To the section: Geography and sustainability

Sonko_Shyian_Maksymenko_Vasylenko_Ogilko

Geographical Foundations of the Sustainable Development Concept: the Paradigmatic Level

Sonko S.P.[1], Shyian D.V.[2], Maksymenko N.V.[3], Vasylenko O.V.[4], Ogilko S.P.[5]

1 Uman National University of Horticulture, 1 Instytutska Str., Uman, 20300, Ukraine
2 Kryvyi Rih State Pedagogical University, 54 Gagarin Ave., Kryvyi Rih, 50086, Ukraine
3 Karazin Institute of Environmental Sciences, V. N. Karazin Kharkiv National University, 6 Svobody sq., Kharkiv, 61022, Ukraine

E-mail: sp.sonko@gmail.com, shiyandv2017@gmail.com, nadezdav08@gmail.com, Vsolga05@gmail.com, zrivola153@gmail.com

Abstract. A constructive solution to the global environmental problem is possible within the framework of the information-space-time paradigm, the main of which is a constant (in terms of the main laws of conservation) amount of information, space and time, and thus deriving equivalent interchangeable units of their measurement. The methodological uncertainty of the very idea of sustainable development prompts the interpretation of this idea precisely taking into account the geographical picture of the world in the context of the informational-spatial-time paradigm.

Introduction. During the 30 years of existence of the sustainable development concept (SDC), the global environmental problem, the solution of which it was aimed at, has not been solved, but continues to worsen. Such aggravation forces scientists to revise the methodological guidelines for the development of the subjects of their sciences [1; 2].

Geography has certain advantages compared to other sciences in the correctness of the formulation and subsequent solution of the global environmental problem, on which the complex interrelationships of Nature-Population-Economy are closed [3; 4]. The correct formulation and justification of real ways of solving the global environmental problem is a unique chance for geography to strengthen its fundamental theoretical and methodological positions in the system of sciences and strengthen its applied status [5].

Ukraine's modern progress towards a "post-industrial", "informational", "globalized" society under the banner of the concept of sustainable development, the methodological guidelines of which have not yet been definitively determined, and therefore are rather dubious, forces us to think about the more general principles of human, regional, and national development – development, which determines the social demand for the formation of certain paradigms of scientific research [6; 7].

For a long time, geography has been dominated by the spatial paradigm, which in modern conditions requires further in-depth development and improvement in accordance with the requirements of the time. The scientific community is only beginning to realize the connection between the correct formulation of many global problems, primarily ecological, and the use of geographical space by Man. Most likely, the correct formulation of the

[1] Uman National University of Horticulture, dsc in Geography, professor.
[2] Kryvyi Rih State Pedagogical University, 54 Gagarin Ave., Kryvyi Rih, 50086, Ukraine, PhD in Geography, assistant professor.
[3] Vasyl Karazin Kharkiv National University, dsc in Geography, professor.
[4] Uman National University of Horticulture, PhD in Agricultura, assistant professor.
[5] Uman National University of Horticulture, PhD student.

ecological problem with the aim of its further solution lies in the optimization of the geographical space – optimization that can be carried out only by researching modern trends in the development of spatial socio-natural systems – Important objects of geographical science.

In fact, the global environmental problem, embodied in the concept of sustainable development, has all the signs of interdisciplinary nature and fundamentally cannot be solved in the realm of only geographical paradigms [8; 9]. The study of the general scientific origins of the global environmental problem allowed the authors to choose an integrative direction for its solution, as well as to consider the typological principles of the formation of spatial socio-natural systems, within which it should be solved as soon as possible.

Research methodology and methods. The concept of noosphere genesis, the geographical roots of which are interpreted in the geographical theory of noosphere genesis and in the geographical picture of the world [10], lies in the field of correct formulation of the global ecological problem. The essence of the geographical theory of noosphere genesis lies in a completely different interpretation of the civilizational development of mankind, considered from the standpoint of ecosystemology [11]. The primary spatial unit of noosphere genesis is not a civilization, but a modified human ecosystem, or an agroecosystem, the evolution of which leads to the formation of other noospheric ecosystems – urboecosystems and infraecosystems [10]. In the process of noosphere genesis, a person modifies trophic relations in a natural ecosystem primarily due to a conscious change in its edaphic (spatial) component. This happens due to the formation of “traps” for time, space and information [10]. As a result, an agroecosystem is formed in which spatial relations have changed. But such a change does not make the modified ecosystem of Man less “natural”. The synthetic nature of the global environmental problem is manifested in specific relationships, the symbiosis of which ensures its correct formulation. In particular, geography provides awareness of spatial relations, ecology – trophic, history – evolutionary, philosophy – cognitive.

The basis of the author's ideas about the geographical content of the global environmental problem is that when any phenomenon (body, process) develops (moves), it necessarily leaves behind a projection of this movement in a dimension one unit higher than the previous one. Thus, the movement (development) of any material body in the direction of a higher dimension gives this body emergent (qualitatively new) properties. If the above approach is applied to spatial phenomena, when projecting (superimposing) any two-dimensional bodies, one should expect the formation in the “fourth dimension” of some qualitatively new spatial formation. But this statement is valid only for such objects, the proof of the objective existence of which is already feasible and a recognized fact – landscape complexes, ecosystems, agricultural areas, types of land use, types of agricultural territory organization [12].

