

INFORMATION IN GEOGRAPHICAL SPACE AS THE BASIS OF CROSS-DISCIPLINARY RESEARCHES IN CULTURE GEOGRAPHY

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Abstract

This article contains an attempt to integrate the ideas of structural processes within the boundaries of the geographical envelope of the Earth, and to identify new universal dependence. The article describes the theoretical and methodological aspects of the study. The existing approaches to the definition of information are considered, main problems of information studies and geography possibilities in the search for solutions have been highlighted. A new definition of information as an organized diversity of systems and models, terminology of systems and information studies, the conceptual model of the interaction of the information field and space, main methods of information storage have been proposed. The following has been presented: potential for the development of methods of semantic reconstruction in semiotics and archeology; determination of the age and origin of objects; importance of fundamental research information for the creation of the theory of natural and cultural heritage.

Keywords: Information, geographical space, natural and cultural heritage, culture geography.

1. INTRODUCTION

The notion of "information" plays a critical role in geography, provides its external cross-disciplinary communication and participates in the development of the scientific world in the information society.

The content of the geography – a science that integrates the knowledge in the system of Earth Sciences, fills the idea of *information as an inherent property of matter*. Object of geographic research – geographical envelope – is considered as a geographical system at a global scale, which is based on flows of matter, energy and information. Information, as the complexity and organization systems, is considered in evolutionary geography and biogeography, geophysics and geochemistry of landscape, historical and cultural geography, as well as in the studies: on biosphere – by V.I. Vernadsky, on ecosystems – by V.B. Sochava, on rhythms in nature – by E.V. Maximov, and other studies of great methodological value by D.L. Armand, A.G. Isachenko, V.I. Paranin, B.B. Rodoman, A.Y. Reteyum and others (Paranin, V.I. 1990, 1995; Paranina, A.N., Grigoriev, Al.A., Eidemiller, K.Y. 2014). In

the context of expansion of informational space and the development of interdisciplinary communication, specific geographical projects dedicated to information are implemented.

2. BACKGROUND

2.1 Literature review

In the era of *information society* the notion of information has not received any universal definition yet. However every branch of knowledge has its own definition, which meets the challenges of theoretical and practical studies (N. Viner, 1968; K. Shannon, 1963; V.M. Glushkov, 1964; A.D. Ursul, 1979; A.N. Kolmogorov, 1987; V.M. Lachinov, S.A. Polyakov, 1999; V.G. Gamaonov, 2000; E.H. Liiv, 2001; E.G. Kapralov, 2005, etc.): the Latin term *informatio* means "data, messages"; in computer science and cybernetics "information" is a measure to eliminate the uncertainty (entropy); in the information theory (computing and communications) it is the number of received, processed or transmitted messages (bits); in synergy - the level of the organization (consistency, coherence, ordering) of system; in informologics – a measure of reflection of reality, etc. (totally about 400). These definitions are applied as needed in geography, but have a limited ability to simultaneously describe coherent geographic space and its diverse parts (Paranina, G.N. 2001, 2005).

The variety of existence and diversity of studies on information provide a number of objective difficulties and contradictions: 1. Information is considered as a feature of substance (attributive concept), or it is bounded only to the processes of administration and self-administration (functional); 2. The term "information" is used in the meanings that reflect different functions: process (a ratio, a relationship), and condition (the result of action on the structure); 3. The uncertainty of values depending on the direction of the information process: source system acts as potential information, and the system as a receiver of information that is relevant; 4. The growing subjectivity of perception of knowledge, reflecting personal experience and professional orientation, level of socio-cultural development of society; 5 *The shortage of knowledge of qualitative aspects of information processes and social demand for research information in nature are escalated.*

2.2 Potential of information approach in geography

The advantage of geographical research of information is studies in an "ideal laboratory" of nature: 1. without destroying the natural horizontal and vertical connections; 2. in geographical coordinates of space-time; 3. taking into account the genesis of systems and all forms of movement.

