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REVIEW ARTICLE

Conceptual approaches to assessment of the ecological security of residential areas: Theoretical analysis

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This article reviews scientific and literary sources with a view to analysing existing conceptual approaches to assessing the environmental safety of residential areas. Our focus has been on methodological approaches that give quantitative and qualitative expression to the sustainability of ecological systems, with complex interactions of social, economic, technological and natural factors. We paid special attention to the concept of "ecological safety". This allowed us to find out that the concept is closely related to the terms ecological hazard and ecological risk. The content of each of these terms is in the sphere of interaction between society and nature.

The results of scientific research available to us are based on the understanding that residential areas are artificial ecosystems with a high population concentration and man-made load. Their security is therefore less stable than that of natural ecosystems. In different countries of the world there are own methodological developments on the assessment of ecological safety of residential areas. First of all, they include the analysis and search for options to improve the environmental and ecological economic situation, the assessment of pollution levels, the rational use of natural resources, human and technological impact on the environment, and the forecasting of emergencies, aaccidents and catastrophes both within whole countries and in their individual regions.

As a result of our theoretical analysis, it has become clear that, at the present stage, there is no single generally accepted concept for defining the ecological security of territorial units: states, regions, large urban agglomerations and smaller residential areas. We understand that the reason for this is the need to take into account a huge number of factors which, in each individual case, will be given priority according to the nature of the situation, the economic situation or other activities. The only and common feature for all existing conceptual approaches is the presence of mandatory environmental assessment in the environmental safety management system of residential areas.

Keywords: Residential areas, Environmental assessment, Methodology, Technological and natural factors.

Introduction

Ecological security, sometimes also referred to as environmental safety, is crucial in shaping the balanced development of residential areas, where population density and economic activity put significant pressure on the environment. At the same time, the residential area is defined not only as the environment within the administrative boundaries of certain human settlements, however also within ecosystems, which form energy and material flows (substances, information and energy) that are often described as urban metabolism and are directly influenced by residential sources (Orlova, et al., 2018). Transforming natural landscapes into residential areas, accompanied by climate change, is associated with such problems as air pollution and noise (Masum, et al., 2021), depletion of water resources (Yar, 2020), soil degradation (Ferreira, et al., 2018), urban heat island effect (Nogueira, et al., 2020), increased levels of stress and corresponding impact on human health (Benjet, et al., 2019), loss of natural habitat and reduction of biodiversity (Schwarz, et al., 2017), floods (Sakieh, 2017), etc.

Nowadays, particularly in countries that have adopted Sustainable Development Goals (SDGs), protection of ecosystems is a national priority from the standpoint of ecosystem services (Bai, et al., 2018; De Groot, et al., 2010). Ecosystem services are the many and varied elements, features and processes, i.e., benefits ecosystems and nature generate and provide to human well-being (Cortinovis and Geneletti, 2019). Given the spatial distribution and social demand for ecosystem services, as well as social and ecological interactions (flows), approaches to assessing the ecological security of residential areas become an increasingly important issue for environmental science (Pan et al., 2021; Malinga et al., 2015). At the same time, there is a scholarly argument that since residential areas are artificial ecosystems with a high concentration of population and man-induced load, their security and safety is less stable than the security and safety of natural ecosystems (Banaszak-Cibicka and Dylewski, 2021).

Materials and Methods

The overall objective of this paper is to conduct a literature review and analyse existing conceptual approaches to assessing the ecological security of residential areas, which provide quantitative and qualitative terms of the sustainability of ecosystems within the complex interaction of social, economic, technological and natural factors. In order to achieve this goal, we used theoretical analysis and synthesis methods, methods for collating and comparing scientific literature on the subject of the study.

Results

At the international level, the United Nations interprets the concept of security as "secure and safe access to natural and other resources, personal safety and protection from natural and man-made disasters" (Benjet, et al., 2019), "access to resources, no risk and the ability to live in a predictable and controlled environment" and as "minimum level of ecological resources (environmentally safe residue) ensuring a sustainable flow of ecosystem services" (Ferreira, et al., 2018; "Purposes and principles of the UN (Chapter I of UN charter)"). Each of the given definition is human-centred as only humans try to predict and control the environment in which they exist and on which they depend.

