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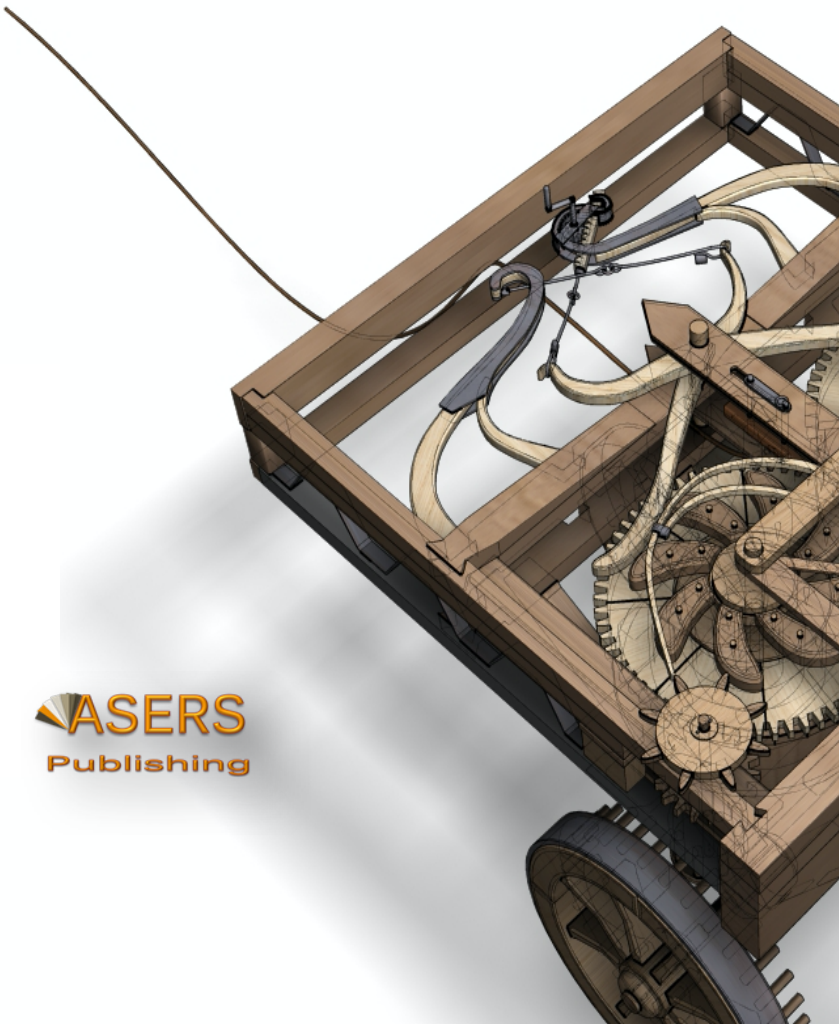

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Evaluation of Environmental Security of Ukraine during the Russian Invasion: State, Challenges, Prospects

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Abstract:

The authors propose to use the method of expert evaluations for studying the state of environmental security of Ukraine during the russian invasion of Ukraine as one of the most acceptable from the point of view of a combination of intuitive and rational approaches. In general, the amount of damage caused to the environment of Ukraine during the russian invasion due to various negative environmental events is 224982 million UAH. From the studies carried out, it is clear that the following components are the most problematic for the complex state policy in the field of environmental security of Ukraine: natural resource efficiency policy, environmental policy, licensing and standardization policy. Considering the situation in the field of environmental security of Ukraine during the russian invasion of Ukraine, it is recommended to supplement Ukraine Recovery Plan with the following National programs: (i) reforming public administration in the environmental industry; (ii) climate policy: preventing and adapting to climate change; (iii) effective waste management; (iv) conservation of natural ecosystems and biological diversity. Restoration and development of protected areas and facilities. The authors underline that intensification of the European integration policy will also contribute to the ecologization of the consciousness of Ukrainians. It is about a more economical attitude of the public towards natural resources, the responsibility of everyone for a clean environment for themselves and subsequent generations.

Keywords: environmental security, russian invasion of Ukraine, expert evaluations, complex state policy.

JEL Classification: O13; F64; Q50; Q53; R11.

Introduction

The Ukrainian ecosystem is of great importance for Europe: it covers 35% of Europe's biodiversity; it is a home for more than 70 thousand biological species; 29% of the territory of Ukraine consists of natural vegetation, as well as cultivated natural vegetation (for example, manicured pastures and hedges); 16% of the territory of Ukraine are forests; almost 63 thousand rivers flow through Ukraine; there are 11% of the Carpathian mountain range on the territory of Ukraine, where a third of all species of plants in Europe sprout (https://www.epravda.com.ua/columns/2022/11/1/693320).

In addition to thousands of deaths and the destruction of important infrastructure, Ukraine may be dogged for years by another, less obvious, but no less severe crisis associated with the invasion of Russia: environmental one. From shelled chemical plants to burned forests – the consequences will be felt not only by the ecosystems of Ukraine, but also by its people.