The ecological (geo-ecological) content of noosphere genesis today is not in doubt among almost anyone, primarily because the spatial boundaries of landscapes and ecosystems have almost been equated [13]. It is from this that the conclusion is drawn that the unifying beginning for the development of socio-natural (noospheric) laws is the territory. At the same time, such a unity does not exclude the formation of their divergent borders in a two-dimensional sense, and, therefore, involves the search for the mechanism of their formation in such a “nature-society” dichotomy, where society is the “Homo Sapiens population” [14].

The general concept of the agroecosystem, or Homo Sapiens ecosystem, was developed in previous works. An agroecosystem is an ecosystem that combines the anthropic and social nature of man [15]. Awareness of the spatial essence of such ecosystems lies within the scope of the subject of geographical sciences and is closest to the content of socio-natural systems. Such a view is also correct because it does not differ from the main position of

ecosystemology [11] and gives the right to include a person in biocenotic ecological niches, in which food relations include humanity. However, the role of inanimate (dead according to V. Vernadskyi) matter in the vital activity of the human population is very special. So, if in other populations this substance does not go beyond the biological limits of the organism, entering it (albeit in transit) as a biochemical component (i.e., included at the organismal level), then the phenomenon of the human population consists in the fact that an inanimate (fossil) substance taken from nature, in its vast majority is deliberately excluded by man from the organismic level and brought to the level of joint consumption by the entire population (Fig. 1).

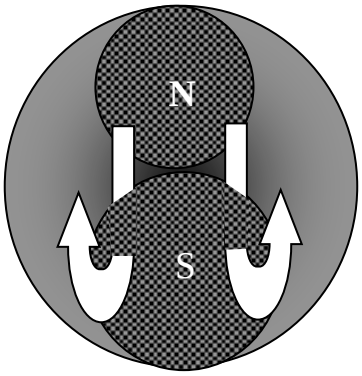

Fig.1. The general direction of the material transformation of the natural environment, which leads to the "compression" of the geographical space (N – nature; S – society)

At the same time, such consumption either does not reach the body, or completely leaves its physiological limits, confirming the purpose of this exchange in only one direction – the extraction of natural inert substance without its return to food chains. It is at this stage that thanks to the technical-cultural-transformative activity of man with the involvement of the inert substance of the biosphere, "materialized information" is formed in the form of "consumer values" [16].

Thus, the transition from the organismic to the population level is conceptually significant in understanding the geoecological essence of the human population. Taking into account the spatio-temporal existence and the total mass of ecological groups of organisms (producers, consumers, reducers) in the biosphere, we concluded that plant species are characterized by a stationary-dispersed type of mediation of geographical space. Animal species and groups (consumers) carry out dynamic and dispersed mediation of geographical space. In contrast to the purely "natural" ones, the human population has a dynamic-continuous type of mediation of geographical space, which is carried out in the direction of its constant "compresion" [17] and fundamental energy-material-informational transformation. At the same time, if in natural geobiocenoses such information exchange is aimed at improving the competitive struggle for

the environment (while not going beyond the boundaries of the ecotope), then the human population long ago won this competitive struggle with other species and conducts it within its own population, thereby reaching ecosystem level of organization of living matter. Therefore, the "ecotope" of Homo Sapiens in the classical sense of this term goes beyond the organismic level of the organization of the species and includes the population and even the ecosystem level. Thus, it is more logical to talk about an ecological niche with vaguely defined spatial boundaries. Considering the spatial behavior of Man as the search and subsequent transformation of his ecological niche in the process of noosphere genesis, the spatial dynamics of the Homo Sapiens population was investigated in historical retrospect [18].

Research results. As a result of the existing spatial dynamics of Homo Sapiens, the information influence of urboecosystems (hinterlands) on the surrounding space is gradually increasing thanks to the means and tools of the information infrastructure [19], which is where the name "infraecosystems" actually comes from. At the same time, the highest level of information influence, which leads to an increase in planetary entropy, is characteristic of today's so-called "world cities" [20]. This influence is manifested in the diversification and inversion of the geographical space by world cities, studied in previous publications (Sonko, 2002, 2003, 2004). According to the results of the author's research, the territories that fall into the hinterlands of neighboring "world" or the highest ranked "central" places are forcibly transformed by them into service, or into infrastructure [10]. From this, an important methodological conclusion is drawn, that in W. Chrystaller's theory, central places have always performed not serving, but diversifying functions, redistributing the geographical space to their advantage.

Research in previous publications of the ontological content of the space of time and information made it possible to build a methodological scheme of the interconnection of agro-, urban- and infra-ecosystems (Fig.2).