In terms of ensuring ecological security in Ukraine the core document is the Law "On Environmental Protection". Article 50 of the Law states that ecological security is "such a state of the environment, when the relevant parties can ensure the prevention of the deterioration of the ecological situation, as well as the danger to human health." The noted interpretation is also human-centred, as it is focused on people, the extent and way of their consumption of natural resources, the consequences of which in the future may pose a threat to public health (Law of Ukraine on Environmental Protection).

As mankind has paid more and more attention to the comfort of its environment, domestic and foreign scientists have conducted extensive research to find quantitative and qualitative parameters for the definition of ecological security; moreover, the relevant theories and methods are constantly evolving and improving (Lin, et al., 2021; Bychenok, 2020; Barabash, 2018; Kharlamova and But'kovsky, 2014; Bokhan, 2014; Chen, et al., 2013; Hope, 2006).

Hence, the "ecological security" concept has become closely related to the concepts of "ecological danger" and "ecological risk" as the essence of all of them is in the field of interaction between society and nature (Bychenok, 2020; Barabash, 2018; Hope, 2006). There is an overwhelming amount of current scientific evidence that the areas (zones) of ecological risk, which actually form the level of ecological security, are locally distributed in the region and are connected mainly with construction, industry, areas of intensive farming, as well as other objects of potential ecological risk. Scientists believes that ecological risk is determined by the interaction of such factors as the characteristics of natural objects, conditions and resources, the type of environmental management, and the level of scientific and technological progress (Bestuzheva et al., 2019).

The study on ecological risk assessment started in the 1970s (Calow, 1998). In 1992, the U.S. Environmental Protection Agency defined the ecological risk assessment and laid out the theoretical foundation and analysis framework for related study (U.S. Environmental Protection Agency, 1992). Nowadays assessments of ecological risk mainly cover hazard assessment, exposure assessment, receptor analysis and risk characterisation (Bestuzheva, 2019; Gadzalo, 2017).

On the whole, different countries have dedicated a great deal of effort and continue to give considerable attention to the issues of ecological security formation and assessment. Given the emergence of new economic, social and environmental priorities of society, the scholars provide scientifically sound proposals for ecological security, based on in-depth analytical research, and develop recommendations for their implementation, whereas the authorities put into effect relevant regulations and create an institutional system of ecological security. The key idea of the ecological security system, i.e. the harmonious development of production and natural resource potential, coordination of human management goals with mechanisms of self-regulation of natural ecosystems in order to avoid environmental degradation, remains relevant today (Mapar et al., 2020; Kuzubov et al., 2010).

There are significant methodological efforts to assess, analyse and improve the ecological and ecological economic situation, pollution levels, environmental management, anthropogenic and man-made environmental impact, emergencies, accidents and catastrophes, both within countries in general and in their respective regions in particular.

Accordingly, among domestic approaches, it's surely one of the prominent scholars in the field (Lisovskyi, 2004). He studied the characteristics of the Oblasts (regions) of Ukraine in terms of ecological security and suggested using the integrated ecological security index. This index is calculated on the basis of 8 integrated sub-indices, namely: population vitality index; index of the availability of the main components of environmental resources; index of the territory provision with the main components of environmental resources; index of anthropogenic load on the territory; index of radioactive contamination of the territory; index of anthropogenic variability of the territory; index of natural resource intensity of GDP; index of potential environmental hazards associated with production.

Basing on this method, the author typified the territory of Ukraine against the state of ecological security into regions with "high", "medium" and "low" ecological security level. We believe that the advantages of this method include its complexity combined with the relative simplicity of calculations, whereas among the disadvantages is the fact that the author did not take into account the indicators related to the quality of land resources, quantity and storage conditions of industrial toxic waste, which are known for playing extremely important role in forming the environmental situation in the region.

