MYKOLAS ROMERIS UNIVERSITY

Public Security Academy

TRANSFORMATIONS, CHALLENGES AND SECURITY

Collective monograph

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Mykolo Romerio universitetas

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Vilnius, 2024

Reviewed:
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Editor-in-chief:
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Approved for publication by the Council of the Public Security Academy of Mykolas Romeris University, at the sitting on 13 September 2024. Resolution No. 1VS-8.

The bibliographic data of the publication is available on the portal of the Lithuanian Integrated Library Information System (LIBIS) "ibiblioteka.lt".

ISBN: ISBN 978-609-488-096-4 (El. - PDF)
ISBN 978-609-488-097-1 (Print)

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3.1. Environmental security in the national security system: Ukraine

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Abstract. *This chapter examines the role of environmental security in regional and national development. The authors argue that enhancing environmental security necessitates a focus on the rational consumption of natural resources and the implementation of new approaches to economic activities.*

The purpose of the chapter is to study the theoretical and methodological foundations of environmental security, develop tools for its assessment, and assess its level in the EU and Ukraine.

The authors systematize the conceptual foundations of environmental security, including its constituent elements and related aspects. The subjects and objects of environmental security, environmental security standards, and levels of environmental quality are then determined, before the principles, criteria, and types of environmental security are grouped. The mechanism for ensuring environmental security is determined through the identification of several functions: organizational and preventive, regulatory and stimulating, administrative and executive, security and protective, and restorative. This text examines modern approaches to environmental security measurement and systematizes its evaluation criteria.

The authors identify factors contributing to changes in the state of environmental security and develop an algorithm for its assessment. The algorithm involves systematizing environmental indicators that can be used for assessment, grading the complex indicator using an expert method, and calculating both indices and

an integral indicator of the environmental component of national security for the countries of Europe and Ukraine.

The proposed tools make it possible to rank the EU countries and Ukraine according to their level of environmental security. This ranking includes the Air Quality Index, the Climate Change Performance Index, and the Environmental Performance Index. Countries are also grouped by level of danger. This information can be used to develop policies that make economic development more sustainable while taking environmental aspects into account.

Keywords: *environmental security, subjects and objects of environmental security, environmental indicator, environmental component, sustainable development, security index, EU.*

Introduction

Environmental security is an important component of global and national security. It provides conditions for the sustainable development of society and ensures the protection of vital human interests. It is worth noting that environmental security is unlikely to become possible in the long-term if sustainable development is not considered in an economic way. That is, the two formulations of environmental security and sustainable development synergistically reinforce each other. Sustainable development will most likely not succeed without environmental security, because conflicts and various disruptions become obstacles to effective initiatives.

The understanding of national security is directly related to the protection of the interests of humans and citizens, society and the state, ensuring the sustainable development of society and the timely detection, prevention, and neutralization of real and potential threats to national interests. In this sense, environmental security is an integral part of the country's national security and is defined as ensuring ecologically and technogenically safe living conditions for citizens and

society. Accordingly, assessing this phenomenon while taking into account the interrelationships between environmental efficiency, green growth, and sustainable development is an urgent issue.

Primary results

Environmental security is an indicator of the environment, in which it is possible to determine the deterioration or improvement of the environment and the occurrence or disappearance of danger for living organisms. Environmental safety is the main criterion for ensuring the safety of life activities. Modern researchers consider environmental security in many dimensions (Table 1).

It can be concluded that environmental security is the state of a territory in which the ecological comfort of life is not disturbed and the ability to resist threats to the life and health of all living beings is realized; from the point of view of law, environmental security is designed to protect the life and health of people and the natural environment from anthropogenic influence. From a scientific point of view, this is the balanced interaction of the human–nature–technology triad, which ensures the formation of a natural and cultural environment that will meet the sanitary, hygienic, aesthetic, and material needs of the inhabitants of each region of the Earth while preserving the natural, resource, and ecological potential of natural systems and the ability of the biosphere to self-regulate.

Environmental protection, the rational use of natural resources, and ensuring the ecological safety of human activities are integral parts of the sustainable economic and social development of any country

Thus, environmental security is determined by optimizing utility and hazard functions. Therefore, environmental security should be considered as a state of protection of the vital interests of human, society, and the state against threats of a natural, human-made, and social nature, along with anthropogenic pollution.

Table 1. Definitions of environmental security

Source: compiled by the authors

Author(s)	Definition
Law of Ukraine On Environmental Protection (1991, Article 50)	A condition of the natural environment in which the prevention of the deterioration of the ecological situation and the occurrence of danger to human health is ensured, and is guaranteed by the implementation of a wide range of interrelated environmental, political, economic, technical, organizational, state-legal, and other measures.
Diakiv (2011)	A science that studies human activity in the environment, i.e., natural and man-made conditions and processes, for the purpose of assessing their direct or indirect impact on the natural environment, individual people, and humanity in general, in view of the threat of vital losses.
Kachynskyi (2001)	One of the components of national security – a set of natural, social, technical, and other conditions that ensure the quality and safety of the life and activities of the population living (or active) in this territory and ensuring a stable state of the biocenosis of the biotope of the natural ecosystem.
United Nations Environmental Program (2023)	Focuses on understanding how environmental degradation and climate change interact with peace and security dynamics.
Pachauri (2000)	The minimization of environmental damage and the promotion of sustainable development, with a focus on transboundary dimensions.
Environmental Security Threat Report (U.S. Department of State, 2001)	An element of regional and national security which encompasses the mitigation and prevention of energy threats, including threats to sources and supply lines, and environmental risks and related stresses that directly contribute to political and economic instability or conflict in foreign countries or regions.

