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IDENTIFICATION OF COMPLEMENTARY ZONES IN THE CHAIN "ENVIRONMENTAL TAXATION – RATIONAL NATURAL USE – ECONOMY SHADOWING – NATIONAL SECURITY"[1]

ВИЗНАЧЕННЯ ЗОН КОМПЛЕМЕНТАРНОСТІ У ЛАНЦЮЗІ «ЕКОЛОГІЧНЕ ОПОДАТКУВАННЯ – РАЦІОНАЛЬНЕ ПРИРОДОКОРИСТУВАННЯ – ТІНІЗАЦІЯ ЕКОНОМІКИ – НАЦІОНАЛЬНА БЕЗПЕКА»

Summary. Environmental and economic challenges of the modern era require innovative approaches to ensure sustainable development for the state. The interdependence between the rational use of natural resources, tax policy, and economic transparency is a decisive factor in preserving ecosystems and biodiversity while ensuring long-term economic stability. The purpose of the article is to validate and substantiate the complementarity that arises from the de-shadowing of environmental taxes, promoting rational natural resource management, and ensuring national security. The study justifies the complementarity arising from de-shadowing environmental taxes, stimulating rational natural resource use, and enhancing national security. Trigger points of environmental taxation's impact on rational resource use, de-shadowing, and national economic security were identified. Using tools like VOSviewer, SciVal, Google Trends, and Google Books Ngram Viewer, three types of bibliometric analysis were conducted: exploring terms such as "Environmental tax" and "De-shadowing"; "Environmental tax" and "Rational nature management"; and "Environmental tax" and "National security." The bibliometric tools confirmed the chain's complementarity: "environmental taxation – rational natural resource management – economic de-shadowing – national security". Specific instruments used include SciVal by Elsevier (validating the relevance of the study and the topic's importance across disciplines), VosViewer (demonstrating the strong interconnections among the categories and pinpointing their trigger points of influence on environmental taxation), Google Trends (highlighting the growing relevance of environmental taxation through the lenses of national security, de-shadowing, and rational resource use) and Google Books Ngram Viewer (providing statistical insights relevant to the research context). The findings significantly contribute to developing effective state policies in environmental protection, optimizing tax systems to encourage ecological responsibility, reducing economic shadowing, and improving national security.

Keywords: environmental taxation, complementarity, rational nature management, tinization the economy, national security.

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Анотація. Екологічні та економічні виклики сучасності вимагають пошуку нових підходів до забезпечення збалансованого розвитку держави. Взаємозалежність між раціональним використанням природних ресурсів, податковою політикою та економічною прозорістю є вирішальним фактором для збереження екосистем та біорізноманіття і забезпечення довгострокової стійкості економіки, що у комплексі формує базис для підтримки та зростання безпеки національної економіки. Метою статті є підтвердження та обґрунтування комплементарності, що виникає в процесі детінізації екологічних податків, стимулювання раціонального природокористування, забезпечення національної безпеки. Для проведення дослідження використано інструментарій SciVal від Elsevier (перевірка актуальності дослідження та важливості теми в різних дисциплінах), VosViewer (демонстрування взаємозв'язків між категоріями та визначення їх тригерних точок впливу на екологічне оподаткування), Google Trends (аналіз актуальності екологічного оподаткування через призму національної безпеки, детінізації та раціонального використання ресурсів) і Google Books Ngram Viewer (аналіз контексту дослідження). У статті обґрунтовано комплементарність, що виникає в процесі детінізації екологічних податків, стимулювання раціонального природокористування, забезпечення національної безпеки. Визначені тригерні точки впливу екологічного оподаткування на забезпечення раціонального природокористування, детінізації та безпеки національної економіки. У процесі дослідження проведено одночасно три типи бібліометричного аналізу: за словами «Environmental tax» та «De-shadowing»; «Environmental tax» та «Rational nature management» та «Environmental tax» та «National security», що дозволило оцінити еволюцію досліджень, виявити найбільш актуальні їх сфери та перспективні напрямки. Результати проведеного дослідження мають важливе значення для формування ефективної державної політики у сфері охорони навколишнього середовища, оптимізації податкової системи для підтримки екологічної відповідальності бізнесу та населення, зменшення тінізації економіки та покращення національної безпеки.

Ключові слова: екологічне оподаткування, комплементарність, раціональне природокористування, тінізація економіки, національна безпека.

Problem statement. In the current conditions of globalization, environmental challenges and economic instability, ensuring environmental, economic and national security is becoming an important task of state policy. The chain of relationships between environmental taxation, rational environmental management, shadow economy and national security is complex. It is worth noting that the main problems that arise in this context are inefficient taxation, which includes an underdeveloped system of environmental taxation and a high level of taxes without proper control (for example, from January 1, 2024, the environmental tax was increased in Ukraine to 90% of rates [1]); challenges for rational environmental management, in particular, the use of natural resources, which occurs in conditions of a low level of state control, the lack of financial incentives for enterprises; shadow economy in terms of understating the level of income, evasion of taxes and environmental fees, which hinders the effective use of funds for environmental protection and creates risks for the stability of public finances and the social sphere. It is worth noting that according to the data of 2021, the share of the shadow economy in Ukraine amounted to 32% of the official GDP, compared to 30% in 2020 [2]. This provokes insufficient funding for environmental protection programs and limits the state's ability to invest in projects for the rational use of natural resources. Thus, further research is relevant and will be aimed on identifying areas of complementarity in the chain "environmental taxation – rational use of nature – shadow economy – national security" in the context of analyzing the relationships between these elements, where they can interact in such a way that one sphere strengthens or weakens the other.

Analysis of recent research and publications. The issue of determining the relationship between environmental taxation, rational use of nature and the shadow economy was addressed by Ukrainian and foreign scientists, in particular, Yu.O. Shvets and L.S. Grigorovich [3], N.S. Makarova, L.D. Garmider, L.V. Mykhalchuk [4], I.V. Dragan [5], Ya.I. Glushchenko, O.O. Korogodova, T.E. Moiseenko, N.O. Chernenko [6], T.E. Gorodetska [7], F. Herweg [8], G. Jabeen et. al. [9], S. Sibdari, Y. Asayesh [10], which indicates the importance of an integrated approach to solving environmental and economic problems. Yu.O. Shvets and L.S. Grigorovich [3] considered the environmental tax as a key tool of the environmental economy through the prism of the analysis of the volume of pollutant emissions into the environment of Ukraine and revenues from the payment of the environmental tax. The authors proposed the measures to change tax legislation, i.e. changing the mechanism for calculating the environmental tax, establishing a connection between the amount of fines and environmental damage, which, as a result, has a direct connection with the elements of the chain "rational environmental management – shadow economy – national security". Along with this, the issue of studying areas of complementarity in the chain "ecological taxation – rational use of nature – shadow economy – national security" requires additional disclosure, since the relationships between the elements of the chain, as well as the areas of their effective interaction, and areas of improvement are not fully defined in modern literature.

