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Impact of the full-scale war in Ukraine on the environment: Environmental damage assessment

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Abstract

The full-scale invasion of the Russian Federation has threatened not only the sovereignty and integrity of Ukraine but also the state of the environment, as military operations have a direct impact on the quality of natural resources, which makes this topic relevant. The study aims to determine the impact of the war on the state of the environment in Ukraine, as well as on the environmental rights of citizens. The methods used in the study included statistical, legal hermeneutics, induction, comparative methods, and others. The study results are the essence of environmental protection and the main components of this category, namely, soil, land, water resources, atmosphere, and biodiversity. The author clarifies the essence of the environmental rights of Ukrainian citizens and what they consist of, as well as how they can be violated. It is pointed out that in the context of military confrontation, Ukrainians are limited in their ability to stay in an environment that is safe for health and life. An estimate of the environmental damage caused by the hostilities is provided, which amounts to $59.7 billion, but is not entirely accurate or definitive, given the obstacles to data collection and lack of access to the occupied territories. The most common negative consequences of military operations and the environmental damage they cause are illustrated, examines in more detail such an environmental crime as the destruction of the Kakhovka hydroelectric power plant, and provides an estimate of material damage to various sectors, as well as the impact on the environment in the region. The differences between the Ukrainian methodology for assessing environmental damage and the American and European ones are noted. The article emphasises the need to take into account international recommendations and the use of the latest technologies to collect data on the long-term consequences of environmental damage caused by a full-scale invasion. The results of the study can be used for further work and practical improvements to the methodology for assessing environmental damage by lawyers and environmentalists

Keywords: damage; natural resources; ecocide; pollution; climate change

Introduction

Among the most common environmental problems caused by Russian aggression against Ukraine are: air pollution due to the shelling of industrial facilities and oil depots; destruction of forests due to fires; loss of biodiversity; and depletion of water resources. The environmental pollution caused by the war will have a long-term impact not only on the environment but also on the economy and gene pool of the country, which determines the relevance of the topic, as the assessment and study of environmental damage is an urgent and urgent need, given the high intensity of hostilities and Russian missile attacks. The problem of this work is the limited access to information on the damage caused in the occupied territories and in the area of intense hostilities, paying insufficient attention to the topic of environmental damage may lead to ignoring the problem and untimely response, and without a clear assessment of damage, it will be difficult to obtain the necessary financial and technical assistance for environmental restoration, which may lead

to the recurrence of environmental disasters and their negative impact on the environment.

As for the consequences of military operations, V. Antonenko *et al.* (2022) pointed out that the focus of the Ukrainian authorities has shifted from assessing and compensating for environmental damage, which is understandable, to other tasks, but the need to restore the country's environment and industrial potential should also be addressed. The authors also emphasised that restoration processes are needed in the Donetsk region, which has been in a state of depletion of environmental resources and environmental pollution due to constant hostilities for years. As a result, ecosystems are being destroyed and changed, making their conditions unsuitable for the existence of some organisms and populations.

The factors that determine the critical environmental situation in Ukraine are described by A.V. Hrytsenko and O.G. Vasenko (2022). The authors pointed to the Russian armed aggression, environmental terrorism by the aggressor state, as well as other aspects that may be caused by military operations on the territory of Ukraine. The problems of environmental pollution as a result of a full-scale invasion are a force majeure circumstance, the occurrence of which does not depend on the will of the parties, but its existence generates several negative consequences, the impact of which cannot be minimised without the end of hostilities. The legal aspect of environmental damage was considered by R.S. Kirin *et al.* (2022). The authors pointed out that it is necessary to distinguish between the categories of "damage" and "losses", as they are not identical. Damage includes several components, namely tangible and intangible. At the same time, losses relate exclusively to the material component, as they are a monetary expression of damage caused to property as a result of unlawful actions. Therefore, in the context of Russian aggression as a cause of environmental pollution, it is more appropriate to use the category of "losses".