The main aspects of environmental security are:

1. The prevention of environmentally significant disasters and accidents. This aspect involves the development and implementation of measures to prevent natural and human-made emergencies, as well as reducing their negative consequences;
2. Ensuring environmentally safe conditions for people's life and activities. This provides for the creation of conditions under which the environment will not pose a threat to human health and life;
3. The creation of sustainable ecosystems that can withstand anthropogenic

impact. This indicates the preservation of natural ecosystems and the creation of new ones capable of resisting the negative impacts of humans.

Environmental security is considered in two aspects: as a subjective category, which is closely related to the right to a safe natural environment for life and health; or as an objectively existing system of the legal protection of environmental security, which regulates environmentally dangerous activities, the mode of use of natural resources, environmental protection, the prevention of the deterioration of the ecological state, and the occurrence of danger to natural objects and the population.

An environmental hazard is a type of environmental situation in which a threat has been created or is likely to emerge, resulting in striking factors and a strong impact on the population, the national economic facility, and the environment. It is possible that environmental hazard factors (a component of any hazardous process or phenomenon caused by a hazard source and characterized by physical, chemical, and biological actions determined by relevant parameters) may arise that can lead to one or a combination of the following undesirable consequences for humans and the environment:

a) negative impact on a person's health, which can lead to serious diseases;
b) the deterioration of the majority of the population due to material or social harm (disruption of the process of normal government activity, loss of any other type of power);
c) the destruction of the ecological balance of environmental resources in the territory;
d) the death of evolutionarily formed biogeocenoses;
e) the local or regional deterioration of the country (polluted atmosphere, water, soil degradation, etc.), which is seen as a threat to the population of the region (Khylko, 2017).

In the scientific literature, five aspects of the occurrence of environmental hazards are distinguished (Srinivas, 2024). The first aspect is related to the scarcity of resources (water, land, labor, energy, etc.) and the competitive environment,

which subsequently cause conflicts between communities, nations, and territories, thus creating danger at the local, regional, or global level. The presence of competition for resources strengthens social inequality and economic instability, in connection with which a question arises regarding the introduction of the practice of the sustainable management of resources using a strategy of fair distribution. Only this can reduce the competitive struggle, and therefore the level of danger, in a particular environment.

The second aspect that causes environmental hazards is related to the large-scale effects of the climate. For example, as a result of climate change, there is a change in precipitation, the state of the ecosystem is disturbed, the water levels in reservoirs rise, extreme weather events or droughts occur, and the process of desertification begins. All of these consequences undoubtedly give rise to population migration (both external and internal), food insecurity, conflict situations (as a result of a struggle for resources), etc. In order to prevent catastrophic consequences, it is necessary for all states to take measures to: reduce greenhouse gases; build sustainable infrastructure; implement methods of the sustainable management of land, water, and energy resources; and carry out preventive measures against natural disasters.

The third aspect which leads to a violation of environmental security is related to the degradation of the surrounding natural environment due to anthropogenic stress (deforestation, pollution of the atmosphere, water resources, soil losses, loss of land fertility, loss of biodiversity, etc.), which leads not only to the violation of ecosystems, but also to their destruction, causing food insecurity, economic instability, and worsening the state of human health. Therefore, in order to prevent environmental hazards, it is extremely important to introduce sustainable practices for forest conservation at the local, regional, and national levels, to promote the principles of a circular economy, and to take measures to reduce anthropogenic load. All of this will not only allow ecosystems to be preserved, but will also

permit their restoration, thereby ensuring environmental safety, well-being, and the prosperity of communities.

The fourth aspect is transboundary environmental problems. There are many examples of environmental challenges that have exceeded national borders (including the accident at the Chernobyl nuclear power plant, the disaster at the Sandoz chemical plant, the fire at the Piper Alpha oil platform, and others), causing a threat to other states. This issue is becoming particularly relevant today, since the military actions taking place in the territory of Ukraine have a cross-border environmental impact on the entire global community (for example, the disaster at the Kakhovka hydroelectric power station). This is why it is extremely important to establish international cooperation, develop diplomatic interaction, strengthen information exchange, conduct joint monitoring, and conclude international agreements. This will not only allow current problems to be solved, but will also allow a rapid response to threats, will permit preventive measures for the emergence of crisis situations to be developed, and will foster stability in cross-border regions.

The fifth aspect is the growing number of environmental refugees and population migration. A large number of natural disasters and/or a significant amount of environmental degradation can lead to the forced migration of people, resulting in refugee crises and increasing social tension. This is because environmental refugees face numerous problems, in particular the loss of means of subsistence, insufficient access to basic services, a lack of support in their new place of residence, etc.

The components of environmental security are:

1) environmentally friendly products – materials or products (for food and technical purposes) that do not have harmful impurities in concentrations dangerous for the natural environment, animals, plants, and humans;
2) ecologically clean soils – soils which do not contain impurities in quantities that threaten soil biocenosis and human health (radiation, chemicals, land

reclamation, acid precipitation, smog, etc., are examples of soil pollutants);
3) ecologically clean production – ensuring a level of production organization that ensures compliance with environmental requirements, norms, and standards.