The new *definition of information as an organized diversity of nature and its models* [10], was formed in the course of our studies of the structure and functioning of natural geosystems and reflection of natural processes – lighting regime of the Earth (semiotics of nature) in the graphic sign and knowledge (semiotics of culture).

2.3 Objects and methods of a research of information in geography of culture

System research on information in geographical space integrate practical and theoretical results obtained in three main blocks of "nature - society - sign systems" using maps, remote photographic materials, scientific publications on the issue and on the sites, work data of own field research.

In 1990-2000 studies of the structure and functioning of local and regional geosystems of the North-West of the East European Plain and the structure of soil and vegetation cover of the North-East of Siberia were carried out. In 2000-2008 social aspects of the problem were studied. Since 2009, the authors have carried out comprehensive studies of natural and cultural heritage in the North, North-West and in the Center of the Russian Plain, the South Urals and Siberia (Altai, Sayan).

The authors used various methods, which included the following: methods of field studies (topographic and landscape mode), thematic maps and data remote sensing of the Earth (landscape interpretation, selection and description of the lineaments of the landscape, the planetary fracture systems, areas of planning of artificial and natural and man-made objects, development of rose diagrams), standard laboratory analytical and statistical methods, methods of metrological analysis of archaeological objects, astronomical and paleo-astronomical calculations (altitude and azimuth position of the sun – using the astro-calculator, length and direction of the shadows – using basic trigonometric functions), and methods of mathematical, cartographic and conceptual modeling (Paranina, G.N. 2011, 2012, 2014, 2015abc; Paranina, G.N., Paranin, R.V. 2009; Paranina, A.N. Paranin, R.V. 2015ab).

3. ANALYSIS OF INFORMATION PROCESSES IN GEOGRAPHICAL SPACE

The definition of information as an organized nature and diversity of its models is based on the most widespread of the existing definitions - *information as the presence of any irregularities in the space-time distribution of matter and energy* (by V.M. Glushkov, 1964), whose approach to research of information in geographical space takes into account two considerations: 1. it is impossible to cover *all* the diversity of nature, 2. it is important to consider first of all objective, repeatable and necessary connections – the laws of nature – for a human to adapt in the environment. The conformity of a new definition to the basic definition of V.M. Glushkov is maintained by the adopted modern scientific paradigm of understanding of randomness as the unknown-term pattern, bringing together "any heterogeneity" and "organized diversity."

The new definition allows us to consider the transfer of information, both individually in natural and artificial systems, and the "nature-society" system, which is important for the development of a number of new interdisciplinary areas, including environmental geography and geocology, historical, semiotic, sacral and cultural geography (geography of culture). In 2013-2015 this definition was approved at international symposia on optics, where its applicability to problems of experimental research has been approved. Simultaneously, upon the recommendation of opticians physics, the concept of "field" was included in the theoretical tools of research information in the geographic space.

The philosophical basis of our definition of the concept is the attributive information system paradigm and the theory of reflection. Scientific methodology provided by the concepts of "structure", "algorithm", "order" (organization and self-administration), and the specificity of the geographical approach – used in geospace on the basis of geographical research methods, taking into account the general laws of the structure and functioning, dynamics and evolution of geographical envelope. Based on this definition of information a geographical approach was developed, which is based on the methods and objectives and can be described as system-information.

3.1 Conceptual framework of system-information approach

Conceptual framework of system-information approach establishes a link between the basic properties and functions of the information system and geographic space-time in the context of the current scientific paradigm (Table 1).

Table 1. The ratio of the basic concepts of system-information approach.