It is important not only to assess the environmental damage caused by Russian aggression, but also to create mechanisms to hold those responsible for illegal actions accountable. O. Pchelina and V. Pchelin (2022) noted that this requires the development of a proper methodology for investigating this type of crime, the gradual systematisation of the circumstances to be clarified in the field of these offences, and the establishment of a clear algorithm for law enforcement officials at all stages of the investigation. It is also necessary to build up specialised knowledge of the specifics of the investigation. According to B.B. Bandurian *et al.* (2022), the areas that were under the Russian occupation even before the full-scale invasion, are on the verge of an environmental catastrophe. A significant threat is posed by strikes on energy facilities, water supply systems, and residential areas, which cause technological accidents that directly affect the environment. The destruction of surface soil layers occurs due to explosions, fires, movement of equipment and various types of weapons, and massive mining and land damage caused by explosions requires further demining and reclamation.

The analysed studies show a high level of focus on environmental issues due to Russian aggression, but insufficient consideration is given to the study of not only environmental damage but also to further steps to be taken to compensate and bring those responsible to justice. Given the above, the study aim was to determine the environmental damage and ways to bring to justice those responsible for illegal actions against the environment.

Materials and Methods

The study was conducted using a range of methods of scientific cognition. First, it is worth highlighting the method of legal hermeneutics,

which allowed to interpret and understand the legal aspects of the research object, and to determine the content of legal provisions and the specifics of their application within the institute of environmental damage. Thus, the objects of research, based on this method, are Law of Ukraine No. 1264-XII (1991) and Criminal Code of Ukraine (2001), Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (2002), Directive 2004/35/EC of the European Parliament and of the Council (2004), Resolution of the Cabinet of Ministers of Ukraine No. 326-2022-p (2022), Order of the Ministry of Environmental Protection and Natural Resources of Ukraine No. 167 (2022a), Order of the Ministry of Environmental Protection and Natural Resources of Ukraine No. 252 (2022b), as well as Order of the Ministry of Environmental Protection and Natural Resources of Ukraine No. 175 (2022c).

The statistical method, based on the collection and interpretation of statistical data, was useful in clarifying and assessing the damage caused by Russia to Ukrainian water resources, soil, land, and atmosphere, and in detailing the damage caused by the destruction of the Kakhovka hydroelectric power station. The source of the latest data was the website of the Ministry of Environmental Protection and Natural Resources (n.d.). It is worth noting that the systemic and structural approach made it possible to characterise the methodology for assessing damages according to the Ukrainian approach and to identify the main criteria considered when making conclusions about material damage in material terms. The author also identified the range of actors responsible for the process of such calculation at the national and international levels. This approach was used to characterise the shortcomings of the Ukrainian methodology of damage assessment and controversial aspects. The systemic and structural approach was used in conjunction with the comparative method based on the comparison of different objects, in particular, the Ukrainian, American and European approaches to environmental damage assessment, and was used to identify the differences between the objects under study.

The analytical method was used to study the characteristics of the American approach to understanding loss and damage, as well as the European experience in understanding pure environmental damage and its main types, the specifics of damage assessment and the need to consider the causal relationship in this matter. The analysis method was used to outline the issues of liability of those responsible for environmental crimes and the possibility of establishing an international tribunal. The analysis method was also used to examine the shortcomings of the Ukrainian approach and the main reasons for the differences between the World Bank's assessment and the Ukrainian working group on the material embodiment of the environmental consequences of the war. The main problems that cause inaccuracies in the final calculation are outlined. The impact of the Russian-Ukrainian war on the environment not only in Ukraine but also abroad was also studied. The analysis method was used to formulate recommendations and ways to improve the Ukrainian methodology for assessing environmental damage in the context of military confrontation. In addition to the analysis method, the induction method was also used to investigate the opinions of various authors and scholars on the general aspects of environmental damage, which were used to form the conclusion.

Results

The protection and use of natural resources covers the areas of water, forest, land, subsoil, air, flora and fauna. The essence of environmental

protection is a system of measures aimed at preserving natural resources, i.e. rational use and restoration of resources such as water, soil, forests, minerals; preventing resource depletion and pollution; promoting the protection of ecosystems and biodiversity; ensuring environmental safety; preventing and eliminating the consequences of environmental disasters; controlling the impact of economic activity on the environment; preserving natural heritage, which consists in protecting unique natural complexes, landscapes and objects, creating nature reserves and national parks; creating favourable conditions for people's lives and reducing risks to their health (Prins, 2022).