The objects of environmental security include everything that is vitally important for security subjects: rights, the material and spiritual needs of the individual, natural resources, and the environment as the material basis of state and social development.

The subjects of environmental security are the individual, society, biosphere, and the state.

According to qualitative indicators, the state of the environment can be represented by three levels, where its quality is considered as a set of natural and acquired properties formed under the influence of anthropogenic activity. These indicators must meet ecological, sanitary, and hygiene standards, which provide conditions for the development and reproduction of living organisms, including in human activities.

The highest quality level in this regard is a pure natural environment. In this case, the pollution of the natural environment is minimal, and it does not cause changes in the normal ecological state in the region.

The second level is a favorable natural environment. Pollution of the natural environment is possible within limits that do not affect human health and where there are no unpleasant factors caused by the specific activities of individual industries.

The third level is a safe natural environment. In contrast to the second level, the possibility of the presence of non-threatening negative factors in the natural environment of the region is found here.

As mentioned, the eco-safety of natural objects is related to the safety of citizens in the field of ecology. This is a prerequisite for the realization of the natural

and inalienable human right to a safe environment (Hetman & Shulha, 2009).

The analysis of the reports of leading international organizations on sustainable development allows the main criteria for assessing environmental security and its key indicators to be identified. The UN Development Program characterizes environmental sustainability using twelve indicators – eight that cover environmental sustainability and four environmental threats. The eight indicators of environmental sustainability are fossil fuel energy consumption, renewable energy consumption, carbon dioxide emissions (expressed in two ways), forest area (expressed in two ways), freshwater consumption, and natural resource depletion as a percentage of gross national income. The four indicators of environmental threats are mortality rates associated with indoor and outdoor air pollution, unsafe water, sanitation and hygiene services, and degraded land. The implementation of the Global Sustainable Development Goals (SDGs) of the UN is also subordinated to the environmental assessment indicators measured by the European Union (Table 2).

Table 2. Selected indicators for assessing the state of the environment in EU countries

Source: compiled by the authors based on Eurostat (2023); United Nations (2022)

Indicator	Characteristics of the indicator and its relation to the sustainable development goals (SDGs)
Emissions of greenhouse gases into the atmosphere	Volume of greenhouse gas emissions into the atmosphere as a result of the economic activity of residents: enterprises, families, and government (greenhouse gases are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and fluorinated gases). ***SDG 13.*** *– taking urgent measures to combat climate change and its consequences.* ***SDG 9.4*** *– by 2030, modernize infrastructure and modernize industries to make them sustainable, with higher resource efficiency and wider adoption of clean and environmentally sound technologies and industrial processes.*
Waste *(volumes of generation, processing, use)*	Volumes of generation and information on waste management (19 types of activities according to the NACE classification and household activities). ***SDG 12.5*** *– significantly reduce waste generation by 2030 through prevention, reduction, recycling and reuse.*

Ecological tax	The volume of revenues from environmental taxes reflects the total tax revenues by categories of environmental taxes: energy taxes, transport taxes, and the sum of taxes on pollution and resources. ***SDG 12.A*** *– support countries in strengthening their scientific and technical potential for the transition to more sustainable structures of consumption and production.*
Expenditures on environmental protection *(EPEA)*	Amounts of expenses for environmental protection (EPEA), operations related to the prevention, reduction, and elimination of pollution and any other deterioration of the environment. The main aggregate indicator is national expenses for environmental protection – that is, resources allocated by residents to protect the natural environment. ***SDG 7.b*** *– by 2030, expand infrastructure and modernize technologies to provide modern and sustainable energy services for all.*
Environmental subsidies and transfers *(ESST)*	Amounts of subsidies and other forms of government support measures (such as tax rebates, tax exemptions, tax credits, tax deferrals) that help protect the environment.

Practice and global experience show that ensuring a country's economic security and its sustainable development are closely related to environmental security. Therefore, it is critically important to maintain the balance of the social, economic, and environmental interests of the population, authorities, and business structures. Accordingly, the system of environmental security assessment indicators should include all types of activities and actions that prevent, reduce, and eliminate pollution and any other deterioration of the environment.

Environmental security is extremely important for all countries of the world. However, despite the relevance of this issue, disparities in the display of comprehensive research, methodological developments, and methodological approaches to the assessment of the national level of environmental security should be noted.

The authors propose to evaluate the level of environmental security using relevant indices and indicators which not only take into account the various components of the security of the state, but which are also common in the statistics of many countries of the world. This will allow the state of security between countries to be compared, will highlight leaders and outsiders, and will lead to the

development of practical recommendations. Thus, through the analysis of statistical databases, the following indicators of environmental security assessment were used: the Air Quality Index (AQI), the Climate Change Performance Index (CCPI), and the Environmental Performance Index (EPI). The AQI informs the population about the level of air quality. To calculate the index, information on the level of pollution in a certain period of time is used, which makes it possible to determine the concentration of harmful substances and their compliance with the established norms of current legislation. The calculation of the index not only allows countries to be compared according to the state of atmospheric quality, but also allows effective tools to be implemented for its improvement in the development of environmental policy.

