchmarking methodology. In the second case, it is proposed to consider and develop this time series analysis within the framework of the competitive benchmarking methodology. A comparative analysis of WWF Water Risk indicators for Ukraine and its closest competitors is proposed for consideration and development within the competitive benchmarking methodology.

3. RESULTS AND DISCUSSION

Time series of values of selected indicators of Sustainable Development Goal 6, "Clean water and sanitation", for Ukraine are presented in Table 1. We took the structure of this table from the work (Serbov, Irtyshcheva, & Pavlenko, 2022), in which we corrected errors in the digital data and added data for 2021 - 2023 based on Sustainable Development Goals (2024), and also clarified the target data for 2025 and 2030 based on Sustainable Development Goals (2017).

Table 1. Time series of key indicators for Sustainable Development Goal 6, "Clean Water and Sanitation," in Ukraine.
Tabela 1. Séries temporais de indicadores selecionados do Objetivo de Desenvolvimento Sustentável 6 “Água Potável e Saneamento” para a Ucrânia.

Indicators	2015	2016	2017	2018	2019	2020	2021	2022	2023	2025*	2030*
1. Safety and quality of drinking water in terms of microbiological indicators (by % of non-standard samples)											
1.1. By type of area											
Urban	3.1	4.3	4.6	5.1	5.7	4.7	5.1	2.1	2.7	**	**
Rural	7.6	10.4	11.2	11.8	11.4	13.8	11.9	11.4	11.0	**	**
1.2. By type of water supply											
Centralized	4.6	6.4	6.7	7.7	8.2	7.6	7.5	3.5	4.3	**	**
Decentralized	18	23.1	20.4	23.4	24.6	22.6	22.9	28.3	25.1	**	**
2. Percentage of the rural population with access to centralized water drainage	3	2.2	2.5	2.5	1.8	5.3	5.2	5.3		50	80
3. Percentage of the urban population with access to centralized water drainage	92	94.1	95.1	96.0	96.6	71.7	74.2	74.8	-	100	100
4. The amount of untreated or inadequately treated wastewater discharged into water bodies, measured in millions of cubic meters	875.1	698.3	997.3	952	737.2	518.4	541.5	374.0	375.7	557	279
5. The proportion of untreated or inadequately treated wastewater discharged into water bodies as a percentage of the total discharge volume	16.38	12.93	21.15	18.27	13.72	10.05	11.56	12.25	11.74	10	5
6. Water usage per unit of GDP, expressed in cubic meters of water per 1000 UAH of GDP (at current prices).	23.62	19.44	15.13	11.59	10.30	9.94	7.33	4.27	3.74	2.9	2.5
7. Current water intensity of GDP, expressed as a percentage relative to the 2015 level	100	82.3	64.06	48.08	43.61	42.08	31.05	18.06	15.84	80	70

Note. * Reference point, ** indicator is specified. Source: Serbov, Irtyshcheva, & Pavlenko (2022); Sustainable Development Goals (2017, 2024).
Nota. * Ponto de referência, indicador especificado. Fonte: Serbov, Irtyshcheva e Pavlenko (2022); Objetivos de Desenvolvimento Sustentável (2017, 2024).

It is interesting to see in which time series there are accentuated differences, starting with Russia's military aggression (2022). We observe such differences for indicators 1.1 (urban area), 1.2 (both indicators), 4, 7. In terms of achieving target values (2025 and 2030), the worst situation is with indicators 2, 3, 7. The proposed Table 1 can serve as a basis for future internal benchmarking, when achieving the SDG6 target indicators will be achieved through the use of best water protection practices.

In our case, such benchmarking should be referred to as SDG6 benchmarking. The integral indicator is the SDG6 Index, which ranges from 0 to 100%, indicating how close each indicator is to its target. For each indicator, the degree of approximation is calculated by subtracting the absolute difference between the actual value and the target value from 1, then dividing the result by the target value and multiplying by 100. The SDG6 Index is then the average of these values across all indicators with defined targets. Let us consider the second case for Table 1.

In Table 1, we have 6 indicators for which we have defined targets at the 2030 level. These six indicators were selected because they have clearly defined quantitative targets for 2030. They are also regularly reported in national statistics and comprehensively represent key dimensions of SDG 6 relevant to Ukraine. For each indicator, we define the SDG6 Index as the percentage of the distance covered to reach 100%. After that, we determine the arithmetic mean of six values of the individual SDG6 Index. As a result, we obtain the total SDG6 Index, which equals 37.1% for the 2022-2023 level in Ukraine.