As the Russian invasion continues to rage on the territory of the country, pollution of soils and waterways is a serious concern for environmental activists. Ukraine is one of the most industrialized countries in Europe, where it is estimated that 6 billion tons of liquid waste are stored, which is generated in coal mines, chemical enterprises and other heavy industries. Over the past year, such extremely sensitive objects have been constantly subjected to Russian shelling.

Artillery shelling of fields leads to the destruction of unique fertile lands, which will take years to restore. Comparing it with the experience of restoring agricultural land, for example, after the First World War, we can talk about decades.

The occupation of the fertile lands of the south and east of Ukraine creates not only food security problems, but also is a threat to steppe and forest protected areas. Land that has not previously been used can be transferred to agricultural use. And it can be the territories of reserves, reserves and national parks.

The article (von Uexkull and Buhaug 2021) states that the study of the security implications of climate change has rapidly evolved from an emerging field of scientific research into an important and thriving one that crosses epistemological and disciplinary boundaries. The authors summarize scientific progress by comparing the last decade of empirical research with the seven main priorities of environmental security research. Overall, the authors emphasize that the research community has made important strides in identifying and evaluating plausible indirect relationships between climate conditions and environmental security.

The article (Dalby 2017) highlights the relationships between environmental change and conflict between states due to environmental problems, as well as broader global policy issues linking resources and international relations concerning different security issues. The paper highlights that the effects of climate change are becoming increasingly apparent. The authors draw attention to the fact that it is unclear under what circumstances climate change may turn out to be a multiplier of the threat leading to conflict. The article emphasizes the need for decision-making on the prevention of the most significant environmental risks, when small states are unable to cope with the stresses caused by rapid environmental changes or, possibly, economic disruptions caused by environmental problems. The same author (Dalby 2017) emphasizes that the states that are most obviously vulnerable to the climate are in the lowlands, and more often face immediate questions of survival. In addition, the author emphasizes that states that are vulnerable to agricultural disruption caused by storms and droughts lack the means to make their existential position a matter of concern to the wider international community. What's more, while climate change may be the biggest existential crisis of humanity, the global challenge is still the lingering political challenges of multiple jurisdictions and policies.

The author (Swatuk 2014) characterizes environmental security schools operating in the United States and Europe. In particular, the article highlights the differences between theoretical schools of environmental security. The author characterizes these competing schools as "environmental security studies" and "critical environmental security studies". The paper also provides a brief case study of the different ways in which environmental security is understood and put into practice, using the example of South Africa.

The paper (Hugh 2001) examines the concept of environmental safety that plays a central role in solving environmental problems. The authors underline that this is a relatively new perspective which defines implications for the study of international environmental relations, possibly in terms of justifying the inclusion of its key concepts into the world environmental perspective.

The article (Khairulliza and Janczewski 2016) provides an overview of big data privacy issues regarding technology, organizational, and environmental security. The main objectives of the review are to identify big data privacy issues and to classify issues related to environmental security.

The article (Liebenguth 2022) examines how transnational corporations can use and generate ideas on

environmental security on a transboundary scale. In particular, the author shows the ways in which transnational corporations turn to environmental security as a source of legitimacy for their broad global environmental management programs. Ultimately, the author reveals how environmental security concepts support a political and economic perspective for understanding the broader consequences of environmental security as a concept that is implemented at the state level.

The latest publications of Ukrainian scientists are devoted to the identification of barriers of the ecologization and opportunities to overcome them in the conditions of post-war recovery (Kosovych, Vaskivska and Kucher 2022), economic assessment of the consequences of soil pollution in the system of sustainable land management (Ulko *et al.* 2022), and justification of foundations of postwar renovation of Ukraine's economy based on sectoral development of innovation-active regions and industries, the principles of Industry 4.0, modernized budget decentralization (Borodina 2022).

Despite numerous studies which were carried out by many scientists and practitioners on environmental security, quantification of its level remains relevant. In addition, it is necessary to distinguish a specific approach to assessing the level of environmental security of any state, which would allow quantitative consideration of heterogeneous qualitative points of view and to unify them.

1. Materials and Methods

The purpose of the article is to carry out an expert evaluation of the state of environmental security of Ukraine during the Russian invasion and outlining the prospects of the post-war reconstruction of Ukrainian environment in the context of activization of European integration.

The theoretical and methodological basis of the research is regularities and principles of development of environmental security. The following scientific methods are used in the article: generalization and comparison – to study the patterns of development of world scientific research concerning environmental security; retrospective analysis – to evaluate the currently implemented measures for the environmental security development at the state level in Ukraine during the russian invasion; structural approach – to determine the relationships between the elements of the complex state policy in the field of environmental security; expert evaluation method – to assess the state of environmental security of Ukraine during the russian invasion; logic and descriptive analysis - to determine the directions of restoration of the environment of Ukraine in the post-war period.

2. Results and Discussion

The Russian invasion has already caused 100 thousand hectares of forests and steppes of Ukraine to burn out. Where the occupiers came – there were always forest fires. Whether east, south or north of the country. Unfortunately, even in the places from which they left; the probability of war-induced fires remains as high. Many forests are still mined, and it can take years and decades to clean up the consequences of hostilities. All this is bad not only because forests and steppes burn. Unique and ecosystem important places are disappearing. For example, the Kinburn Spit is a nesting area for many species of birds. The 60 species found here are listed in the Red Book. Rare plant species, such as Wild Orchids, also grow here. If the territory of the border between Russia and Ukraine today has almost completely become scorched earth, then the consequences for other neighboring countries also become tangible. Unfortunately, this information continues to be confirmed due to numerous studies that are carried out using modern photometric methods for processing images from satellites (Akhmetov *et al.* 2020; Parimucha, *et al.* 2019).