The purpose of the article is to confirm and substantiate the complementarity that arises in the

process of de-shadowing environmental taxes, stimulating rational use of nature, and ensuring national security.

Summary of the main research material. To carry out the first stage of the study, a selection was made from articles indexed by the Scopus scientometric database, the keywords of which simultaneously contain pairs of concepts from the studied chain. Thus, the Scopus database contains 76 articles that are simultaneously devoted to the study of the topic of environmental taxes and shadowing. The use of the SciVal by Elsevier toolkit made it possible to determine a range of key phrases for this chain, including shadow economy, shadow price, ecosystem services, environmental policy, environmental taxes, emission taxes, fiscal policy, etc. (Fig. 1).

A structural analysis was carried out by subject area for the chain "environmental tax" and "shadow" or "shadowing" (Fig. 2) showed that the largest number of studies related to environmental taxes and shadowing are the object of research: environmental sciences (51.1%); economics, econometrics and finance (35.6%); and energy (22.2%). Thus, the topic of de-shadowing of environmental taxes is relevant and solving the problem of shadowing of such mandatory payments is crucial to establish a balance

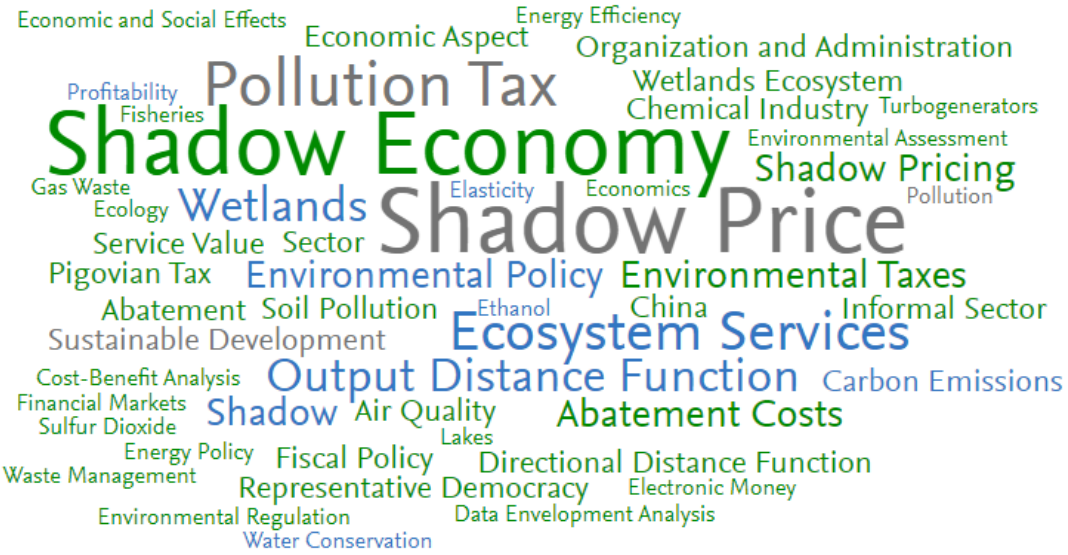


Figure 1 – Results for key phrases analysis for the chain "environmental tax" and "shadow" or "shadowing"

Source: compiled by authors via SciVal by Elsevier

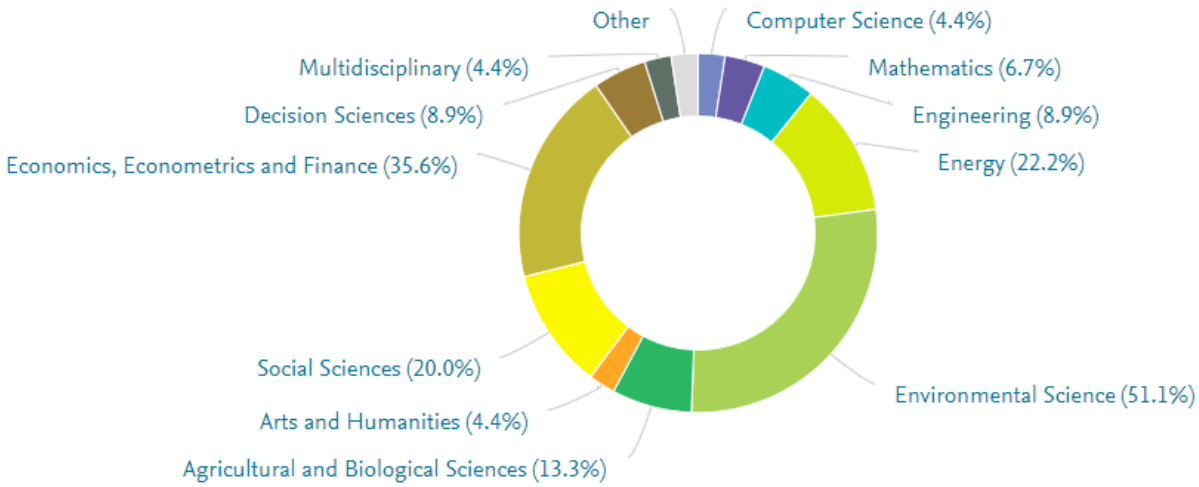


Figure 2 – Structural analysis by subject area for the chain "environmental tax" and "shadow" or "shadowing"

Source: compiled by authors via SciVal by Elsevier

between the level of environmental damage and the payments, which provide a compensatory effect if they are purposefully used.

Database of 76 articles indexed by the Scopus database, the keywords of which simultaneously contain pairs of concepts with "environmental tax" and "shadow" or "shadowing", the VOSviewer bibliometric analysis tool was applied. Thus, using VOSviewer, the coincidence of keywords in the selected articles was analyzed and four clusters were formed, which are the most common (Table 1). Thus, the largest cluster was the red one, which contains 14 keywords and generally indicates that environmental taxes and shadowing have the greatest impact on the environment. This shows that due to an increase in the level of shadowing of environmental payments, the quality of atmospheric air, water and soil is reduced, due to underfinancing of environmental measures, which reduces the quality of the environment and makes the issue of environmental control and monitoring relevant.