A similar index, calculated by Voza (2024) for the 2017 level based on the Sustainable Development Goals Report (2018) for 13 upper-middle-income countries, including Ukraine, was equal to 72.25%. The same paper calculated the

SDG6 index for 28 high-income countries, which was equal to 83.30%.

Rajapakse et al. (2023) calculated the SDG Index for Eastern European and Central Asian countries, which was 69.9% in 2017 and 71.6% in 2022. As we can see, our calculated SDG6 Index for Ukraine is two times lower than the average values of this index for groupings of countries that include Ukraine.

A recent study conducted by Korolchuk (2024) reveals that a qualitative analysis shows no progress in achieving Goal 6 (Table 6), which is consistent with our results.

From the website of the Department of Economic and Social Affairs (United Nations), We have selected current data on eight available SDG6 indicators for Ukraine and four countries in Central and Eastern Europe (United Nations, 2024), and presented them in Table 2. We selected these eight indicators based on the availability of data for Ukraine and the comparator countries. Also, their alignment with the official SDG6 global indicator framework and their relevance in assessing progress toward clean water and sanitation were considered. As can be seen from this table, Ukraine had the worst performance compared to other countries for the key indicators of the shares of population using safety-managed drinking water services (6.1.1) and safely treated domestic wastewater flows (6.3.1). The same was noted for indicator 6.5.1, namely that Ukraine is performing poorly in integrated water resources management.

Ukraine also had the worst value for the water use efficiency indicator (6.4.1). Note that this indicator in Table 1, compared to Table 2, had the inverse value (m^3/1000 UAH) in terms of GDP. In terms of water stress level (6.4.2), Ukraine had intermediate values among the countries under consideration, i.e. Its values were higher than those for Slovakia and Hungary, but lower than those for Poland and the Czech Republic.

Water stress is higher in Poland and the Czech Republic than in Ukraine, primarily due to more intensive agricultural and industrial water use. In Poland, water-demanding crops and droughts increase irrigation needs (PIWOWAR, 2023). In the Czech Republic, irrigation deficits have nearly doubled since the 1960s, primarily due to changes in crop and land use (MOZNY et al., 2021). The lower water withdrawals reflect less pressure from these sectors in Ukraine.

Table 2. SDG6 indicator values for selected Central and Eastern European countries.
Tabela 2. Valores indicadores do ODS6 para países selecionados da Europa Central e Oriental.

6.1.1. Percentage of the population with access to safely managed drinking water services, % (2022)				
Ukraine	Poland	Czech Republic	Slovakia	Hungary
87,6	88.9	97.9	99.2	100
6.3.1. Proportion of Safely Treated Domestic Wastewater Flows, % (2022)				
Ukraine	Poland	Czech Republic	Slovakia	Hungary
50.2	77.4	91.3	82.0	82.1
6.3.2. Percentage of water bodies with good overall water quality, % (2023)				
n/d	67.6	15.5	61.4	13.0
6.4.1. Water Conservation Efficiency (United States Dollars Per Cubic Meter) (2021)				
Ukraine Total – 7.77	Industries –4.96	Agriculture –0.11	Services – 20.3	
Poland Total – 51.7	Industries – 2.9	Agriculture – 0.11	Services – 173	
Czechia Total – 139	Industries –82.0	Agriculture –1.62	Services – 210	
Slovakia Total – 153	Industries – 106	Agriculture – 1.71	Services – 205	
Hungary Total – 26.3	Industries – 9.78	Agriculture – 0.46	Services – 135	
6.4.2. Water Stress Level: Freshwater Withdrawal Relative to Available Freshwater Resources, % (2021)				
Ukraine Agriculture – 3.8	Industries – 5.02	Services – 3. 44	Total – 12, 3	
Poland Agriculture – 4.54	Industries – 20.7	Services – 6.83	Total – 32, 1	
Czechia Agriculture – 0.56	Industries – 10.4	Services – 9.53	Total – 20, 5	
Slovakia Agriculture – 0.13	Industries – 1.02	Services – 1.28	Total – 2.44	
Hungary Agriculture – 0.95	Industries – 5.98	Services – 1.14	Total – 8.07	
6.5.1. Proficiency in Implementing Integrated Water Resources Management, %				
Ukraine (2020)	Poland (2023)	Czechia (2023)	Slovakia (2023)	Hungary (2023)
39	75	80	57	76
6.5.2Proportion of Transboundary Aquifers with Established Water Cooperation Agreements, % (2023)				
Ukraine	Poland	Czechia	Slovakia	Hungary
63.8	66.5	100	27.9	100
6.6.1. Permanent Water Area of Lakes and Rivers (sq km)				
Ukraine (2022)	Poland (2021	Czechia (2021)	Slovakia (2022)	Hungary (2022)
3.93K	1.18K	893	106	1.14K

Source: United Nations (2024).
Fonte: Nações Unidas (2024).

