INTRODUCTION

Mandatory conditions for sustainable development of the regions of Ukraine include protection of the natural environment, rational use of natural resources and ensuring the ecological safety of human life. Ecological monitoring is a modern form of environmental research conducted using information tools that provide regular assessment and forecasting of anthropogenic impact on the environment and the functioning of ecosystems for management decisions on environmental safety, environmental protection and nature management. EU countries have accumulated vast experience in environmental management. The evolution of EU environmental policy has shaped clear approaches to identifying and addressing environmental issues. The use of environmental standards is the key to the sustainable functioning of ecosystems in developed European countries. Practice shows that thoughtless copying of the experience of other countries without taking into account the national peculiarities of the formation and development of the ecological space of Ukraine cannot increase the efficiency of the available natural resource potential and ensure sustainable development of the state. Of course, achieving high EU environmental standards should be a strategic goal of Ukraine’s environmental policy in the near future, but at the same time it is necessary to realize that the current significant achievements in the European Union are the result of a long process of reforms at state and regional levels. It is also important for every citizen to be aware of the importance of creating conditions to ensure a dignified existence not only for themselves but also for future generations. That is why the study of the ecological conditions of the regions is extremely necessary and of strategic importance.

LITERATURE REVIEW

Many scientific works of domestic and foreign scientists are devoted to the study environmental development, modern innovative technologies, namely innovation activity of regions, among them are: Chvátalová (2021); Chen, Sinha (2021); Dzhidzhelava, Fedina (2020); Dubyna, Zhavoronok (2021); Grazhevksa, Mostepaniuk (2020); Hysa, Kruja (2020); Ivanova, Zhuk (2020); Khasanova, Dotsenko (2020); Larionov, Siraeva, Gromova (2019); Lazarenko (2020); Li, Wan, Xu, Lin (2021); Liu, Chen (2021); Loučanová, Nosáľová, Olšiaková (2019); Melis, Wold, Bjørgen (2020); Mhlanga (2021); Revko, Butko (2020); Sorokoumova, Cherdyymova (2021); Shkarlet, Shytrhun (2020); Teixeira, Tisocek-Dufner, Marin (2021); Tropea, Hynds, McDermott (2021); Veilleux, Misutka, Glover (2021); Wu (2019); Zamula (2015) and others.

The analysis of publications within the chosen research topic makes it possible to state that some researchers (DZHIDZHELAVA et al., 2020; SHKARLET, 2020; HYSYA et al., 2020;
MHLANGA, 2021; LIU et al., 2021) studied the ecological system as a component of sustainable development, considering it in relation to social and economic components of development at different levels of economic systems, but emphasizing the key importance of the meso level in the development of the ecological sphere and the improvement of the ecological condition of the territories.

Other scientists see that improving the environmental situation at the local level is possible by addressing certain local issues, such as using nucleic acid-based biomonitoring, controlling the environmental impact of maize growing, and some others, which in general will have a positive impact on the environmental situation. Proponents of this approach to solving environmental problems include: (TROPEA et al., 2021; VEILLEUX et al., 2021; LARIONOV et al., 2019). There are also substantiated statements of the authors, which include (MELIS et al., 2020; ZAMULA, 2015; TEIXEIRA et al., 2021; SOROKOUMOVA et al., 2021; LOUČANOVÁ et al., 2019; DUBYNA et al., 2021; GRAZHEVSKA et al., 2020; LAZARENKO et al., 2020; LI et al., 2019), emphasizing the responsibility of a man for the ecological state and sense of belonging of each individual to nature, including wildlife, the formation of ecological consciousness, as well as the need to manage environmental obligations by economic entities. Scientists around the world have focused on the innovative component of environmental development but emphasizing the innovations implementation in accordance with the industry 4.0 concept in certain areas of production, which affects the environmental situation. Scientists who have considered the following aspects include: (LAZARENKO et al., 2020; LI et al., 2021; MHLANGA et al., 2021; CHEN et al., 2021; LIU et al., 2020; KHASANOVA et al., 2020; WU, 2019; LOUČANOVÁ et al., 2019; LAZARENKO et al., 2020).

In the article of the Chinese scientist (Wu, 2019) established that technological innovations have a significant inhibitory effect on regional environmental pollution. According to (SEDDON, 2021), environmental sustainability has become a key concept in ecosystem management. Paleoecological records are useful archives for addressing ecological sustainability, as they can be used to reconstruct long-term temporary changes in ecosystem properties.