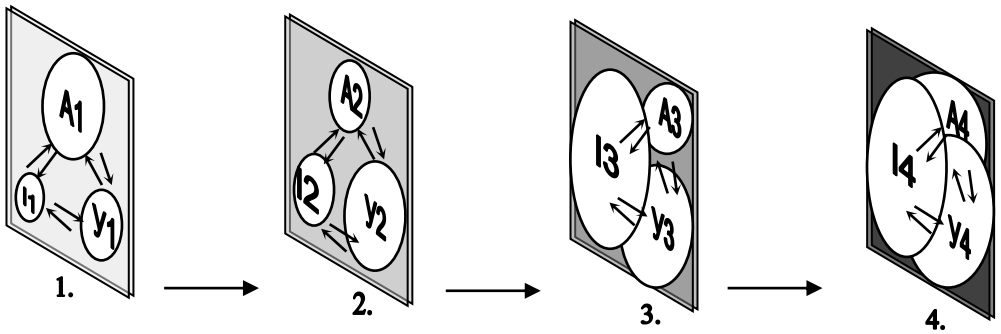

Fig.2. The system of relations in the modified ecosystem of Homo Sapiens and its development over time. "Agroecosystems (A) – urban ecosystems (У) - infraecosystems (I)"

At the early stages of the formation of the modified human ecosystem (agroecosystem), the greatest attention was paid to the actual "food extraction" (Fig. 2.1.). At the same time, information connections between different ecosystems were embodied in the primitive cults of paganism, primarily due to the lack of study of nature and the blind worship of its individual material components. At the same stage, urbo-ecosystems were just beginning to be born (recruitment of the supreme power, priests, and troops into stationary settlements). The degree of compression of the geographical space is the lowest.

At the second stage (Fig. 2.2.) as a result of the Neolithic revolution, which is also called the "axial time" (with the beginning of the process of noosphere genesis), the informational component of this process in the form of the main world religions began to relentlessly and

predestinedly form infraecosystems by introducing a spiritual beginning into international spatial relations. Cities (urboecosystems) become the main centers of such informational influence, around which hinterlands are gradually formed, which leads to a gradual "compression" of geographical space.

The third stage – modern – is associated with the acquisition of the highest level of information density by urban ecosystems and the transformation of some of them (world cities) into infraecosystems (Fig. 2.3). At the same time, global entropy acquires the highest degree, the result of which is the greatest "compression" of geographical space due to the growth of its material filling.

At the fourth stage (Fig. 2.4.), the most developed infraecosystems "pull up" other types of noospheric ecosystems to their level. All three types of ecosystems will grow spatially due to the increase in interdependence, which will lead to the maximum compression of geographical space and the maximum growth of global entropy. According to the author's concept of border conflicts, the next stage of the formation of the modified ecosystem of Man is now beginning – the cosmic one, when cosmoecosystems are already beginning to form [21].

The deepening of general scientific ideas about the role of geographical space as a carrier of physical interactions, gravity, landscape and morphogenesis, the process of interaction between nature and society, modern globalization and post-industrialism, and many other things that are carried out in Nature and perceived by Man, encourage the construction of a proper geographical picture of the world [10].

The existing space-time paradigm of geography developed in the works of K. Ritter, Y. G. Herder, T. Hegerstrand, A. Pred, O. Topchiiev, I. Chervanov, and others developed an idea about the participation of the category of time in the development of the geographical process. Just as the classical spatial paradigm (Kant-Ritter-Hettner) was focused on the selection of geocomplexes and geosystems according to their spatial form and territorial structure, the new paradigm is focused on the selection of geographic complexes and systems according to their functioning and vital activity, on the analysis of life cycles of geographic complexes of various types and scales.

For our study, the idea of time as an integral attribute of the process of interaction between nature and society plays a special role, since this process is inextricably linked with the space that life fills as a result of noosphere genesis. In our case, the process of interaction between nature and society (movement) in planetary space-time is considered. It is imagined in the form of its two main components – nature and society. Together, they actively fill the geographical space since the Neolithic, which gradually leads to its compression [10]. Considering the process of noosphere genesis as one that is formed in a certain frame of reference, it is concluded that the compression of geographical space must be compensated by real time. For such compensation, a person creates "time traps" as if putting it off "for later". To a certain extent, humanity has "borrowed" time from nature, by which it is "ahead" of it in the process of its development.

Thus, the main cause of the environmental problem lies in the different rates of development of nature and society. The result of this difference is necessarily "postponed" in geographical space. For a constructive solution to the "global ecological problem", it is necessary to find such areas of space, in which the difference in the speed of nature and society is reflected, and in the future, gradually reducing them, bring them to optimal ratios.

In the future, according to logic, in addition to the real territory, it is necessary to find those "segments" of time that are "borrowed" and that are reflected in space. In order to search for "negative" segments of space, the spatial dynamics of agroecosystems formed on the territory of the Kharkiv region were investigated (Fig. 3). The study of agroecosystems (Sonko, 1990-1997) made it possible to draw a conclusion about the simultaneous existence

of two types of borders, the dynamics of which go beyond the limits of two-dimensional understanding. According to modern ideas, such "non-coincidence" leads to an increase in the level of planetary entropy [10], and, therefore, to informational “tension”, which, most likely, is the cause of the emergence of not only environmental, but also many other global problems. The above analysis was carried out in the context of the modern space-time paradigm. The absence of an interpretation of the category of information (entropy/negentropy) explains, in the opinion of the author, the impossibility of correctly posing the environmental problem.