Team of scientists (Agarkova and Kaczynski, 1996) propose a comprehensive analysis of the state of the Oblasts (regions) of Ukraine with the help of integrated security indicators. While calculating the integrated indicator, these authors used the analytic hierarchy process (AHP), developed by Thomas L. Saaty. This is a structured technique that allows measuring the impact of the factors on an element above them in the hierarchy. From our point of view, this study has a remarkable division, as the first level, i.e. the highest element in the hierarchy, is the natural and man-induced safety of Ukraine, while the third level includes such threats to natural and man-induced safety as radiation, chemically hazardous objects, seismic hazard zones, potential forest fire risk zones, objects with fire and explosion hazards, areas with potential for catastrophic flooding. Based on the appropriate calculations, the authors built a matrix of eigenvectors of local priorities for administrative units of our state and suggested an integrated indicator of the danger or hazard for the Oblasts (regions) of Ukraine, primarily from the standpoint of disasters of natural and man-made origin.

Other scientists (Kuzubov and Yedynak) proposed an approach for the environmental assessment of the region, which takes into account the assimilation characteristics of the environment of a particular region combined with assessing the actual contamination/pollution level. The scholars propose an environmental performance indicator, which is calculated on the basis of specific contamination indicators and adjustment factors that take into account the self-cleaning capability of nature. The authors argue that the self-cleaning capability of environment, reflected in the adjustment factors, is determined by the type of land and their share in a particular region.

There are also foreign approaches to determining the ecological security of residential areas by assessing the interaction of social and environmental factors within them. Indicatively, a group of Chinese scientists assessed the possibility of positive synergies between social and ecosystem services in cities and towns with different population sizes. These studies provided a quantitative assessment of five (most important, according to the authors) ecosystem services (factors): carbon sequestration and oxygen production; habitat quality; surface water reserves; removal of atmospheric fine particulate matter; lowering the temperature, as well as five social services (factors) within the settlements, namely: educational services; medical services; housing services; social security services; tourist facilities. One of the study results was identifying the thresholds of urban public services that can prevent a rapid decline in ecosystem services in urban areas and disrupt their ecological security (Hou, et al., 2021).

Many other studies support the concept of smart urbanisation and stability of ecosystems as a guarantee of ecological security of residential areas (Cui, et al., 2019; García-Nieto, et al., 2018). At the same time, many scientists emphasize that there are significant environmental risks of deteriorating soil, water and other natural environments within residential areas (Masum, et al., 2021; Karimi Alavijeh, et al., 2021; Yar, 2020; Ferreira, et al., 2018). For instance, within the framework of assessing the ecological security of Iran's settlements, twelve indicators analysed by scientists formed a new combined urban water security index in urban areas (Karimi Alavijeh, et al., 2021).

The scholars also used the Driver-Pressure-State-Impact-Response (DPSIR) Framework, an assessment structure, which provides indices of ecological security for urban environment, as a theoretical guide for sustainable development of settlements. For example, according to this method the average level of ecological security is between 0.535 and 0.647. The results of the spatial analysis of 16 cities carried out according to the noted approach suggest that the surrounding areas easily affect the city's ecological security, showing a clustering effect (Ke, et al., 2021).

Somewhat earlier, other researchers used the DPSIR framework for quantitative assessment of environmental sustainability in Chinese coastal cities, and the results show that the ecological security network has a relatively high network occupation rate (A/C=0.6898) (Nathwani, et al., 2019).

The concept of urban ecological security assessment through the analysis of the formation of their natural and ecological framework is also well-known. The method underlying this concept is based on comprehensive consideration of the following factors: the location of the town/city in the system of protected areas; landscape and biological diversity of the territory, natural resource potential of the region and its use; ecological state of urban geosystems, the degree and pattern of harmful natural and man-made processes (Buldakova, 2018).

While considering the available modern conceptual approaches to assessment of the ecological security of residential areas, we noted that the vast majority of scientist's study and analyse in detail the specific factors (services) that are part of ecological security, furthermore, according to the authors they are decisive or top-priority for specific research areas.

