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Information: interdisciplinary significance of socio-geographical concept

Liudmyla Niemets [1]
DSc (Geography), Professor, Head of the K. Niemets Department of Human Geography and Regional Studies, [1] V.N. Karazin Kharkiv National University, Kharkiv, Ukraine,
e-mail: ludmila.nemets@karazin.ua, https://orcid.org/0000-0001-9943-384X;
Kateryna Sehida [1]
DSc (Geography), Professor, K. Niemets Department of Human Geography and Regional Studies,
e-mail: kateryna.sehida@karazin.ua, https://orcid.org/0000-0002-1122-8460;
Kateryna Kravchenko [1]
PhD (Geography), Associate Professor, K. Niemets Department of Human Geography and Regional Studies,
e-mail: kateryna.kravchenko@karazin.ua, https://orcid.org/0000-0003-4654-3185;
Josep Vila Subirós [2]
PhD (Geography), Professor of the Department of Geography, Socioenvironmental Research Group, [2] University of Girona, Catalonia, Spain,
e-mail: josep.vila@udg.edu, https://orcid.org/0000-0001-7746-9227;
Aleksandar Valjarević [3,4]
PhD (Geography), Associate Professor of the Department of Geospatial and Environmental Science,
[3] University of Belgrade, Belgrade, Serbia;
[4] University of East Sarajevo, Faculty of Education, Bijeljina, Bosnia and Herzegovina,
e-mail: aleksandar.valjarevic@gef.bg.ac.rs, https://orcid.org/0000-0003-2997-2164;
Cezar Morar [4]
PhD (Geography), Associate Professor in the Department of Geography, Tourism and Territorial Planning,
[4] University of Oradea, Oradea, Romania,
e-mail: cezar.morar@gmail.com, https://orcid.org/0000-0003-0211-5883;
Pavlo Kobylin [1]
PhD (Geography), Associate Professor, K. Niemets Department of Human Geography and Regional Studies,
e-mail: pavlo.kobylin@karazin.ua, https://orcid.org/0000-0001-9718-5838;
Liudmyla Kliuchko [1]
PhD (Geography), Associate Professor, K. Niemets Department of Human Geography and Regional Studies,
e-mail: ludmila.klychko@karazin.ua, https://orcid.org/0000-0001-6937-3364;
Ievgeniia Telebienieva [1]
PhD (Geography), Associate Professor, K. Niemets Department of Human Geography and Regional Studies,
e-mail: eugene.telebeneva@karazin.ua, http://orcid.org/0000-0002-7013-8836

ABSTRACT

The purpose of the article is to determine the role of information in human-geographical research. Therefore, the authors analyzed and characterized the features of types and categories of information and analyzed the concepts and theories of information used in information geography as initial and basic options for identifying the definition of "information". Based on the analysis, they propose the concept of "information" from the perspective of human geography and identify its role in human-geographical research, as it enables human geographers to analyze and comprehend the intricate interactions between society, nature, and the connections between spatial structures.

Results. The article reveals the fundamental role of information in human geography, providing the basis for the analysis, interpretation, and prediction of social and spatial processes. The interdisciplinary significance of the human-geographical concept is also considered. Its primary function is to combine data from various fields of knowledge and contribute to a comprehensive understanding of the complex interaction between humans and nature. The authors analyzed previous foreign and domestic studies of various scientific areas, in particular human geographers, and also examined the most common philosophical concepts of information: attributive, functional, and anthropocentric. Today, there is constant discussion and no single point of view among scientists about information concepts. The article analyzes the concepts and theories of information used in information geography as initial and basic, the definitions of the concept of "information", and the peculiarities of its use in human-geographical research. Based on the analysis, the authors proposed the concept of "information" from the standpoint of human geography and its role in human-geographical research. The main contradictions between society and nature were also revealed, and the basic principles of interaction between society and natural systems in the multisystem of environmental management were considered. The authors highlighted the ideas of the formation of the concept of the social and geographical system and the socio-geographical process and revealed the peculiarities of the embodiment of ideas in human-geographical research. In human-geographical research, information plays a crucial role in determining the level of society's development. Researchers use this information to study the distribution of human activities

and natural resources, plan and manage territories, analyze dynamics and transformations in spatial structures and communication networks, and understand their impact on society. The collection and processing of primary geodata allow for the integration of different types of information and the creation of cartographic models. The utilization of information facilitates socio-economic and urban analysis, enabling the study of the demographic system's features, including its structure, distribution, and the characteristics of its primary categories. In further studies, the authors are going to prepare a model illustrating the role of information in the processes of territorial management, regional development, and restoration.

***Keywords**: information, information interaction, environmental management, system "Human – Society – Nature", social and geographical system, socio-geographical process, human-geographical studies, sustainable development.*

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Introduction of the research problem. The issues surrounding the interaction between humans and nature date back to ancient historical periods, when humans first emerged, developed, and formed societies on Earth. Humans, as components of human society, could only survive and develop by consuming the resources of the natural environment, learning, and consuming increasingly more resources for their own development. The first natural crises, troubles, and catastrophes appeared because of human society's anthropocentric attitude, which violated the millennia-old laws of nature.

The rivalry over resources and territory, as well as the dynamics of human attempts and mistakes at mastering the natural environment to meet the growing population's needs, have shaped the entire history of the relationship between humans and nature. The development of science and technology increased humans' ability to influence nature more intensively, but it also reduced nature's potential for self-renewal. This led to new contradictions, crises, and cataclysms on the planet.

The long history of human knowledge of nature's laws, phenomena, and patterns of development prompted the emergence of new sciences about nature, as well as the rapid development of new technologies, means of influence, and so on. For a long time, physics was at the heart of scientific progress's evolution. It was the founder of the initial mechanistic scientific picture of the world and gave impetus not only to the further development of the scientific picture of the world (electromagnetic, quantum-field, etc.) but also to other new sciences, in particular chemistry, biology, genetics, and mathematics. Without it, there would be no rapid development of research methods and approaches.

Geography has always held a special place in this process of developing the scientific picture of the world, serving as the foundation for knowledge of the surrounding natural world and as the founder of classical natural science. In the future, geography will continue to surpass other sciences in its exploration of the planet's nature, including the discovery of new territories and continents. This allowed humanity to develop an understanding of its planet and nature, accelerating the development of new sciences, improving humans' ability to survive, and fostering the development of the economy and technology to meet growing needs.