So, the border of Belarus and Ukraine today has actually turned into a militarized zone. The forests care mined. The Polissia state radiation and ecological reserve was seriously damaged due to the actions of bussian military equipment. The loss was also caused by other reserves and national parks located both on the territory of Ukraine and on the territory of Belarus. Polissia remains an ecosystem that suffers not only from climate change, but also from human activity. Illegal mining of amber, sand mining, plans for the construction of the E-40 waterway are the consequences of reclamation of the Soviet era. And military exercises and even real military actions were added to this. From the territory of Belarus, despite the protests of the population, shelling of Ukraine continues, the south of the Republic has become a militarized zone, and environmental activities after the liquidation of all environmental organizations are almost reduced to zero (https://eco.rayon.in.ua/blogs/536709-ekologichni-naslidki-viyni-piv-roku-bolyu-ukraini).

The Black Sea also has catastrophic cross-border consequences of the bussian invasion. Active hostilities in its water area have already led to the mass death of dolphins. Experts talk about thousands of animals. The protected areas located on its shores, such as the Tuzlovsky Liman, which remains the only nature protection facility on the Black Sea and Azov coasts that is not occupied by bussians, are also affected. It is the Black Sea

that undergoes additional pollution caused by the destruction of the infrastructure of large cities such as Mariupol. This includes water from Kherson, Zaporizhzhia, Dnipro regions, part of which is poisoned by military operations. Therefore, it is still difficult to analyze all the environmental consequences of the bussian invasion for the Black Sea. It is obvious that they will only grow and affect the environment not only in Ukraine, but also in the whole world (https://eco.rayon.in.ua/blogs/536709-ekologichni-naslidki-viyni-piv-roku-bolyu-ukraini).

In general, if we evaluate the environmental consequences of russia's full-scale invasion of the territory of Ukraine, then the estimated calculations of losses made by the State Environmental Inspectorate are shown in Tables 1, 2 (Ecosagroza. Official resources of the Ministry of Environmental Protection and Natural Resources. 2023).

Table 1. Approximate calculations of Ukrainian environmental losses in 2022 accrued by the State Environmental Inspectorate in accordance with approved methods

Type of pollution	Losses, million UAH
Air, including:	983086
combustion of petroleum products	49162
forest fires	928352
fire of other objects	5572
Soil pollution	11531
Waste	834265

Source: Ecosagroza. Official resource of the Ministry of Environmental Protection and Natural Resources. 2023. https://ecozagroza.gov.ua

Table 2. Statistics on negative environmental events and related losses in Ukraine during 2022

Events	Scale	Losses, million UAH
Cutting down or toppling a forest	281223 hectares	6521
Violation of natural reserve fund facilities	1240113 hectares	102309
Oil product spill (soil)	14589 tons	8835
Oil product spill (water)	11070 tons	106347
Explosives (projectiles)	333 pieces	4
Waste pollution	1594840 m²	966

Source: Ecosagroza. Official resource of the Ministry of Environmental Protection and Natural Resources. 2023. https://ecozagroza.gov.ua

In general, the amount of damage caused to the environment of Ukraine during the Russian invasion, due to various negative environmental events, is 224982 million UAH (Ecosagroza. Official resource of the Ministry of Environmental Protection and Natural Resources. 2023). In the summer of 2022, the whole world experienced abnormal weather events. Europe faced its worst drought in 500 years. High temperatures were recorded in other countries, for example, in Pakistan and India (Environmental consequences of war. Half a year of pain in Ukraine 2022).

All these problems are caused by climate change and human activity. And the worst thing people can do at this difficult time is launch an invasion of a neighboring country, thereby increasing greenhouse gas emissions at times, creating a stir around carbon fuel, questioning the goal of achieving climate neutrality. This is exactly what Russia did in February 2022 and continues with its actions to destroy everything that has been done by the world community to adapt to climate change in recent years (Environmental consequences of war. Half a year of pain in Ukraine 2022).

This is not all the environmental consequences of the Russian invasion that Ukraine and the whole world are experiencing today. The infrastructure of entire regions is destroyed, which leads to air and groundwater pollution. Many environmental protection facilities are forced to cease their activities, that has immediate negative environmental consequences. A serious problem is the impact of the Russian invasion on the energy sphere, reflected in the renaissance of carbon fuel. And that means even more emissions and pollution.

Taking into account the above-mentioned problems it is necessary to carry out evaluation of the state of environmental security of Ukraine during the russian invasion. Such an assessment can be carried out using different methods.

It is advisable to analyze forecasting methods. In general, there are more than 150 of them, but in practice about 15–20 ones are used. By making conditional separation of forecasting methods, groups of intuitive, formalized and complex ones can be distinguished.