METHODS
The study uses general economic methods of scientific knowledge, for example: abstraction, analysis and synthesis, monographs, which allowed to analyze the ecological development of regions. A systems approach is used, which allows us to consider regions as complex, dynamic systems with a large number of processes and heterogeneous causal relationships. The applied cartographic method allowed to visualize the ecological condition of the regions of Ukraine and to distinguish groups of regions with high, medium and low level of ecological condition, to demonstrate the dynamics of the integrated index of ecological development for the last 3 years and to rank the regions.

RESULTS AND DISCUSSION
The authors investigated the dynamics of the integrated index of innovative development of the regions of Ukraine (Table 1). It is proved that during the study period there is no region that would have a constant positive trend for eight years. Kyiv, Kharkiv and Dnipropetrovsk oblasts and the city of Kyiv have the highest average values according to the integrated index of innovative development. These regions are the most developed in terms of economic development and act as centers of scientific activity. Regarding the arithmetic mean of the integrated index of innovation development, the highest value falls on 2014, after which there is a decrease. 2020 is the least important year, which indicates the urgent need to increase innovation activity in the regions and attract financial resources for research and innovation. The general decline in the values of the integrated index of innovative development of regions has a negative impact not only on the innovation component, but also on sustainable development in general, as the modern paradigm involves achieving economic, social and environmental development goals based on the innovation component.
The value of the integrated index of innovative development of Ukraine’s regions ($I_{in}$), 2013-2020

| Regions          | $I_{in}$ 2013 | $I_{in}$ 2014 | $I_{in}$ 2015 | $I_{in}$ 2016 | $I_{in}$ 2017 | $I_{in}$ 2018 | $I_{in}$ 2019 | $I_{in}$ 2020 | $I_{in}$ avg. | Rank of the region by the average value of the integrated index |
|------------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|---------------------------------------------------------------|
| Vinnitsia        | 0.133        | 0.144        | 0.151        | 0.155        | 0.153        | 0.144        | 0.135        | 0.128        | 0.143        | 12                                                            |
| Volyn            | 0.073        | 0.055        | 0.064        | 0.084        | 0.074        | 0.048        | 0.050        | 0.063        | 0.064        | 20                                                            |
| Dnipropetrovsk   | 0.201        | 0.287        | 0.334        | 0.359        | 0.340        | 0.369        | 0.349        | 0.283        | 0.316        | 4                                                             |
| Donetsk          | 0.061        | 0.069        | 0.073        | 0.068        | 0.046        | 0.036        | 0.032        | 0.033        | 0.053        | 22                                                            |
| Zhytomyr         | 0.063        | 0.067        | 0.070        | 0.073        | 0.072        | 0.067        | 0.064        | 0.058        | 0.067        | 15                                                            |
| Transcarpathian  | 0.048        | 0.035        | 0.036        | 0.048        | 0.035        | 0.035        | 0.050        | 0.039        | 0.041        | 25                                                            |
| Zaporizhzhia     | 0.149        | 0.182        | 0.144        | 0.128        | 0.124        | 0.130        | 0.172        | 0.165        | 0.150        | 11                                                            |
| Ivano-Frankivsk  | 0.212        | 0.194        | 0.169        | 0.146        | 0.127        | 0.103        | 0.081        | 0.081        | 0.078        | 13                                                            |
| Kiev             | 0.366        | 0.377        | 0.355        | 0.339        | 0.344        | 0.366        | 0.410        | 0.443        | 0.375        | 2                                                             |
| Kirovohrad       | 0.218        | 0.207        | 0.187        | 0.163        | 0.157        | 0.165        | 0.201        | 0.207        | 0.188        | 10                                                            |
| Luhansky         | 0.059        | 0.063        | 0.066        | 0.043        | 0.021        | 0.019        | 0.031        | 0.035        | 0.042        | 24                                                            |
| Lviv             | 0.210        | 0.202        | 0.262        | 0.232        | 0.209        | 0.255        | 0.275        | 0.206        | 0.231        | 8                                                             |
| Mykolaiv         | 0.078        | 0.074        | 0.051        | 0.095        | 0.052        | 0.056        | 0.053        | 0.058        | 0.065        | 19                                                            |
| Odessa           | 0.217        | 0.234        | 0.245        | 0.252        | 0.249        | 0.234        | 0.221        | 0.207        | 0.232        | 7                                                             |
| Poltava          | 0.229        | 0.372        | 0.221        | 0.303        | 0.284        | 0.221        | 0.232        | 0.254        | 0.264        | 6                                                             |
| Rivne            | 0.059        | 0.068        | 0.066        | 0.061        | 0.051        | 0.047        | 0.061        | 0.063        | 0.059        | 21                                                            |
| Sumy             | 0.068        | 0.073        | 0.069        | 0.066        | 0.062        | 0.059        | 0.069        | 0.072        | 0.067        | 16                                                            |
| Ternopil         | 0.058        | 0.083        | 0.074        | 0.058        | 0.056        | 0.073        | 0.068        | 0.065        | 0.067        | 17                                                            |
| Kharkiv          | 0.305        | 0.355        | 0.380        | 0.355        | 0.289        | 0.392        | 0.402        | 0.418        | 0.362        | 3                                                             |
| Kherson          | 0.062        | 0.067        | 0.070        | 0.072        | 0.072        | 0.067        | 0.063        | 0.059        | 0.066        | 18                                                            |
| Khmelnytsky      | 0.383        | 0.420        | 0.333        | 0.299        | 0.250        | 0.259        | 0.229        | 0.204        | 0.297        | 5                                                             |
| Cherkesy         | 0.045        | 0.048        | 0.050        | 0.044        | 0.041        | 0.040        | 0.044        | 0.045        | 0.045        | 23                                                            |
| Chernivtsi       | 0.222        | 0.234        | 0.231        | 0.175        | 0.168        | 0.184        | 0.216        | 0.216        | 0.206        | 9                                                             |
| Chernihiv        | 0.069        | 0.075        | 0.078        | 0.080        | 0.079        | 0.075        | 0.070        | 0.066        | 0.074        | 14                                                            |
| Kyiv city        | 0.706        | 0.763        | 0.798        | 0.821        | 0.809        | 0.763        | 0.717        | 0.672        | 0.756        | 1                                                             |