Some researchers believe that modelling of social-ecological systems (SES) is a reliable analytical tool that can ensure the assessment of ecological security of residential areas (Pan, 2021; Kalantari, et al., 2019). Typically, this approach views land use and ecosystem services as a reflection of the interaction of residential areas with elements of natural landscapes. The approach proponents believe that such a concept can reveal the driving forces and feedback between the two systems. Simultaneously, in order to understand their interaction better, the scholars use a land-cover based value assessment for the services to quantify the values based on native vegetation cover in the structure of land use in the region (Crossman, et al., 2013; Chen, et al., 2013). Based on these approaches, the results of the case study of Sweden's land use structure show that accessibility in ecosystem services drives urban residential and commercial development, even though it is characterised by non-linearity. Areas around existing urban centres show high accessibility in ecosystem services and high development probabilities, whereas smaller population centres in large areas enjoy high accessibility to ecosystem services and low urban development probabilities (Qiu, et al., 2021; Zuniga-Teran, 2020).

There are also conceptual approaches, in which the level of scientific and technological progress, as well as social and economic development of residential areas is the major factor determining the level of ecological risks and security (Beck, et al., 2021). Other scholars consider the ecological orientation of the construction industry development within certain residential areas to be one of the important evaluation criteria, in particular they pay attention to the problem of security for human health in the manufacturing of construction materials, products and structures (Lukashevych, et al., 2017).

In fact, the research views ecological security of construction as an integral part of the global national system of ecological security. As a result of this approach the scholar developed a method for forming a system of ecological security in construction (SOESC). The method author argues that "the functioning of construction production does not meet the objectives of sustainable development of modern civilization, harms the environment, reduces the quality of life, negatively affects the health of the population" (Bolsherotov, 2013).

There is another interesting and unique concept of assessing the ecological security of residential areas, which is based on the analysis of green spaces of built-up areas and adjacent natural landscapes. The authors of this idea use a separate tree as an object of study, i.e., a unit of ecosystem services. At the same time, the researchers determine the following: tree trunk diameter, which

affects the dry biomass and growth rate and determines carbon binding rate; the position of the tree relative to other trees and buildings, which, taking into account local growth conditions and the length of the growing season, determines how much carbon the tree will actually bind, etc. (a total of 114 factors). The aggregation of the quantitative assessment of the established factors provides empirical data, according to which the authors suggest assessing the degree of residential area protection from the negative effects of urbanisation (Ranta, et al., 2021; Cimburova and Berghauser Pont, 2021). The scholars see the reasonableness of this concept in the undeniable ecosystem services of trees. For instance, deforestation causes increased landslides, reduced forest moisture retention, rapid snowmelt and, as a consequence, floods with large short-term floodplains, which are later replaced by shoaling of water bodies and streams (Revelles, et al., 2015; Lakhdar, et al., 2015).

On the whole, a significant number of domestic and foreign scientific papers take advantage of the concept of ecological security assessments of the environment and residential areas (or urban territories) through the definition of biological objects' parameters (Allred, et al., 2021; Aygün and Baycan, 2020). The experts consider the health of the population to be an informative biomarker of ecological security of urban areas, whereas human biological specimen characterise long-term impact of environmental factors. For instance, one can provide a comprehensive mutagenic assessment of the urban environment by determining the frequency of nuclear disorders in mucosal epithelial cells of preschool children (Horovaia, et al., 1995). Another approach determines the unfavourable situation in settlements when metal concentrations in children's hair samples exceed the baseline values (C_{fact}/C_{back}) (Tunakova, et al., 2020). The noted approaches simmer down to the calculation of integral coefficients, which display the proportion of the feature in specific conditions with the share of the relative number of observations associated with it in these conditions relative to the total number of all such cases.

Likewise, some scientists believe that the quality of life and psychosomatic health of the population (Rusak, et al., 2020; Bolsherotov, 2013), standard values of urban built-up density (BD) (Chen, et al., 2020), or direct man-made environmental effect of road transport (Rossi, et al., 2020; Fedotov, et al., 2017) are priority criteria for assessing the ecological security of residential areas. In view of the position that the share of road transport in the total pollution of residential areas is 93%, and environmental impact should be the main criterion for assessing the urban BD, a different study came up with another conceptual idea of assessing the ecological security of residential areas (Bolsherotov, 2020). In this assessment the researcher needs to determine the environmental setting indicators of the territory, the ecological reserve, the range of sustainable state of the ecosystem, as well as to calculate the BD degree.