In particular, it is advisable to use intuitive methods in cases where there is no possibility to quantify individual processes or phenomena or there is no possibility to take into account a large volume of influencing factors due to the complexity of the object of study. Intuitive methods are based on the use of individual and group expert evaluations.

Methods related to formalized ones consider the general actions and methods of obtaining forward-looking information and are divided into two groups: methods of extrapolation of the trend and methods of economic and mathematical modeling.

In turn, the method of extrapolation of the trend can be implemented using simple extrapolation, time trend, autoregression, exponential smoothing, harmonic weight. It is also possible to use a complex method that allows combining several previously mentioned methods in the forecasting process, as well as a scenario type method.

As for economic-mathematical modeling, models of deterministic and stochastic types are distinguished. In particular, models of deterministic type are traditionally implemented on the basis of linear programming methods and allow to obtain a one-variant optimal plan of the perspective state of the research object. Stochastic models are implemented using methods of mathematical statistics in conditions of uncertainty and provide the opportunity to use not only the basic model, but also the accompanying system of characteristics and parameters in perspective planning.

There are a number of alternative forecasting methods based on the use of specific principles. The first of them – "anything can happen" – comes from the impossibility of influencing the future state of the object of research in the desired direction, that is, does not imply the possibility of foresight. The second principle – "famous past" – is a conservative approach based on the satisfactory state of the research object in the past. However, this principle is not able to take into account the dynamics of socio-economic development, so it should not be considered acceptable for forecasting. The third principle – forecasting "through the blinders" – is built on the basis of systematic improvement of the results achieved. However, this approach should be considered too straightforward and does not involve other options for orientation, as well as the use of more optimal methods.

Ultimately, this principle may be completely ineffective. The fourth principle – "decisive actions" – is based on the assumption that it is impractical to carry out forecasting until certain problems appear. In this case, there is no carefully developed strategy based on the construction of forecasts, so the development is zigzag in nature, and proper measures are developed only in the crisis situations with the expectation that there will be enough time for their justification, development and implementation. The fifth principle – forecasting with the help of "genius" – involves finding a qualified expert and obtaining a forecast from him based on intuitive assumptions. At the same time, the possibility of using accurate and rational methods of constructing forecasts is completely excluded. This type of alternative prediction should be accepted on the basis that there is no way to test it.

In general, based on preliminary analysis of prediction methods, it is advisable to conclude that purely intuitive methods for constructing forecasts cannot completely replace rational ones. Therefore, it is advisable to use a combination of them.

In particular, the article proposes the use of the method of expert evaluations as one of the most acceptable from the point of view of a combination of intuitive and rational approaches, however, it is still more subjective in nature. This subjectivity is a consequence of the fact that a group of experts formulates and expresses their own judgments about both the past situation and the prospects for its development concerning the object of the study. In particular, this method allows to identify the degree of criticality of the condition of components of the complex state policy in the field of environmental security of Ukraine.

Most often, the expert evaluations method is used with insufficient information or in determining the degree of criticality of the condition of the study object, which, in turn, does not give the opportunity to analyze past indicators.

The essence of using this method to identify the degree of criticality of the condition of components of the complex state policy in the field of environmental security lies in the fact that experts analyze the level of their risk from the point of view of the impact on the ecological situation in Ukraine with the help of point estimates. In accordance with the method of expert evaluations, the detection of the degree of criticality of the condition of components of the complex state policy in the field of environmental security is carried out within following stages:

1) setting of goals and tasks;

2) formation of a working group that performs all the provided scope of work in the specified sequence of works on expert evaluation;

3) selection of members of the expert group, to which it is advisable to involve both internal and external specialists with certain experience concerning the issue under investigation;

4) development of a questionnaire for conducting an expert survey;

5) direct procedure for interviewing experts (Lavery, Cockton and Atkinson 1997).

In particular, in the course of a direct expert survey, significant attention should be paid to the following points:

1) prevention of the possibility of influence of answers provided by some experts on the results of responses of other experts;

2) objective evaluation of the average level of competence of the members of the expert group.

In general, the average level of competence of experts depends on the degree of their qualification, which, in turn, is estimated using individual competence values, the value of which is determined by the experts themselves. Accordingly, the average level of competence of a certain expert is calculated as an arithmetic value from the individual values of this indicator using the following formula:

$$\overline{K_j} = \frac{K_1 + K_2 + \ldots + K_n}{n}, \quad 2.1$$

where $\overline{K_j}$ is the average level of competence of the *j*-th expert;

$K_1 + K_2 + \ldots + K_n$ – the value of individual competence values provided by all experts to the j-th expert, including his own evaluation;

n – the total number of experts.

The last step in the implementation of the expert evaluation method is the processing of survey results. It consists in determining indicators of criticality of the condition of indicators of the complex state policy in the field of environmental security of Ukraine. These indicators are traditionally calculated as weighted average values in the following way:

$$\overline{BC_i} = \frac{\sum_{i=1}^{n} BC_{ij} \cdot K_j}{\sum_{i=1}^{n} K_j}, \quad 2.2$$

where $\overline{BC_i}$ is the average level of competence of the j-th expert;

BC_{ij} – the value of individual competence values provided by all experts to the j-th expert, including his own evaluation;

n – the total number of experts.