The next most important is the green cluster, which contains 13 keywords and shows the relationship and impact of the shadow price on the components of environmental and economic policy, which in aggregate has a direct effect on the number of emissions and discharges, and taxation of the level of damage caused plays a significant role in this (fig. 3). Therefore, the third most important cluster is blue, which contains 12 keywords and mediates

Table 1 – Clusters in the bibliometric map of publications for the keywords "environmental tax" and "shadow" or "shadowing"

№	Cluster	Key words
1	Red (environmental economics)	Biodiversity, conservation of natural, ecology, ecosystem service, environmental economics, environmental monitoring, environmental protection, human, pollution control, shadow pricing, sustainability, sustainable development, tax, wetland
2	Green (shadow price)	abatement cost, carbon, carbon dioxide, carbon emission, commerce, cost benefit analysis, directional distance function, emissions trading, marginal abatement costs, pollution tax, shadow price, trade-off
3	Blue (taxation)	Costs, economic analysis, economics, energy efficiency, environmental impact, environmental policy, investments, pollution, shadow economies, shadow economy, tax system, taxation
4	Yellow (environmental tax)	cost-benefit analysis, environmental tax, greenhouse gas

Source: compiled by authors via VosViewer

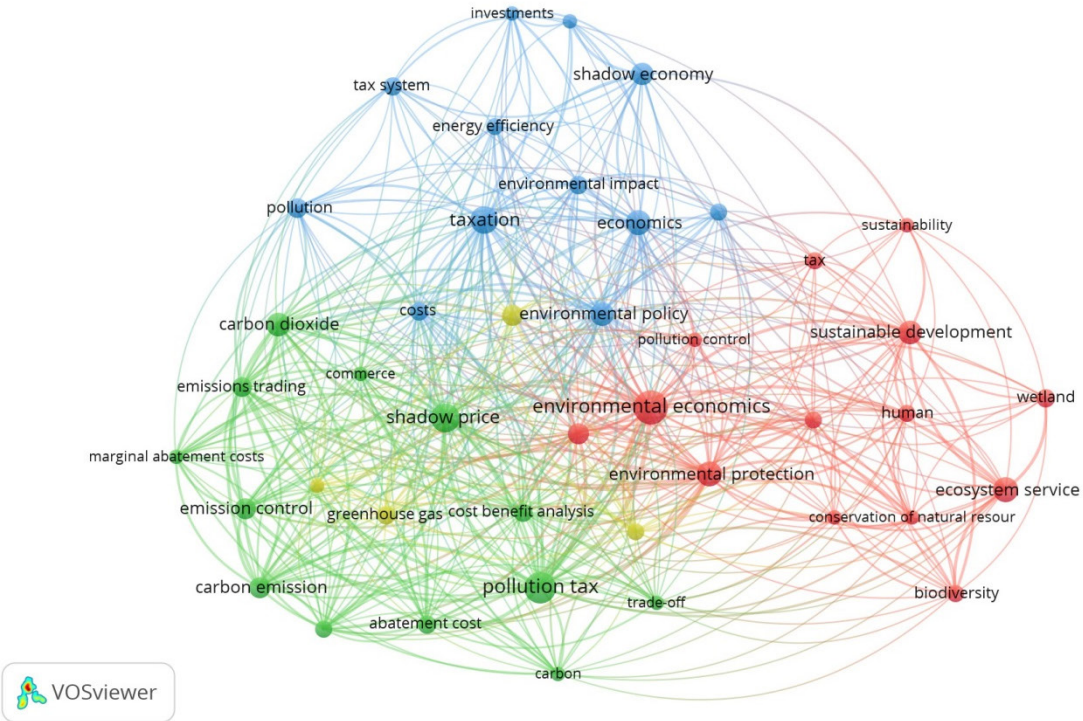


Figure 3 – Results of bibliometric analysis of keywords that simultaneously occur in publications indexed by the scientometric database Scopus, for the queries "environmental tax" and "shadow" or "shadowing"

Source: compiled by authors via VosViewer

the connections between anthropogenic impact and environmental protection through taxation. After all, taxation is an integral mechanism of state control over the size of emissions, the amounts of environmental costs and the amounts of taxes paid to the budget. At the same time, taxation helps to regulate relations between polluters, the state and the population. And the last is the yellow cluster, which confirms the existence of cause-and-effect relationships between an increase in the amount of greenhouse gases by households that leads to an increase in environmental tax obligations, stimulating them to analyse costs and benefits, which can lead to both the introduction of more eco-friendly production conditions and the evasion of environmental taxation.

In addition, the chronological development of the chain of "ecological tax" and "shadowing" was assessed (Fig. 4). In the period 2010–2012, the most popular topic was taxes, tax systems and environmental impact, as people began to talk about climate change, assess the level of anthropogenic impact, look for ways to minimize it, etc. Therefore, from 2012 to 2015, research is already based on mathematical calculations of the impact of individual environmental and economic indicators on the amount of emissions and discharges of pollutants into the environment. As a result of rapid economic, climatic and social shocks in 2015, the UN General Assembly adopts the "Sustainable Development Goals", which every nation should strive for. This is what influenced the fact that environmental taxation began to be considered through the prism of sustainable business development, while the increase in the level of shadowing of environmental payments influenced the increase in research in the field of investment, energy efficiency, and emission and discharge control since 2016.

The next stage of the study was to identify areas of complementarity that arise in the chain of "environmental tax" and "rational nature management". This made it possible to identify 152 articles devoted to this topic. Using the built-in toolkit SciVal by Elsevier, a range of key phrases for this chain was identified (Fig. 5). According to Figure 5, the topic of sustainable environmental management can be considered an effect of environmental taxation, since excessive tax burden serves to optimize emissions and discharges of pollutants into the natural environment by enterprises and households using, for example, treatment facilities or installing alternative energy sources. Thus, in total, this creates a need for environmental analysis, assessment, control and management to ensure a balance between the volumes of natural resources involved and measures designed to restore them.

The study of the chain "ecological tax" and "rational nature management" has become the object of analysis and the purpose of scientific study of various fields of knowledge (Fig. 6). It has been determined that the study of this topic correlates not only with

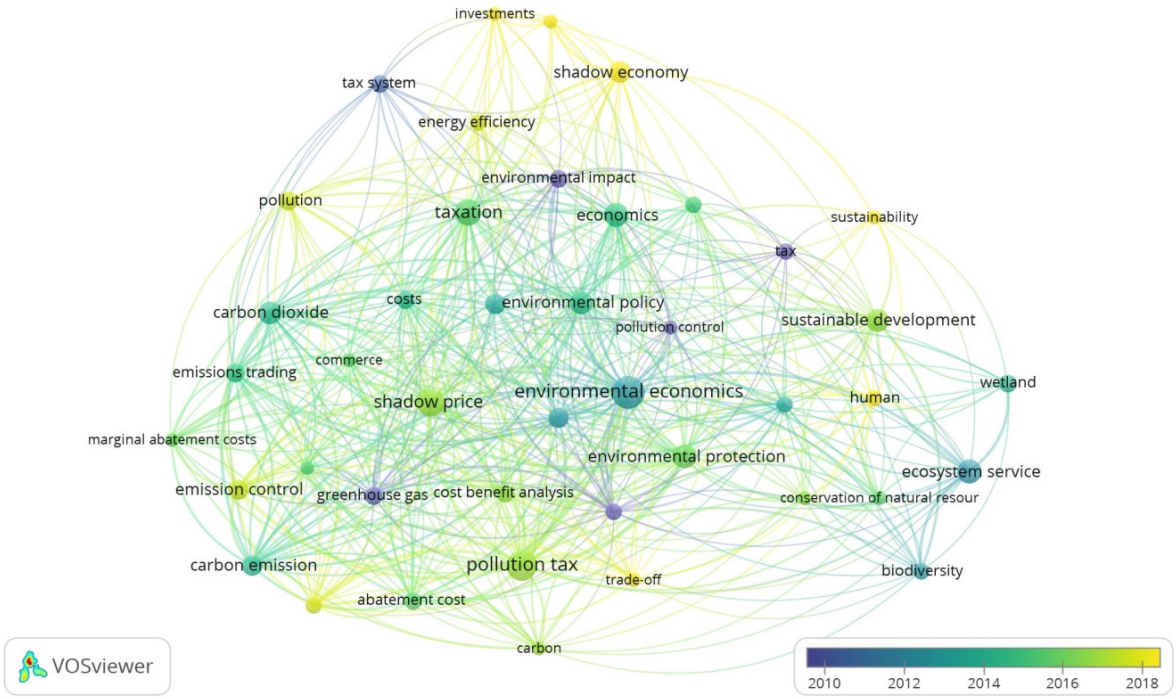


Figure 4 – Results of bibliometric analysis of the chronological development of the research "environmental tax" and "shadow" or "shadowing"