The authors suggest considering the indicator of rational use of subsoil resources as the main factor in the ecological component of balanced development of the region (Polianskaia and Yurak, 2018). However, the authors of this theoretical and methodological approach do not use the term "ecological security". On the contrary, they introduce the concept of "balanced subsoil use", which is considered an important criterion for balancing economic activity within the use of natural resource potential of the region while taking into account the available statistical data characterising the region in terms of economic activities and social factors.

Our extensive study in line with its overall objective allows us to note that quite often the scientists add up cultural (Tam and Milfont, 2020), social (Skrimizea, et al., 2021; Mitra et al., 2017), historical, political (Hertel and Baldos, 2016; Gera, 2016; Popper, 2014), national (Kopanchuk, 2020) and other factors to the priority criteria for assessing the ecological security of residential areas. It is evident that such improvement of approaches to environmental impact assessments allows managing issues of ecological security in various areas of human activity.

Conclusion

Taking all the aforesaid into consideration, in this analytical paper, we can emphasize that nowadays, there is no single common concept for determining the ecological security of territories at different levels, particularly: state, region, large urban agglomerations and residential areas of smaller scale. It is apparent that the reason for this is the need to take into account a huge number of factors, which in each case will have priority over the characteristics of natural conditions, existing economic or other activities. Nevertheless, the only obvious fact, which remains in all existing conceptual approaches, is that the environmental assessment function in the system of ecological security of residential areas lies in accurate and timely monitoring of changes in environmental status in any intervention in their structure, regulation and restriction, if necessary, of man-made environmental impact of new and existing facilities, or any other human impact on the environment.

References

Agarkova, N.V., Kaczynski, A.B. (1996). Regional dimension of ecological safety of Ukraine taking into account the threats of man-made and natural disasters: Monograph. Kyiv: National Institute for Strategic Studies, p:74 (in Ukrainian).

Allred, S., Stedman, R., Heady, L., Strong, K. (2021). Incorporating biodiversity in municipal land-use planning: An assessment of technical assistance, policy capacity, and conservation outcomes in New York's Hudson Valley. Land Use Policy, 104:105344.

Aygün, A., Baycan, T. (2020). Risk assessment of urban sectors to climate change in Istanbul. Economic and Social Changes: Facts, Trends, Forecast, 13:211-227.

Bai, Y., Wong, C.P., Jiang, B., Hughes, A.C., Wang, M., Wang, Q. (2018). Developing China's ecological Redline policy using ecosystem services assessments for land use planning. Nature Communications, 9:3034.

Banaszak-Cibicka, W., Dylewski, L. (2021). Species and functional diversity-A better understanding of the impact of urbanization on bee communities. Science of The Total Environment, 774:145729.