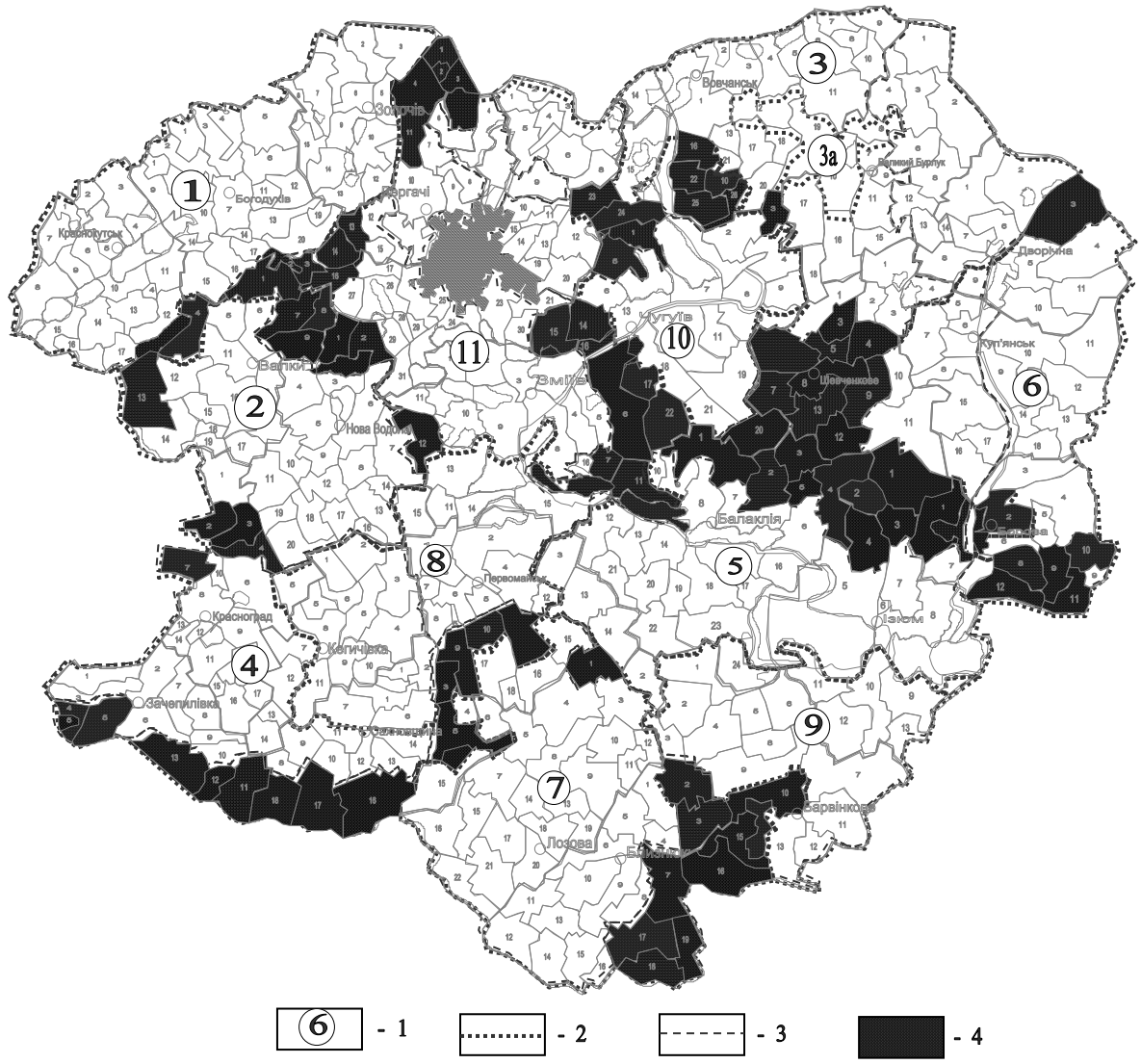

Fig.3. Spatial “mismatch” of agroecosystem boundaries.
Explanation of symbols: 1. numbers of agricultural districts; 2. Boundaries of agricultural districts (economic boundaries of agroecosystems); 3. Boundaries of type of territory organization (natural boundaries of agroecosystems); 4. areas (segments) of space, on which natural and economic boundaries do not “coincide”

It is from this antithesis that the general logic and stage sequence of the development of the new – information-space-time paradigm, reflected in the diagram (Fig. 4), originates. In this scheme, each of the blocks (stages) that reflect the development of the specified paradigm

is a cybernetic system with feedback, where the most contradictory theses that were put forward during the research act as a regulator (R). The horizontal directions of the table reflect the logic of the formation of scientific knowledge from the extraction of empirical facts to the construction of a new theory, and on its basis – a scientific picture of the world. The process of scientific research logically ends with the practical implementation of the results of theoretical research.