Source: compiled by authors via VosViewer

Figure 5 – Results for key phrases analysis for the chain "environmental tax" and "rational nature management"

Source: compiled by authors via SciVal by Elsevier

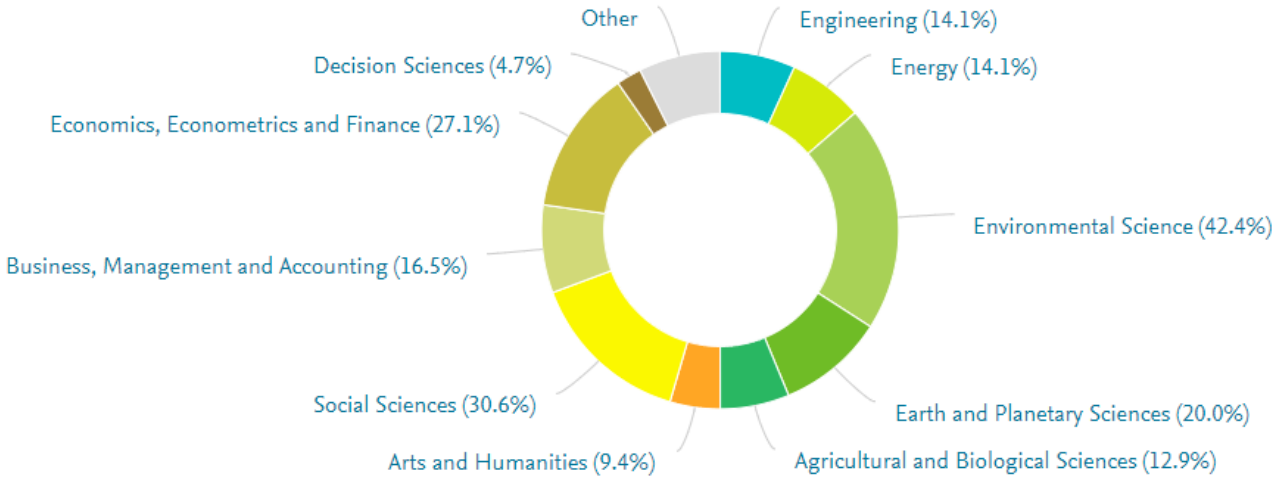
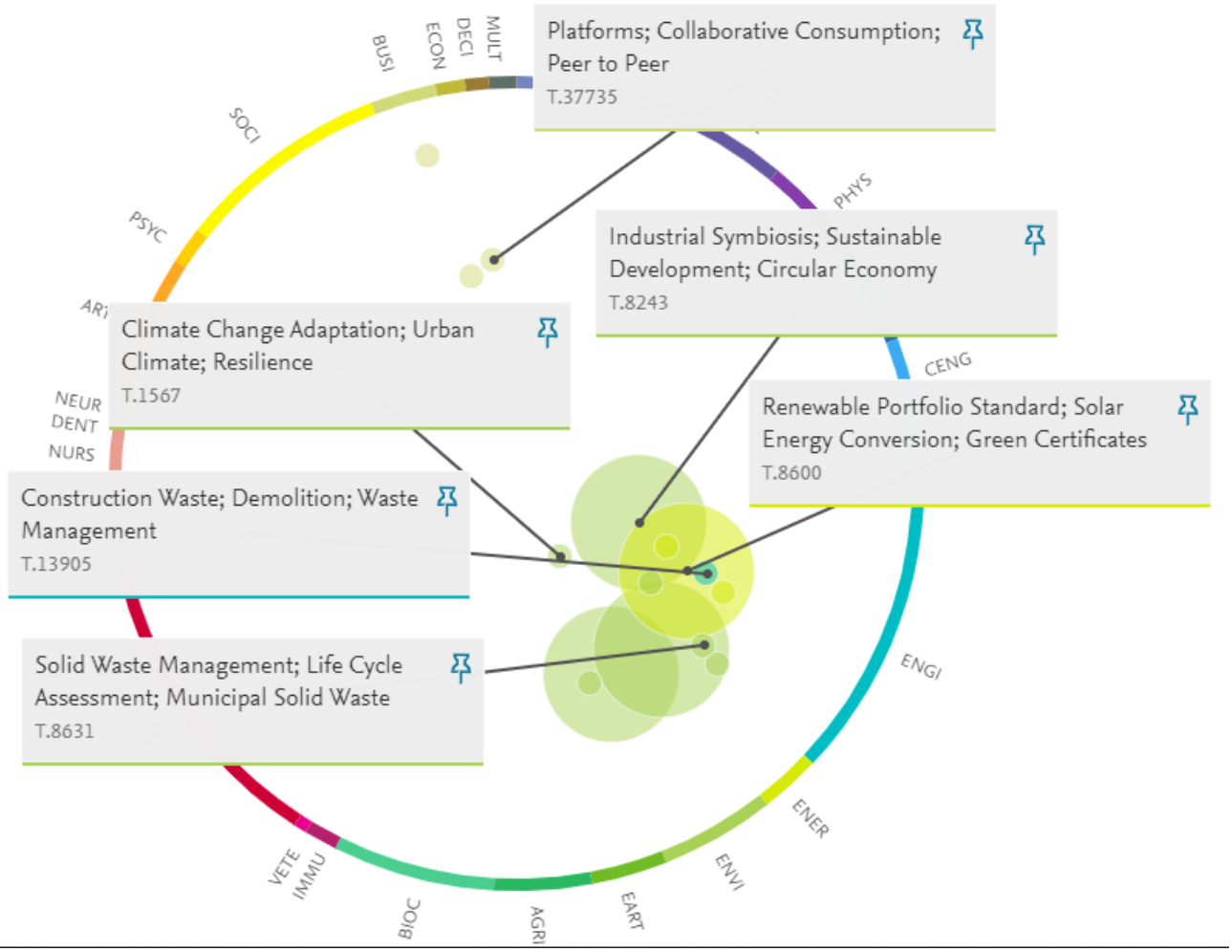


Figure 6 – Structural analysis by subject area for the chain "environmental tax" and "rational nature management"

Source: compiled by authors via SciVal by Elsevier

economics and finance (27.1%) and ecology (42.6%), but also often analyzes these categories in Earth and planetary sciences (20.0%), business, management and accounting (16.5%), energy (14.1%) etc.