Water stress is higher in Poland and the Czech Republic than in Ukraine, primarily due to more intensive agricultural and industrial water use. In Poland, water-demanding crops and droughts increase irrigation needs (PIWOWAR, 2023). In the Czech Republic, irrigation deficits have nearly doubled since the 1960s, primarily due to changes in crop and land use (MOZNY et al., 2021). The lower water withdrawals reflect less pressure from these sectors in Ukraine.

According to the values of the indicator “Proportion of Transboundary Aquifers With An Operational Arrangement for Water Cooperation", Ukraine ranked fourth among the five countries under consideration. According to the total permanent area of rivers and lakes, Ukraine ranked first among the countries under consideration.

It should be noted that the UN SDG 6 indicators differed from the indicators used in Ukrainian statistics. Taking the first two indicators from Table 2 for which the target indicators are equal to 100%, the average SDG6 Index for Ukraine is 68.9%. In contrast, the average SDG6 Index for the four countries under consideration is 89.9%. As noted above, the 2022 SDG6 Index for Eastern Europe & Central Asia, calculated based on a larger number of individual indicators, was equal to 71.6%. (RAJAPAKSE et al., 2023).

The values of the Water Stress indicator (6.4.2) in Table 2 are close to the values of this indicator for the five countries under consideration, calculated in the FAO and UN Water (2021) report for the level of 2018: Ukraine - 13.87%, Poland - 33.22%, Czechia - 24.19%, Slovakia - 2.39%, Hungary - 7.65%.

From the SGD6 indicators, we will proceed to a more complex system of indicators proposed by the World Wildlife Fund (WWF), which has not yet been discussed in the Ukrainian scientific literature. The SGD methodology, with its 17 goals, considers individual indicators that are not aggregated to obtain aggregated and integral indicators. The WWF methodology employs a weighted aggregation of individual indicators to calculate integral indicators, with initial individual indicators determined based on both statistical data and expert surveys.

In 2012, the World Wildlife Fund (WWF) introduced the Water Risk Filter, a screening tool designed for corporations and investment portfolios to identify water-related risks and prioritize actions regarding water resources. It's worth mentioning that the WWF operates in over 80 countries worldwide.

The WWF Water Risk Filter framework is structured into three levels: First, it categorizes risks into three types: physical, regulatory, and reputational. Second, 12 risk categories provide insights into each risk type. Finally, it includes 42 indicators, with various indicators corresponding to different risk categories. Most of these indicators are derived from publicly available, peer-reviewed datasets. We understand that these indicators are reviewed and updated every two years, incorporating the latest research and the best available data.

The weighting coefficients within this framework were established using expert assessment methods. The values for all individual and aggregated indicators are scaled from 0 to 5, with the overall Risk Score automatically fitting within this range. An overview of the WWF Risk Filter Suite and its tools can be found in the Guide (WWF, 2024a), while the detailed calculation methodology is outlined in (WWF, 2024b).

In the following discussion, we will focus on physical risks, particularly basin physical risks, that encompass both water and climate-related hazards. It is crucial to recognize that these physical risks arise from the reliance of businesses and their supply chains on various natural and anthropogenic factors affecting land, freshwater, climate, and marine environments. Additionally, it is important to consider that these pressures may compromise ecosystem services over time.

Country profiles for water risks as of 2020 are provided by WWF (2024c). The structure of the Risk Score in the Ukrainian Basin Physical Risk is provided in Table 3. From it, we see that the values of the integral and aggregate risks are worse than the average value for the entire sample of countries, if we conditionally take 2.5 for this value. From this Table, we also see that the integral indicator (Physical Score) consists of five aggregated sub-indicators, which in total consist of 23 individual indicators.

Table 3. Risk score structure in the Ukrainian Basin Physical Risk.
Tabela 3. Estrutura de pontuação de risco na Bacia Ucraniana de Risco Físico.

Basin Risk	Risk Score	Ranking	Number of Indicators
Physical Risk	2.69	74	23
Water Availability	1.9	51	4
Drought	3.24	68	2
Flooding	2.29	61	2
Water Quality	3.52	108	9
Ecosystem Services status	2.44	49	6

Source: WWF (2024c).
Fonte: WWF (2024c).