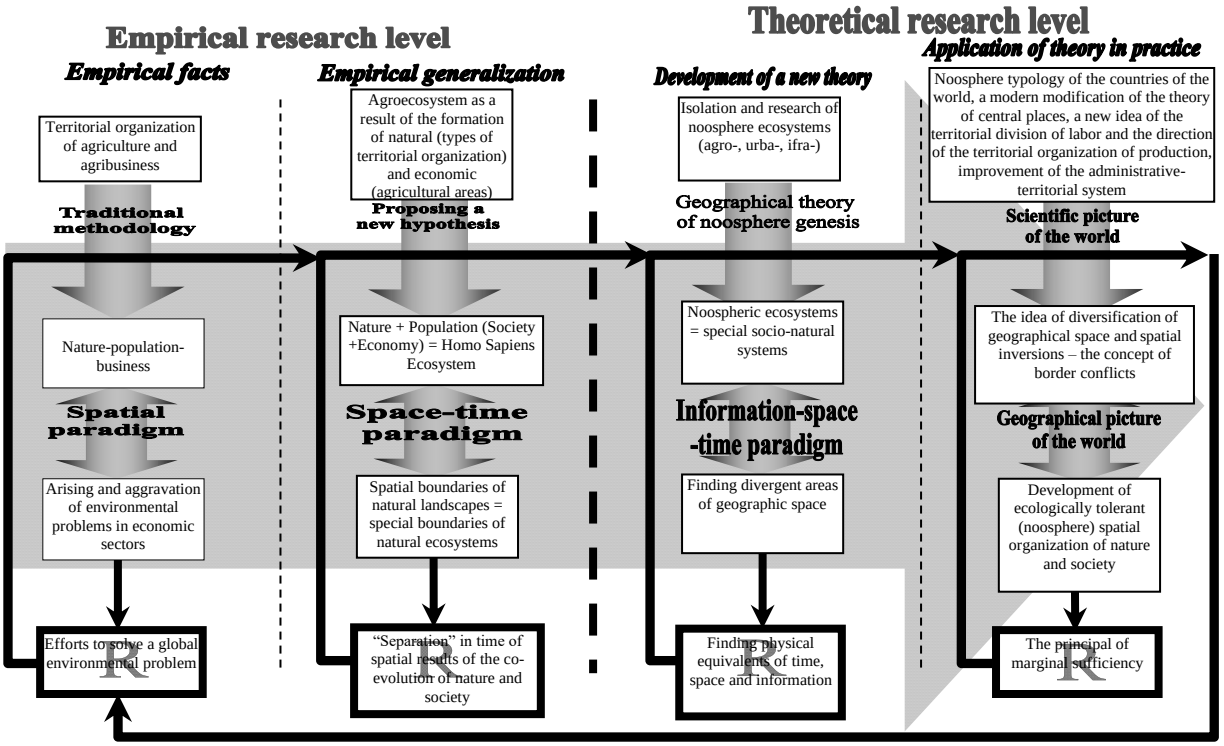

Fig.4. Development of information-space-time paradigm

At the same time, the main features of the new information-space-time paradigm should be:

- genetic unity of space, time and information in the interpretation, description and modeling of geographical process;
- equal "participation" of space-time and information in the ontological content of the information-space-time paradigm, which implies the same equal "inclusion" of them by geographers and philosophers in the corresponding types of models, classifications and typologies;
- a constant (in accordance with the main laws of preservation) amount of information, space and time in the areas of development of the geographical process in the entire oecumene;
- a close cause-and-effect relationship between the qualitative structure of information, time and space and the level of planetary entropy;
- the presence of invariant information, space and time, consistent with the logic of the process of noosphere genesis;

- closeness of the development of ideal models of space use to calculations of world constants;

- the possibility of deriving equivalent interchangeable units of measurement of space and time information.

Based on the above signs of the new information-space-time paradigm, it is necessary to consider several examples of "deviation" of the development of its information component from the invariant. Thus, in the modified ecosystem of Homo Sapiens, trophic relations are artificially "stuffed" by humans into "time traps" – grain storage in elevators, meat freezing in refrigerators, preservation of vegetables, fruits, meat, milk, production of concentrated products, which almost do not deteriorate over time. "Traps for space" are manifested at the level of agroecosystems in the organization of crop rotations, fodder arable land [22], contour-ameliorative farming systems, and other types of land use, with the help of which Homo Sapiens artificially regulates trophic relations in its own modified ecosystem. Urboecosystems generally lead to asymmetry of geographical space [19].