This confirms the fact that rational nature management is an integral condition for the sustainable development of territories, where environmental taxation acts as a regulatory, fiscal, incentive and regulatory mechanism designed to ensure the economical use of natural resources. The highest share of publications for the chain "ecological tax" and "rational nature management" in the period 2012–2021 represents such topics as: "Shared consumption", "Adaptation to climate change", "Waste management", "Solid waste management; Life cycle assessment; Solid household waste" which are characterized by a small result of this set of studies (taking into account the size of the bubble); with a large result of the conducted research are the works "Industrial symbiosis; Sustainable development; Circular economy", etc. (Fig. 7). Based on 152 papers indexed by the Scopus database, the VOSviewer bibliometric analysis tool was applied. It was possible to analyze the coincidence of keywords in the selected articles and form five clusters that are the most common (Table 2).



Note: COMP Computer Science; MATH Mathematics; PHYS Physics and Astronomy; CHEM Chemistry; CENG Chemical Engineering; MATE Materials Science; ENGI Engineering; ENER Energy; ENVI Environmental Science; EART Earth and Planetary Sciences; AGRI Agricultural and Biological Sciences; BIOC Biochemistry, Genetics and Molecular Biology; IMMU Immunology and Microbiology; VETE Veterinary; MEDI Medicine; PHAR Pharmacology, Toxicology and Pharmaceutics; HEAL Health Professions; NURS Nursing; DENT Dentistry; NEUR Neuroscience; ARTS Arts and Humanities; PSYC Psychology; SOCI Social Sciences; BUSI; Business, Management and Accounting ECON Economics, Econometrics and Finance; DECI Decision Sciences; MULT Multidisciplinary.

Figure 7 – Top 1% Topics for the chain "environmental tax" and "rational nature management"

Source: compiled by authors via SciVal by Elsevier

Table 2 – Clusters in the bibliometric map of publications for the keywords "environmental tax" and "rational nature management"

№	Cluster	Key words
1	Red (environmental protection)	Biodiversity, conservation of natural, developing country, economics, environment, environmental manager, environmental protection, forestry, human, land use, nature conservation, planning, pollution
2	Green (taxation)	Commerce, costs, emission control, energy policy, gas emissions, greenhouse gases, laws and legislation, public policy, renewable energy resource, taxation
3	Blue (environmental policy)	carbon dioxide, carbon footprint, economic development, environmental impact, environmental policy, recycling, sustainable development, tax
4	Yellow (Ecology)	Ecology, environmental tax, natural resource, natural resources, renewable resource, tax system
5	Purple (environmental economics)	climate change, economic analysis, environmental economics, pollution tax

Source: compiled by authors via VosViewer

The first in size is the red cluster (covering 13 keywords) and summarizes the context of environmental protection and preservation. In turn, the second in value cluster (green, containing 10 keywords) establishes a contextual connection between rational environmental management and taxation, which can reduce emissions and discharges of pollutants in the short term, improve public policy and increase the need for enterprises and households to install, for example, renewable energy sources. The next is the blue cluster, which contains 8 keywords and indicates the relationship of the studied chain with environmental policy.

This should be interpreted as the need for rational environmental management intensifies the political activity of all countries of the world in terms of environmental restoration, guaranteeing environmental safety and establishing harmonious relations with the environment to ensure sustainable development of territories. The next largest is the yellow cluster (Fig. 8), which contains 6 keywords and represents the connection of the studied chain with ecology, thereby forming the opinion that the lack of rational use of natural resources by business entities has a significant negative impact on their availability, renewability and quality. In addition, in Figure 8, we have reflected the content-contextual connections of resource renewability with four identified clusters. Thus, the opinion is confirmed that environmental taxation can have a positive impact on reducing the level of emissions and discharges of pollutants into the environment, which is accordingly transposed to the state of the surrounding natural environment, while adapting environmental policy and ensuring sustainable development. And the last cluster is purple, which characterizes the connection between "environmental tax" and "rational nature management" with ecological economics, which confirms the fact of the existence of cause-and-effect relationships and dependencies between the ecosystem and economic phenomena.

Chronological development of the studied chain shows the newer developments in this area aimed at developing measures to reduce greenhouse gases, carbon dioxide emissions, carbon footprint, as well as economic and environmental development of individual territories (Fig. 9). The third stage of the study was to identify areas of complementarity that arise in the chain of "environmental tax" and "national security", for which a simultaneous search was established in the Scopus database for such phrases as: environmental AND tax; AND national AND security – which made it possible to form a sample of 114 relevant articles. The use of the built-in SciVal by Elsevier made it possible to determine a range of key phrases that occur in parallel in articles that correspond to the specified search query (Fig. 10).

Thus, this chain is often analyzed through the context of energy and environmental security, which are components of national security. At the same

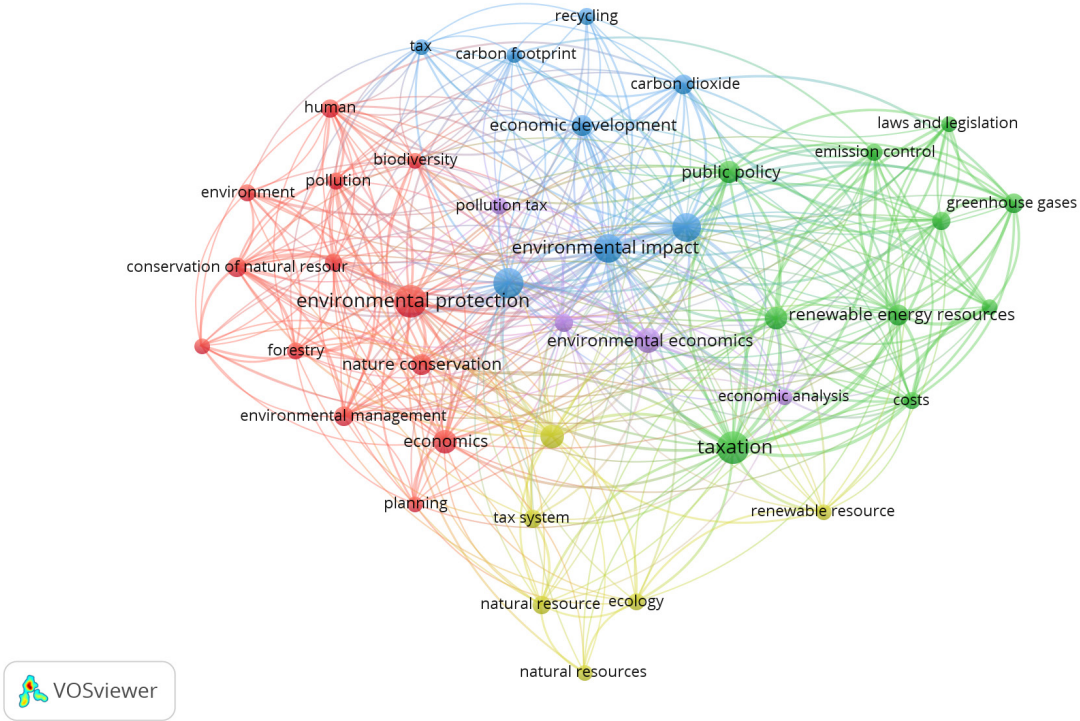


Figure 8 – Results of bibliometric analysis of keywords that occur simultaneously in publications indexed by the database Scopus, for the queries "environmental tax" and "rational nature management"