These provisions are in line with the principles contained in Law of Ukraine No. 1264-XII (1991) and create a framework for environmental protection activities. Article 9 of this law also stipulates that every citizen of Ukraine has environmental rights and obligations, thus, unauthorised encroachment on environmental protection facilities becomes an encroachment on the environmental rights of an individual. In this context, the Russian full-scale invasion of Ukraine violates the principles of environmental protection and violates the environmental rights of citizens, including the right to a clean environment through air, water and soil pollution, the right to access information on the state of the environment, as such access may not be provided or may be complicated in the occupied territories or territories where active hostilities are taking place. This also affects the right of citizens to participate in environmental decision-making, the right to a safe environment is violated due to increased health risks arising from hostilities and the destruction of infrastructure, and the process of compensation for damage and losses caused to the environment and human rights in particular is also complicated. The damage to the Ukrainian environment in material terms caused by the Russian invasion is illustrated in Figure 1.

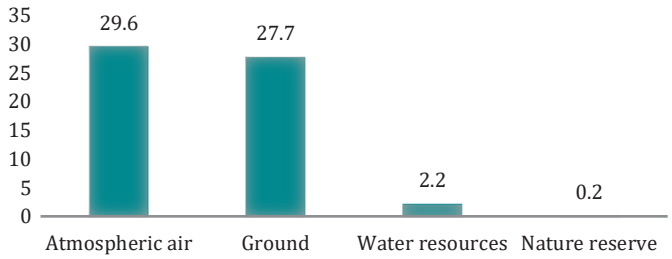

Figure 1. Total losses for the Ukrainian environment as of 2023, USD billion

Source: Ministry of Environmental Protection and Natural Resources (n.d.)

Thus, Ukraine's ecology has suffered $59.7 billion in damage, but this figure cannot be recognised as accurate or final, in particular, because it is impossible to calculate the amount in some Ukrainian territories due to occupation or active hostilities, and the duration of the war also affects the final amount, as military clashes occur every day. Such calculations are carried out by both the Ministry of Environmental Protection and Natural Resources of Ukraine and the State Environmental Inspectorate.

It is worth analysing in more detail the specific damage caused by the Russian invasion. Firstly, it is the waste from the destroyed equipment of the

aggressor state, for example, more than 700,000 tonnes of waste and 70,000 tonnes of air emissions were obtained from about 40,000 units of destroyed equipment (Ministry of Environmental..., n.d.). Attacks on large industrial enterprises also cause damage, in particular, because of the toxicity of the substances released during combustion. The detonation and explosion of various types of munitions cause most fires, the combustible substances from which also pollute the atmosphere, and the consequences damage biodiversity and plantations, as well as soils (Imran *et al.*, 2022). All of this violates the human right to a safe and healthy environment, including through water, air and land pollution, as well as diseases that can develop from the decomposition of unburied bodies and cause contamination of soil and groundwater.

The hostilities also affect general climate change, in particular greenhouse gas emissions, which amounted to about 150 million tonnes over the 18 months of the Russian invasion (Ministry of Environmental..., n.d.). This figure is driven by the need for both ongoing and future reconstruction of the infrastructure that has been destroyed, as well as direct hostilities, fires, leaks of hazardous substances due to damage to the Nord Stream pipeline, increased flight distances for civil aviation to avoid the aggressor state, and the movement of people who have been forced to leave their homes as a result of the war (Padányi & Földi, 2022; Smith, 2022). Another significant impact on the environment was the explosion of the Kakhovka hydroelectric power station, which led to several catastrophic consequences, including disruption of the ecosystem of water bodies associated with hydroelectric power stations (HPPs); water quality disruption due to the massive death of aquatic organisms and the natural environment in which these organisms existed; flooding of land areas poses a threat to the existence of rodents and other animals living in the respective environment. The consequences of the hydroelectric power plant explosion also disrupted the habitat of vegetation, particularly in coastal areas, as well as in steppe and forest-steppe complexes, polluted river and sea waters, disrupted water supplies in the surrounding areas, flooded houses, businesses and livestock, causing hazardous substances to leak into the water, and affected the local climate. The environmental damage caused by the destruction of the Kakhovka HPP is illustrated in Figure 2.