Information	Key notions	Processes	Vertical structure of field – space	Information resources	Use by humans
The form of continuity - the information field; the form of discreteness - space-time	Actual information (structures) and potential (processes), active (actual) and passive (latent)	Reflection at interaction: transmission, encoding, saving and transformation nep	Informational: knowledge	Culture	Various forms of adaptation, including creation of an information system for life support
			Geocultural: material and non-material culture		
			Geographical geographical envelope of the Earth	Nature	
			Space: planet Earth, Solar system, Universe		

Information field is a continuous heterogeneity of distribution of matter and energy in space-time. In the block diagram (Table 1) information field transfers continuity of information as an attribute of matter, infinite in breadth and depth, and discreteness is regarded as a form of information through the space-time. The main states of the information are considered: potential and actual, active and passive. Reflection is considered as the basis for all kinds of information exchange. Vertical heterogeneity of the information field is represented as a system of embedded subordinate spaces – levels of implementation of organized diversity of nature.

The spherical model, which we developed on the basis of the classic concept of the shell structure of the Earth, is the most objective reflection of correlation of spaces - cosmic, geographical and geo-cultural. But the shell structure of the Earth does not include information space, it is only conceived as a part of culture. To illustrate the hierarchy of all the allocated spaces a multi-tiered pyramid (Figure 1) can be used. Although, in fact, each successive level seems to be the point on top of the previous one.

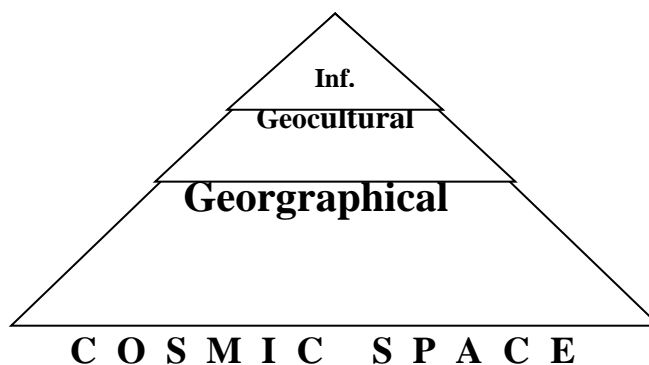


Figure 1. Vertical structure of the information field

Cosmic space encompasses the Universe and the objects of the Solar system, including planet Earth, subordinated to the laws of space.

Geographical space is understood as a form of existence and a communication method of geographical objects within the geographical envelope of the Earth – it is an external circuit

on the diagram. By age, by the mass of material, by energy and information, by social functions the geo-space is the foundation and geo-cultural and informational spaces. The special position of geo-space is based on the fact that a constructive impact of space is refracted through its features (spherical, spatial-temporal organization, evolution and other general geographic regularities).

On the basis of the geographical space a *geocultural space* is shaped – a form of existence and way of communication between objects, processes and phenomena of the "second" nature. In geographic science culture is traditionally reviewed as an expertise of adaptation. It is aimed at the survival and development of society. Geocultural space is studied by the principle of geographical determinism, taking into account multifaceted reflection of the landscape in culture and culture in the landscape (Streletsky, V.N. 2005).

Culture includes the knowledge, allocated in the *information space*, whose objects are the signs of nature, material and non-material culture and their relationship, disclosed by the system of concepts, which collectively shape information model of the world (IMW). In contrast to mythopoetic model of the world of humanitarian studies, the IMW reflects quantitative compliance, i.e. objectively discloses cause-effect relationship. Information space is the most dynamic subsystem of geospace, the top of "iceberg" of natural and cultural diversity – the developed part of resources of the information field, available for use at this stage of the development of technology (civilization).

While territoriality of geo-cultural space is obvious, and it is considered in geography of culture and historical geography as a form of geo-system, the *information space may seem independent from geo-graphical space-time*. Here all idealistic concepts are implemented in the consciousness of modern society originate. Unlike humanitarian approaches, geography has a rich evidence base, quantitative methods and theoretical tools to review information about the processes in the system "nature-society" on a materialist basis.