The arithmetic mean value of the integral index ($I_{in \ avr.}$) = 0.168. Twelve regions, namely: Vinnitsia, Dnipropetrovsk, Zaporizhzhia, Ivano-Frankivsk, Kiev, Kirovohrad, Lviv, Odessa, Poltava, Kharkiv, Khmelnytsky and Chernivtsi regions had the value of the average integrated index of ecological development of regions higher than the average in Ukraine.

Source: search data.

The authors also calculated the integrated index of ecological development of the regions of Ukraine, which are presented in Table 2. The data show that only Zaporizhzhia and Kiev regions have constantly growing indicators of the integrated index of ecological development of the regions throughout the period. The arithmetic mean value of the integrated index of ecological development of regions for all regions shows a decline in values for 2013-2020, and in 2018-2020 the trend changed to the opposite. The arithmetic mean value of the integrated index of ecological development of regions for all regions for 2013-2020 was $I_{eco \ avr.} = 0.168$. Twelve regions, namely: Vinnitsia, Dnipropetrovsk, Zaporizhzhia, Ivano-Frankivsk, Kiev, Kirovohrad, Lviv, Odessa, Poltava, Kharkiv, Khmelnytsky and Chernivtsi regions had the value of the average integrated index of ecological development of regions higher than the average in Ukraine.
Table 2. The value of the integrated index of ecological development of regions ($I_{ec}$) for 2013-2020