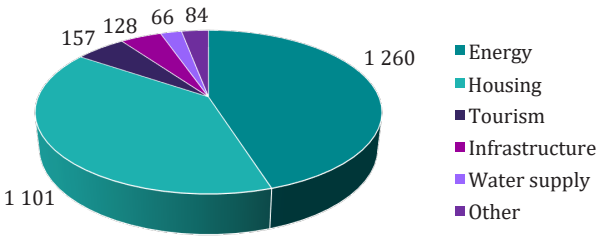

Figure 2. Losses due to the explosion of the Kakhovka HPP, 2023, USD million
Source: Ministry of Environmental Protection and Natural Resources (n.d.)

The total losses shown in Figure 2 are approximately $2.8 billion. The "Other" category includes the social sphere, the destruction of businesses, and agriculture. The habitat of about 1,000 species of flora and more than 1,000 species of fauna was also destroyed, almost 64,000

hectares of forests were flooded, and 700,000 people were left without water supply (Ministry of Environmental..., n.d.).

The study analyses the main methods of assessing the damage caused to Ukraine's environment as a result of Russian military aggression. First, it is worth noting the Resolution of the Cabinet of Ministers of Ukraine No. 326-2022-p (2022), which specifies the procedure for determining the damage caused by the military actions of the Russian Federation. Thus, the main indicators that are assessed in the case of damage to land resources are the following: the costs necessary to ensure land reclamation; damage to landowners; damage to soils that may affect their fertility due to pollution by substances, as well as contamination by foreign objects. Damage caused to water resources is assessed in terms of water pollution, unauthorised use, and damage to the environment within the sea. The assessment of damage to atmospheric air depends on the volume of emissions. Losses to the forestry fund are assessed through restrictions on the rights of forestry users, loss of income due to lack of access to land plots, and loss of production in the forestry sector. Damage is calculated by the authorised bodies, including the Ministry of Environmental Protection and Natural Resources and the State Environmental Inspectorate. The basis for calculating the damage caused to soils is the monetary value of the land plot within which the soil was contaminated (Order of the Ministry..., 2022a). The assessment of water pollution, except for marine waters, is carried out according to certain categories, in particular, by the affected water, by its type, and by the amount of substance that caused the pollution (Order of the Ministry..., 2022c). Concerning atmospheric air, the type of substance that caused the pollution, the emission rate of such substance, and its mass are considered; the tax rate for unauthorised emissions, the hazard level of the substance, and the environmental impact are also taken into account (Order of the Ministry..., 2022b).

It is worth noting that the assessment of environmental damage calculated by the authorised bodies of the Ukrainian authorities is significantly different from the damage assessment carried out by the World Bank as part of the RDNA2 (Rapid Damage and Needs Assessment). Thus, as of 24.02.2023, the damage to forestry and the environment amounted to 2 billion dollars. The RDNA2 analysis, which focuses exclusively on the restoration of physical assets and infrastructure, does not consider the spillover effects on the environment, which may include pollution caused by damaged or inoperable facilities (Ukraine rapid damage..., 2023). It also does not address lost ecological functions due to forest destruction or water pollution. Thus, this assessment considers only the damage caused at the moment, while the Ukrainian loss and damage analysis takes into account the indirect lost profits and subsequent costs of rebuilding and restoring lost ecological functions (Rexhepi *et al.*, 2022).

At the same time, the Ukrainian methodology cannot be considered perfect. For example, the methodology assesses environmental losses and damage by analogy with the concept of damage in civil law and does not consider several international and European recommendations. For example, the US (United States) Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) defines the fundamental concepts, including damage (injury) as an observable or measurable negative change in a natural resource or deterioration in the quality of services related to natural resources; compensation for damages (losses) as compensation for damage, destruction, loss or inability to use natural resources,

including reasonable costs of assessing damages; restoration as actions aimed at returning damaged natural resources or services to their baseline condition – the condition that would have existed if the incident had not occurred (Comprehensive environmental response..., 2002).

It is also advisable to cover Directive 2004/35/EC, where environmental damage covers various forms of harm, through the impact on protected species and habitats, including significant harm that prevents the establishment or maintenance of a favourable environmental status for these protected sites. Deterioration of water resources, which is manifested in significant adverse effects on the ecological, chemical or quantitative state or potential of water resources. Soil degradation, which includes any pollution that creates a significant risk of adverse effects on human health because of direct or indirect penetration of substances, preparations, organisms or microorganisms into the soil. The document also emphasises the need to investigate the existence of a causal relationship, which is calculated according to a scheme based on the presence of such elements as driving force, pressure, state, exposure and, accordingly, reaction (Directive 2004/35/EC of..., 2004).