At every level – the "floor of the pyramid" and then – within each area (i.e. in relation to the system under consideration), it is possible to distinguish potential and actual, active and passive information. *Potential information* is an original property of matter and any super-system in the "nested doll" of hierarchical relations, based on the movement (processes); *actual information* (realized) is a variety of existing systems and models (structures); distinguishing of the active and passive states of the information does not imply absolute opposition, and various forms of participation in the information process - direct and indirectly hidden.

Following the algorithm of the system approach, the structure of the study takes into account a factor of *goal-setting* proposed in cybernetics, which is considered by the subject-associative idealist thinking as the absolute world of consciousness and control. Our concept of information modeling is based on the general geographic regularities in which the administration is understood as the constructive role of the super-system (on K.N. Dyakonov), which determines the range of capabilities of the system (in our case - potential information, its highest possible expression - chaos); further it is assumed that all forms of movement "from chaos to cosmos" are directed by potential difference (the implementation of the global free energy into information – according to A.D. Armand); it is taken into account that the environment of the geographical space is Cosmic space – an example of high orderliness (especially when compared to the dynamic landscape of the Earth). The reflection of this order is manifested at all levels: the geographic space exists according to the geographical laws, but is subject to space - in terms of the adequacy of the structures exposure, gravity field, tidal, and other manifestations of interactions; geocultural space – is similarly subordinated not only to social, but also geographical and cosmic processes; finally, the information space reflects (models) integral information field, but in the part which relates to the existence of humans. It is also clear that, under the leadership of external

regulation, quality of system determines the overall development of a set of internal processes (self-regulation and self-administration).

The primary objective of information modeling in all forms of life is adaptation. *Adaptation* (Latin *adapto* – to adapt) is the process of adaptation to changing conditions of the external environment. The concept is used in biology (*biological, physiological*), archeology, ethnography, geography of culture, evolutionary geography and interdisciplinary studies (*ecological, social*). We consider adaptation (and inherent orientation in space-time) as the main condition for life-support and way of studying of the matter. This idealization of study conforms to the theory of reflection, in which the ultimate goal of the movement of matter is perception.

In this study, *adaptation is optimization of human activities on the basis of an adequate modeling of natural processes*, and to characterize informational adaptation component it is proposed to use the concept of "*information system of life-support*" – a system of evidence, tools and concepts, which characterize the vital facilities, processes and phenomena of the world. Obviously, the system-information approach extends the semantic content of health and safety – a science of safe human interaction with the environment. Taking into account the spatial component of the process, we can speak about the *geographic adaptation*.

Information resources are the diversity of the world, available for use in the block diagram on the genesis divided into natural and cultural (Table 1), with respect to the technology real and potential are distinguished, and a detailed analysis can be considered separately for each space level. In this case, the resource of each level can be traced to the influence of the super-system design and its parts (external relations), and the feedback from the subsystems (internal relations) – whose combination provides a flow, and therefore – stability of the entire system.

Obviously, the information resources of geographical space are formed in the first place under the influence of planetary-cosmic nature, but also reflect the impact of human activities. It is very difficult, but important to highlight these factors: in geo-ecology, for example, it is the problem of estimating the parameters of anthropogene effects and the ecological state of the landscape. *Information resources of geo-cultural space* are formed at the intersection of the factors geographical environment and social experience - culture: there are acute problems of the dating of objects of nature and culture, the division of artificial elements of autochthonous and allochthonous genesis, their cultural and ethical features. But still no methodology has been developed for the definition of the nature the origins of the tradition. Resources of information space also reflect all levels of supersystem and complexity of internal organization - databases, systems of signs and knowledge. Paradoxically, the problem of allocation of natural and artificial component has not been identified yet. For example, in semiotics, there has been enough separation of signs based on the principle of reflection of the subjective (the sign-symbol as agreed) or objective reality (sign-icon – by similarity), and the third group, distinguished by to C. Peirce, specifying connection denoted in space-time (signs indexes), has not been used.