The CCPI serves as a tool for increasing the transparency and effectiveness of the international policies of countries in the face of climate change. The calculation and use of the index allows the efforts and progress of countries in protecting and preserving climatic conditions to be compared. This index uses a system of standardized criteria for assessing the climate indicators of fifty-seven countries and EU Member States, accounting for more than 90% of global greenhouse gas emissions. The calculation method includes fourteen indicators which are divided into four categories: greenhouse gas emissions, renewable energy sources, energy consumption, and the country's climate policy. Using rating data, it is possible to investigate both the broken promises and the effectiveness of implementation by one or another state. The ranking does not include the first three places – the numbering starts from fourth place, because in order to lead the top three, a country must do enough to prevent dangerous climate change. This means that it needs to move alongside the benchmark greenhouse emissions target of 2 °C or below.

The EPI reflects the sustainable development of countries and their ability to solve and eliminate existing environmental problems. The index is based on

the calculation of thirty-two indicators, which are divided into eleven categories, thanks to which it is possible to monitor the trends in a country's development in the environmental sphere, as well as to analyze the effectiveness of the implementation of environmental policy in the state. The environmental efficiency index acts as a powerful tool for achieving the goals of the sustainable development of the UN and ensuring the movement of society towards a sustainable future. According to the results of the calculation of the environmental efficiency index, it has been established that countries with high GDP per capita have greater opportunities for investing in environmental protection activities and building the necessary infrastructure. In order to achieve an increase in GDP per capita, a country needs to develop industry, and therefore increase the level of pollution, which determines the importance of using environmental management. The countries leading the environmental efficiency index ranking cannot claim a completely sustainable development trajectory, because the process of increasing GDP is endless.

Therefore, using the specified indices, we propose to determine the level of environmental security of Ukraine and EU countries, which is relevant in the context of European integration. The proposed methodology for assessing the level of environmental security of the country involves the following algorithm of actions: collection of initial data and their analytical justification; development of a mathematical apparatus for calculating indices and an integral indicator; and setting the level of the integral indicator by its gradations.

In accordance with this list, a notation is introduced for the integral indicator and indices (Table 3).

Table 3. Indicator and indices of assessment of the environmental security of a country

Source: compiled by the authors based on EPI (2022); CCPI (2022); Numbeo (2023)

Integral Indicator	Marking Indicator	Index	Marking Index
Environmental security assessment indicator	I_{ES}	AQI	I_{AQ}
		CCPI	I_{CCP}
		EPI	I_{EP}

Indices (I_g) are calculated as the ratio of statistical data for the country of study and the EU member state, which has the maximum value among all EU countries, according to the formula:

$$Ig = \frac{Scg}{ScgEU} \qquad (1)$$

where: S_{cg} – statistical value of the g-th index by country; S_{cgEU} – maximum statistical value of the g-th index for the country.

The selected indices are stimulating factors. The AQI, which is calculated using the statistical data of the Pollution Index (I_{PLT}) – a disincentive factor – needs an explanation. The AQI is calculated according to the following formula:

$$Ig = \frac{ScEU}{Sc} \qquad (2)$$

The integral indicator (I_{ES}) is calculated as a geometric mean value according to the following formula:

$$I_{ES} = \sqrt[m]{Ig1 * Igm} \qquad (3)$$

where: m – the number of indices in the integrated indicator ($m = 3$).

It is proposed to determine the level of environmental security of a country based on five gradations, which are established by the following method:

$0 \le I_{ES} < 0.2$ – unsatisfactory;

$0.2 \le I_{ES} < 0.4$ – low;

$0.4 \le I_{ES} < 0.6$ – satisfactory;

$0.6 \le I_{ES} < 0.8$ – sufficient;

$0.8 \le I_{ES} \le 1.0$ – high.

The statistical data of the Numbeo (2023) rating organization, the CCPI (2022), and the EPI (2022) were used as starting points (Table 4).

Table 4. Source data for assessing the environmental security of countries

Source: compiled by the authors based on EPI (2022); CCPI (2022); Numbeo (2023)

Country	AQI			EPI			CCPI		
	2021	2022	2023	2021	2022	2023	2021	2022	2023
Ukraine	64.3	62.9	62.1	55.48	49.6	49.6	49.50	60.40*	60.40*
Belgium	50.3	50.1	50.1	45.11	51.9	51.9	73.30	48.38	55.0
Bulgaria	64.5	64.3	63.3	42.64	59.9	59.9	57.00	49.15	46.94
The Czech Republic	36.3	35.9	35.3	38.98	59.9	59.9	71.00	44.16	45.41
Denmark	20.4	21.0	21.9	69.42	77.9	77.9	82.50	79.61	75.59
Germany	27.5	27.8	29.2	56.39	62.4	62.4	77.20	61.11	65.77
Estonia	19.0	19.7	16.7	46.01	61.4	61.4	65.30	75.14	72.07
Ireland	33.9	34.8	34.2	45.47	56.2	56.2	72.80	48.47	51.42
Greece	51.9	51.9	51.6	48.11	56.2	56.2	69.10	57.52	60.34
Spain	39.6	39.7	39.6	45.02	56.6	56.6	74.30	58.59	63.37
France	41.8	42.4	42.9	53.72	62.5	62.5	80.00	52.97	57.12
Croatia	30.6	31.2	31.3	56.69	60.2	60.2	63.10	52.04	57.32
Italy	53.9	54.1	54.7	53.05	57.7	57.7	71.00	52.90	50.60
Cyprus	-	-	-	38.73	58.0	58.0	64.80	49.39	53.09
Latvia	33.9	32.7	30.8	61.88	61.1	61.1	61.60	56.81	57.68
Lithuania	27.0	26.7	26.9	58.03	55.9	55.9	62.90	58.21	62.99
Luxembourg	23.3	23.9	21.8	55.23	72.3	72.3	82.30	60.76	65.09
Hungary	47.8	47.9	47.7	38.22	55.1	55.1	63.70	38.51	45.93
Malta	77.9	81.0	81.2	62.21	75.2	75.2	70.70	60.42	59.8
The Netherlands	25.3	25.1	21.8	50.96	62.6	62.6	75.30	62.24	69.98
Austria	19.2	21.7	21.8	48.09	66.5	66.5	79.60	51.56	58.17
Poland	54.3	54.7	54.5	38.94	50.6	50.6	60.90	37.94	44.40
Portugal	29.6	30.5	28.7	56.80	50.4	50.4	67.00	61.55	67.39
Romania	58.4	58.6	58.5	50.33	56.0	56.0	64.70	38.51	61.50
Slovenia	22.7	22.9	22.4	37.02	67.3	67.3	72.00	48.16	53.57
Slovakia	39.1	39.1	38.3	49.51	60.0	60.0	68.30	50.12	54.47
Finland	11.9	12.1	12.0	62.63	76.5	76.5	78.90	61.24	61.11