For instance, hostilities can complicate data collection, access to affected areas, restrictions on monitoring equipment and the movement of personnel, and the full extent of environmental damage often takes years to manifest, making it almost impossible to properly account for long-term effects such as changes in groundwater levels, species migration or persistence of pollutants, while ongoing active hostilities cause damage and losses to increase almost every day (Saktiawan *et al.*, 2022; Haque *et al.*, 2022; Barchielli *et al.*, 2022). At the same time, military operations cause a shortage of resources and therefore create limited opportunities for a comprehensive assessment of the environmental impact of a particular disaster or ecocide crime. It would be advisable to engage international experts in cooperation to create standardised and accurate data collection protocols for further assessment of losses and damage, considering the practical experience of the process of compensation for environmental damage in the framework of the American and European experience. Given the advancement of technology, it is also possible to develop artificial intelligence-based models to simulate the long-term consequences of the war, considering all possible negative impacts on the environment and natural resources, to assess and estimate the costs of further restoration of Ukraine's environment.

The liability of those responsible for causing damage to the Ukrainian environment should also be addressed. The actions of the Russian Federation fall under the Rome Statute of the International Criminal Court (1998), which defines a crime against the environment as an attack that causes serious damage to the environment and natural resources and is not related to military superiority. Ukrainian legislation, namely the Criminal Code of Ukraine (2001), also defines mass destruction of the environment or actions that may provoke an environmental disaster as a crime of ecocide. Russian actions as an aggressor state fall under this offence. However, the practical component of bringing Russia to justice can be implemented with the establishment of a separate military tribunal for war criminals, following the example of the Nuremberg Tribunal.

Discussion

The damage caused to the environment by Russia's armed aggression is measured in billions of dollars and has a significant impact not only on the condition of soil, water quality, land and air,

but also on human health and safety, and thus on their right to live in a safe environment. Environmental pollution, as pointed out by D. Rawtani *et al.* (2022), has various sources of origin, including shelling of industrial facilities, explosions releasing harmful chemicals, and massive fires. These pollutants pose a significant risk to public health and threaten long-term environmental damage. The authors also pointed to the potential threat of unexploded mines, which not only pose a physical danger to civilians but also hinder environmental recovery and reconstruction efforts. In the article, the authors emphasised the importance of addressing environmental issues, which is to be agreed upon, but it is necessary to consider not only the existing but also the long-term environmental impact of the war. Thus, this requires a more qualitative and comprehensive approach to identify the priority and urgent needs to restore certain environmental functions, as well as to develop a plan for the gradual restoration of areas that are less in need of urgent response.

R.J. Wenning and T.D. Tomasi (2022) suggested that the assessment should be based on the provisions of the US law – Natural Resource Damage Assessment (NRDA). This legal act defines the nature of the damage, i.e., the types of environmental resources that have been affected (e.g., air, water, soil, wildlife) and the extent of damage to each of them. These characteristics are crucial for planning and budgeting for remediation or economic strategies. Furthermore, quantification of damage creates opportunities to hold the responsible party accountable and provide resources for future environmental restoration. The authors' results do not fully correspond to the findings in this paper, but the authors agree with the researchers on the need for a qualitative assessment of environmental damage. However, the use of American experience in this area may be problematic given that the NRDA was created under the American legal system and therefore does not consider the specifics of data collection and assessment in the Ukrainian environment, which is affected by hostilities and limited access to certain areas, raising questions about the accuracy of the data collected. Despite these limitations, the authors argue that even a modified and adapted approach inspired by NRDA principles can be valuable. This statement is valid, as the law can provide an effective theoretical framework for specific types of environmental damage.