The structure of the developed information system approach also includes concepts: *information processes* – transmission, encoding, saving and transformation of information or reflection of the diversity of the interaction of objects, phenomena, the processes of the world; *information cooperation* – exchange of information, understood as non-deterministic process, as impact and response do not always coincide in space and time; *information flow* - a high level process of internal and external information exchange; *information society* – a society in the conditions of high flowage of information; *systemic crisis of civilization* – a society under conditions of violations of information flow.

The definitions designed to study the information in the geographic space, do not alter existing definitions, but rather complement and make them more precise, expanding the

scope of their application. To compare, we can give some example of specific definitions of "information processes – processes of creation, collection, processing, accumulation, storage, retrieval, distribution and consumption of information," (Federal Law number 85 dated 04/07/96); "Information interaction is the interaction of two or more subjects, the purpose and the main content of which is to change the available information at for least one of them" (Dictionary of business terms).

3.2 Law of conservation of information

Different manifestations of information allow us to formulate the **law of conservation of information** – information does not disappear, but it passes from one states to another. In a classic example of a falling coin corresponding movement is the potential information on its possible stationary states when a certain part of the information is realized, the resumption of movement reveals prospects for the realization of hidden potential. The law of conservation, one way or another, is developed by many researchers, in particular, synergetic theory of information "in any structural transformations of discrete systems that occur without changing the total number of elements, the amount of chaos and order in the structure of the system always remains constant (conservation the amount of chaos and order)"[Vyatkin, V.B. 2012, p. 3].

Schematically, the combination of the basic states of the information can be presented at the intersection of two axes (Figure 2): 1. The potential / real - on the horizontal axis; 2. Active / Passive - on the vertical axis.

POTENTIAL processes	ACTIVE		ACTUAL structures
	actual		
	PA	RA	
	PP	RP	
	latent		
	PASSIVE		

Figure 2. Basic states of the information

There are four types of combinations of states: PP - a potential passive, PA - potential active, RA - a real active, RP - real passive. States are determined with respect to a particular system (relative), and are connected through their active form - the interaction and movement. For example: PP - the universe; PA - solar activity; RA - geosystems, the system; RP - Memory: geological, genetic, cultural, etc.

The transition of potential information of landscape in the state is considered as implemented on the materials of our ecological and geographical studies of slope geosystems in the middle reaches of the river Luga. The transition of potential information in the lighting mode signs and knowledge in the process of orientation in the space-time-looking has been studied by the example of the development of navigation technologies and patterns of information-insulating simulation.

Highlighting of potential and actual information states in natural and natural-cultural systems coordinates with the contents of the famous principles: geographical determinism, the potential difference as a motion base, exponential development and others. For example, large resources of unrealized potential information may explain the exponential nature of the structural processes in the early stages of development and the "plateau leveling" parameter in approach to equilibrium (climax ecosystems, shaped longitudinal profile of the river, the slope of equilibrium profile, etc.).

The increasing complexity of the system can be considered as the transition of information from the potential state to the implementation, degradation – as the reversed process, the direct participation in the implementation process – an active, current status, and memory structures – as a relatively passive, but, in fact, - latent. In the developed systems, memory shapes most of the information and is an essential foundation of stability, even if a large part of it is not used (mass strata of geological structures formed by indigenous landscapes, the gene pool of the population, the individual experience, the traditional national culture). Use of memory – models of successfully completed states, continues constantly and ensures quality preservation.

3.3 Ways to save the information

Ways to save the information are of particular theoretical and practical interest. A state of "chaos" in this search can become the "starting point". It is noteworthy that the current scientific paradigm does not have a clear definition of this concept. When considering options for its manifestation, the authors emphasize that any conceivable chaos bears rudiments and elements of the structure. Moreover, even a theoretical complete homogeneity can be seen as a clear example of the organization.