Source: compiled by authors via VosViewer

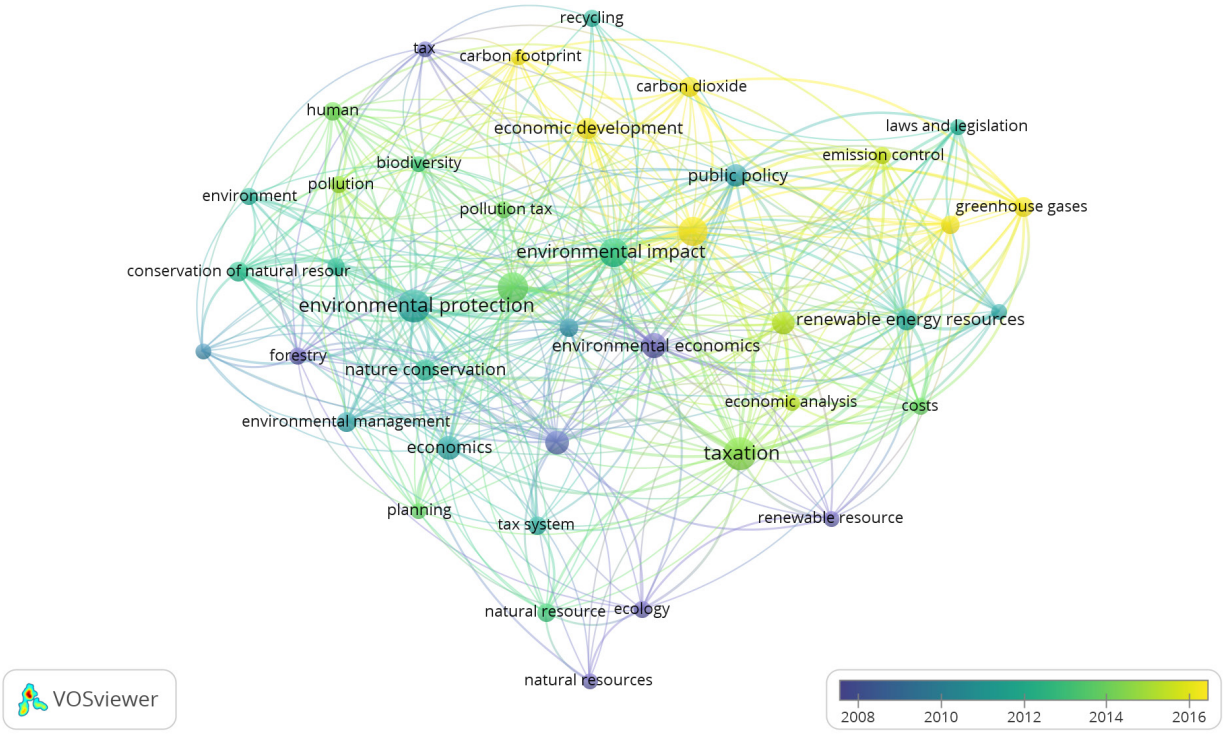


Figure 9 – Results of bibliometric analysis of the chronological development of the research "environmental tax" and "rational nature management"

Source: compiled by authors via VosViewer

Figure 10 – Results for key phrases analysis for the chain "environmental tax" and "national security"

Source: compiled by authors via SciVal by Elsevier

time, important elements of achieving the protection of the vital interests of society, the state and the planet are the spread of renewable energy, emission control, the application of differentiated environmental tax rates, compliance with regulatory norms and requirements, etc.

In addition, we identified those areas in which there is a close contextual connection between the concepts of "environmental tax" and "national security" (Fig. 11). The close relationship of this chain is traced in works on social (36.8%) and environmental sciences (30.9%). At the same time, a significant

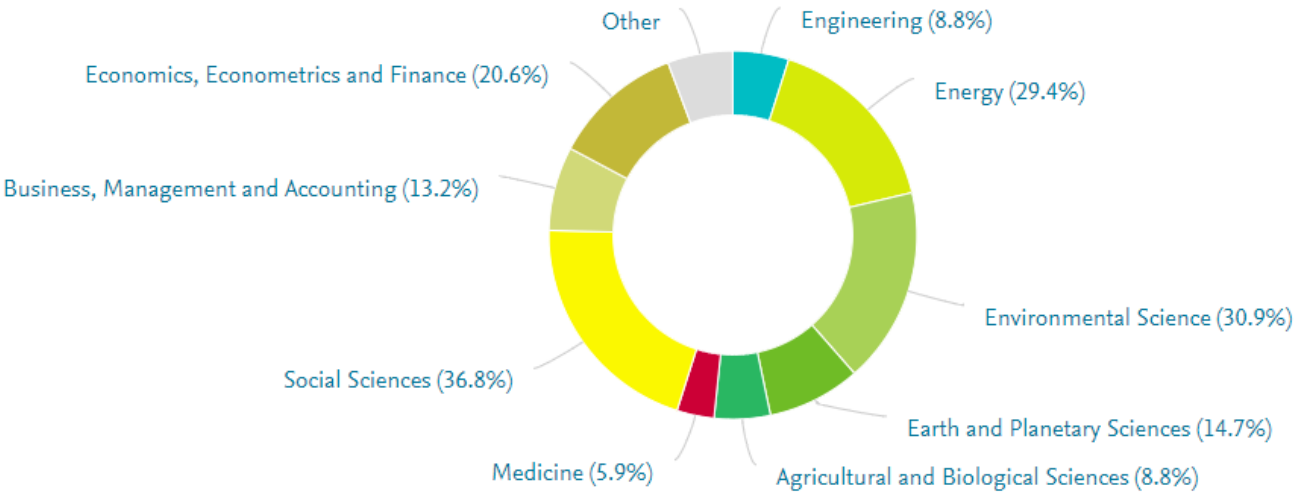


Figure 11 – Structural analysis by subject area for the chain "environmental tax" and "national security"

Source: compiled by authors via SciVal by Elsevier

number of works relate to the energy field (29.4%), which confirms the impact of the environmental tax on all components of national security and is evidence of the importance of such a tax for each of the identified categories.