The positioning of Ukraine in terms of basin physical risk, compared to its nearest competing countries, is presented in Table 4. In this Table, we have listed the countries with the best and worst Physical Score values, along with their corresponding ranks. The maximum risk is observed for the Palestinian Territory, and the minimum for Norway. Since the Palestinian Territory's rank is 119, we see that the World Wildlife Fund makes quantitative Physical Score estimates for 119 countries. Ukraine's closest neighbors in terms of Risk Score values, except for three countries in central, eastern, and southern Europe, are island countries, as well as countries in Africa and Latin America.

The following calculations on the Risk Score will lead to even worse values of this indicator for Ukraine, as they will be carried out during wartime or post-war times, with destroyed water infrastructure.

Table 4. Positioning of Ukraine in terms of basin physical risk compared to its nearest competing countries.
Tabela 4. Posicionamento da Ucrânia em termos de risco físico da bacia em relação aos países concorrentes mais próximos.

Country	Risk Score	Rank
Palestinian Territory	3.678	119
Mexico	2.724	77
Guadeloupe	2.719	77
Gambia	2.71	76
Czech Republic	2.705	75
Moldova	2.688	74
Ukraine	2.688	74
Mauritania	2.687	74
US Virgin Islands	2.682	73
British Virgin Islands	2.682	73
Greece	2.675	72
Togo	2.669	72
Norway	1.622	1

Source: WWF (2024c).
Fonte: WWF (2024c).

Based on a 5-level uniform classification scale for Risk Score (Opperman et al., 2022), we observe that the Risk Score for Ukraine falls within the interval 2.6-3.4, corresponding to a medium risk. At the same time, Serbov (2022) notes that the considered indicator for Ukraine is in the "high risk" zone and is steadily moving towards a "very high risk" status.

Tables 2 and 4, which we have reviewed, can be used in the future to construct competitive benchmarking procedures, where the achievement of the leaders' target indicators will be facilitated through the use of best water protection practices.

For SGD benchmarking in general, the procedure was developed by the ESPON (European Spatial Planning Observation Network) and described in ESPON's SDGs benchmarking tool (2020), which consisted of selecting an SDG, selecting an indicator, selecting an EU region (NUTS 2) and comparing the regions on the SDG6 index. This does not address the technical issue of actually accelerating the movement towards SDG6 through the use of best practices, as required by the benchmarking. This shortcoming was addressed in Alzlzly (2024), which described best practices for the SGD7 benchmarking, but the four steps of the SDGs benchmarking tool (2020) were not considered. Therefore, the development of a full-fledged SGD6 benchmarking process requires further efforts.

The analysis of SDG indicators over time for Ukraine (see Table 1) enables us to address the initial research question posed in the Introduction. It demonstrates that there has been limited advancement towards the targets set for 2025 and 2030 concerning the proportion of the rural population with access to centralized water drainage, the proportion of the urban population with similar access, and the current water intensity of GDP compared to levels in 2015.

Moreover, a comparative evaluation of the current statistics for Sustainable Development Goal 6, "Clean Water and Sanitation," across selected Central and Eastern European nations, including Ukraine, using UN data (see Table 2), sheds light on the second research question mentioned in the Introduction. This evaluation reveals that Ukraine performs the worst among its counterparts in crucial indicators, such as the percentage of the population with access to safely managed drinking water services (6.1.1) and the percentage of the population with access to safely treated domestic wastewater flows (6.3.1).

Furthermore, a comparative evaluation of the current values of the World Wildlife Fund Water Risk (WWF Water Risk) for Ukraine and its closest competitors (Tables 3 and 4) addresses the third research question raised in the Introduction, demonstrating the values of the aggregate indicators (water availability, drought, flooding, water quality, ecosystem services status) and the integral indicator (physical risk) for Ukraine are worse than the average values of these indicators for 119 countries of the world.

It is demonstrated that the time series analysis of SDG indicator values for Ukraine can be conveniently transformed into an internal benchmarking procedure to track the movement of these indicator values toward their target values, provided that the achievement of these target indicator values is achieved through the use of best water protection practices. Similarly, the comparative analysis of SDG6 and WWF Water Risk indicators for Ukraine and other countries (research questions 2 and 3) can be transformed into a competitive benchmarking procedure if the achievement of target indicator values by leaders can be achieved through the use of best water protection practices. This is the answer to the fourth research question.