| Regions         | $I_{ec}$ | $I_{ec\_avg}$ | The average for 2013-2020 |
|-----------------|----------|---------------|---------------------------|
|                 | 2013     | 2014          | 2015          | 2016          | 2017          | 2018          | 2019          | 2020          |                      |
| Vinnytsia       | 0,229    | 0,229         | 0,212         | 0,209         | 0,202         | 0,216         | 0,239         | 0,268         | 0,226            |
| Volyn           | 0,096    | 0,085         | 0,067         | 0,057         | 0,053         | 0,058         | 0,063         | 0,074         | 0,069            |
| Dnipropetrovsk  | 0,276    | 0,300         | 0,281         | 0,276         | 0,293         | 0,272         | 0,288         | 0,297         | 0,285            |
| Donetsk         | 0,047    | 0,055         | 0,054         | 0,047         | 0,032         | 0,024         | 0,026         | 0,031         | 0,040            |
| Zhytomyr        | 0,102    | 0,099         | 0,097         | 0,091         | 0,090         | 0,091         | 0,092         | 0,091         | 0,095            |
| Transcarpathian | 0,065    | 0,070         | 0,069         | 0,055         | 0,046         | 0,058         | 0,067         | 0,069         | 0,063            |
| Zaporozhzhia    | 0,185    | 0,200         | 0,204         | 0,207         | 0,216         | 0,226         | 0,241         | 0,244         | 0,216            |
| Ivano-Frankivsk | 0,327    | 0,272         | 0,233         | 0,241         | 0,272         | 0,292         | 0,296         | 0,304         | 0,279            |
| Kiev            | 0,662    | 0,602         | 0,525         | 0,516         | 0,516         | 0,560         | 0,653         | 0,732         | 0,596            |
| Kirovohrad      | 0,270    | 0,249         | 0,241         | 0,228         | 0,218         | 0,207         | 0,210         | 0,218         | 0,230            |
| Luhansk         | 0,026    | 0,045         | 0,056         | 0,053         | 0,025         | 0,014         | 0,014         | 0,025         | 0,033            |
| Lviv            | 0,212    | 0,226         | 0,216         | 0,235         | 0,232         | 0,209         | 0,239         | 0,249         | 0,231            |
| Mykolaiv        | 0,091    | 0,089         | 0,083         | 0,080         | 0,086         | 0,095         | 0,097         | 0,091         | 0,089            |
| Odesa            | 0,239    | 0,230         | 0,213         | 0,198         | 0,195         | 0,204         | 0,235         | 0,294         | 0,226            |
| Poltava         | 0,281    | 0,244         | 0,238         | 0,234         | 0,224         | 0,205         | 0,198         | 0,208         | 0,229            |
| Rivne            | 0,081    | 0,091         | 0,102         | 0,110         | 0,094         | 0,092         | 0,081         | 0,075         | 0,091            |
| Sumy            | 0,094    | 0,092         | 0,083         | 0,075         | 0,070         | 0,080         | 0,083         | 0,086         | 0,083            |
| Ternopil        | 0,079    | 0,073         | 0,064         | 0,053         | 0,046         | 0,059         | 0,074         | 0,075         | 0,065            |
| Kherson         | 0,204    | 0,252         | 0,274         | 0,245         | 0,204         | 0,178         | 0,191         | 0,227         | 0,286            |
| Khmelnytsky     | 0,052    | 0,056         | 0,057         | 0,058         | 0,056         | 0,056         | 0,057         | 0,058         | 0,056            |
| Cherkasy        | 0,279    | 0,217         | 0,194         | 0,179         | 0,164         | 0,190         | 0,229         | 0,244         | 0,212            |
| Chernivtsi      | 0,080    | 0,075         | 0,077         | 0,085         | 0,078         | 0,084         | 0,085         | 0,065         | 0,078            |
| Chernihiv       | 0,145    | 0,165         | 0,177         | 0,172         | 0,158         | 0,135         | 0,139         | 0,158         | 0,156            |
| Kyiv city       | 0,088    | 0,111         | 0,142         | 0,149         | 0,162         | 0,186         | 0,204         | 0,220         | 0,157            |
| The arithmetic mean value of the integral index ($I_{ec\_avg}$) | 0,177 | 0,175 | 0,166 | 0,161 | 0,156 | 0,161 | 0,173 | 0,184 | 0,168 |

Source: search data.

In Fig. 1, the grouping of regions by the integrated index value of the regional ecological status of Ukraine is presented.