Barabash, O. (2018). The effectiveness of the environmental management system as an indicator environmental safety of agglomerations. Ecological Sciences, 4:14-18.
Beck, S., Jasanoff, S., Stirling, A., Polzin, C. (2021). The governance of sociotechnical transformations to sustainability. Current Opinion in Environmental Sustainability, 4:143-152.
Benjet, C., Sampson, L., Yu, S., Kessler, R., Zaslavsky, A., Evans-Lacko, S., Galea, S. (2019). Associations between neighborhood-level violence and individual mental disorders: Results from the World Mental Health surveys in five Latin American cities. Psychiatry Research, 282:112607.
Bestuzheva, S., Litovchenko, I., Bestuzhev, V. (2019). Theoretical and methodological ensuring increase of level of ecological safety of Ukraine in conditions of European integration. Scientific opinion: Economics and Management, 1:149-159 (in Ukrainian).
Bichenok, M.M (2020). Assessment of risks of human life and population in the natural and man-made environment in a special period. Modern Information Technologies in the Field of Security and Defense, 37:145-150 (in Ukrainian).
Bokhan, A. (2014). Global dimensions of ecological security in dominanta strategic partnership. Bulletin of Taras Shevchenko National University of Kyiv Economics, 160:6-9 (in Ukrainian).
Bolsherotov, A.L. (2020). The degree of concentration of real estate is the main criterion for assessing the environmental safety of a building site. Vestnik of Brest State Technical University. Civil Engineering and Architecture, 1:152-156.
Bolsherotov, A.L. (2013). Scientific basis and methodology for the establishment of a system for assessing the ecological security of urbanized territories. Thesis for the degree of Doctor of Technical Sciences, Ecological Safety of Construction and Urban Economy. Moscow (Unpublished doctoral dissertation), p:335.
Buldakova, E.V. (2018). Prospects for increased environmental security of urbanized areas: design of natural and ecological framework. Analysis, prediction and management of natural risks in view of global climate change "GEORISK-2018": Materials X of the International Scientific and Practical Conference: in 2 volumes, Moscow: Russian University of Friendship of Peoples, p:296-302 (in Russian).
Calow, P. (1998). Ecological risk assessment: Risk for what? How do we decide? Ecotoxicology and Environmental Safety, 40:15-18.
Chen, S., Chen, B., Fath, B.D. (2013). Ecological risk assessment on the system scale: A review of state-of-the-art models and future perspectives. Ecological Modelling, 250:25-33.
Chen, X., Bai, J., Li, X., Luo, G., Li, J., Li, B.L. (2013). Changes in land use/land cover and ecosystem services in Central Asia during 1990-2009. Current Opinion in Environmental Sustainability, 5:116-127.
Chen, Y., Zhu, M., Lu, J., Zhou, Q., Ma, W. (2020). Evaluation of ecological city and analysis of obstacle factors under the background of high-quality development: Taking cities in the Yellow River basin as examples. Ecological Indicators, 118:106771.
Cimburova, Z., Berghauser Pont, M. (2021). Location matters. A systematic review of spatial contextual factors mediating ecosystem services of urban trees. Ecosystem Services, 50:101296.
Cortinovis, C., Geneletti, D. (2019). A framework to explore the effects of urban planning decisions on regulating ecosystem services in cities. Ecosystem Services, 38:100946.
Crossman, N.D., Bryan, B.A., De Groot, R.S., Lin, Y., Minang, P.A. (2013). Land science contributions to ecosystem services. Current Opinion in Environmental Sustainability, 5:509-514.
Cui, X., Fang, C., Liu, H., Liu, X. (2019). Assessing sustainability of urbanization by a coordinated development index for an urbanization-resources-Environment complex system: A case study of Jing-Jin-Ji region, China. Ecological Indicators, 96:383-391.
De Groot, R., Alkemade, R., Braat, L., Hein, L., Willemen, L. (2010). Challenges in integrating the concept of ecosystem services and values in landscape planning, management and decision making. Ecological Complexity, 7:260-272.
Fan, P., Ouyang, Z., Nguyen, D.D., Nguyen, T.T., Park, H., Chen, J. (2019). Urbanization, economic development, environmental and social changes in transitional economies: Vietnam after Doimoi. Landscape and Urban Planning, 187:145-155.
Fedotov, V., Gorbacheva, A., Dorodnikova, A., Yerokhina, M. (2017). Cleaning of atmospheric air in a city street and road network as an environmental safety technology for road transport. Transportation Research Procedia, 20:200-204.
Ferreira, C.S., Walsh, R.P., Ferreira, A.J. (2018). Degradation in urban areas. Current Opinion in Environmental Science and Health, 5:19-25.
Gadzalo, A. (2017). Peculiarities of ecological and economic systems of cross-border cooperation of the carpathian region. Scientific Bulletin of UNFU, 27:108-111 (in Ukrainian).
García-Nieto, A.P., Geijzendorffer, I.R., Baró, F., Roche, P.K., Bondeau, A., Cramer, W. (2018). Impacts of urbanization around Mediterranean cities: Changes in ecosystem service supply. Ecological Indicators, 91:589-606.
Gera, W. (2016). Public participation in environmental governance in the Philippines: The challenge of consolidation in engaging the state. Land Use Policy, 52:501-510.
Gorovaya, A.I., Digurko, V.M., Skvortsova, T.V. (1995). Cytogenetic evaluation of the mutagenic background in the industrial Dnieper region. Cytology and Genetics, 29:16-22 (in Ukrainian).
Hertel, T.W., Baldos, U.L. (2016). Attaining food and environmental security in an era of globalization. Global Environmental Change, 41:195-205.
Hope, B.K. (2006). An examination of ecological risk assessment and management practices. Environment International, 32:983-995.
Hou, X., Wu, S., Chen, D., Cheng, M., Yu,X., Yan, D., Peng, M. (2021). Can urban public services and ecosystem services achieve positive synergies? Ecological Indicators, 124:107433.