Sweden	18.4	18.3	17.7	74.42	72.7	72.7	78.70	73.28	69.39

** CCPI did not evaluate Ukraine's climate performance. This decision was due to the far-reaching effects of the Russian war against the country. The war has caused massive damage and destruction in the energy, industry, transport, and building sectors.*

The data shown in Table 4 show that compared to EU countries, Ukraine is one of the most heavily polluted according to the Pollution Index. Thus, the level of pollution in Ukraine is 5 times higher than the level of pollution in Finland. The top 3 cleanest countries in 2021 are Finland (1st place), Sweden (2nd place), and Estonia (3rd place); in 2022 – Finland (1st place), Sweden (2nd place), and Estonia (3rd place); in 2023 – Finland (1st place), Estonia (2nd place), and Sweden (3rd place). According to the Environmental Performance Index, Ukraine is not a leader compared to the EU countries, which indicates an insufficient level of ability in solving and eliminating existing environmental problems. The leaders by EPI are Denmark, Finland, and Sweden.

It should be noted that the CCPI indicator in Ukraine was significantly ahead of such countries as Poland, the Czech Republic, Bulgaria, Italy, Austria, Slovenia, Slovakia, Hungary, and Ireland in 2022, which indicates significant successes of Ukraine in combating climate change before the beginning of the full-scale invasion. Unfortunately, the war with the Russian Federation makes it impossible to implement certain measures to achieve climate neutrality and poses a great threat, particularly an ecological one, for the entire civilized world. Among the EU countries, Denmark, the Netherlands, and Sweden are the leaders in terms of climate change.

Achieving environmental security is an important task for all countries in the context of ensuring sustainable development for current and future generations. Despite the relevance of this topic, there are no methodological approaches to assessing the level of environmental security in the scientific literature. We suggest evaluating the level of environmental security using appropriate indices that allow countries to be ranked by security level, identifying leaders and outsiders.

The results of the calculations of the sub-indices of the ecological security of countries are presented dynamically in Figures 1, 2, and 3.