Only in the middle of the twentieth century, despite significant scientific achievements and the development of powerful technologies that significantly improved living conditions and met physical and biological needs, humanity realized the negative anthropocentric role it played in the emergence of serious global crises on planet Earth. At this stage, geography also properly performed its traditional functions. However, there came a stage when scientific research (geographical research in particular) led to more catastrophic manifestations due to human influence, without taking into account the needs of nature to preserve their capabilities and patterns. These include the destruction of lakes and rivers, pollution and salinization of soils, and many other consequences that, at times, are virtually impossible to overcome. Scientific searches began to find answers to these challenges. The understanding of the need to protect the environment, the emergence of ecology, and its swift integration into education all contribute to this new phase.

All sciences strive to address the same questions: enhancing human productivity, mitigating the impact of human activity on the environment and society, and integrating intelligent and sustainable technologies into all aspects of society. Indeed, geographical science in general and human geography, as a complex scientific direction that explores the system "Human-Society-Nature," have joined this quest. Today, we can assert that information interaction serves as a potent instrument, facilitating the amalgamation, interplay, and exchange of all components within the social and geographical system. The intensity and nature of this interaction currently determine and will continue to determine the level and intensity of its evolution in the future.

Analysis of recent research and publications. Aurelio Peccei, the founder of the Club of Rome, raised the issue of the interaction of humans and nature and the impact of human activity on the environment as a crucial issue at the level of the world's general scientific problem. It led to an understanding of the need to change human qualities. From this

point forward, scientists from various fields began conducting powerful scientific research on nature, humans, and society. Their goal was to identify the most effective ways to meet the increasing needs of humanity, ensure the rapid advancement of technology and production, and preserve the planet's natural resources for both self-preservation and self-renewal. There are known documents of the first World Conference in 1972 in Helsinki, the work of a powerful team of scientists, businessmen, and politicians under the leadership of the former Prime Minister of Norway, Gru Harlem Bruntland, in preparation for the World Forum in Rio de Janeiro after 20 years of achievements of the Helsinki Forum. This commission prepared a detailed analysis of all processes in the relationship in the global System "Human-Society-Nature". Most countries in Rio de Janeiro unanimously adopted the renowned Strategy for the Sustainable Development of the World for the 21st Century, taking into account the research of world-renowned scientists, a thorough examination of the evolution of hazardous phenomena and processes within the Earth's biosphere, and the human role in these processes. This strategy would guide most countries' efforts to address the manifestations of global crises caused by reckless and anthropocentric human behavior.

The concept (Strategy) of sustainable development gave impetus to interdisciplinary studies of the problems of contemporary civilization and, most importantly, raised the question of the anthropocentric role of humans, his negative role in these problems. They are rapidly spreading to the social components of the relationship between humans and nature, and the spread on a global scale is precisely due to the anthropocentric nature. However, the world quickly split into supporters and opponents of this Strategy, because it required extraordinary actions from the part of human civilization, rejection of many unreasonable needs, material losses, etc. But a lot of useful things have been done, a number of countries have developed their own strategies, created appropriate bodies, etc. The question of the next generations of earthlings and the provision of opportunities for their survival became relevant and required rapid action, including scientific development on an interdisciplinary basis of the sciences of nature, humans, and society.

Since then, the potential and role of social and natural sciences in solving contemporary civilization's problems have increased. This has led to modifications in the conceptual framework, terminology, and methodology of various sciences, especially geography, thereby enhancing the significance of social and socio-economic (human) geography. Interesting studies, projects, and works of scientists-geographers in this direction have appeared; there are also changes in the educational sphere. The acquisition of information is extremely important, about not only society, science, and technology, but also about the structural information contained in natural systems in particular.

Today, the digital realm encompasses every aspect of human activity. Digitalization, the coding of any type of information known to humanity, is the main trend in contemporary society's development. This simplifies a person's life on the one hand and creates powerful challenges requiring urgent solutions on the other. Many foreign and domestic researchers in various scientific fields, particularly human geographers, have covered the issue of information, information exchange, and the role of information in the life and evolution of society in their current papers.

Liu, C. (2024), based on the author's research experience in the Curating Digital Lives project, presented a "stick to the digital" methodological approach that views the digital as a tangible entity embedded in everyday spaces and practices. This methodology emphasizes the importance of recognizing the conditional, unpredictable, and uncertain nature of digital procedures and processes that people influence. Applying this approach enables geographers to gain a nuanced understanding of how digital technologies contribute to geographic knowledge from a grassroots perspective.

Using transfer entropy metrics and the I-CEEMDAN framework, Umar et al. (2023) looked at how information moves between geopolitical risk (GPR) and global financial assets like stocks, bonds, and commodities. They focused on the war between Russia and Ukraine. The results of the study demonstrated that crude oil and Russian capital manifest the opposite reaction to georadar in the short term, and georadar information increases risk in the financial market in the medium and long term.

De Sabbata et al. (2023) attempted to study everyday geographical information through quantitative analysis using data from the social network Twitter. Using statistical approaches based on term frequency and the most up-to-date large language models, the authors also conducted a case study of Twitter content geolocated in Leicester, Great Britain. Scientists have shown that large language models combined with spatial analysis and visualization can contribute to the study of the geography of everyday life and demonstrated the potential of large language models and visual analytics in democratizing complex natural language processing.

Darendeli et al. (2024) explore the geography of corporate fake news. The authors created a complete database of (negative) fake news about American firms, identified accounts that distribute news on social network X (Twitter), and used machine

learning methods to determine the geographical location of these fake news distributors. Foreign accounts are more likely to share corporate fake news than corporate non-fake news, according to the scholars. Corporate fake news is likely to originate in Africa and the Middle East, and tends to increase during periods of high geopolitical tensions at the country level.

Wilson and Wakefield (2021) proposed a methodology for assessing demographic and health indicators with incomplete geographical information, describing a spatial hierarchical model that accounted for the inaccuracy in the location of clusters. The scientists observe that their developed computation algorithm is swift and circumvents the challenging computations associated with the pure MCMC approach.

Acheson and Purves (2021) considered the extraction and modeling of geographical information from scientific articles. The authors developed a fully automatic conveyor to extract and represent locations, such as fieldwork sites or patient treatment centers, from scientific articles and applied it to two distinct buildings. The authors noted good performance with full accuracy on the conveyor for ecological and biomedical buildings, visualized in the form of simple global maps. It allows human annotators to both explore the templates of buildings in space and sort the results for further analysis.