In our opinion, similar to "traps" for time and space, there are also "traps for information", skillfully "set" by man in the process of noosphere genesis. A very large-scale "trap for information" is the phenomenon of "stretching" by Man of the single gene pool of cultivated plants (N. Vavilov) in the process of noosphere genesis. The difference from time traps at the organismal level is quite significant, since this process vividly embodies the transformation of geographical space through the spatial destructurization of the ecological niche and time, if we consider the desire to breed new high-yielding varieties as "saving time". It is significant that the share of genetically modified food products has been constantly increasing since the beginning of the noosphere genesis process and, according to modern estimates, almost doubles the area of Great Britain. [23] At the same time, there is an increasing decrease in the resistance of the human population to microbiological disturbances [24]. "Traps for information" are manifested in the economy as well. In particular, the very term "shadow economy" comes from hidden (at least from the payment of taxes) commodity and information flows. As for the production of contraband products under the brand name of well-known brands, this is generally an ideal case of "traps for information". Given that such products are much cheaper than the original, the price difference between them can be the monetary equivalent of "stolen" information. Therefore, searches in the geographical space for informational imprints such as the Retheum sphragides can help in understanding the complex structure of planetary space-time. According to our concept, any socio-natural systems carry and leave complex sphragide information, which actually regulates all spatial relations [10].

Conclusions. The basis of the modern informational-space-time paradigm of geography is the following basic theoretical propositions, which should help in the formation of the modern geographical picture of the world:

- during the evolutionary development of humanity on the planet Earth, significant spatial transformations of its surface took place. The modern stage of these transformations is described by complex information processes, which in turn cause the corresponding energy-matter flows. Thus, modern "globalization" of production and social life is carried out under the slogans of the civilizational process, which seems to be able to lead underdeveloped countries to a better fate.
- at the same time, with the help of a system of repeaters (urboecosystems), there is a spatial redistribution of various resources in favor of developed countries due to the indirect influence on the resource potential of the planet;

- "civilization" and anthropocentrism embedded in this term acquires modern forms of spatial chauvinism, which gives reason to automatically assign individual ethnic groups and even entire countries from the standpoint of "civilization" to "civilized" and "uncivilized", "developed" and "underdeveloped". However, the biosphere role of the Australian aborigines, or the "primitive" naturalized societies of South Asia, is much more positive than that of the superpowers. And even further – there is a desire to distinguish between "higher animals" and "lower animals". However, the role of these "lower animals" in maintaining the stability of the biosphere (reducers) is much more positive than the "higher" ones and, above all, the Homo Sapiens species;
- the so-called "global environmental problem" is the result of spatial incoherence of territorial combinations of different types of relays – infraecosystems, agroecosystems, urban ecosystems; from here, the search for optimal models of the territorial organization of society is quite logically perceived;
- higher "informatization" will imply at some stage the oversaturation (compression) of geographical space with various combinations of "retransmitters", which will lead to qualitatively new shifts in the spatial being of humanity. Most likely, such shifts will lead to the identification of two main directions of information density reduction. The first direction is extensive – artificial stretching of the critical limit of compaction due to the development and implementation of optimization models of geographic space (W. Christaller, W. Isard, B. Rodoman, O. Topchiiev). The second direction is intensive – the gradual formation of artificial ecosystems (cosmoecosystems) in extraterrestrial space;
- when implementing an extensive (more realistic) way of further development, one should be guided by the principle of marginal sufficiency, according to which the optimization of the geographical space by humans should take place in the direction of rotation of individual groups of elements of the territorial structure and their functions. In particular, the gradual conscious transformation of urboecosystems into agroecosystems and vice versa (A. Chaianov) while preserving the binding function of infraecosystems.
- the civilization process is a certain period (qualitatively a new stage) of a much longer-term process, which went back to the "axial time" (K. Jaspers) and which is based on the informational processes of the universe, which were embodied in the birth of the biosphere, its further complication, fundamental its transformation by the species Homo Sapiens due to the spatial re-planning of the flows of matter and energy and the subsequent exit beyond the limits of the terrestrial biosphere into the Cosmos.
- the biosphere-noosphere theory of V. I. Vernadskyi –is the ultimate ideal model of the development of the biosphere, in the event that Humanity becomes "smarter". Predecessors of V. I. Vernadskyi in the spatial sciences developed models narrower in scope (J. Thunen, A. Weber, W. Christaller). The development of such models relates the mentioned studies to the finding of world constants (absolute zero, acceleration of free fall, speed of light, etc.), but in our case these constants are spatial;
- the development of ideal models of spatial organization may continue in the search for spatial equivalents of time, energy, and information, based even on the existing laws of conservation. Based on the assumption that the amount of planetary space is constant (invariant), it is possible to search for excess or negative segments of space that arise in the process of noosphere genesis as a result of the formation of "time traps" and "information traps". Thus, it becomes possible to calculate the corresponding coefficients of "exceeding" the invariant due to going beyond its limits. Most likely, the highest coefficient of space consumption (spatial entropy) will be developed countries that most actively structure it.
- the system of spirituals and ethical values of humanity should be based on the principles of observing biosphere interests, which requires a deep understanding of one's place (humanity), and therefore participation in biosphere processes. Instead, humanity should

not separate itself within the framework of “globalist”, “post-industrial”, “civilizational” concepts from the process taking place in the biosphere of its evolutionary development. When developing development programs at the national level, it is necessary to take into account global trends in the structuring of geographical space with the subsequent “search” of one’s place in the process. This forces us to look for other perspectives of Ukraine’s “entry” into the “post-industrial” society.