K.H. Harada *et al.* (2022) highlight the close relationship between war and environmental and human health damage. The article discusses the potential health risks associated with environmental damage caused by the ongoing war in Ukraine. These risks include exposure to pollutants, including the risk of air, water and soil contamination due to damaged infrastructure, explosions and industrial facilities, and increased risk of infectious diseases due to problems in healthcare systems, as well as a shortage of clean drinking water. The authors also pointed to the negative impact of war on mental health, which can be exacerbated by environmental damage. The researchers emphasise that overcoming such damage and subsequent health consequences requires concerted efforts by the international community. This includes providing resources for environmental clean-up, conducting health assessments, and supporting long-term recovery efforts; it also notes the importance of strengthening international law to hold perpetrators accountable for environmental damage caused during conflicts. It is important to note that the results of this work are in line with the conclusions of the authors, in particular in terms of cooperation and joint efforts to create a reliable and effective system of prosecution of those

responsible for creating environmental disasters in Ukraine and committing ecocide.

It is also worth noting the study by F. Racioppi *et al.* (2022) on the impact of war on the environment and health. Environmental damage poses significant threats to the health of the Ukrainian population, in particular, polluted air from industrial destruction, explosions and fires can cause respiratory diseases such as asthma, bronchitis and lung cancer. Disrupted water treatment systems and contaminated water sources increase the risk of waterborne diseases. Contamination of both water and soil with hazardous materials can lead to poisoning and long-term health problems. The author's findings are important and consistent with the conclusions of this paper, but it is also worth noting that understanding the extent and nature of the damage that exists is problematic due to the limited data that can be collected, as well as the lack of access to occupied territories or areas where active fighting is ongoing.

The Russian-Ukrainian war has dealt a devastating blow to the environment with widespread and long-lasting consequences, as P. Pereira *et al.* (2022) pointed out. The authors highlighted air pollution caused by fires, deterioration of water quality due to damage to water treatment plants, soil degradation due to chemical and explosive contamination, and loss of biodiversity. In addition, the environmental impact of the war goes beyond Ukraine's borders. Disruptions to global food supplies and the potential for cross-border air and water pollution pose challenges for the entire world. A similar opinion is shared by K. Mahreen (2022), who pointed out that damage to power plants, wastewater treatment plants and industrial facilities can cause spills and leaks of hazardous substances, which pollute both air and soil. The article also highlights the indirect impact of war on the environment, for example, through violations of environmental regulations, as law enforcement is weakened during hostilities, and compliance with environmental rights and obligations sometimes becomes impossible. Environmental damage caused by war has long-term consequences. Contaminated land can take decades or even centuries to remediate, hampering agricultural productivity and negatively impacting food security. In addition, the environmental impacts of war can transcend national borders. Air and water pollution can spread over long distances, affecting neighbouring countries and regions, through additional carbon emissions due to the increased flight distance of civilian aircraft flying around the territory of the parties to the conflict. In general, the authors' conclusions on the research topic are consistent with those of this paper. It is worth noting that the emphasis of the scholars is on the need to create effective international norms to restore the damaged ecological functions of the environment, as well as to establish a mechanism for bringing perpetrators to justice, by forming a special tribunal for war criminals.

As for the impact of the war on the air quality in Ukraine, R. Zalakeviciute *et al.* (2022) pointed out that in some regions there has been an improvement in air quality due to a decrease in industrial activity, which in turn has led to a decrease in emissions from factories and power plants. The war has also caused a sharp decline in traffic due to reduced active movement and curfews. This resulted in lower concentrations of air pollutants usually associated with vehicle emissions, such as nitrogen dioxide (NO_2). At the same time, military activities, such as rocket attacks and fires, have exacerbated existing air quality problems in most parts of Ukraine, as they result in the release of significant amounts of air pollutants, including particulate matter, nitrogen oxides and volatile organic compounds. Although

the authors' study does not confirm the results of this paper, it provides an understanding of the complex impact of Russian armed aggression on air quality, which is crucial for developing strategies to reduce this impact on the life and health of the Ukrainian population.

Russian military aggression has serious consequences for Ukraine. This concerns not only natural resources, such as soil, water, land and air quality, but also human health and safety, which violates their right to live in a safe environment. Compensation for damages caused by environmental pollution during shelling, explosions and fires requires a systematic assessment similar to the US law on natural resource damage assessment. This will allow for the efficient use of recovery resources and the involvement of those responsible for recovery efforts. It is essential to address unexploded mines that complicate environmental rehabilitation. To restore the environment and reduce the effects of the war, it is necessary not only to clean up the environment and support from the international community, but also to bring those responsible to justice.