In Ukraine, one of the first powerful papers in this direction was by V. Vernadsky, the founder of the National Academy of Sciences and author of the landmark paper "Biosphere" (1945). He insisted and substantiated that a nature-centric basis should justify all powerful scientific achievements and technologies within the relationship between nature and society. We must transform the biosphere into the noosphere, the mind's sphere. We should only use powerful scientific technologies and means of influencing nature for the mutual benefit of humans and nature. This is particularly true in the field of nuclear physics. The atom must be peaceful. However, the tragic events of Hiroshima and Nagasaki transformed the peaceful atom into a destructive force for contemporary civilization, posing a threat not only to human lives but also to the entire planet.

In the scientific papers of representatives of the Kharkiv Scientific Human-Geographical School, the issue of interaction in the system "Human–Society-Nature is widely covered. In particular, in Doctor of Geographical Sciences, Professor Kostiantyn Niemets's papers – scientific monographs, articles, the role of information in the evolution of society, and the importance of the information approach in human and geographical research are highlighted. As a scientist, he was deeply concerned about understanding the laws governing the mutual development of human society and the natural environment, which are based on the ever-increasing flow of information. The development of the relationship between humans and nature cannot occur without a perfect mastery of the principles of information exchange in the global system at all its hierarchical levels. These theories were developed in many subsequent publications of the Kharkiv Scientific School, in particular monographs: "Information: nature, human, and society (human-geographical aspects)" (*Niemets et al., 2023a*), as well as in papers highlighting aspects of the role of human geography in solving various problems (*Niemets et al., 2023b*), informational and synergetic components of human-geographical research (*Niemets et al., 2022b*), methodology of human-geographical research (*Niemets et al., 2022a*). In addition, the application of the information approach was considered in applied human-geographical research, in particular in the application of the geoinformation approach to the urban, demographic research (*Kostrikov and Sehida, 2016; Kravchenko, 2017; Kostrikov et al., 2018*), the study of innovation and investment potential of a region (*Niemets et al., 2018d*), tourism development (*Morar et al., 2021a; Niemets et al., 2018c*), the study of the interaction between society and nature (*Valjarević et al., 2021; Morar et al., 2021b; Garau et al., 2023; Salhi et al., 2022*), urban studies (*Niemets et al., 2021a; Morar et al., 2022; Niemets et al., 2019a*), brownfields and greyfields of a city (*Morar et al., 2019*), regional development (*Niemets et al., 2019c; Niemets et al., 2018a*), migration challenges (*Niemets et al., 2019b; Sehida et al., 2018*), trade (*Kobylin, 2016*), social infrastructure development of the region (*Nemets et al., 2014*), development of IT-industry (*Niemets et al., 2021b*).

Serhii Puhach's papers cover communication networks in the regional dimension and analyze the theory, methodology, and practice of human-geographical research. The author identifies the key features of geographical, social, and virtual spaces from the standpoint of social geography, formulates the socio-geographical concept of communication networks of the region as a reflection of social interactions in a certain territory, and proposes methodological principles of socio-geographical research of communication networks of a region as a whole and transport networks, mobile communication networks, social Internet networks, and migration networks of the region (*Pugach, 2021*).

Highlighting previously unsolved parts of the general problem dedicated to the article;

The contemporary world is dynamic and changing, and information plays an increasingly powerful and decisive role in societal evolution. Therefore, the issue of the role of information in the

evolution of society and the interaction of humans and nature deserves further development and new research.

Information is a central element in human-geographical research, as it allows obtaining, analyzing, and interpreting data on complex relationships between people and the environment. The use of contemporary information technologies significantly expands the possibilities of research and contributes to making decisions that are more informed in the planning and management of territories. In particular, studying the transformation of social relations and the structure of society under the influence of the latest information technologies, the dependence of access to innovative technologies on social equality, the manipulation of information and the impact of disinformation on the development of society, the peculiarities of the evolution of communication means, the role of information in the dynamics of types of employment and the actual nature of work, the impact of the global information space on national identity, etc., is crucial for the development of society under the concept of sustainable development.

Formulation of the purpose of the article. To determine the role of information in human-geographical research, it is necessary to analyze and characterize the features of types and categories of information, analyze the concepts, theories of information used in information geography as initial and basic, provide options for defining the term "information", and, on the basis of the analysis, propose the concept of "information" from the standpoint of human geography and determine the role of information in socio-geographical research. Since it allows human geographers to analyze and understand the complex interactions between society, nature, and connections between spatial structures.

The main material of the research and explanation of scientific results. There are two fundamentally different types of information in the universe, namely, *structural* (according to some authors, physical) and *social*. *Structural information* reflects the state of order (organization) of any tangible or intangible system. The opposite concept is *entropy*, a measure of the diversity, heterogeneity, and unpredictability of such systems. *Social information* is inevitably *the product of human cognitive activity*, that is, the transformation of structural information in systems through the cognitive function of intelligence into social information. Thus, structural information is primary, has a probabilistic nature, and exists objectively, independently of human consciousness. Social information is secondary and always subjective, which gives it a probabilistic character. Therefore, prior to the emergence of humans, social information was non-existent. Similar to information technology, humans began to generate it as their cognitive abilities developed. But this does not mean that there is no information exchange in natural systems. As will be shown below, it is information exchange through various processes of material transfer that underlies the development (change in the state) of systems.

Today, there is no single meaningful definition of information that could integrate all partial definitions. Moreover, there is not even a single philosophical platform for such a definition yet, because there are **at least three philosophical concepts of information.**

The first concept – *attributive (aspect) – defines* information as an objectively existing attribute, an intrinsic property of any material objects and systems. According to this concept, information is an intangible substance that is inherent in all material objects, without exception. It reflects the state and dynamics of these objects, which is one of the fundamental concepts in the material world. According to this concept, information is contained in the form of structures inherent in material objects (which is why it is called structural), regardless of their nature – mineral, biological, social, artificial, etc. Thus, the attributive concept implies the widest comprehension of information as a reflection of the diversity of any objects and processes of animate and inanimate nature. Information is a measure of the heterogeneity of the distribution of matter and energy in the space-time continuum, and it accompanies all processes in the universe. From this perspective, it is crucial that the information reflect the interaction of material objects, specifically their mutual influence on each other. This approach enables the exploration of all processes in the material world, which later transforms into the virtual realm through changes in information exchange. This required the development of a method for evaluating the object's structural information. K. Shannon solved this problem in 1948, when he founded the quantitative-information approach and proposed a formula for calculating information entropy as a measure of the uncertainty of the state of an object (*Shannon, 1948*). Indeed, any heterogeneity (disorder, variability, diversity, etc.) in the structure of an object always carries some information. In case of the structure changes (in a broad sense) when interacting with other objects, new information arises that reflects these changes. Consequently, the development (mutations) of this object are recorded in the amount of its structural information.