Developing a geographical world picture in the context of the information-space-time paradigm allows for the modification of the main theoretical foundations of modern geography, as well as a new look at the structuring and awareness of the global environmental problem. “Hopelessness” in its solution comes from an incorrect definition of methodological guidelines in the study of the main foundations of the interaction of nature and society, and a derived from this erroneous understanding of the phrase “sustainable development”. The methodological uncertainty of the very idea of sustainable development prompts the interpretation of this idea precisely taking into account the geographical picture of the world in the context of the information-space-time paradigm.

References

[1] Caiado R G G, de Freitas Dias R, Mattos L V, Quelhas O L G and Leal Filho W 2017 *Journal of Cleaner Production* **165** 890–904
[2] Levcheniuk E V, Vlasenko F P, Tovmash D A and Rykhlitska O D 2020 *Journal of Geology, Geography and Geoecology* **29** 745–754
[3] Chernov B nd Dudka H 2021 *Journal of Geology, Geography and Geoecology* **30** 407–420
[4] Pylypenko S and Ivashchenko O 2022 *Philosophy and Cosmology* **28** 22–31
[5] Topchiiev O 2022 *Ukrainian Geographical Journa*l **3** 3–12
[6] Prybytkova I 2019 *Visnyk KhNU imeni V. N. Karazina. Series Sociological research of modern society: methodology, theory, methods* **42** 51–58
[7] Boichenko M 2021 *Anthropological Measurements of Philosophical Research* **19** 15–22
[8] Hickel J 2020 *Ecological Economics* **167** 106331
[9] Shindaulova R 2022 *Philosophy and Cosmology* **28** 107–117
[10] Sonko S et al. 2019 *Philosophy and Cosmology* **22** 51–74
[11] Holubets M 2000 Ecosystemology (Lviv: Polli)
[12] Andreichenko A, Andreichenko S and Smentyna N 2021 *Philosophy and Cosmology* **26** 46–61
[13] Denysyk H, Chyzh O and Kanskyi V 2022 *Landscape Science. Scientific And Theoretical Magazine* **1** 5–17
[14] Dronova O and Nahornyi T 2021 *Ukrainian Geographical Journal* **2** 20–30
[15] Hudzevich A, Nikitchenko L, Baiurko N, Hudzevich L, Frytsiuk V and Levchuk N 2020 *Journal of Geology, Geography and Geoecology* **29** 520–529
[16] Sonko S, Maksymenko N, Vasylenko O, Chornomorets V and Koval I 2021 *Biodiversity and landscape diversity as indicators of sustainable development E3S Web of Conferences* vol **255** (EDP Sciences) p 01046
[17] Puhach S *2019 Economic and social geography* **82** 27–33
[18] Masikevych Y, Shestopalov O, Nehadailo A et al. 2015 *Theory of Systems in Ecology (Sumy: Sumy State University)*
[19] Petrykivska O et al. 2021 *Philosophy and Cosmology* **27** 135–144
[20] Husieva N, Kucheriava G and Suptelo O 2017 *Bulletin of Kharkiv National University named after VN Karazin, series "Geology. Geography. Ecology*" **47** 91–100
[21] Soroka L et al. 2020 *Philosophy and Cosmology* **25** 43–56
[22] Boyko A, Sus N, Boyko O and Orlovskyi A 2020 *Agricultural Science and Practice* **7** 35–43
[23] 2021 ISAAA-2021from partnerships to public trust https://www.isaaa.org/resources/publications/annualreport/2021/pdf/ISAA 2021-Accomplishment-Report.pdf
[24] Radchenko M, Ponomareva I, Pozynych I and Morderer Y 2021 *Agricultural Science and Practice* **8** 50–70

Reference:

1. Rodrigo Goyannes Gusmão Caiado, Raquel de Freitas Dias, Lisiane VeigaMattos, Osvaldo Luiz Gonçalves Quelhas, Waler Leal Filho. Towards sustainable development through the perspective of eco-efficiency - A systematic literature review. / Journal of Cleaner Production Volume 165, 1 November 2017, Pages 890-904

2. Evheniia V. Levcheniuk, Fedir P. Vlasenko, Dmitry A. Tovmash, Oxsana D. Rykhlitska.(2020) Ecologism as a Modern Strategy of Human Survival (Regional and Global Dimensions). / Journ. Geol. Geograph. Geoecology, 29 (4),745–754. doi: 10.15421/112067

3. Borys O. Chernov, Inna H. Dudka. Theoretical and methodological essence of noospheric geography of the 21 st century. / Journ. Geol. Geograph. Geoecology, 30(3), 407–420. doi: 10.15421/112137

4. Pylypenko, Svitlana and Olha Ivashchenko (2022) A Philosophical Discourse of the Earth. Philosophy and Cosmology, Volume 28, 22-31. https://doi.org/10.29202/phil-cosm/28/2.