Kalantari, Z., Santos Ferreira, C.S., Page, J., Goldenberg, R., Olsson, J., Destouni, G. (2019). Meeting sustainable development challenges in growing cities: Coupled social-ecological systems modeling of land use and water changes. Journal of Environmental Management, 245:471-480.

Karimi Alavijeh, N., Falahi, M.A., Ahmadi Shadmehri, M.T., Salehnia, N., Larsen, M.A., Drews, M. (2021). Perspectives of current and future urban water security in Iran. Journal of Cleaner Production, 321:129004.

Ke, X., Wang, X., Guo, H., Yang, C., Zhou, Q., Mougharbel, A. (2021). Urban ecological security evaluation and spatial correlation research-based on data analysis of 16 cities in Hubei province of China. Journal of Cleaner Production, 311:127613.

Kharlamova, G., But'kovsky, V. (2014). Environmental safety index: The concept and evaluation. Bulletin of Taras Shevchenko National University of Kyiv Economics, 160:92-97 (in Ukrainian).

Kopanchuk, V. (2020). Environmental security as a component of national security of Ukraine: modern concepts and approaches. Bulletin of the National Academy of Public Administration under the President of Ukraine, 2:45-49 (in Ukrainian).

Kuzubov, M.V., Edinak, O.M. (2010). Modeling of economic and ecological-economic processes. Kyiv: КСУ, p:170 (in Ukrainian).

Lakhdar, B., Tayeb, S., Boudersa, G. (2015). Vulnerability's evaluation front of flood risk in urban space precaution as a principle of sustainable development. Case of Ghardaia town. Energy Procedia, 74:1000-1006.

Law of Ukraine on Environmental Protection. (1991).

Lin, J., Lin, M., Chen, W., Zhang, A., Qi, X., Hou, H. (2021). Ecological risks of geological disasters and the patterns of the urban agglomeration in the Fujian delta region. Ecological Indicators, 125:107475.

Lukashevich, O.D., Lukashevich, V.N., Filichev, S.A., Tsvetkova, L.N. (2017). Environmental safety management is a condition for the economic development of the urbanized territories of Siberia. Investments, construction, real estate as a material basis for modernization and innovative development of the economy: materials of the VII International scientific and practical conference. Tomsk: Publishing House of Tomsk State University of Architecture and Civil Engineering, p:268-271 (in Russian).

Malinga, R., Gordon, L.J., Jewitt, G., Lindborg, R. (2015). Mapping ecosystem services across scales and continents-A Review. Ecosystem Services, 13:57-63.

Mapar, M., Jafari, M.J., Mansouri, N., Arjmandi, R., Azizinezhad, R., Ramos, T.B. (2020). A composite index for sustainability assessment of health, safety and environmental performance in municipalities of megacities. Sustainable Cities and Society, 60:102164.

Masum, M., Pal, S., Akhie, A., Ruva, I., Akter, N., Nath, S. (2021). Spatiotemporal monitoring and assessment of noise pollution in an urban setting. Environmental Challenges, 5:100218.

Mitra, R., Cantello, I.D., Buliung, R.N., Faulkner, G.E. (2017). Children's activity-transportation lifestyles, physical activity levels and social-ecological correlates in Toronto, Canada. Journal of Transport and Health, 6:289-298.

Nathwani, J., Lu, X., Wu, C., Fu, G., Qin, X. (2019). Quantifying security and resilience of Chinese coastal urban ecosystems. Science of The Total Environment, 672:51-60.

Nogueira, M., Lima, D.C., Soares, P.M. (2020). An integrated approach to project the future urban climate response: Changes to Lisbon's urban heat island and temperature extremes. Urban Climate, 34:100683.

Orlova, V.G., Arutyunova, D.V., Chernobrovkina, N.I. (2018). Prospects for the development of the economy of the Russian Federation. System Analysis in the Economy, p:115-118 (in Russian).