A large number of scientists, not only of the natural profile, supports the attributive concept of information, due to its breadth of generalization, because it represents the fundamental (philosophical) basis for the study of all processes and phenom-

ena in nature and society.

The second philosophical concept of information – *functional (species)* – arose in connection with the development of cybernetics as a management science in biological, social, and artificial systems that self-organize and self-develop. N. Wiener, the founder of cybernetics, defined information as the messages we receive from the outside world and how we adapt to them (*Wiener, 1948*). Thus, the functional concept limits the relevance of information (information processes) only to objects, phenomena, and processes of living nature and connects it with mental activity and consciousness. In this view, information is a substance that is present in all living things. It makes sure that the environment is reflected, that organisms (populations, biocenoses, and the biosphere as a whole) adapt to it through mutational processes that genetic traits are passed down through inheritance, and that biological evolution goes in the right direction. From the perspective of the functional concept of information, the exchange of information within mineral systems is either non-existent or overlooked.

The third concept of information – *anthropocentric* – is even more limited in content and is based on a logical-semantic approach, according to which information is considered only in a pragmatic sense and is interpreted as active knowledge for activity, management, and self-improvement. In this sense, information in the meaning of a concept approaches the thesaurus of an individual or society. As you can see, the anthropocentric concept of information assumes that there is no information outside of human participation. If this holds true for social (secondary) information, this concept neglects the primary structural information of natural and social systems, significantly limiting its potential applications.

There are advocates for each of these philosophical concepts of information, leading to a lively debate among philosophers that has yet to settle on a single point of view. Therefore, it is not surprising that in solving applied scientific problems related to the study of information exchange, depending on the subject area and the task of the study, there are a large number of definitions and interpretations of information. Here are some examples. In complex systems, *cybernetics* associates the concept of information with control processes, encompassing both living organisms and artificial (technical) systems. Management processes are primarily concerned with the generation, transmission, storage, and transformation of information. Environmental management and social (public) management are two typical examples of the management process in *human geography*. In *physics*, the interaction of objects is considered the transmission of "signals" (information exchange) in the form of quanta of matter or energy that change the state of the "transmitter" and "receiver". It's possible to measure object parameters periodically to determine changes in information. In *biology*, information is "responsible" for adaptation, the accumulation of mutations, and the formation of gene programs in biological species and populations. In the field of *computer science*, information functions as "signals" for data transmission, unaffected by semantics, which undergo additional processing to determine content, store information, and so on. In *Earth sciences*, information is mainly considered an indicator of spatial and temporal variability (heterogeneity, diversity, and organization), as well as the evolution of natural and social systems.

As you can see, some definitions of information have similar content. Three groups of definitions are relevant from a human geography perspective (Fig. 1.1).

Information from the perspective of human geography is a set of data, knowledge, and messages about the spatio-temporal characteristics of social, economic, cultural, and environmental processes that allow analyzing, modeling, and interpreting the interaction between humans and nature. We use this information to study the distribution of human activities and natural resources, plan and manage territories, analyze dynamics and transformations in spatial structures and communication networks, and understand their impact on society.

In the classification of information, we distinguish between static and dynamic information based on how we consider the system under study. Thus, from this point of view, static information characterizes, for example, the spatial structure of geosystems, and dynamic information characterizes their evolution. These approaches are used in geographical comparative analysis.

Another important classification of information is based on the corresponding *inhomogeneity*'s time of existence. Depending on the peculiarities of the adaptation of the system to changes in the external environment (other systems), it generates new heterogeneity (structural information), which can lead to stable changes in the structure of the system for a certain period of time (macro-information). This refers to the system's memorization of short-term structural variations, also known as micro-information, which the system does not retain in memory. In other words, high-frequency (random) changes in the structure's heterogeneity do not persist (the system "forgets" them). Low-frequency changes remain in the form of stable transformations of the structure for a certain time. The low-frequency changes in heterogeneity then serve as the primary framework for the system's heterogeneity,

Fig. 1.1. Groups identified information from the perspective of information geography (generalized by the authors according to *(Niemets et al., 2022a; Niemets et al., 2022b; Niemets et al., 2023a; Niemets et al., 2023b*)

while the high-frequency changes are short-term random fluctuations that have no effect on the system's structure. The question of a clear definition of the boundary between these two system states remains relevant. It is possible that, under the influence of a large number of factors in the formation of structural information, these processes occur simultaneously, possibly even affecting each other. The process of structure formation, when influenced by the lowest-frequency change in heterogeneity, becomes decisive. In fact, this clarifies G. Kastler's definition of information. The first to consider this issue was L. Brillouin, exploring the relationship of information with physical entropy (Brillouin, 1952). He distinguished between free information and related information in the system's microstates. Furthermore, the latter turned out to be proportional to physical entropy, which gave reason to call it related

information or negentropy. Subsequently, a critical analysis of the thermodynamic interpretation of information proved that negentropy has no relationship to the system's structural information (*Chernavskii, 1975*). Generally, we distinguish four types of information: classical information, where heterogeneity exists infinitely and is absolutely stable; macroinformation, where heterogeneity exists for at least the system's existence and is essentially stable; information, where the heterogeneity's time of existence is less than the system's time of existence with stable heterogeneity; and microinformation, where the heterogeneity's time of existence is less than the process's time, and heterogeneity is unstable (*Gurevich, 2011*).

For geography, this classification of information is important, given the study of the field of features (parameters) of objects, that is, the spatial distribution of parameters. Given the assumption that the intensity of heterogeneity formation factors varies in both space and time, the primary objective of spatial analysis in this context is to distinguish between macro- and micro-information. Geographical processes are specific, occurring on a different time scale compared to processes in the microcosm, such as elemental particles, atom nuclei, molecules, and so on. The typical time for the development of geographical systems ranges from tens to hundreds of thousands. The behavior of the most mobile, namely social subsystems, determines the dynamics of social and geographical systems, sometimes leading to changes over several years. Researchers have established that as the method's resolution or sensitivity increases, they can observe higher-frequency components of field heterogeneity, and vice versa. This allows us to decompose and explore, over time, the field of heterogeneity of geosystems, ranking them by the frequency of their formation. As a result, we get a set of heterogeneity field approximation surfaces with different time structures (*Niemets, 2016*). We approximate the field of heterogeneity based on the integral influence function (IFF) of geographical objects, using the radius of the object's zone of influence as a filter (R0). By changing it, we can separate "macro-information" and "micro-information" (quoted because they have a slightly different interpretation in the spatial version). As a result, we get a set of heterogeneity field approximation surfaces with different spatial structures depending on R_0 (*Niemets, 2014*). The above examples from the methodology of human-geographical research demonstrate the possibility of describing the heterogeneity of social and geographical systems based on one of the most common definitions of information – as a measure of the heterogeneity of objects.