Among the publications with the highest share of publications for the chain "ecological tax" and "national security", it is determined that most of them are characterized by a small result of the research set (Fig. 12). Thus, taking into account the placement of bubbles between 7 publications, three of them can be attributed to interdisciplinary sciences (T.4690, T.3195, T.5457, T.3646), and the large result of the research is an article on solar energy conversion.

The VOSviewer bibliometric analysis was used to identify complementarity areas in the study of the chain "environmental tax" and "national security". Four clusters were identified (Table 3), where the largest one is the red cluster, which contains 9 keywords and mediates the studied chain through the economic context (taxation, spending, investment). The other in importance is the green cluster, which also contains 9 keywords, but is dedicated to energy efficiency and energy security.

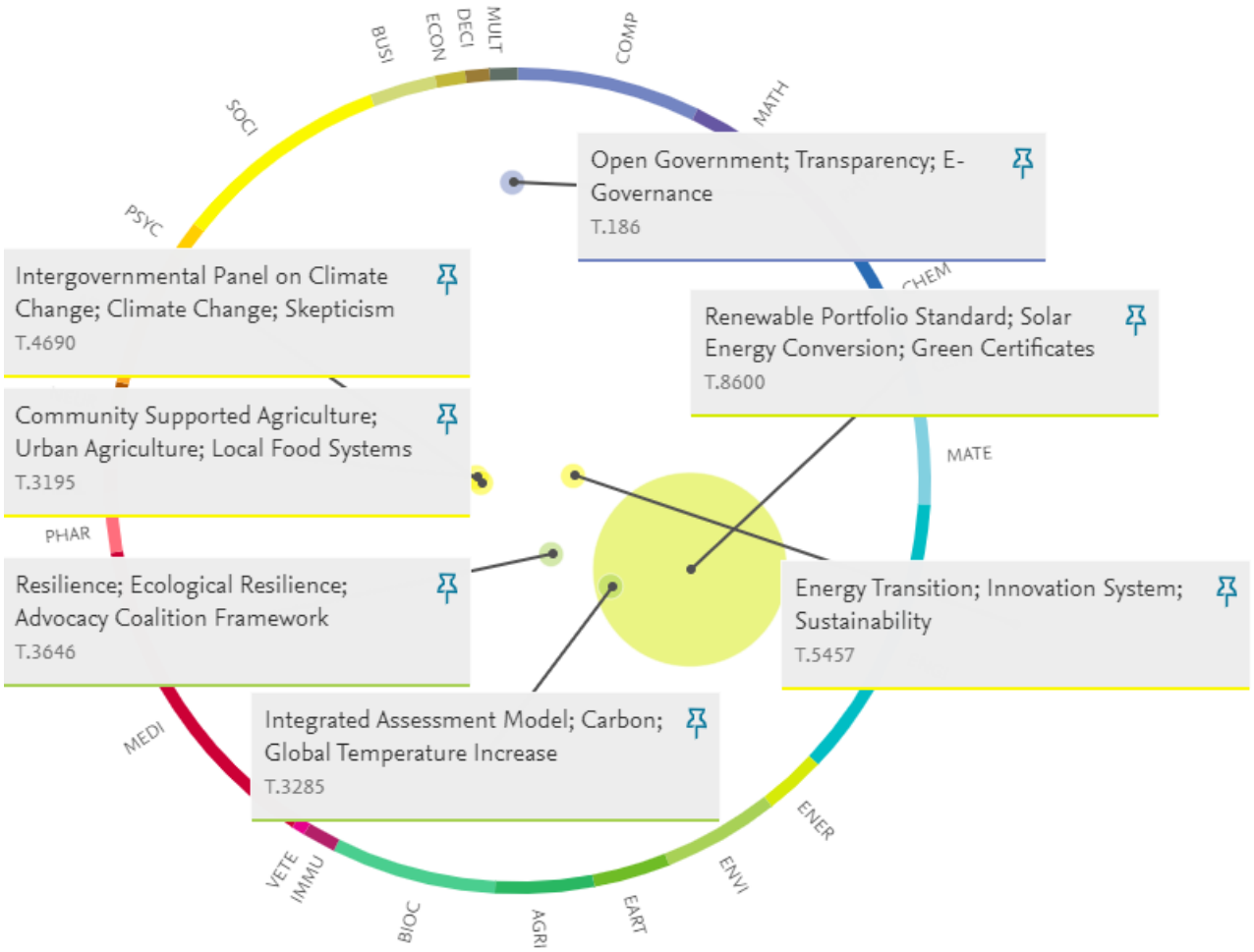
The third largest is the blue cluster and contains only 7 keywords. It shows the relationship of national security with economic (investment, spending, taxation) and environmental (energy efficiency, energy security, environmental protection, climate change) categories through the prism of sustainable development (Fig. 13).

The smallest in terms of number in the study of this chain is the yellow cluster (6 keywords), which can be attributed to the direction of guarantees regarding economic and physical access of individuals to high-quality, environmentally friendly and healthy food products. Analyzing the contextual and semantic connections of "environmental tax" and "national security", it is also important to identify the most commonly used phrases in scientific research. Thus, Figure 14 shows that the issue of national security (in particular energy) began to be emphasized in 2016–2017, while the topic of food security began to be raised in works only in 2018.

Table 3 – Clusters in the bibliometric map of publications for the keywords "environmental tax" and "national security"

№	Cluster	Key words
1	Red (taxation)	climate change, commerce, costs, economics, emission control, environmental protection, ethanol, investments, taxation
2	Green (energy security)	air pollution, carbon dioxide, carbon tax, carbon taxes, energy efficiency, energy policy, energy security, greenhouse gases, planning
3	Blue (sustainable development)	Carbon, environmental economics, greenhouse gas, national security, pollution tax, sustainability, sustainable development
4	Yellow (environmental impact)	economic development, environmental impact, food security, human, humans, tax

Source: compiled by authors via VosViewer



Note: COMP Computer Science; MATH Mathematics; PHYS Physics and Astronomy; CHEM Chemistry; CENG Chemical Engineering; MATE Materials Science; ENGI Engineering; ENER Energy; ENVI Environmental Science; EART Earth and Planetary Sciences; AGRI Agricultural and Biological Sciences; BIOC Biochemistry, Genetics and Molecular Biology; IMMU Immunology and Microbiology; VETE Veterinary; MEDI Medicine; PHAR Pharmacology, Toxicology and Pharmaceutics; HEAL Health Professions; NURS Nursing; DENT Dentistry; NEUR Neuroscience; ARTS Arts and Humanities; PSYC Psychology; SOCI Social Sciences; BUSI; Business, Management and Accounting ECON Economics, Econometrics and Finance; DECI Decision Sciences; MULT Multidisciplinary.