5. Topchiiev O. H. A New Look at Geography: Geographical Imperatives. / Ukrainian Geographical Journal 2022 (3). – С.С.3-12.

6. Prybytkova, I. (2019). Ukraine's Transition to a Post-Industrial Economy as a Prerequisite for the Development of Mobile Labor Markets / Visnyk KhNU imeni V. N. Karazina. Series "Sociological research of modern society: methodology, theory, methods", 42(-), 51-58. https://doi.org/10.26565/2227-6521-2019-42-05

7. Boichenko M. I. Human Evolution: the Limits of Technocentrism. / Anthropological Measurements of Philosophical Research, 2021, NO 19. – p.p.15-22.

8. J Hickel The sustainable development index: Measuring the ecological efficiency of human development in the anthropocene. / Ecological Economics. - Volume 167, January 2020, 106331. - https://doi.org/10.1016/j.ecolecon.2019.05.011

9. Shindaulova, Raushan (2022) Noohumanism as a New Worldview Paradigm of the 21 st century. Philosophy and Cosmology, Volume 28, 107-117. https://doi.org/10.29202/phil-cosm/28/9

10. Sonko. S. Man in Noosphere: Evolution and Further Development. Philosophy and Cosmology, 2019. V. 22. P.51- 75. DOI: https://doi.org/10.29202/phil- cosm/22/5

11. Holubets Mykhailo Andriiovych Ecosystemology.- Lviv: Polli, 2000.- 286 c.

12. Andrii Andreichenko, Svitlana Andreichenko, Nataliia Smentyna. Ensuring Biosphere Balance in the Context of Agricultural Waste Management. / Philosophy and Cosmology, Volume 26, 2021. - p.p.46-61

13. Denysyk Hryhorii Ivanovych, Chyzh Olha Petrivna, Kanskyi Volodymyr Stanislavovych Revival of Landscape Science In Ukraine/ Landscape Science. Scientific And Theoretical Magazine.- №1, 2022. – С.С.5.17.

14. Dronova Olena, Nahornyi Tymofii Development Directions of Ukraine According to Different Globalization Scenarios / Ukrainian Geographical Journal. - 2021, 2(114). СС.20-30 DOI:

15. Anatoliy V. Hudzevich, Lilia O. Nikitchenko, Natalia V. Baiurko, Ludmila S. Hudzevich, Valentina A. Frytsiuk, Natalia V. Levchuk. Geoecological approach to organization of naturalized anthropogenically-modified territory. / Journ. Geol. Geograph. Geoecology, 29 (3), 520–529. – p.p.

16. Sergiy Sonko, Nadiya Maksymenko, Olha Vasylenko, Viktoriia Chornomorets, Iryna Koval. Biodiversity and landscape diversity as indicators of sustainable development. / E3S Web of Conferences. Volume 255 (2021). International Conference on Sustainable, Circular Management and Environmental Engineering (ISCMEE 2021). **Odesa, Ukraine, April 16, 2021** A. Generowicz, B. Burkinskyi and V. Koval (Eds.). / https://doi.org/10.1051/e3sconf/202125501046.

17. Puhach Serhiy Conceptualization of Geographical Space in the Scientific Literature/ Ekonomichna ta Sotsialna Geografiya, 2019, Vol. 82 PP.27-33

18. Masikevych Yurii, Shestopalov Oleksii, Nehadailo Anatolii and other. Theory of systems in ecology: a textbook. - Sumy: Sumy State University, 2015. – 330 c.

19. Petrykivska, Olena (2021) The Human Position in Urban Space. Philosophy and Cosmology, Volume 27, 135-144. https://doi.org/10.29202/phil-cosm/27/10.

20. Husieva, N. V., Kucheriava, G. O., & Suptelo, O. S. (2018). Становлення концепції світових міст: суспільно-географічні аспекти. Вісник Харківського національного університету імені В. Н. Каразіна, серія «Геологія. Географія. Екологія», (47), 91-100. вилучено із https://periodicals.karazin.ua/geoeco/article/view/10334

21. Soroka Larysa. Space Doctrine and Guidelines for Long-Term Sustainability of Outer Space Activities as Basis for Sustainable Earth Development. / Philosophy and Cosmology, Volume 25, 2020. – p.p. 43-56. https://doi.org/10.29202/phil-cosm/25/4

22. Boyko A. L., Sus N. P., Boyko O. A., Orlovskyi A. V. CLINOROTATION AS A PROMISING AND ENVIRONMENTALLY FRIENDLY BIOTECHNOLOGY IN AGRICULTURE AND SOME INDUSTRIES. / Agricultural Science and Practice, 2020, Vol. 7, No. 2. – p.p. 35-43.

23. From Partnerships to Public Trust https://www.isaaa.org/resources/publications/annualreport/2021/pdf/ISAAA-2021-Accomplishment-Report.pdf.

24. Radchenko M. P., Ponomareva I. G., Pozynych I. S., Morderer Ye. Yu. STRESS AND USE OF HERBICIDES IN FIELD CROPS. / Agricultural Science and Practice, 2021, Vol. 8, No. 3. – p.p. 50-70