Numerous discoveries in various fields of science – physics, chemistry, biology, sociology, geography, geology, linguistics, journalism, social science, etc. – contributed to the meaningful content of the concept of "information". The idea of the unity of the processes of development of both animate and inanimate nature and society, and the crucial role of information in them, emerged in the middle of the twentieth century. The emergence of computers, electronic information technologies, and the development of mass media in response to the social demand for information processing and dissemination have created technical and technological opportunities for research in this area. The diverse interpretations and comprehensions of this field necessitate significant scientific and, primarily, philosophical generalizations. Philosophers fundamentally investigate the formation of a modern understanding of information, as noted at the beginning of this subsection. Philosophy distinguishes the substantial, attributive, and functional concepts of information. According to the *substantial concept,* information is a substance, namely an independent entity. Proponents of this concept rely on N. Wiener's opinion, who believed that information still exists in the world in addition to matter and energy (*Wiener, 1948*). N. Wiener's papers did not develop this idea, but it provided a powerful impetus for understanding information as a fundamental philosophical category. For example, the founder of systems theory, L. von Bertalanffy, generally conceived of information as a physical quantity along with energy (*Bertalanffy, 1968*).

The attributive concept regards information as an inalienable attribute, an essential property of matter. People often emphasize that information is a qualitative and quantitative characteristic of the organization or orderliness of display, or that it reflects the structure of matter. Understanding the unified nature of information (as well as the unity of matter and energy) is an important step towards realizing the world's material unity. Information exists only where there is a difference, i.e., information is a reflected variety (*Ursul, 1966*). V. Glushkov defined information as a measure of the heterogeneity of matter (*Encyclopedia of Cybernetics*). Information exists independently of human consciousness in both animate and inanimate nature, according to the attributive concept.

The followers of the *functional concept of* information believe that it is a property only of systems that are capable of self-organization and is associated with their functioning. Thus, information does not belong to all forms and types of matter, but is associated with a complex dynamic control system capable of adaptation (*Kopnin, 1961*). Many scientists believe that information is only an attribute of highly organized matter. Information is inex-

tricably linked to the control process. The functional concept divides information into three types: syntactic, semantic, and pragmatic. The last two types do not exist in physical objects by themselves; they are only associated with control processes in controlled or self-organizing systems.

Information as a general scientific concept became the object *of the probabilistic-statistical theory of encoding and transmission of information* (R. Hartley and C. Shannon) through electronic communication channels (*Hartley, 1968; Shannon, 1948*). In particular, K. Shannon used the concept of information to solve practical communication problems: optimizing message encoding, increasing noise immunity, recognizing signals in the presence of noise, channel bandwidth, etc. Information is a measure of the uncertainty removed by the receiver, according to C. Shannon's understanding. In the absence of information loss, it is equal to the information entropy of the transmitter, which is independent of the receiver. This mathematical theory of information primarily focuses on the transmission capacity of a communication channel, irrespective of its content. Numerous publications provide a classic example of this approach, reversing letters to form a meaningful phrase. The amount of information remains unchanged, but the meaning of the phrase becomes unclear.

Based on K. Shannon's ideas about information as a removed uncertainty, later (in the 1960s), L. Brillouin substantiated the negentropic principle, according to which information is a negative contribution to (physical) entropy (*Brillouin, 1952*). Subsequently, people began to comprehend negentropy in two ways: firstly, as a measure of the quantity of information in the message they received (the difference between the initial message before receiving it and the final message after receiving it with entropy), and secondly, as the attributes of reverse entropy, which mirrors the arrangement of material objects.

The probabilistic-statistical approach of K. Shannon in information theory studies did not dominate for long; from about the mid-1950s, the semantic aspect began to attract more attention. It became clear that, in addition to the quantitative characteristics of information, the qualitative ones are no less important and relevant – its content and value. In linguistics, semiotics was highlighted. The object of research on semiotics was the use of natural and artificial languages as sign systems. Thus, semiotics served as the foundation for the development of a semantic theory of information, which emphasizes the inalienability of information from its carriers, such as signs, words, and languages. The semantic theory of information was developed by R. Carnap, I. Bar-Hillel et al. (*Carnap, 1950; Bar-Hillel, 1952*). The receiver's properties, not the transmission channels, should be given special attention in the analysis of information transmission processes. In order to perceive information, the receiving system must have some initial (threshold) information of its own–thesaurus. If the threshold information is sufficient, the receiving system will extend its thesaurus with the information received. Semantic information theory is relevant for a variety of social activities, particularly cognitive ones.

Synergetic (dynamic) information theory is based on G. Haken's ideas on the relationship between self-organization and information, as well as I. Prigogine's ideas on the irreversibility of time and the constructiveness of chaos (*Haken, 2006; Prigogine, 1983; Prigogine, 1977*). Specifically, researchers investigated the mechanisms of genetic information storage and use (*Chernavskii, 1975*), leading to a clearer definition of G. Kastler's information. As a result, information manifests itself in the form of a random event, which the system manages to remember. The ability of a system to generate random events depends on its complexity; a simpler system is more likely to degenerate, and a more complex system is more likely to be dynamically stable and self-evolve. The non-rememberable choice is micro-information related to the system's physical entropy, which does not affect its structure. Macro-information, which is not associated with physical entropy, is a memorized choice. When analyzing real information processes, we are always talking about macro-information. Information value is fundamentally subjective and depends on the system's purpose.

People increasingly perceive information as a process that involves stages of generation and encoding. At the generation stage, the system randomly selects one option from many possible ones based on its fixation on a material carrier. The broadcast channel prepares the signal for transmission during the encoding stage. The described information process takes place in a self-organizing system at the time of bifurcation (the chaotic state of the system); that is, the generation of information is the exit of the system from the state of chaos. The process of receiving information is mostly considered irreversible and unbalanced, while the receiving system is considered dissipative, capable of arbitrarily increasing the degree of orderliness.

