NEW PARADIGM OF GEOINFORMATION SPACE IN TERRITORIAL ASPECT

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Abstract: The topicality of the study is conditioned by the need to develop a new paradigm for constructing the geoinformational space in terms of geoinformational activities on the territory in connection with the change of technology tenors. The objectives of the work are to identify the essence and principles of the new geospatial paradigm, to substantiate the basic prerequisites for development of fundamentally new ideas about geographical space and spatial data infrastructure and for modernization of the means and technologies for processing geoinformation. The methods of formal-logical analysis, linear programming, and the theory of matrix games with nature were used. **The results of the study.** The authors proposed a new interpretation of the concept of "geospace" as a kind of socio-cultural reality "laid over" the territory. Conclusions are made regarding the features and correlation of the "space" and "territory" concepts. The essential characteristics of geoinformation supply of vital activity in different epochs, as well as features and differences of corresponding geoinformation paradigms were considered from the standpoint of the structural-functional approach. The authors carried out a formal logical analysis of conceptualization of vital activity in the surrounding geospace, associated with optimizing of the use of the resources based on all-encompassing geoinformation support. The concept of "geofragment" is introduced as an elementary unit of geospace, in which technological and/or natural processes occur and interactions of objects from different spaces take place. **Theoretical and practical value.** The authors proposed new approaches to solving the problems of correlation of physical and geoinformation space. Application of these approaches in technological discourse allows one to define and improve ways and means of geospatial support for optimization of territorial management. **The conclusions.** Through combination of new ideas, potential opportunities, and structural transformations, the new paradigm of geoinformation space sets the vector for the formation of the modern geospatial industry providing systemic support for the needs of society and focused on services and activities optimizing the use of territorial resources. **Keywords:** geoinformation, tenor of technology, formal-logical conceptualization, matrix games with nature.

1. Introduction

The change of tenors of technology dictates the change of ideas about space, its multidimensionality, and coordinate systems. In particular, in current conditions, ideas about the geoinformation space and its emanations are becoming increasingly widespread. The space-coordinate system is viewed as the axis of spatial structure. At the same time, theorists recognize the possibility of existing of other dimensions of space in addition to the three spatial and one temporal that are usual to us. Many of these scientists agree that studies of multidimensionality can be a decisive step in the creation of a general theory that unites the laws of nature (the theory of hyperspace [1]). Of course, such approaches challenge well-established paradigms of traditional sciences about the Earth. From this point of view, the risk of unmanageable global changes and the uncertainty associated with the emergence of new determinants of development in conditions of formation of modern communicative and information space call for formation of a new geospatial paradigm. The key role here belongs to the modern geoinformatics, which is part of the global information technology (IT) market, whose volume is estimated at about $ 3.5 trillion [2] and accounts for about 4% of the global gross product with the prospect of further growth [3]. The situation is developing similarly in the market of geoinformation services.

In the field of geoinformatics, the first practical results associated with the creation and use of geographically defined geoinformation spaces [4] are noted. In combination with the capabilities of the Internet, the importance of spatial data rises [5]. At the same time, new trends in obtaining, presenting, and applying geoinformation are emerging. Geoinformation began to be considered as one of the strategic tools for managing the territory [6, 7], planning and ensuring its sustainable development [8, 9, 10], supporting political decisions in regulation of land use [11, 12], and integrating heterogeneous data from different sources [13]. Now, there is a need to use a 4-dimensional spatial monitoring of phenomena for digital geo-information representation of territories [14, 15]. There are new opportunities for receiving, processing, and providing geoinformation to consumers, including its cartographic form [16, 17]. There are completely new [18] and even exotic geospatial problems such as the dream space [19].

In this regard, the formation in the field of geoinformatics of the prerequisites for development of radically new ideas about geographical space and spatial data infrastructure becomes evident. In fact, there is a need for a different paradigm of the geoinformation space. By the paradigm, the authors mean an integral worldview structure. It includes fundamental approaches and serves as a recognized model of scientific activity. The author of the concept of revolutionary paradigm shift, T. Kuhn integrated philosophical-scientific, historical, methodological, and sociological methods of measuring scientific development. In the scientific community, the paradigm fulfills the function of a disciplinary matrix formed by institutions and knowledge that everyone, who enters this corporation, has to adopt as a norm [20, p. 238]. It should be noted that a number of scientists, including those who study the sphere of the reproduction of knowledge [21], do not agree with the mandatory revolutionary character of the paradigm shift. They considered that this process became mobile-evolutionary in the 21st century, using “back and forth” switching between paradigms [22, p. 131].