The mentioned visualization makes it possible to state that only Kiev and Ivano-Frankivsk regions belong to the group of regions with the best value of the integrated index of ecological status. These two regions have a high level of ecological development. Vinnytsia, Dnipropetrovsk, Zaporizhzhia, Ivano-Frankivsk, Kharkiv, Khmelnytsky, Kirovohrad, Lviv, Odesa, Chernivtsi and Poltava regions and the city of Kyiv belong to the group of regions with the integrated index value of ecological development above the average. This group is the largest and includes eleven regions and the city of Kyiv. Chernihiv region is one, which belongs to the regions with an average value of the integrated index of ecological development. Regions that have a low level in terms of the integrated index value of environmental development include Volyn, Donetsk, Zhytomyr, Ternopil, Luhansk, Mykolaiv, Rivne, Sumy, Ternopil, Kherson and Cherkasy regions. It should be noted that in Donetsk and Luhansk regions military actions are taking place on the territory of Ukraine, which has had a very negative impact on these regions development, including environmental development. Eleven regions belong to the group with a low level of ecological development, which necessitates the intensification of innovative factors of the development.
Fig. 1. Grouping of Ukraine’s regions by the integrated index value of ecological development

Source: search data.

Visualization of the dynamics of the values of the ecological development index of the regions of Ukraine makes it possible to visually assess the asymmetry of ecological development of the regions. The asymmetry between Kiev region and Luhansk in terms of the average index of ecological development is 18 times.

CONCLUSION
The obtained results are necessary for the work of environmental departments in district state administrations, as they allow to conduct strategic research on the ecological state of regional economic systems. The value of the integrated index of innovative development of regions is calculated in the article. The authors emphasize that innovation should be aimed at improving the development of the environment.

Further research requires applied mechanisms to intensify innovation processes in regional economic systems and develop a methodological approach to determine the effectiveness of management decisions in this area, namely the intensification of innovation in regional economic systems and determine the impact of this management on development ecology. This strategic study can serve as a basis for further research to predict dynamic changes in the environment.

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Strategic assessment of the ecological condition of the regions in the context of innovative development

Avaliação estratégica da condição ecológica das regiões no contexto do desenvolvimento inovador

Evaluación estratégica de la condición ecológica de las regiones en el contexto del desarrollo innovador

Resumo
No artigo, é examinada a dinâmica do índice integrado de desenvolvimento inovador das regiões da Ucrânia. Comprova-se que durante o período estudado não há região que apresentasse tendência positiva constante por oito anos. Os autores defendem que as principais condições para o desenvolvimento sustentável das regiões são a proteção ambiental, o uso racional dos recursos naturais e a segurança ambiental da vida humana. Calcula-se o índice integrado de desenvolvimento ecológico das regiões da Ucrânia. A visualização da dinâmica dos valores do índice de desenvolvimento ecológico das regiões da Ucrânia permite avaliar visualmente a assimetria de desenvolvimento ecológico das regiões. Este estudo estratégico pode servir de base para pesquisas futuras para prever mudanças dinâmicas no ambiente.

Palavras-chave: Desenvolvimento de inovação. Desenvolvimento sustentável. Desenvolvimento ecológico. Sistema económico regional. Regiões.

Abstract
Within the article, it is examined the dynamics of the integrated index of innovative development of the regions of Ukraine. It is proved that during the studied period there is no region that would have a constant positive trend for eight years. The authors argue that the main conditions for sustainable development of the regions are environmental protection, rational use of natural resources and environmental safety of human life. The integrated index of ecological development of the regions of Ukraine is calculated. Visualization of the dynamics of the values of the index of ecological development of the regions of Ukraine makes it possible to visually assess the asymmetry of ecological development of the regions. This strategic study can serve as a basis for further research to predict dynamic changes in the environment.

Keywords: Innovation development. Sustainable development. Ecological development. Regional economic system. Regions.

Resumen
En el artículo, se examina la dinámica del índice integrado de desarrollo innovador de las regiones de Ucrania. Está comprobado que durante el periodo estudiado no existe ninguna región que tenga una tendencia positiva constante durante ocho años. Los autores argumentan que las principales condiciones para el desarrollo sustentable de las regiones son la protección ambiental, el uso racional de los recursos naturales y la seguridad ambiental de la vida humana. Se calcula el índice integrado de desarrollo ecológico de las regiones de Ucrania. La visualización de la dinámica de los valores del índice de desarrollo ecológico de las regiones de Ucrania permite evaluar visualmente la asimetría del desarrollo ecológico de las regiones. Este estudio estratégico puede servir como base para futuras investigaciones para predecir cambios dinámicos en el medio ambiente.

Palabras-clave: Desarrollo de la innovación. Desarrollo sostenible. Desarrollo ecológico. Sistema económico regional. Regiones.