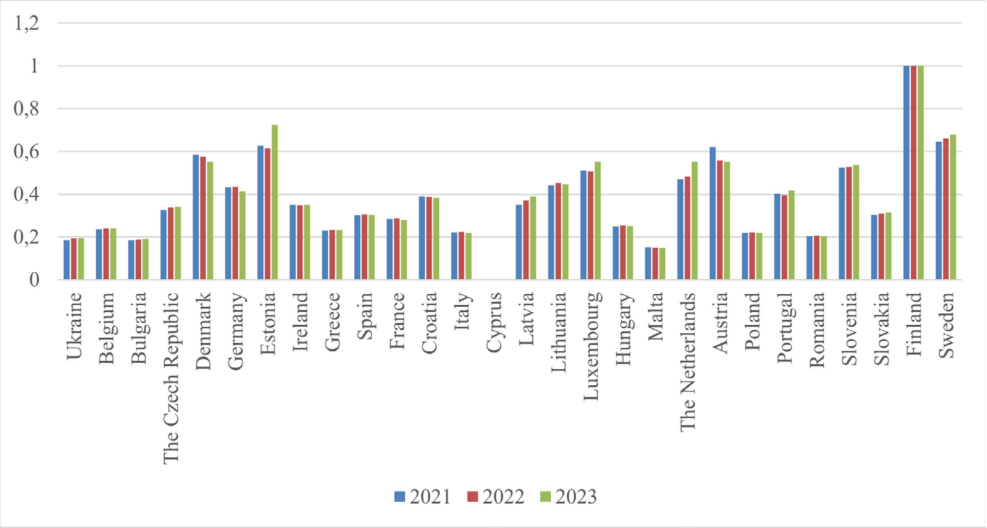

Figure 1. Dynamics of the AQI of EU countries and Ukraine in 2021–2023

Source: developed by the authors

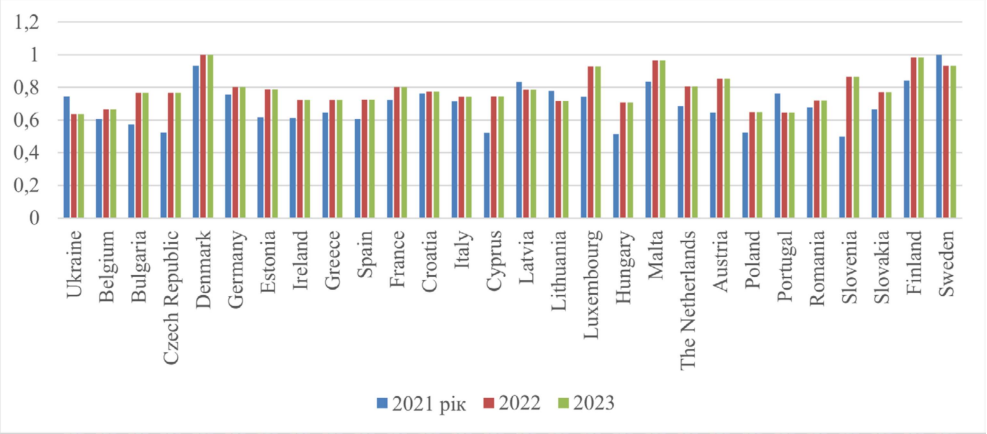

Figure 2. Dynamics of the EPI of EU countries and Ukraine in 2021–2023

Source: developed by the authors

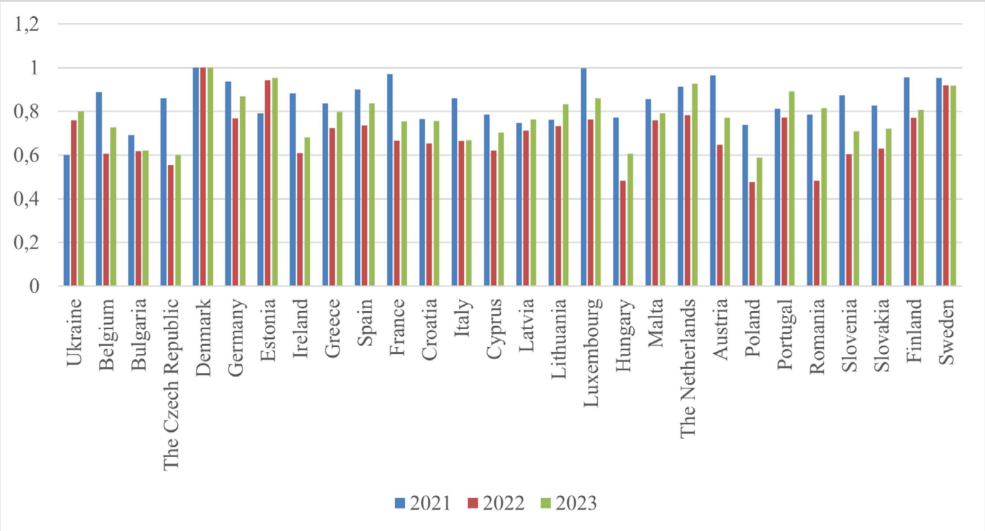

Figure 3. Dynamics of the CCPI of EU countries and Ukraine in 2021–2023

Source: developed by the authors

The results of the calculations of the integral index of environmental security over the past 3 years are presented in Table 5.

Table 5. The integrated index of environmental security of EU countries and Ukraine in 2021–2023.

Source: compiled by the authors

Country	2021	2022	2023
Ukraine	0.4358	0.4529	0.4628
Belgium	0.5032	0.4607	0.4892
Bulgaria	0.4179	0.4470	0.4503
The Czech Republic	0.5287	0.5238	0.5410
Denmark	0.8164	0.8321	0.8206
Germany	0.6745	0.6444	0.6610
Estonia	0.6742	0.7703	0.8166
Ireland	0.5741	0.5345	0.5564
Greece	0.4789	0.4953	0.5117
Spain	0.5470	0.5463	0.5694
France	0.5841	0.5341	0.5535
Croatia	0.6097	0.5808	0.6079
Italy	0.5135	0.4793	0.4774
Cyprus	0.6018	0.5916	0.6155

Latvia	0.6399	0.6195	0.6438
Lithuania	0.7230	0.7170	0.7605
Luxembourg	0.4621	0.4421	0.4764
Hungary	0.4784	0.4783	0.4833
Malta	0.6649	0.6717	0.7427
The Netherlands	0.7284	0.6756	0.7124
Austria	0.4392	0.4092	0.4380
Poland	0.6293	0.5832	0.6225
Portugal	0.4764	0.4156	0.4806
Romania	0.6105	0.6512	0.6896
Slovenia	0.5513	0.5314	0.5582
Slovakia	0.9302	0.9108	0.9259
Finland	0.8513	0.8282	0.8343

The results of the calculations show that no country achieved a state of complete environmental security during the analyzed period, but there are countries that are approaching the value of the maximum indicator. As for Ukraine, the indicator of environmental security is increasing, which indicates the effectiveness of measures in the environmental policy of the state.