4. CONCLUSIONS

This study analyzed Ukraine's progress toward achieving Sustainable Development Goal 6 (SDG 6), comparing its indicators with those of Central and Eastern European countries, and evaluating water and climate risks using the WWF Water Risk framework. The findings revealed significant shortcomings in Ukraine's performance. Key SDG6 indicators, such as access to centralized water drainage for rural and urban populations and safely managed drinking water services, lag far behind regional peers. Comparative analyses with Poland, the Czech Republic, Slovakia, and Hungary highlighted Ukraine's consistent underperformance, particularly in wastewater treatment and water-use efficiency. Furthermore, Ukraine ranked 74th globally in Basin Physical Risk, with vulnerabilities in water availability, drought, flooding, and water quality.

Achieving the 2025 and 2030 SDG6 targets requires urgent implementation of best practices in water protection, robust policy reforms, and benchmarking procedures.

5. REFERENCES

ALZLZLY, K. R. H. The role of benchmarking technique in achieving the seventh goal of Sustainable Development Goals in the business sector. **Pakistan Journal of Life and Social Sciences**, v. 22, n. 1, p. 4798-4806, 2024. https://doi.org/10.57239/PJLSS-2024-22.1.00353

ARUNRAT, N.; PUMIJUMNONG, N.; SEREENONCHAI, S.; CHAREONWONG, U.; WANG, C. Assessment of climate change impact on rice yield and water footprint of large-scale and individual farming in Thailand. **Science of the Total Environment**, v. 726, e137864, 2021. https://doi.org/10.1016/j.scitotenv.2020.137864

BELOKUROV, A.; DÉCHELETTE, C.; GRIFFITHS, M.; HALPERN, G.; SEGUIN, P.; ZINKE, A. A shared water culture between the European Union and the Countries of the Eastern Neighbourhood. **Water International**, v. 49, n. 3-4, p. 563–571, 2024. https://doi.org/10.1080/02508060.2024.2321772

CAPARRÓS-MARTÍNEZ, J. L.; RUEDA-LÓPEZ, N.; MILÁN-GARCÍA, J.; DE PABLO VALENCIANO, J. Public policies for sustainability and water security: the case of Almeria. **Global Ecology and Conservation**, v. 23, e01037, 2020. https://doi.org/10.1016/j.gecco.2020.e01037

CHERKASHYNA, M. Environmental Policy of Ukraine in the Field of Water Legal Relations. In: **The Palgrave Handbook of Environmental Policy and Law. Palgrave Studies in Sustainable Futures**. Palgrave Macmillan, Cham, 2024. p. 1-12. https://doi.org/10.1007/978-3-031-30231-2_15-1

DEMYDENKO, A. What SDG6 is about: 'sustainable management' or 'rational use'? **Water Policy**, v. 22, n. 6, p. 1015-1023, 2020. https://doi.org/10.2166/wp.2020.062

DIEGTIAR, O. A.; HORNYK, V. H.; KRAVCHENKO, S. O.; VALENTYNA, V.; SHTAL, T. V. Improving public water resources policy in Ukraine: Municipal and environmental issues. **Journal of Environmental Management and Tourism**, v. 11, n. 3, p. 672-678, 2020.

DOROSH, Y.; DERKULSKYI, R.; DOROSH, A.; KABUZAN, A. Restrictions on the use of agricultural land in Ukraine for the protection of water resources.

Acta Scientiarum Polonorum Administratio Locorum, v. 22, n. 4, p. 511-524, 2023. https://doi.org/10.31648/aspal.9175

ESPON's SDGs benchmarking tool, 2020. https://sdg.espon.eu/. Accessed on: 10 Dec. 2024.

FAO and UN Water. **Progress on level of water stress**. Global status and acceleration needs for SDG Indicator 6.4.2, 2021. Rome. https://doi.org/10.4060/cb6241en

FEDULOVA, S.; DUBNYTSKYI, S.; NAUMENKO, N.; KOMIRNA, V.; MELNIKOVA, I.; AGABEKOV, B. Effective economic growth under conditions of regional water management dependence. **Agricultural and Resource Economics**, v. 7, n 1, p. 22-43, 2021. https://doi.org/10.51599/are.2021.07.01.02

FAO_Food and Agriculture Organization of the United Nations. **Ukraine - Aquastat country profile**. Rome: FAO, 2017. Available at: https://www.fao.org/aquastat/en/countries-and-basins/country/UKR. Accessed on: 12 Jun. 2025.