3.3.1 Variety reproduction

In the anisotropic geographical space homogeneity is completely excluded. Heterogeneity can be understood as the cause and the result of the movement and **preservation of information, "in the broadest sense" - an opportunity to develop or reproduce the structure at any point in space-time**. Thus, the development of natural environments – water, land and air at different stages of evolution of the organic world conducted similar to the formation of adaptive devices (convergence of signs of different species in similar environmental conditions). The possibility of this type of saving was proved by our research of semiotic productivity of astronomical instrument - the gnomon of a sundial-calendar, which in ancient times gave the world a reliable astronomical basis of all measurement systems, and with it - all the sciences and arts. The symbolism of the gnomon-stick as image of eternity, formed on the basis of its ability to transmit information of space-time as long as there is a light source. As you can see, this type of conservation is based on relatively conservative super-systems, i.e. information in the potential state. Using state index (Figure 2) it can be displayed as a PA - RA.

3.3.2 Coding of information

Saving data "in the narrow sense" is provided by the *transition to economic compressed shape*, which allows us to create a model (Latin modulus - Measure) - proxy object of the original object. Based on the concept of an algorithm for navigation of the natural process of coding models of different types (Navigation, toponymic, map, semiotic, linguistic, sacred) and shows that the *basis of IMW is the space-time*. This confirms the adequacy of reflection of information of nature throughout the history of civilization.

Objective process of replenishment, complexity and updating models leads to the enrichment of the culture and the accumulation of cultural memory RA – RP. When saving the external shape, the gap between practice and active involvement in the development process, leads to the loss of the original content. Studies in the Humanities, because of lack of specific knowledge about the natural processes, have to create reconstruction "from above" (from the present to the past), through search of repetition in those modifications, applying a

status of the original element to it. This path of reconstruction is used in comparative linguistics, cultural studies, archeology and gives, as a rule, artificial schemes and unverifiable results.

System-information research based on the navigation IMW showed that algorithm of repeating *allows to reconstruct, i.e. restore the information*, and compare the resulting models with the object under study. This is the reconstruction of "from below", i.e. from the source (origin). This method of reconstruction can significantly improve the quality of created models, for example, the definition of autochthonous ancient artifacts with calendar functions on art history criteria are based on the subjective opinion of the expert. Comparison with single objects of a similar style and performance art, and the calculation of the astronomic, geographical and landscape settings (playback of information of super-system) objectively shows the degree of functional correspondence of the tested object to the conditions of a particular space and time.

3.3.3 Pro-accuracy of systems

Of course, in a dynamic world, complete repetition and copying never happen. "Prototypes" of systems and models do not persist unchanged. Therefore, the most widespread way of saving in geographical space is ***dynamic stability and development***, assuming the maximum information flow systems. The stability of this type is widely seen in nature and may be designated as PP-PA-RA-RP.

Flexibility of geo-cultural space is manifested in the sacralization and conservation of vital elements in terms of any socio-cultural transformation. Elasticity of information space is reflected in the adequate response to the real change in the nature and society, regardless of the units originating from controversial sources. Thus, the limited management decisions, and the total as instruments of globalization, are opposed to the new means of navigation, communications, software and system analysis technology, as an expression of immunity of holistic natural and cultural organism – the humanity. History shows that no matter what deformations natural and cultural environment experiences, information flows restore the broken quality. It can be assumed that such a dynamic stability will reproduce and maintain geosystem of planet Earth in balance, as long as the Sun exists (Grigoriev, A.A., Paranina, G.N. 2012).

4. CONCLUSIONS

According to authors, the research of interaction of information of the nature and culture can be a basis of development of geography of culture. Main conclusions of a research:

1. The authors formulate the definition of information that provides simulation tasks in the whole geographical area "information as organized variety of systems and models" on the basis of theoretical generalizations and results of the field of geographical research
2. The methodological proof of rational reconstruction algorithm of natural and cultural heritage "from below" is given, i.e. the process of development of geographic space-time.
3. Research of information in geographical space provides restoring of connections in a single geography, increase efficiency of interdisciplinary research and general information flowing, as the basis for stability of our civilization.

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