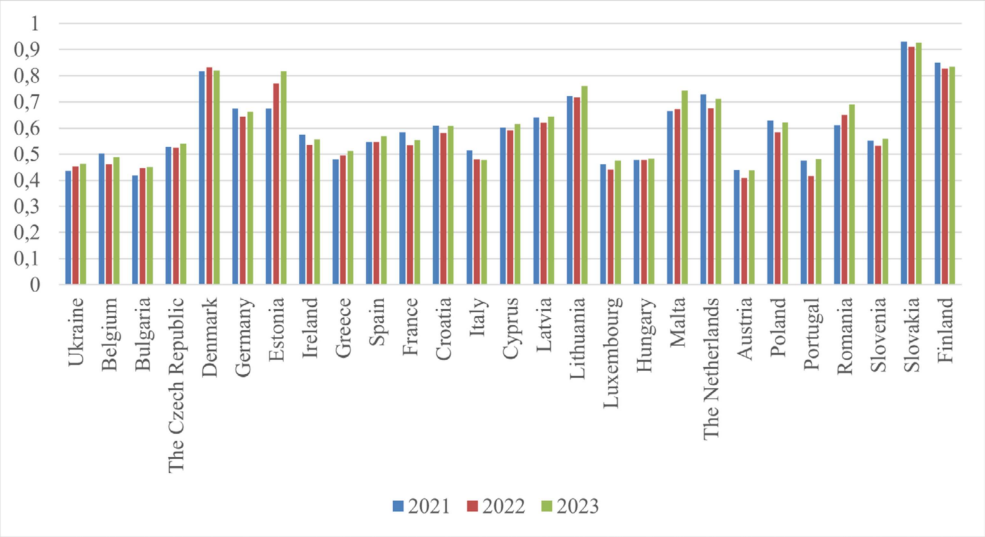

Figure 4. Dynamics of environmental security of EU countries and Ukraine in 2021–2023

Source: developed by the authors

Based on the results above, countries were grouped according to the level of environmental security. The results of this grouping are presented in Table 6.

The grouping of countries made it possible to establish that Denmark, Finland, and Sweden had a high level of environmental security during 2021–2023. Denmark achieved a high level of environmental security due to being a leader in the indicators of the EPI (the index value is equal to the maximum value of 1) and the CCPI (the index value is equal to the maximum value of 1). Finland achieved a high level of environmental security because it occupied the maximum indicator value according to the AQI. The level of environmental security in Sweden is due to high indicator values in the EPI and the CCPI. During 2021 and 2021, Estonia was among the countries with a sufficient level of environmental security, but in 2023, thanks to effective measures aimed at combating climate change, it reached a high level of security in the environmental sector.

Table 6. Grouping of countries by level of environmental security in 2021–2023

Source: compiled by the authors

Level of environmental security	**Countries**
Unsatisfactory $0 \leq I_{ES} < 0.2$	-
Low $0.2 \leq I_{ES} < 0.4$	-
Satisfactory $0.4 \leq I_{ES} < 0.6$	Ukraine, Belgium, Bulgaria, the Czech Republic, Ireland, Greece, Spain, France, Croatia, Italy, Latvia (2022), Hungary, Malta, Poland, Portugal (2022), Romania, Slovakia
Sufficient $0.6 \leq I_{ES} < 0.8$	Germany, Estonia (2021 and 2022), Croatia (2021 and 2023), Latvia (2021 and 2023), Lithuania, Luxembourg, the Netherlands, Austria, Portugal (2021 and 2023), Slovenia,
High $0.8 \leq I_{ES} \leq 1.0$	Denmark, Estonia (2023), Finland, Sweden

Countries with a sufficient level of environmental security during 2021–2023 include Germany, Lithuania, Luxembourg, the Netherlands, Austria, and Slovenia. Portugal, Latvia, and Croatia had a sufficient level in 2021 and 2023, and a satisfactory level in 2022, indicating corresponding gaps in the environmental

policy of these states.

The following countries had a satisfactory level of environmental security during the analyzed period: Ukraine, Belgium, Bulgaria, the Czech Republic, Ireland, Greece, Spain, France, Croatia, Italy, Hungary, Malta, Poland, Romania, Austria and Slovakia. In 2022, Latvia also belonged to this group of countries, although in 2021 and 2023 it had a sufficient level of environmental security.

Environmental security is a component of sustainable development and is inextricably linked to the processes of ensuring the ecological efficiency of the development of countries and the development of a green economy, which is one of the key guidelines of economic strategies for the development of national economies. Therefore, another vector of research was the assessment of the impact of the ecological performance of countries on their progress in the implementation of the SDGs (Sustainable Development Goals Index, SGDI). To measure environmental performance and green growth in international practice, international rating assessments are used, such as: the EPI, which evaluates the effectiveness of the implementation of state environmental policy measures and was included in previous calculations (EPI, 2022), and the Green Growth Index (GGI; GGGI, 2023), which measures the achievements of countries in implementing a green economy.

Using the above-mentioned indices, an attempt was made to evaluate the relationships between the processes of ensuring sustainable development, environmental efficiency, and green growth (Bulatova et al., 2024).