In the article it was decided to interview experts – representatives of regional divisions of the Ministry of Environmental Protection and Natural Resources of Ukraine.

Of course, in practice there is no need to carry out pre-expertise of all specialists. It is more expedient to form a representative group of experts, from the general population, allowing some error in ingress.

According to Bernoulli's theorem, the representation error Mg can be calculated using the following formula:

$$M_g = t\sqrt{\frac{r \cdot g}{n}}, \quad 2.3$$

where t – confidence factor (Student's criterion) for a given probability level (usually 0.95–0.99);

r – the proportion of sampling elements having a predetermined characteristic;

q – the proportion of sample elements that do not have such a characteristic;

n – the number of the representative sample.

The initial data for calculating the number of representative sample are given in Table 3.

Table 3. The initial data for calculating of the number of representative sample

Repressibility error allowed, Mg	Confidence factor, t	Specific weight of absolutely qualified experts, r	Specific weight of less qualified experts, g
0.21	2.23	0.95	0.05

Source: authors' own.

According to Table 3 and Formula 2.3, the number of representative samples will be the following:

$$\mathrm{n} = \frac{2.27^2 \cdot 0.95 \cdot 0.05}{0.21^2} \approx 5$$

That is, the representative number of experts for the research is 5.

First, the experts evaluated each other's competence. The results of this survey are shown in Table 4.

Table 4. Expert competence ratios

Expert	The value of the competency coefficients				
	Expert A	Expert B	Expert C	Expert D	Expert E
Expert A	1.00	1.00	0.95	0.97	1.00
Expert B	0.94	1.00	0.95	0.99	0.98
Expert C	0.97	0.96	0.96	0.98	1.00
Expert D	0.96	0.95	1.00	0.96	0.97
Expert E	0.98	0.96	1.00	1.00	0.94

Source: authors' own.

Based on the initial data given in Table 1, the average expert competence levels were calculated using the formula 2.1:

$$КА = \frac{1.0+1.0+0.95+0.97+1.0}{5} = 0.98;$$

$$КВ = \frac{0.94+1.0+0.95+0.99+0.98}{5} = 0.97;$$

$$КС = \frac{0.97+0.96+0.96+0.98+1.0}{5} = 0.97;$$

$$КD = \frac{0.96+0.95+1.0+0.96+0.97}{5} = 0.97;$$

$$КЕ = \frac{0.98+0.96+1.0+1.0+0.94}{5} = 0.98.$$

Further, experts were interviewed on the likely level of criticality of the components of the complex state policy in the field of environmental security. The evaluation procedure was carried out on a ten-point scale. The survey results are shown in Table 5.

Table 5. Significance of the criticality level of the components of the complex state policy in the field of environmental security according to a survey of experts

Name of the component of the complex state policy in the field of environmental security	Expert				
	A	B	C	D	E
Environmental monitoring policy	0.70	0.15	0.15	0.50	0.40
Licensing and standardization policy	0.80	0.80	0.60	0.98	0.75
Environmental information development policy	0.50	0.60	0.40	0.30	0.45
Scientific and educational policy	0.10	0.05	0.05	0.05	0.05
Innovative policy	0.50	0.40	0.30	0.25	0.45
Investment policy	0.50	0.90	0.60	0.25	0.30
Infrastructure policy	0.70	0.15	0.15	0.50	0.40
Territorial development policy (geopolitics)	0.30	0.50	0.55	0.45	0.60
Environmental policy	0.95	0.80	0.90	0.75	0.85
Policy of European integration	0.60	0.30	0.80	0.50	0.40
Natural resource efficiency policy	0.98	0.95	0.98	0.99	0.90

Source: authors' own.

First, the experts evaluated each other's competence. The results of this survey are shown in Table 4.

Based on the data of Table 5, the weighted average values of the criticality of the condition of components of the complex state policy in the field of environmental security were determined:

$$ВС_1 = \frac{0.7 \cdot 0.98+0.15 \cdot 0.97+0.15 \cdot 0.97+0.5 \cdot 0.97+0.4 \cdot 0.98}{0.98+0.97+0.97+0.97+0.98} = \frac{1.86}{4.87} = 0.38;$$

$$ВС_2 = \frac{0.8 \cdot 0.98+0.8 \cdot 0.97+0.6 \cdot 0.97+0.98 \cdot 0.97+0.75 \cdot 0.98}{0.98+0.97+0.97+0.97+0.98} = \frac{3.8}{4.87} = 0.78;$$

$$BC_3 = \frac{0.5 \cdot 0.98 + 0.6 \cdot 0.97 + 0.4 \cdot 0.97 + 0.3 \cdot 0.97 + 0.45 \cdot 0.98}{0.98 + 0.97 + 0.97 + 0.97 + 0.98} = \frac{2.2}{4.87} = 0.45;$$

$$BC_4 = \frac{0.1 \cdot 0.98 + 0.05 \cdot 0.97 + 0.05 \cdot 0.97 + 0.05 \cdot 0.97 + 0.05 \cdot 0.98}{0.98 + 0.97 + 0.97 + 0.97 + 0.98} = \frac{0.29}{4.87} = 0.06;$$