FEDULOVA, S.; PIVOVAROV, O.; KHUDOLEI, V.; KOMIRNA, V.; KALYNOVSKYI, A. Water infrastructure and economic security of regional socio-economic systems: evidence from Ukraine. **Problems and Perspectives in Management**, v. 18, n. 2, p. 166-179, 2020. https://doi.org/10.21511/ppm.18(2).2020.15

GELSANDA, C. I.; MARCHIANTI, A. C. N.; NURDIAN, Y. The Relationship Between Well Water Quality and Cognitive Function in Well Water Users. **Futurity Medicine**, v. 3, n. 2, p. 4-13, 2024. https://doi.org/10.57125/FEM.2024.06.30.01

GUNDA, T.; HESS, D.; HORNBERGER, G. M.; WORLAND, S. Water security in practice: The quantity-quality-society nexus. **Water Security**, v. 6, e100022, 2019. https://doi.org/10.1016/j.wasec.2018.100022

HAN, X.; ZHAO, Y.; GAO, X.; JIANG, S.; LIN, L.; AN, T. Virtual water output intensifies the water scarcity in Northwest China: current situation, problem analysis and countermeasures. **Science of the Total Environment**, v. 765, e144276, 2021. https://doi.org/10.1016/j.scitotenv.2020.144276

HAPICH, H.; NOVITSKYI, R.; ONOPRIIENKO, D.; DUBOV, T. Water on fire: losses and the post-war future of ecosystem services from water resources of Ukraine. **Reg Environ Change**, v. 24, e154, 2024. https://doi.org/10.1007/s10113-024-02320-6

HAPICH, H.; NOVITSKYI, R.; ONOPRIIENKO, D.; DENT, D.; ROUBIK, H. Water security consequences of the Russia – Ukraine War and the post – war outlook. **Water Security**, v. 21, e100167, 2024. https://doi.org/10.1016/j.wasec.2024.100167

IPCC Sixth Assessment Report. **Climate Change 2021**: The Physical Science Basis. Chapter 8: Water Cycle Changes, 2021, p. 1055-1210. Available at: https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_Chapter08.pdf.

ISKAKOVA, M. Prospects for Using E-Learning Tools to Implement the Concept of "Lifelong Learning". **E-Learning Innovations Journal**, v. 2, n. 2, p. 80-101, 2024. https://doi.org/10.57125/ELIJ.2024.09.25.05

KHILCHEVSKYI, V. K. Characteristics of Ukraine's water resources based on the global information system FAO Aquastat database. **Hydrology, Hydrochemistry, and Hydroecology**, v. 1, n. 59, p. 6-16, 2021. https://doi.org/10.17721/2306-5680.2021.1.1

KITOWSKI, I.; SUJAK, A.; DRYGAŚ, M. The water dimensions of Russian - Ukrainian Conflict. **Ecohydrology & Hydrobiology**, v. 23, n. 3, p. 335-345, 2023. https://doi.org/10.1016/j.ecohyd.2023.05.001

KOROLCHUK, L. V. Assessing Progress Towards Achieving the Sustainable Development Goals in Ukraine in the Context of War: Key Challenges and Solutions. In: **The International Community and Ukraine in the Processes of Economic and Civilizational Progress: Current Economic-Technological, Resource, Institutional, Security and Socio-Humanitarian Problems**. Riga, Latvia: Publishing House "Baltija Publishing", 2024. p. 302-332. https://doi.org/10.30525/978-9934-26-480-1-13

Kyiv School of Economics. Report on damages to infrastructure from the destruction caused by Russia's military aggression against Ukraine as of January 2024, 2024. p. 1-38. Available at: https://kse.ua/wp-content/uploads/2024/05/Eng_01.01.24_Damages_Report.pdf.

LEVKOVSKA, L.; IRTYSHCHEVA, I.; DUBYNSKA, I. Current trends in the development of the water management complex: Ukrainian realities and international experience. **Baltic Journal of Economic Studies**, v. 6, n. 5, p. 196-202, 2020.

LEVKOVSKA, L.; PUSHAK, Y.; MANDZYK, V.; LAGODIIENKO, V.; NECHEPURENKO, M. Ukraine's water management complex: opportunities for climate action and sustainable development. **Review of Economics and Finance**, v. 21, p. 1002-1009, 2023.

MAHATS, N. Principles of Water Infrastructure Management in Ensuring Sustainable Water Use in Ukraine. **Agora International Journal of Economical Sciences**, v. 17, n. 1, p. 70-82, 2023.