Table 7. Distribution of EU countries and Ukraine according to GGI and SDGI

Source: GGGI (2021); United Nations (2022)

Country	GGI, 2021, 147 countries	SDGI, 2022, 166 countries
Austria	77.78	82.28
Belgium	64.33	79.46
Bulgaria	63.93	74.62
Croatia	68.07	81.50

Cyprus	59.35	72.49
Czech Republic	75.13	81.87
Denmark	76.08	85.68
Estonia	68.27	81.68
Finland	71.69	86.76
France	70.93	82.05
Greece	64.46	78.37
Spain	68.33	80.43
The Netherlands	66.04	79.42
Ireland	59.95	80.15
Lithuania	68.47	76.81
Luxembourg	67.99	77.65
Latvia	68.85	80.68
Malta	50.72	75.53
Germany	75.01	83.36
Poland	66.66	81.80
Portugal	69.54	80.02
Romania	68.01	77.46
Slovakia	74.04	79.12
Slovenia	67.68	81.01
Sweden	76.64	85.98
Hungary	69.75	79.39
Italy	70.89	78.79
Ukraine	57.31	76.52
World:	55.724	66.69

With the use of correlation analysis tools, a matrix of relationships was obtained (Table 8). The results allow the following conclusions to be drawn:

- there is a close, direct correlation (0.71) between sustainable development and green growth; therefore, achieving sustainable development is impossible without implementing the principles of the green economy, and vice versa;
- a moderate correlation (0.49) was observed between environmental performance and sustainable development, which is unexpected and, accordingly, may lead to the conclusion that environmental objectives in the structure

of the SDGI do not demonstrate a significant impact on the overall level of sustainability, because the effectiveness of environmental measures is insufficient;

– the correlation between environmental performance and green growth is insignificant (0.24), which indicates the low efficiency or insufficiency of environmental policy levers to ensure a high level of green growth.

Table 8. Matrix of relationships between the studied indices

Source: compiled by the authors

	EPI	GGI	SDGI
EPI	1	0.24	0.49
GGI	0.24	1	**0.71**
SDGI	0.49	**0.71**	1

Figure 5 presents the nature of the dependence between green growth and sustainable development. It can be observed that 49.7% of the change of SDGI is explained by the variation in the GGI; if the GGI changes by 1% for the analyzed countries, the sustainable development index will increase by 0.38%.

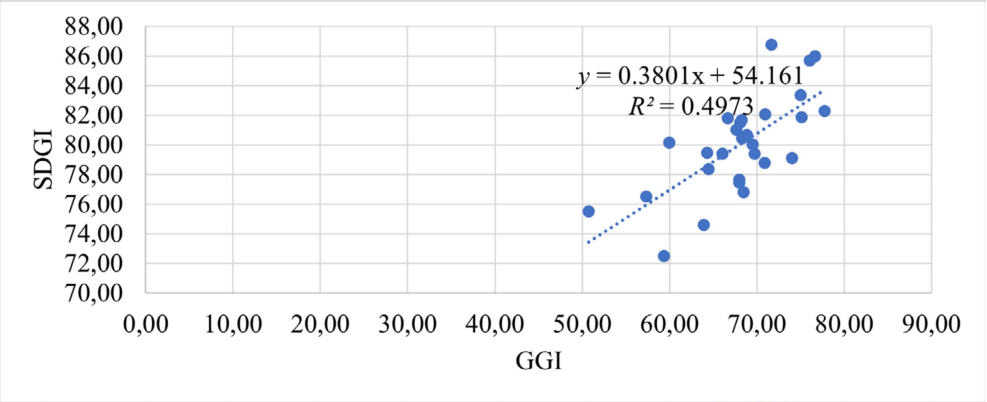

Figure 5. Correlation field for the dependence of the SDGI on the GGI (a sample of EU countries and Ukraine)

Source: developed by the authors

The analysis of the distribution in Figure 5 makes it possible to identify those countries (located above the line of the regression equation on the graph) that are more effective in terms of achieving sustainable development by ensuring green

growth (i.e., possessing a certain level of development of the green economy). Among such countries are: Finland, Denmark, Sweden, France, Poland, Latvia, Estonia, Slovenia, Ireland, Malta, and Greece.

Thus, the combination of the authors' previous studies and the attempt made here to assess the environmental security of different countries confirms the thesis that sustainable development is directly related to environmental security. The countries with the highest levels of environmental security (Table 6), such as Denmark, Sweden, Finland, and Estonia, are also the most advanced in terms of achieving the SDGs. It is therefore clear that further economic growth should take place alongside the more active use of innovative, environmentally friendly technologies. The focus of further research can be broadened by using more indicators to measure environmental security and by comparing the territorial and sectoral structures of the economies of the world, the EU, and Ukraine.

Conclusions

The assessment of a country's environmental security is an important tool for achieving the SDGs and increasing international prestige. In the context of Ukraine's integration into the EU, increasing the level of security in the environmental context is extremely important as it will both hasten the integration process and prove that our state not only supports European values, but is also a real leader of change, particularly in the environmental sphere.

For the EU, climate change and environmental deterioration is a threat to development, in order to overcome which the European Green Deal (European Commission, 2019) was approved. The key goal of the latter document is to transform the EU into a modern, resource-efficient, and competitive economy by: ensuring climate neutrality; accelerating the transition to the use of renewable energy sources; developing a circular economy; increasing the amount of green financing and investment; ensuring the effective fight against the loss of

biodiversity and guaranteeing a clean environment; and actively cooperating with other countries to achieve global goals in the field of climate and ecology. For the vast majority of countries, actions to achieve the SDGs are strategic guidelines, among which environmental security is a driver of sustainable economic growth. At the same time, strengthening environmental security requires increasing the effectiveness of environmental measures and the use of more effective levers of environmental policy.

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