2. Materials and Methods

The objectives of the article are to identify the main features and fundamental differences between modern approaches to the definition of geospatial representations, to develop fundamentally new concepts of geoinformation space, and to propose ways and means of modernization of intellectual tools and technologies for processing geoinformation. In this connection, the authors of the article presented studies of various aspects of construction of geoinformation space, including the following:

- analysis of modern concepts and views on the topic;
- development of ideas about the relative independence of macrospace and spatiotemporal forms from ongoing macroprocesses;
- development of the principles and essence of the new paradigm of construction of geoinformation space;
- analysis of the essence of geoinformation support of territories within the framework of the structural-functional approach;
- application of mathematical modelling method based on the principles of strategic matrix game with nature for substantiation of optimization of multisectoral use of geoinformation resources;

- identifying of capabilities of the proposed paradigm for optimizing the management of territories.

To ensure the consistency and reliability of the logical judgments, as well as the validity of the conclusions and the correctness of the obtained results, the authors proposed to apply the methods of mathematical modeling and tools of formal logic.

3. Results

The authors of the article suppose that in the new representation of "geospace", it is necessary to take into account the relative independence of the macroscopic spatiotemporal form from the macroprocesses. It should be noted that the relative independence of a particular spatiotemporal form is nothing but the stability, the conservation of spatiotemporal properties of material systems of a certain level and type. These properties are, for example, "location in space", "time irreversibility", "dimensionality of space". However, along with the mentioned stability or conservation, there is the variability of many spatiotemporal properties, such as the size of objects, their relative location, the pace of processes, and the like. That is why the spatiotemporal properties, like any other properties of reality, represent a unity of stability and variability. Definiteness, specificity, relative separateness of macroprocesses from processes of other levels is, in particular, the definiteness, specificity, and relative separateness of the corresponding spatiotemporal properties of corresponding spatiotemporal form of what we call matter. After all, if we follow our understanding of the spatiotemporal form, if the macrophysical spatiotemporal form is realized by these macrophysical processes, then the question arises how they can change the basic characteristics of their own spatiotemporal form? If, as a result of certain macroscopic processes, a radical change in the spatiotemporal properties of the macrolevel was observed, then these "certain macrophysical processes" would no longer be macrophysical processes. In this regard, one should speak not about independence of the macrophysical spatiotemporal form from the macrophysical form of motion, but about the correspondence of the present spatiotemporal form to the present form of motion. The illusion of independence of the location in space is generated by the stability of certain moments of the considered spatiotemporal form, associated with the stable moments of macrophysical processes.

All of the said above does not mean the understanding of macroscopic systems as something flat, in particular, in their spatiotemporal properties. Of course, macrosystems have spatiotemporal properties associated with processes of other levels (in particular, mega- and micro-levels). The aggregates of these properties are related to the spatiotemporal forms of these other levels. It should be noted that all the space-time properties of the material system are described only by the entire system of spatiotemporal forms. Therefore, the phenomena of a particular level do not change the whole of this system of spatiotemporal forms and coordinates, but they affect mainly the spatiotemporal form corresponding to them. It should also be taken into account that the macrosystems are qualitatively diverse. They include qualitatively different forms of motion and, consequently, qualitatively different spatiotemporal forms of what we call matter.

It should be borne in mind that although the concept of "space" in the sciences about the Earth is often used as a synonym for dimensionality, volume or territory (global space, Eurasian space). It rather characterizes a certain sociocultural reality "laid over" the territory. From that comes the concept of a populated, economic, political, cultural or information space. The territory is not just a physicogeographical space, but also a habitat. This is the physical sphere of life. We do not call the surface of Venus or the Moon "territory", because there is no human life activity.

The territory can be defined as a part of the physicochemical environment (of the surrounding world), which allows the existence of certain types of life on it. This territory is capable of providing such a life with necessary and accessible resources, assigned to these kinds of life or allowing such assignment in different ways. In contrast to it, space is organization of territory for specific types of life activity. This is a construction created by human for settling life and using the given territory and its resources. "Geospace" is its informational reflection.

In the process of social development, the approaches to space become more complicated; functionally successive, but qualitatively heterogeneous spheres of human life are organized. In the distant past, traditional division of the territory on the functional basis prevailed. There were areas for hunting, cooking, recreation, crafts, and rituals. This is household-economic human space, which at the beginning of the 21st century is concentrated in his apartment, garage, on the personal plot. With the transition to property relations, a legal space has arisen that organizes relations of people in connection with possession, disposal, and transfer of property. The regularity of exchanges and their growing volumes brought about a market. Its complication eventually led to a modern economic space characterized by "spatial turbulence", which includes different types of markets, production and service connections, state regulation of the economy, and much more [23].