Pan, H., Page, J., Cong, C., Barthel, S., Kalantari, Z. (2021). How ecosystems services drive urban growth: Integrating nature-based solutions. Anthropocene, 35:100297.

Polyanese, I.G., Jurak, V.V. (2018) Balance of natural resources management of the region: dynamic regulatory assessment. Economy of the Region, 14:851-869 (in Russian).

Popper, L.V. (2014). The environmental movement and its role in the political consolidation of the world system to ensure environmental security. Gileya: Scientific Bulletin, 81:339-343 (in Ukrainian).

Purposes and principles of the UN (Chapter I of UN charter). (2020).

Qiu, M., Yang, Z., Zuo, Q., Wu, Q., Jiang, L., Zhang, Z., Zhang, J. (2021). Evaluation on the relevance of regional urbanization and ecological security in the nine provinces along the Yellow River, China. Ecological Indicators, 132:108346.

Ranta, E., Vidal-Abarca, M.R., Calapez, A.R., Feio, M.J. (2021). Urban stream assessment system (UsAs): An integrative tool to assess biodiversity, ecosystem functions and services. Ecological Indicators, 121:106980.

Revelles, J., Cho, S., Iriarte, E., Burjachs, F., Van Geel, B., Palomo, A., Terradas, X. (2015). Mid-Holocene vegetation history and Neolithic land-use in the lake Banyoles area (Girona, Spain). Palaeogeography, Palaeoclimatology, Palaeoecology, 435:70-85.

Rossi, I.A., Vienneau, D., Ragettli, M.S., Flückiger, B., Röösli, M. (2020). Estimating the health benefits associated with a speed limit reduction to thirty kilometres per hour: A health impact assessment of noise and road traffic crashes for the Swiss city of Lausanne. Environment International, 145:106126.

Rusak, S., Filatova, O., Khadartseva, K. (2020). Indicators of pollutants in the atmospheric air of an urbanized area and their impact on public health. Complexity Mind Postnonclassic, 2:5-15 (in Russian).

Sakieh, Y. (2017). Understanding the effect of spatial patterns on the vulnerability of urban areas to flooding. International Journal of Disaster Risk Reduction, 25:125-136.

Schwarz, N., Moretti, M., Bugalho, M.N., Davies, Z.G., Haase, D., Hack, J., Knapp, S. (2017). Understanding biodiversity-ecosystem service relationships in urban areas: A comprehensive literature review. Ecosystem Services, 27:161-171.

Skrimizea, E., Bakema, M., McCann, P., Parra, C. (2021). Disaster governance and institutional dynamics in times of social-ecological change: Insights from New Zealand, The Netherlands and Greece. Applied Geography, 136:102578.

Sulikova, S., Brand, C. (2021). Investigating what makes people walk or cycle using a socio-ecological approach in seven European cities. Transportation Research Part F: Traffic Psychology and Behaviour, 83:351-381.
Tam, K., Milfont, T.L. (2020). Towards cross-cultural environmental psychology: A state-of-the-art review and recommendations. Journal of Environmental Psychology, 71:101474.
Tunakova, Y.A., Shagidullina, R.A., Grigorieva, I.G., Valiev, V.S. (2020). Use of human biosubstrates as environmental monitoring sites for polymetallic pollution in urban areas. Natural and Technical Sciences, 11:33-37.
U.S. Environmental Protection Agency. (1992). Framework for ecological risk assessment. Washington, DC: Risk Assessment Forum, U.S. Environmental Protection Agency. EPA/630/R-92/001.
Yar, P. (2020). Urban development and its impact on the depletion of groundwater aquifers in Mardan city, Pakistan. Groundwater for Sustainable Development, 11:100426.
Zuniga-Teran, A.A., Gerlak, A.K., Mayer, B., Evans, T.P., Lansey, K.E. (2020). Urban resilience and green infrastructure systems: Towards a multidimensional evaluation. Current Opinion in Environmental Sustainability, 44:42-47.
Lisovsky, C.A. (2004). Economic and geographical principles of balanced development of Ukraine. p:36 (in Ukrainian).

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