Conclusions

Russian aggression has caused significant damage to the Ukrainian environment and natural resources. The Ukrainian authorities estimate that the damage was worth $59.7 billion. However, the process of collecting data to arrive at the final figure makes it impossible to determine it as accurate, in part because experts' access to some areas was restricted due to occupation or active hostilities. The environmental damage is also caused by the disposal and destruction of the aggressor state's equipment, strikes and destruction of industrial facilities, energy companies, fires, and mines that impede land reclamation. Thus, all areas of the environment are affected: soil, water resources, atmosphere and biodiversity. Environmental pollution also affects the protection of human environmental rights and freedoms, including the right to a clean and safe environment, as the conditions in which some Ukrainians live cannot be described as completely safe for their health due to air and water pollution.

One of the biggest environmental crimes was the destruction of the Kakhovka hydroelectric power station. This process resulted in a decline in water quality, flooding of economic facilities, and disruption of the living conditions of land and water species. Thus, the total amount of damage caused by the destruction of the hydroelectric power plant was $2.8 billion. Russian armed aggression causes environmental pollution not only in Ukraine but also provokes an increase in greenhouse gas emissions around the world, in particular through the disruption of gas transportation systems and the displacement of people. Ukraine's system of environmental damage and loss assessment differs significantly from international standards and practises, with RDNA2 estimating environmental damage at $2 billion, compared to Ukraine's $59.7 billion. This difference is caused by various approaches to the concepts of damage and loss, as well as what these concepts include.

The European experience of determining environmental damage under Directive 2004/35/EC, in particular the recommendations on establishing a causal link between the damage caused and the action that caused it, should be adopted. It is also necessary to involve international organisations in the process of developing effective methods for assessing damage and losses, as well as to use the possibilities of modern technologies, including artificial intelligence, to collect and interpret data on the long-term effects of the war on the Ukrainian environment. Topics for further research include the possibility of establishing a

special tribunal to try war crimes related to environmental damage, the development of international law on environmental protection during armed conflicts, and the impact of environmental damage on the Ukrainian economy.

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None.

Conflict of Interest

None.

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Вплив повномасштабної війни в Україні на довкілля: оцінка екологічних збитків

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Анотація

Повномасштабне вторгнення Російської Федерації поставило під загрозу не лише суверенітет та цілісність української держави, але й стан навколишнього середовища, адже військові дії мають прямий вплив на якість природних ресурсів, що і зумовлює актуальність дослідження даної теми. Метою наукової роботи є визначення впливу війни на стан екології в України, а

також на екологічні права громадян. У дослідженні використано такі методи, як статистичний, юридичної герменевтики, індукції, порівняльний метод та інші. Основні результати науково-дослідної роботи полягають у розкритті суті охорони навколишнього середовища та основних складових даної категорії, а саме ґрунтів, земельних, водних ресурсів, атмосфери, біорізноманіття. З'ясовано суть екологічних прав громадян України та в чому вони полягають, а також яким чином вони можуть бути порушені. Вказується, що в умовах воєнного протистояння українці обмежені у можливості перебувати у безпечному для здоров'я та життя навколишньому середовищі. Окреслено оцінку збитків для довкілля, що були спричинені військовими діями, така оцінка складає 59,7 млрд доларів, однак не виявляється цілком точною чи остаточною, зважаючи на перешкоди у процесі збору даних та відсутності доступу до окупованих територій. Проілюстровано найбільш поширені негативні наслідки ведення воєнних дій та в якій шкоді для довкілля вони постають, детальніше розглянуто такий екологічний злочин, як руйнування Каховської гідроелектростанції, наведено оцінку матеріальних збитків для різних сфер, а також вплив на стан довкілля у регіоні. Зазначаються відмінності між українською методикою оцінки збитків для довкілля та американською і європейською. Акцентовано на необхідності врахування міжнародних рекомендацій і долучення новітніх технологій для збору даних щодо довгострокових наслідків шкоди, завданої довкіллю через повномасштабне вторгнення. Результати дослідження можуть бути використані для подальших робіт і практичних вдосконалень методики оцінки екологічної шкоди правознавцями та екологами

Ключові слова: шкода; природні ресурси; екоцид; забруднення; кліматичні зміни