When we summarize the evolution of information understanding, we find that the common comprehension of information dominated until the early 1900s. In the middle of the last century, philosophical and scientific interpretations of this concept began to spread. At this time, mathematical, probabilistic-statistical, and quantitative approaches to understanding information within the main technical

sciences prevailed. Later, as qualitative, semantic, and welcoming approaches begin to develop, the concepts of value and information content come to the fore. Representatives of the natural sciences greatly facilitated this process by paying close attention to information. Synergistic information concepts emerged at the end of the twentieth century, combining quantitative and qualitative approaches. The beginning of the 21st century brought a rethinking of the nature of information, attempts to combine the statistical and semantic principles of its research.

Probably, the above brief overview of the study of the concept of information will be incomplete if we do not consider the history of its definition from the standpoint of linguistics. L. Soldatova carried out a detailed etymological and linguistic analysis of the information; we will rely further on her work (*Soldatova, 2013*). Based on the analysis of the history of the development of the concept of information, she attempted to synthesize its complete and unambiguous definition, which could be universal for all branches of the sciences of objective reality. L. Soldatova in her analysis applies the theory of reflection. In particular, she notes that since ancient times, information has been correlated with a certain object, the properties of which it reflects. At the same time, information is relatively independent of its carrier, because it can be transmitted in different media using physical signals, regardless of its content. Information arises due to reflection, which has various forms – from elementary to the highest (consciousness). Thus, reflection means the interaction of objects of the material world. In the inorganic nature, reflection exists as mechanical, physical and chemical interactions, and objects are passive. In organic nature, there are more advanced forms of reflection – physiological and psychological. As a result, living organisms form the ability to adapt to changes in the external environment. A person has even more complex forms of reflection (cognitive and creative), which are conscious and allow a person not only to adapt to the environment, but also to consciously (purposefully) influence it. In the second half of the twentieth century, the concept of information acquires the status of the general scientific category and ambiguity up to homonymy – information is an abstract concept, physical properties, the function of systems that self-manage and self-organize, and at the same time information is a certain thing, property, attitude, etc. At this time, pragmatic (value) and semantic (meaningful) approaches to the consideration of information are formed.

L. Soldatova, having analyzed the history of the use of the concept of information, identifies the following main concepts (content groups) formed today:

1. *Objectively idealistic* concept, which asserts the universality of information, its transcendent nature and refutes the presence of its material substance.

2. *The anthropocentric (existential)* concept, according to which information is considered as a subjective phenomenon in which human is the center and the highest goal of the Universe. In the center of study and reflection is the individual spiritual life, in which intuition plays the role of the main method of comprehending reality.

3. *Cybernetic* concept, according to which information is a substance necessary for systems that are controlled and self-organized – biological, artificial, social, etc. The main essence of this concept is that information is the "working body" of management and self-management processes. It is fundamentally important that after the information is delivered to the recipient, there will be a decrease in his uncertainty about a certain process, event, etc.

4. *Physical* is a concept in which information is considered as a physical phenomenon and becomes on a par with such categories as matter and energy. In this interpretation, information is identified with the organization of systems. It is in this concept that numerous definitions of information lie as measures of heterogeneity, diversity, complexity of structure, etc.

5. *The ontological* concept, according to which information is understood as an aspect of the side of the reflection that is subject to objectification and can be transmitted (knowledge, genomes, etc.). In other words, information is a form of representation of reality, where human experience is localized, that is, it replaces the material world and, as a result, it itself acquires materialization and turns into essence.

6. *Communicative* concept, in which information is a tool of information approach, the content and scope of which vary depending on communicative and organizational phenomena. Information is the movement of knowledge, messages, information, etc. in social time and space.

7. A concept that presents information as *the organic quality of living systems*, which distinguishes them from inanimate nature, as an integral substance of living matter, psyche and consciousness. In these concepts, information acts as a "life force" that manages the processes of metabolism in living beings, organizes the mapping of the environment and adaptation to it and the preservation and transmission of the consequential features that form populations, biocenoses and the biosphere as a whole.

8. Concepts that are not the essence of information but reflect the processes of its generation, transmission, storage, use, etc.

Based on a critical assessment of the existing definitions of information, L. Soldatova proposes a

comprehensive and unambiguous definition of the concept of information (*Soldatova, 2013*). According to L. Soldatova, *information is a collection of components within the state of matter, reflecting in an appropriate form and to a certain extent some qualities and quantities of essences (and/or manifestations of essences) of another being (other states of being). This includes those created by thought processes, which represent both reality and irreality, as well as abstraction at any given time (past, present, future).*

L. Soldatova's proposed definition of information is indeed complete and unambiguous from the point of view of linguistics, but in content, it almost completely coincides with the definitions of information, where the key word is reflection (*Kopnin, 1961; Ursul, 1966*). The variety of interpretations emphasizes the concept of information's universality and the possibility of its use in various aspects of the study of physical and virtual reality. Depending on the purpose, object, and research methodology, established practices employ varying interpretations of information to achieve the desired result in the most efficient manner. It is evident that as the content (specification) of a concept increases, its volume decreases, and its scope of application narrows. In other words, each variant of the definition of information has a certain scope of application. In a pragmatic sense, such an essentially adaptive approach is quite enough to analyze the processes of information exchange.

From the point of view of human geography, information shows how natural, natural-technogenic, and social systems change over time and space (through heterogeneity, diversity, and organization), as well as how they have changed over time.

Meaningful information analysis requires the object's mental activity, which is a complex psychological act. Specialists in psychology, semiotics, didactics, pedagogy, logic, and other cognitive processes study the issue of perception and understanding of information in detail. The works of some scientists in the interpretation of K. Nemets, which classify information by the levels of its mental and active processing (*Niemets, 2005a*), are interesting in understanding the problems of information analysis considered within the framework of this paper. Specifically, Nemets distinguishes three classes of information:

1. Syntactic information representing a set of signs and the rules for constructing some messages from them.

2. Semantic information allows for the possibility of disclosing either the encoded content or the content of the message.

3. The practical knowledge aims to trigger a specific mindset, behavior, or condition.

Semantic information, among the selected classes of information, is the most crucial for understanding the actions of individuals or societies in their environment. It is, in fact, the subject and outcome of scientific analysis or creativity. So let's look at it in detail.