MALEC, K.; GEBELTOVÁ, Z.; MAITAH, M.; APPIAH-KUBI, S. N. K.; SIROHI, J.; MAITAH, K.; JANKŮ, J. Water management of Czech crop production in 1961–2019. **Agriculture**, v. 12, n. 1, e22, 2021. https://doi.org/10.3390/agriculture12010022

MYKHAILENKO, V.; SAFRANOV, T.; ADOBOVSKA, M. Biological wastewater treatment plants as sources of environmental pollution by persistent organic pollutants (on the example of Odesa industrial-and-urban agglomeration). **Visnyk of V. N. Karazin Kharkiv National University, Series "Geology. Geography. Ecology**, n. 58, p. 350-359, 2023. https://doi.org/10.26565/2410-7360-2023-58-26

QASEMIPOUR, E.; TARAHOMI, F.; PAHLOW, M.; SADATI, S. S. M.; ABBASI, A. Assessment of virtual water flows in Iran using a multi-regional input-output analysis. **Sustainability**, v. 12, n. 18, e7424, 2020. https://doi.org/10.3390/su12187424

OPPERMAN, J. J.; CAMARGO, R. R.; LAPORTE-BISQUIT, A.; ZARFL, C.; MORGAN, A. J. Using the WWF water risk filter to screen existing and projected hydropower projects for climate and biodiversity risks. **Water**, v. 14, n. 5, e721, 2022. https://doi.org/10.3390/w14050721

PAZOS, V. C.; FARIAS, J. V. L. L.; CALIXTER, A. L.; MEDEIROS, J. M. M.; DE ANDRADE, L. M. S. Education for sustainability - The reabilita E-learning course and the 2030 agenda in Brazil: Perspectives and influences on the professional life of graduates. **Contribuciones a las Ciencias Sociales**, v. 16, n. 8, p.

8436-8452, 2023. https://doi.org/10.55905/revconv.16n.8-014

PIWOWAR, A. **Water shortage in Polish agriculture and its economic consequences**. 2023. https://doi.org/10.36689/uhk/hed/2023-01-049

POKHREL, Y.; FELFELANI, F.; SATOH, Y.; et al. Global terrestrial water storage and drought severity under climate change. **Nature Climate Change**, v. 11, p. 226-233, 2021. https://doi.org/10.1038/s41558-020-00972-w

Progress towards the Sustainable Development Goals (2024). **Report of the Secretary-General**. United Nations. General Assembly Economic and Social Council. 2 May 2024, 2024. p. 1-26. Available at: https://unstats.un.org/sdgs/files/report/2024/SG-SDG-Progress-Report-2024-advanced-unedited-version.pdf.

QUANDT, A.; O'SHEA, B.; OKE, S.; OLOLADE, O.O. (2022). Policy interventions to address water security impacted by climate change: Adaptation strategies of three case studies across different geographic regions. **Frontiers in Water**, v. 4, p. 1-15, 2022. https://doi.org/10.3389/frwa.2022.935422

RAJAPAKSE J.; OTOO, M.; DANSO, G. Progress in delivering SDG6: Safe water and sanitation. **Cambridge Prisms: Water**, v. 1, e6, p. 1–15, 2023. https://doi.org/10.1017/wat.2023.5

OOBAVANNAN, M.; KANDASAMY, J.; PANDE, S.; VIGNESWARAN, S.; SIVAPALAN, M. Sustainability of agricultural basin development under uncertain future climate and economic conditions: a socio-hydrological analysis. **Ecological Economics**, v. 174, e106665, 2020. https://doi.org/10.1016/j.ecolecon.2020.106665

RUDEVSKA, V.; GUTSUL, T.; TESAK, O.; KYSELOV, O. Investment attractiveness of agriculture in Ukraine: factors and prospects for the future. **Futurity Economics&Law**, v. 4, n. 1, p. 22-37, 2024. https://doi.org/10.57125/FEL.2024.03.25.02

SAPIŃSKI, A.; SZYDŁOWSKI, D. Paradigm of philosophy of security in Poland through the prism of pandemic and socio-political changes: analysis of problem origin and risks of spreading attention focus. **Futurity Philosophy**, v. 1, n. 3, p. 4-27, 2022. https://doi.org/10.57125/FP.2022.09.30.01

SERBOV, M. H. **Formuvannia sotsio-ekoloho-ekonomichnoi systemy prisnovodnykh resursiv: rehionalni osoblyvosti ta zavdannia upravlinnia**. Mykolaiv: FOP Shvets V.M., 2021. (In Ukraine) Available at: http://monograph.com.ua/pctc/catalog/book/978-617-7319-64-0.