Figure 12 – Top 1% Topics for the chain "environmental tax" and "national security"

Source: compiled by authors via SciVal by Elsevier

Conclusions. Based on the conducted research, the goal was achieved, namely: the complementarity that arises in the process of de-shadowing of environmental taxes, stimulation of rational use of nature, ensuring national security was confirmed and substantiated. To confirm the complementarity of these categories bibliometric analysis tools were used: SciVal by Elsevier, VosViewer, Google trends, Google Books Ngram Viewer. The Scopus database contains 76 articles, which are simultaneously devoted to the study of the topic of environmental taxes and shadowing. The use of the SciVal by Elsevier toolkit allowed to determine a range of key phrases for this chain, in particular, shadow economy, shadow price, ecosystem services, environmental policy, environmental taxes, emission taxes, fiscal policy, which confirms their interdependence and complementarity. Thus, the harmonization of the elements of the chain "environmental taxation – rational nature management – shadowing of the economy – national security" will contribute to strengthening the environmental security of Ukraine and increasing the efficiency of nature management, which is confirmed by the conducted conceptual, categorical and content analysis of existing research in the context of the selected research topic.

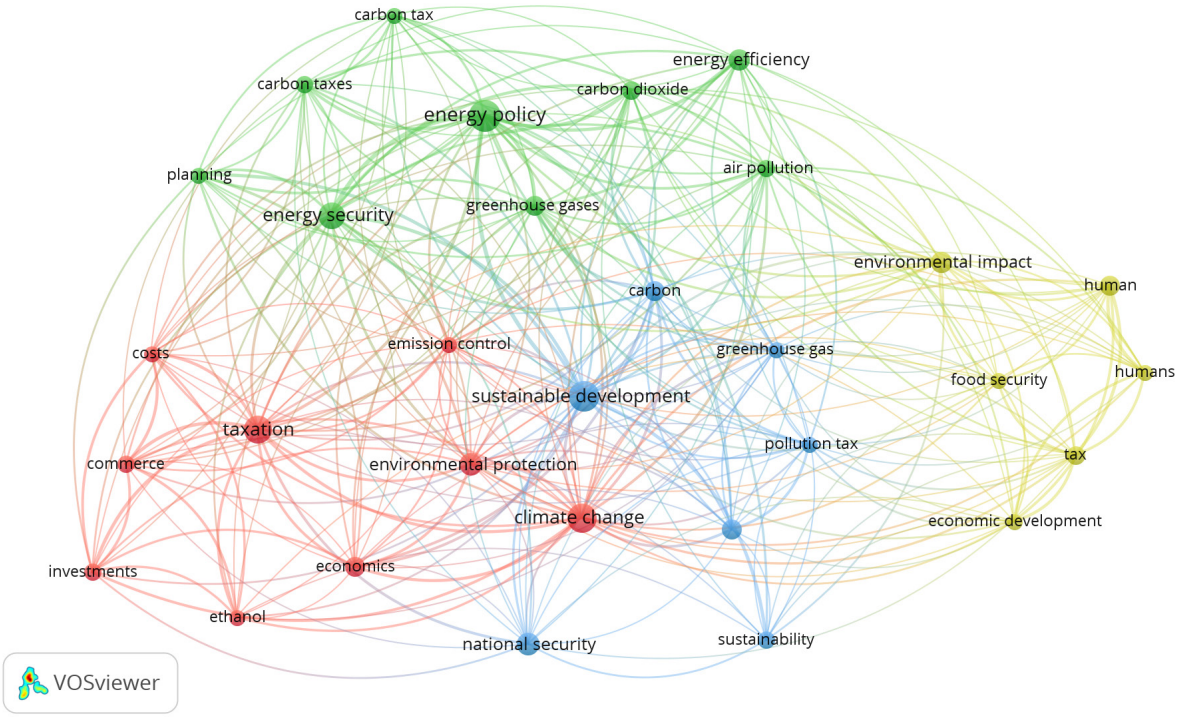


Figure 13 – Results of bibliometric analysis of keywords that simultaneously occur in publications indexed by the Scopus database, for the queries "environmental tax" and "national security"

Source: compiled by authors via VosViewer

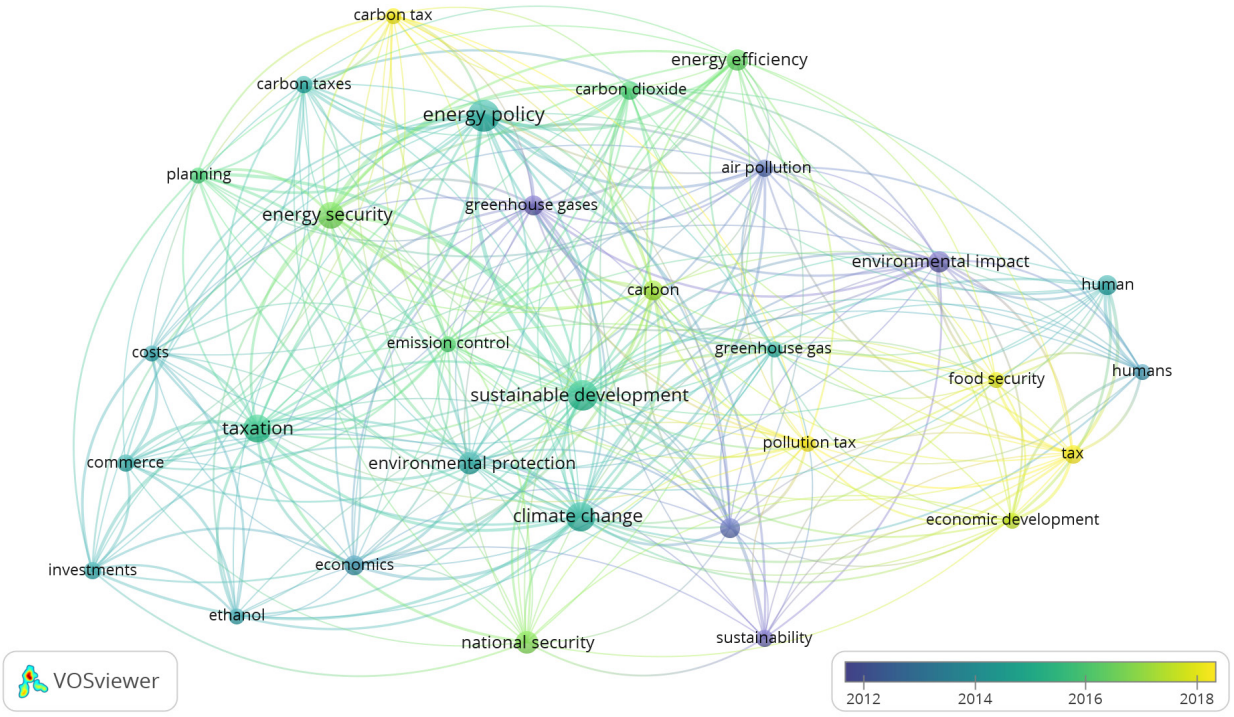


Figure 14 – Results of bibliometric analysis of the chronological development of the research "environmental tax" and "national security"

Source: compiled by authors via VosViewer

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