The analysis of semantic information properties leads to the following conclusions:

1. According to statistical information theory, there is a non-equivalence between qualitative and quantitative assessments of information. Qualitative assessment depends on the degree of perfection of the thesaurus available to the researcher. The quality assessment of the received message will be zero if it does not relate to the thesaurus (for example, belongs to another field of science) or does not contain any information that could alter it. We should note that comparing information with the subject's thesaurus gives it a subjective character, despite its objective existence.

2. Information ages over time. This is because the informativeness of a message changes over time, based on the content of subsequent messages. From a schematic perspective, we can represent that the thesaurus replenishes itself only with information that is "new" to it. Therefore, the depreciation of the thesaurus occurs when new information arrives late.

3. The semantic dependence of the sequence of messages explains why semantic information is not subject to the laws of additivity, communicativeness, and associativity.

4. The value of semantic information for the recipient depends on the time, energy, or material resources required to create or receive it. This conclusion has significant theoretical implications because it emphasizes the objectivity of obtaining information.

5. The content of information depends on its form of fixation, presentation, or transmission. Different methods can encode, transmit, or store the same message. The quality of the information will not change. This implies another important property of semantic information: its ability to transform (*Niemets, 2005b*).

All these properties of semantic information make it possible to characterize its kind, namely scientific information, as a special kind of information that exists in the mind at the level of the individual in the form of an individual thesaurus or society as a whole in the form of a generalized thesaurus. Together with other elements of scientific theory, it presents a scientific picture of the world in the public consciousness. We define "scientific information" as logical data gathered during the cognitive process, which accurately depicts natural phenomena, societal norms, and thought processes, and

finds application in social and historical contexts (*Niemets, 2005a*). As a result, the level of scientific development in society becomes the most important criterion for assessing the latter's progress. The entire development of the global social and geographical system demonstrates that the role of science and information in society is constantly increasing.

Many researchers refer to this phenomenon as an information revolution, a term further validated by the swift advancement of communication methods. This is fundamental to the formation of the information society. The development of scientific knowledge is influenced by external causes, such as the manifestation of society's needs and the formation of the social order, as well as the presence of a diverse system of internal contradictions in science: "…Between the historical limitations of knowledge and the unlimited creative possibilities of science, between truth and error, empirical and theoretical, new fundamental facts and existing theory, new and old theories, competing hypotheses, theories…" (*Scarecrow, 2004*).

There is no generally accepted solution to the problem of quantifying the quality of information. Integral assessment of the qualitative informativeness of the thesaurus, which has a complex multilevel structure with complex and ambiguous connections between different branches of the conceptual tree, is a very difficult task, even for a relatively small field of science. It is much more difficult (if not impossible) to assess the integral qualitative informativeness of the entire scientific knowledge system of contemporary humanity. However, there are currently some approaches to solving this problem. The works (*Niemets, 2008; Niemets, 2003*) most fully describe the statistical approach that K. and L. Niemets proposed to assess the informativeness of the conceptual apparatus in order to optimize the educational process.

It can also be used to solve these problems. Conceptually, the approach focuses on the fundamental "bricks" of any science's structure, and the quantity of these concepts in the thesaurus dictates the science's information capacity. This means that the degree of development and diversity of the conceptual apparatus reflects the ability of this science to describe, explain, and predict the world's phenomena in varying detail, more or less. This approach uses K. Shannon's formula to calculate the amount of information in the concept tree based on the probability of individual concepts.

Concluding the discussion of information quality, we note that in the future we will use the local concept of "volume of accumulated and processed information." The need for this arises because part of the information extracted from the environment is amenable to scientific analysis and complements the thesaurus; the other part remains undeciphered and "forgotten". As society develops more and more information and improves scientific research methods, the ratio of these portions of information changes over time. Therefore, the above concept refers to the entire volume of scientific information withdrawn from the environment and "remembered" by society.

It follows from the above that information passes the stage of scientific analysis and eventually turns into knowledge, which symbolizes the "memorization" of information in the consciousness of a person or society. According to V. Kusherets, knowledge is the ultimate reflection of a certain side of objective reality in human consciousness in the form of ideas (concepts, ideas, etc.) (*Kusherets, 2004*). Therefore, knowledge is both objective and subjective. As society disseminates and introduces knowledge into the public consciousness, it gradually liberates itself from the subjective ideas of an individual or a limited society, leading to its objectification. Thus, society transforms empirical information about individual events, phenomena, or processes into generalized, abstracted, strict, and unambiguous scientific information. The importance of this transformation of information is difficult to overestimate because knowledge and the scientific information generated by it in communication (regardless of the method of communication) play an extremely important role in the evolution of society, its needs, and its interaction with the natural environment.

We have highlighted above the key characteristics of scientific information, which include deciphered, generalized, and "memorized" semantic information. Here, we will examine various aspects of scientific information transfer and its crucial role in shaping the interaction between society and nature. First of all, we note the importance of ways of transmitting scientific information.

Information can be transmitted in space and time (*Niemets, 2005b*). Existing means and channels of communication disseminate new scientific facts, discoveries, and generalizations, constituting the first method of communication (*Niemets, 2008*). The second way of communicating is through the through the storage of information in a preserved form on various media, which allows to withdraw it at the right time. When we consider society as a complex social system in interaction with the natural environment, we inevitably understand that society's needs are not a random product of its development (*Niemets, 2012*). Their formation is closely connected to the possibility of satisfying these needs through the use of natural resources, which in this case are involved in the economic activity of society and, together, form a multisystem of environmental management. It possesses a universal energy capa-

ble of meeting any social need. The current operation of natural systems expends one part of this energy, while the remaining portion remains in its potential form. New knowledge (scientific information) through changing the goals of environmental management and the development of more advanced technologies and means of environmental management releases the potential energy of the multisystem and directs it into an active channel. As V. Kusherets notes (2003), scientific information is not a material engine of the multisystem; it releases material forces (energy, material), transfers them from the latent state to the active one, and activates environmental management.

This feature of scientific information and knowledge in general, namely the ability to initiate material actions in the multisystem of environmental management, gradually turns into an important strategic resource.

From the point of view of the role of information in human-geographical research in determining the level of development of society and its evolution, it is worth noting the following possibilities of using information (Fig. 1.2).

Fig. 1.2. Using the information approach for certain cases of human-geographical research (constructed by the authors)

In the future, information will be the primary form of capital, not land, production means, money, or technology. This determines the emergence of property relations to scientific information, making it the most expensive product that can be accumulated, sold, or bought. Computer science focuses on the exchange of scientific information through communication channels, its processing, transformation, coding and decoding, and the identification and removal of obstacles. Obviously, the importance of semantic analysis and computer science in the transition to an information society will continue to grow.