$$BC_5 = \frac{0.5 \cdot 0.98 + 0.4 \cdot 0.97 + 0.3 \cdot 0.97 + 0.25 \cdot 0.97 + 0.45 \cdot 0.98}{0.98 + 0.97 + 0.97 + 0.97 + 0.98} = \frac{1.85}{4.87} = 0.38;$$

$$BC_6 = \frac{0.5 \cdot 0.98 + 0.9 \cdot 0.97 + 0.6 \cdot 0.97 + 0.25 \cdot 0.97 + 0.3 \cdot 0.98}{0.98 + 0.97 + 0.97 + 0.97 + 0.98} = \frac{2.47}{4.87} = 0.50;$$

$$BC_7 = \frac{0.7 \cdot 0.98 + 0.15 \cdot 0.97 + 0.15 \cdot 0.97 + 0.5 \cdot 0.97 + 0.4 \cdot 0.98}{0.98 + 0.97 + 0.97 + 0.97 + 0.98} = \frac{1.86}{4.87} = 0.38;$$

$$BC_8 = \frac{0.3 \cdot 0.98 + 0.5 \cdot 0.97 + 0.55 \cdot 0.97 + 0.45 \cdot 0.97 + 0.6 \cdot 0.98}{0.98 + 0.97 + 0.97 + 0.97 + 0.98} = \frac{2.20}{4.87} = 0.45;$$

$$BC_9 = \frac{0.95 \cdot 0.98 + 0.8 \cdot 0.97 + 0.9 \cdot 0.97 + 0.75 \cdot 0.97 + 0.85 \cdot 0.98}{0.98 + 0.97 + 0.97 + 0.97 + 0.98} = \frac{4.14}{4.87} = 0.85;$$

$$BC_{10} = \frac{0.6 \cdot 0.98 + 0.3 \cdot 0.97 + 0.8 \cdot 0.97 + 0.5 \cdot 0.97 + 0.4 \cdot 0.98}{0.98 + 0.97 + 0.97 + 0.97 + 0.98} = \frac{2.53}{4.87} = 0.52;$$

$$BC_{11} = \frac{0.98 \cdot 0.98 + 0.95 \cdot 0.97 + 0.98 \cdot 0.97 + 0.99 \cdot 0.97 + 0.9 \cdot 0.98}{0.98 + 0.97 + 0.97 + 0.97 + 0.98} = \frac{4.67}{4.87} = 0.96.$$

The ranked weighted average levels of criticality of the components of the complex state policy in the field of environmental security are given in Table 6.

Table 6. Ranked weighted average levels of criticality of components of the complex state policy in the field of environmental security

Name of the component of the complex state policy in the field of environmental security	Weighted average of criticality
Natural resource efficiency policy	0.96
Environmental policy	0.85
Licensing and standardization policy	0.78
Policy of European integration	0.52
Investment policy	0.50
Territorial development policy (geopolitics)	0.45
Environmental information development policy	0.45
Environmental monitoring policy	0.38
Infrastructure policy	0.38
Innovative policy	0.38
Scientific and educational policy	0.06

Source: authors' own.

Further, it is advisable to evaluate the general level of security of the complex state policy in the field of environmental security based on the data of Table 7.

Table 7. A generalized scale for evaluating the level of criticality of the components of the complex state policy in the field of environmental security

Weighted average value of criticality of components of the complex state policy in the field of environmental security	Conclusion on the level of security of the complex state policy in the field of environmental security
$\overline{BC_i}$ = 1	Crisis level
0.75 < $\overline{BC_i}$ < 1	Critical security level
0.50 < $\overline{BC_i}$ < 0.75	Pre-critical level
$\overline{BC_i}$ = 0.50	Level of uncertainty
0.25 < $\overline{BC_i}$ < 0.50	Unstable level
0 < $\overline{BC_i}$ < 0.25	Normal security level
$\overline{BC_i}$ = 0	Absolute security level

Source: Lavery, Cockton and Atkinson 1997

Decision-making in accordance with the obtained weighted average values of criticality of the components of the complex state policy in the field of environmental security is given in Table 8.

Table 8. Evaluation of the level of criticality of the components of the complex state policy in the field of environmental security of Ukraine

Name of the component of the complex state policy in the field of environmental security	Conclusion on the level of criticality
Natural resource efficiency policy	Critical security level
Environmental policy	Critical security level
Licensing and standardization policy	Critical security level
Policy of European integration	Pre-critical level
Investment policy	Level of uncertainty
Territorial development policy (geopolitics)	Unstable level
Environmental information development policy	Unstable level
Environmental monitoring policy	Unstable level
Infrastructure policy	Unstable level
Innovative policy	Unstable level
Scientific and educational policy	Normal security level

Source: authors' own.

From the studies carried out, it is clear that the following components are the most problematic for the complex state policy in the field of environmental security of Ukraine:

1) natural resource efficiency policy;
2) environmental policy;
3) licensing and standardization policy.