SERBOV, M. Development of innovative model of regional management of freshwater resources in conditions of sustainable development. **Technology audit and production reserves**, v. 2, n. 4/64, p.16-27, 2022. https://doi.org/10.15587/2706-5448.2022.256618

SERBOV, M.; IRTYSHCHEVA, I.; PAVLENKO, O. Strategic directions of economic and environmental management of regional resources in the conditions of continuous development. In: **Innovative development of national economies**. Kharkiv: PC Technology Center, 2022. p. 103-145. https://doi.org/10.15587/978-617-7319-64-0.ch4

SEMBIYEVA, L.; ZHAGYPAROVA, A.; ZHUSUPOV, E.; BEKBOLSYNOVA, A. Impact of Investments in Green Technologies on Energy Security and Sustainable Development in the Future. **Futurity of Social Sciences**, v. 1, n. 4, p. 61-74, 2023. https://doi.org/10.57125/FS.2023.12.20.03

SNIZHKO, S.; DIDOVETS, I.; BRONSTERT, A. Ukraine's water security under pressure: Climate change and wartime. **Water Security**, v. 36, e100182, 2024. https://doi.org/10.1016/j.wasec.2024.100182

SNIZHKO, S.; TRIPOLSKA, G.; SHMURAK, A.; SHEVCHENKO, O.; GREBEN, V.; YUSHCHENKO, Y.; ... OVCHARUK, V. Technical needs assessment of the water sector to the climate change adaptation in Ukraine. **Hidrolohiia, hidrokhimiia i hidroekolohiia**, v. 3, p. 98-99, 2019.

Sustainable Development Goals. **Ukraine. National Report**. Ministry of Economic Development and Trade, 2017. (In Ukraine). Available at: https://www.kmu.gov.ua/storage/app/sites/1/natsionalna-dopovid-csr-Ukrainy.pdf.

Sustainable Development Goals. **Monitoring Report, 2021**. (In Ukraine). Available at: https://ukrstat.gov.ua/csr_prezent/2020/ukr/st_rozv/publ/SDGs%20Ukraine%202021%20Monitoring%20Report%20ukr.pdf.

Sustainable Development Goal 6. **Clean Water and Sanitation**, 2024. (In Ukraine). Available at: https://sdg.ukrstat.gov.ua/6/.

The Sustainable Development Goals Report, 2018. Available at: https://unstats.un.org/sdgs/report/2018.

UBERMAN, V.; VASKOVETS, L. Problems of implementation of basic European environmental concepts in Ukrainian water legislation. **Law Herald**, n. 1, p. 237-245, 2020. (In Ukraine). Available at: https://doi.org/10.32837/yuv.v0i1.1617

UN DEPARTMENT OF ECONOMIC AND SOCIAL AFFAIRS. **The Sustainable Development Goals Report 2024 – June 2024**. New York: UN DESA, 2024. Available at: https://unstats.un.org/sdgs/report/2024/.

UN World Water Development Report, 2023. Available at: https://www.unwater.org/publications/un-world-water-development-report-2023.

United Nations. **Department of Economic and Social Affairs**. Statistics, 2024. Available at: https://unstats.un.org/UNSDWebsite/undatacommons/.

VOZA, D. Sustainable development progress and challenges-Modelling SDG's based on the income level in European countries. In: MEB - 22nd International Conference on Management, Enterprise, Benchmarking. **Proceedings I...** Budapest, Hungary: Óbudai Egyetem, 2024. Available at: https://oda.uni-obuda.hu/handle/20.500.14044/25941

World Resources Institute. **Water risk atlas**. Aqueduct, 2023. Available at: https://www.wri.org/aqueduct.

WU, Z.; ZHANG, Y.; HUA, Y.; YE, Q.; XU, L.; WANG, S. An improved system dynamics model to evaluate regional water scarcity from a virtual water perspective: A case study of Henan Province. **Sustainability**, v. 12, n. 18, e7517, 2020. https://doi.org/10.3390/su12187517

WWF. WWF **Risk Filter Suite 101 Guidance Version 2.0**, October 2024, 2024a. Available at: https://doi.org/10.5281/zenodo.13691613

WWF. **WWF Water Risk Filter Methodology**. Documentation Version 2.0, 2024b. Available at: https://doi.org/10.5281/zenodo.13768279.

WWF. **Water Risk Filter**. Country Profiles, 2024c. Available at: https://riskfilter.org/water/explore/countryprofiles.

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