Conclusions. Information in human geography plays a fundamental role, providing the basis for the analysis, interpretation, and prediction of social and spatial processes. The interdisciplinary significance of this concept lies in its ability to combine data from different fields of knowledge and contribute to a comprehensive understanding of the complex interactions between humans and nature. After analyzing the most common philosophical concepts of information, such as attributive, functional, and anthropocentric, we can observe that each of these concepts has its supporters, leading to an ongoing discussion among scientists that has yet to settle on a single point of view. Therefore, a multitude of definitions and interpretations of information exist to solve applied scientific problems related to the study of information exchange, which vary depending on the subject area and the study's task. Particularly in human geography, environmental management and social (public) management serve as typical examples of the management process, inextricably linked with information. We can group the wide range of different definitions of "information" based on its role and function, which include its use as an indicator of evolution, a gauge of system heterogeneity and disorder, and a semantic object. Accordingly, information from the perspective of human geography is a set of data, knowledge, and messages about the spatio-temporal characteristics of social, economic, cultural, and environmental processes that allow analyzing, modeling, and interpreting the interaction between humans and nature. We use this information to study the distribution of human activities and natural resources, plan and manage territories, analyze dynamics and transformations in spatial structures and communication networks, and understand their impact on society. This concept closely relates to the phenomenon of synergy, which is the ability to self-improve and self-develop open systems, as information always serves as an incentive for development.

From the point of view of the role of information in human-geographical research in determining the level of development of society and its evolution, it is worth noting the following possibilities of using information. These are the collection and processing of primary geodata, which allows to integrate various types of information and create cartographic models that help identify patterns and trends of spatial development and conduct socio-economic and urban analysis. It allows us to identify the features of the demographic system, determine its structure and distribution, and characterize such categories as fertility, mortality, migration, labor resources, employment, types of economic activity, use of resources, transport communications, industrial zones, and the course and transformational consequences of urbanization processes. In further studies, the authors plan to prepare a model illustrating the role of information in the processes of territorial management, regional development, and restoration.

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Інформація: міждисциплінарне значення суспільно-географічного концепту

Людмила Нємець [1]
д. геогр. н., професор, завідувач кафедри соціально-економічної географії
і регіонознавства імені Костянтина Нємця,
[1] Харківський національний університет імені В.Н. Каразіна, Харків, Україна;
Катерина Сегіда [1]
д. геогр. н., професор, кафедра соціально-економічної географії
і регіонознавства імені Костянтина Нємця;
Катерина Кравченко [1]
к. геогр. н., доцент, кафедра соціально-економічної географії
і регіонознавства імені Костянтина Нємця;
Джозеп Віла Субірос [2]
д. філософії (географічні науки), професор, кафедра географії,
Соціоприродна дослідницька група, [2] Університет Жирони, Жирона, Каталонія, Іспанія;
Александар Валяревич [3,4]
д. філософії (географічні науки), доцент, кафедра геопросторових та екологічних наук;
[3] Белградський університет, Белград, Сербія;
д. філософії з географії, доцент, факультет освіти,
[4] Університет Східного Сараєво, Бієліна, Боснія і Герцеговина;
Чезар Морар [5]
д. філософії (географічні науки), доцент, кафедра географії, туризму і територіального планування,
[5] Університет Орадя, Орадя, Біхор, Румунія;
Павло Кобилін [1]
к. геогр. н., доцент, кафедра соціально-економічної географії
і регіонознавства імені Костянтина Нємця;
Людмила Ключко [1]
к. геогр. н., доцент, кафедра соціально-економічної географії
і регіонознавства імені Костянтина Нємця;
Євгенія Телебєнєва [1]
к. геогр. н., доцент, кафедра соціально-економічної географії
і регіонознавства імені Костянтина Нємця

У статті розкрито фундаментальну роль інформації як суспільно-географічного концепту, що виступає основою для аналізу, інтерпретації та прогнозування суспільно-просторових процесів. Також розглянуто його міждисциплінарне значення, основна роль якого полягає у здатності об'єднувати знання різних галузей та сприяти комплексному розумінню складної взаємодії в системі «Людина – Суспільство – Природа». В статті представлено аналіз попередніх закордонних та вітчизняних досліджень різних наукових напрямів, проаналізовано найбільш поширені філософські концепції інформації: атрибутивну, функціональну та антропоцентричну. У вирішенні прикладних наукових задач, пов'язаних з дослідженням інформаційного обміну, в залежності від предметної області і завдання дослідження існує велика кількість визначень і тлумачень інформації. У статті проаналізовано концепції, теорії інформації, які використовуються в інформаційній географії як вихідні та базові, розглянуті дефініції поняття «інформація» та особливості її використання у суспільно-географічних дослідженнях з огляду на їхнє міждисциплінарне значення. На основі проведеного аналізу авторами було запропоновано узагальнене трактування поняття «інформація» з позиції суспільної географії, обґрунтовано її роль у суспільно-географічних дослідженнях. Зокрема дефініція «інформація» має широке коло різноманітних визначень, які можна згрупувати відносно до її ролі та функції, а саме: як показник еволюції, міру неоднорідності і невпорядкованості системи та об'єкт семантики. З позиції суспільної географії інформація – це сукупність даних, знань і повідомлень про просторово-часові характеристики соціальних, економічних, культурних та екологічних процесів, які дозволяють аналізувати, моделювати та інтерпретувати взаємодію в системі «Людина-Природа». Інформація – це завжди стимул для розвитку, тому з даним поняттям тісно пов'язане явище синергізму – здатність до самовдосконалення та саморозвитку відкритих систем. Розкрито основні протиріччя між соціумом та природою, розглянуто основні принципи взаємодії суспільства і природних систем в мультисистемі природокористування; висвітлені ідеї становлення концепцій соціогеосистеми та соціогеопроцесу, розкриті особливості втілення ідей у суспільно-географічних дослідженнях. У майбутньому авторами заплановано підготовку моделі, яка буде ілюструвати роль інформації у процесах територіального управління, регіонального розвитку та відновлення.

***Ключові слова**: інформація, інформаційна взаємодія, природокористування, система «Людина – Суспільство – Природа», соціогеосистема, соціогеопроцес, суспільно-географічні дослідження, стійкий розвиток.*

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