As for the policy of European integration, it is in a pre-critical state due to the political situation in the country, although the weighted average value of its criticality is close to an unstable state. In fact, in this context it is meant that European integration of Ukraine is a complex, multi-level, gradual process in various spheres – political, economic, social and cultural ones. Speaking about the current level and nature of pro-European sympathies of Ukrainian society, a qualitatively new nature of motivation should be noted – citizens, on the one hand, are aware of the naturalness of the European path for Ukraine, including as a mean of preserving national statehood in opposition to aggressive russian influence, but on the other hand they are already more realistically aware of the difficulties and duration of European integration. Accordingly, in the same unstable state there are the following components of the complex state policy in the field of environmental security: investment policy, territorial development policy (geopolitics) and environmental monitoring policy, which directly depend on the policy of European integration.

It should be also noted that Environmental Monitoring Policy and Infrastructure policy depend on Innovative policy that, in turn depend on Scientific and educational policy and Investment policy. But Investment policy is within the level of Uncertainty because of the russian invasion of Ukraine and because of the pre-critical level of the European integration taking into account the above described.

In general, after the expert evaluation, it can be seen that, despite the existing state support for the complex state policy in the field of environmental security, the condition of its components still remains not sufficiently favorable due to the ongoing Russian invasion of Ukraine.

This article continues the author's publications (Kucher, Kucher and Myts 2020; Shvedun, *et al.* 2023) and deepens the cycle of scientific works of other scientists regarding the impact of the war on the environment of Ukraine (Kireitseva, Demchyk, Paliy and Kahukina 2023), in particular, land resources (Baliuk *et al.* 2022), forest resources (Zamula *et al.* 2022), climate (Kicaj *et al.* 2023), environmental security (Irtyshcheva *et al.* 2022), and justification of strategic directions for the post-war restoration of natural resources and environmental security (Shvedun *et al.* 2023, Zamula *et al.* 2022, Zamula and Shavurska 2023). That's why post-war reconstruction of Ukraine should take place on the basis of the European Green Course and the use of advanced environmental tools.

Ukraine has a difficult task during reconstruction – to implement several vectors at the same time: restoration of the environment, implementation of European integration reforms and implementation of policy on climate change.

Since April 2022, after the liberation of part of the territory from the russian invaders, Ukraine began to prepare for restoration. By Presidential Decree, the National Restoration Council was created, and the work on

the restoration plan began, which was presented in Lugano, Switzerland. From the beginning of this process, the public has control over it to ensure its transparency, accountability and compliance with European values, in particular concerning the foundations of sustainable development and the European Green Deal. Thus, in May 2022, a number of public organizations, in particular members of the Working Group "Environment, Climate Change and Energy Security" of the Ukrainian National Platform of the Eastern Partnership Civil Society Forum, published the general principles of green restoration of Ukraine as the basis of the future strategy for post-war reconstruction of Ukraine.

In June 2022, environmental NGOs appealed to the leadership of the European Union to clearly link the plan of post-war reconstruction of Ukraine "Rebuild Ukraine" with environmental reforms and coordination of national legislation with the EU environmental acquis. Thus, the initiative "Environmental Reforms for Post-War Recovery and European Integration of Ukraine" is now being implemented within the framework of the project "Support to the activities of the Ukrainian National Platform of the Eastern Partnership Civil Society Forum 2021–2023" which is implemented by the Institute of Economic Research and Political Consultations with the financial support of the European Union.

Modern Ukraine's promotion to the European path is unprecedented in the history of the European Union and shows success of the current stage of European integration.

Obtaining a candidacy of the EU member is an important act of consolidated support and solidarity of the European community with Ukraine. On the other hand, opening up the prospects of entry the EU is a powerful moral and psychological incentive for citizens of the country who are fighting for its European choice. The EU carries out active military, political, financial, economic, humanitarian support of Ukraine in opposition to russian expansion.

The intensification of the European integration policy will also contribute to the ecologization of the consciousness of Ukrainians. It is about a more economical attitude of the public towards natural resources, responsibility of everyone for a clean environment for themselves and subsequent generations.

In the long term, the process of postwar economic development should be used for the fundamental transformation of Ukraine into a green economy with a clean zero level of harmful emissions. Switching to a green economy will provide more economic efficiency, stronger competitiveness of Ukraine in European and world markets and the welfare of its people.

As significant funds are expected to be available for reconstruction work, the financial flows should contribute to the achievement of environmental and green goals.

Ukraine should also continue modernization of environmental protection institutions at national and local levels to ensure high administrative potential to plan and implement environmentally sustainable reconstruction, and introduction of regulation in transparent, professional, risk-based and results-oriented method.

Nowadays the Government of Ukraine approved the Ukraine Recovery Plan. In particular, the framework of this Plan provides different National Programs for the Restoration of Ukraine in the post-war period. Thus, the National Program "Energy Independence and Green Deal" which is estimated at 130 billion USD contains the following activities: smart grids' building; be-building of the damaged energy objects; nuclear capacity increasing; gas transmission and distribution networks' modernization; replenishment of natural gas stock etc. (Ukraine Recovery Plan 2023).

Conclusions

This article proposes to use the method of expert evaluations for studying the state of environmental security of Ukraine during the russian invasion of Ukraine as one of the most acceptable from the point of view of a combination of intuitive and rational approaches. From the studies carried out, it is clear that the following components are the most problematic for the complex state policy in the field of environmental security of Ukraine: natural resource efficiency policy, environmental policy, licensing and standardization policy.

Considering the situation in the field of environmental security during the russian invasion of Ukraine it is necessary to supplement the Ukraine Recovery Plan with the following National programs:

1) reforming public administration in the environmental industry;

2) climate policy: preventing and adapting to climate change;

3) effective waste management;

4) conservation of natural ecosystems and biological diversity. Restoration and development of protected areas and facilities.

Achievement of the goal is going to be provided in three stages, each of which has the corresponding tasks. At the same time, the emphasis on priorities is placed on the reform of environmental control through the

adoption of the Draft Law of Ukraine "On State Environmental Control", which will be able to solve the existing environmental problems.

The main principles of post-war reconstruction of Ukrainian environment should be the following:

1) cross-cutting environmental policy and country development on the basis of the European Green Deal;

2) restoration should serve the needs of Ukrainians and contribute to the sustainable development of Ukraine;

3) compliance with environmental standards at all levels of environmental policy formation and implementation;

4) compliance with European environmental planning tools in the development of Ukraine;

5) effective functioning and use of trust/donor funds for post-war recovery and development of the green economy.

One of the key limitations of this study is the use of only the method of expert evaluations to determine environmental security. Therefore, we consider the evaluation of environmental security using other methods as a promising direction, as well as the development of proposals for improving the environmental security of Ukraine at the stage of post-war recovery.

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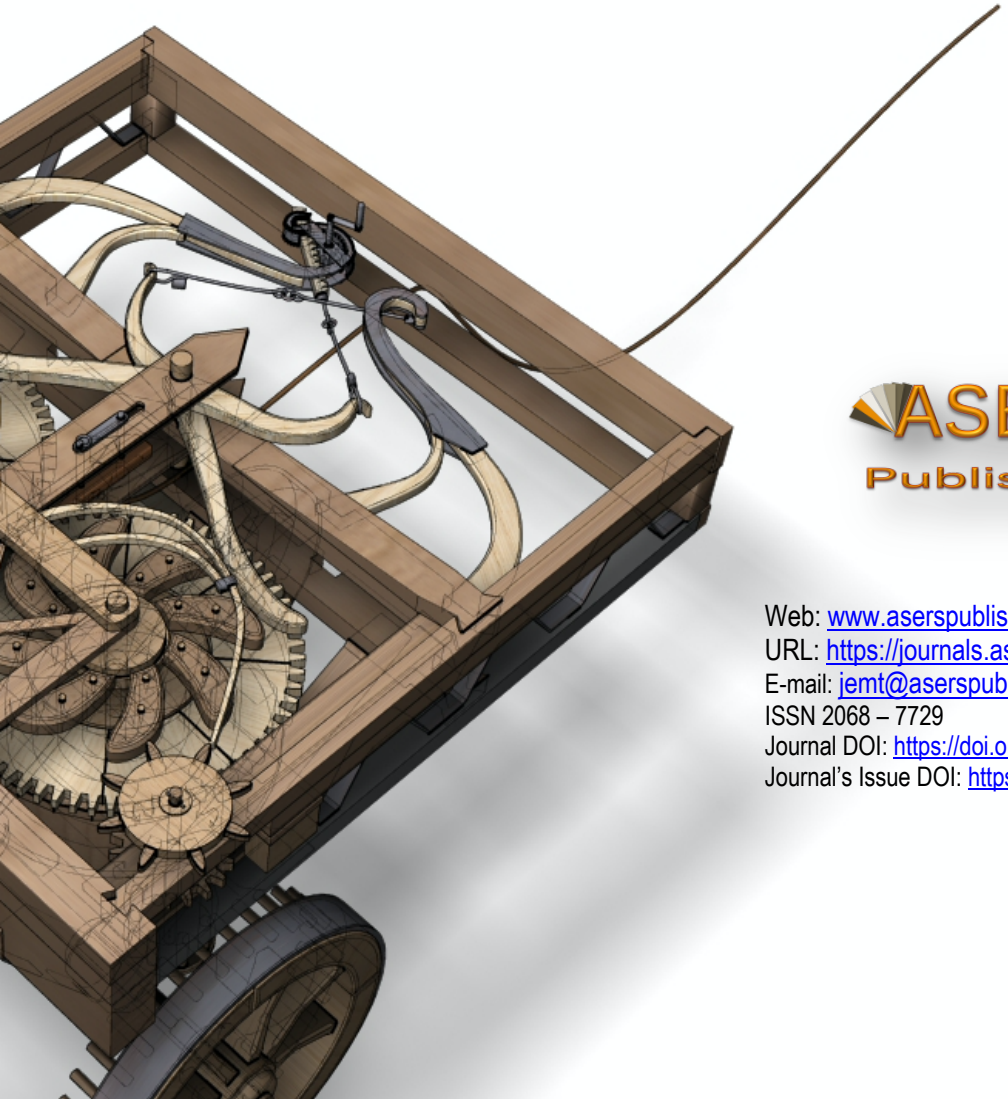

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