The growth of the population of the society and its segmentation according to demographic, professional, and many other criteria led to the emergence of a social space, the sphere of civil relations, social mobility, and various types of human support.

This leads to a number of conclusions. First, the same territory is capable of accommodating many spaces. Second, the space can be more stable than the territory. The people driven from their territory can live for a long time in the new place in the old way, "in the usual spaces". Third, the development of society is expressed and the level of development is measured, among other things, by the saturation of the territory with spaces, their internal complexity, and the quality of their interaction. Fourth, the definite space organizes not just some kind of frequent occupation of a person, but a stable sphere of relatively long-term activity. Finally, fifth, the formation of the spatial form of this field of activity can be regarded as a certain stage of its historical evolution.

According to these conclusions, the ideas about geospace undergo conceptual change. There is a phenomenon described by German scientist Ernst Cassirer. He writes that all substantial is totally transferring into the functional; all permanent loses the character of existing being in space and time, becoming quantities and relations of quantities that form universal constants in any description of information, physical, social, political processes [24].

In the past eras of organized economic activity (agricultural and industrial), geoinformation was used within the industry or as s supply for certain technological processes aimed at obtaining the required products or providing a specific service. If we assume all activities in these epochs as a multitude of spheres of activity (called economic sectors), then geoinformation was used in each of these spheres to achieve intra-sectoral goals (or for carrying out intra-sectoral functions). It did not serve as independent productive force of society (in fact, it was auxiliary in character and devoid of independent meaning). At the same time, the nature of its use reflected the specifics of the sectors served. In accordance with this, the geoinformation paradigm was based on supply of these social and technological processes in the structure of the sectoral spaces, and practically in the organization of intra-sectoral activities.

The peculiarity of the post-industrial era is the transformation of certain areas of information activities into information industries, which gives grounds for calling it the information era. One of such industries is geoinformation support for the development of territories, which acquires the character of an original industry.

In the framework of this industry, technological processes are carried out aimed at identification and isolation of environmental objects through revealing semantic heterogeneities and subsequent spatial coordination of these objects.

In the post-industrial environment, along with the preservation of information support functions, geoinformation acquires new content as an independent factor of production and management, especially at the level of territorial complex interaction of economic sectors and clusters. The new geoinformation paradigm in this context is based on supply of diverse processes of intersectoral nature, intersectoral interaction of sectoral spaces and nature within a common geospace.

Among the tasks of geoinformation supply of territories, there are assessment of the potential of localized areas and objects of the territory, assistance in analyzing their capabilities within different sectors (subspaces), informational support for the organization of spatial interaction, determining the mutual influence of objects and processes of certain sectors (subspaces) on objects and processes of other sectors (subspaces). Thus, on the basis of a four-dimensional coordinate system, inter-dimensional interaction of objects of the surrounding world is realized.

Let us consider the essence of geoinformation support of life activity in different epochs with features and differences of the corresponding geoinformation paradigms from the standpoint of the structural-functional approach.

Each sphere (industry) of life activity (and the natural environment) can be formally represented as some *j*-th space (where $j = 1,...,M$), which includes a set O_j of industrial (or natural) objects $o_{jr} \in O_j$, $r = 1,...,V_J$. These objects require a certain number of various resources for the implementation of their industrial (natural) activities.

Each of the object o_{jr} in addition to a set of semantic resources $\bar{s}_{jr}$ also needs a set of geospatial resources $\bar{g}_{jr}$ in the form of its location, shape, and size, allowing it to be considered as a structural element of the surrounding geospace. The same applies to nature, the individual components of which can also be considered as geospatial resources. Hence, between each o_{jr} (*r*-th object of *j*-th space) and a set of semantic and geospatial resources, there is a one-to-one correspondence

$$o_{jr} \leftrightarrow \left(\bar{s}_{jr}, \bar{g}_{jr}\right), j = 1,...,M,\ r = 1,...,V_J. \qquad (1)$$

For object o_{jr}, it is possible to find characteristic property reflecting its essence $z_{jr} \in Z_j, j = 1,...,M$, where Z_j is a set of values of the characteristic properties of the object from the position of the *j*-th industry (nature). In this case, the set of geospatial resources $\bar{g}_{jr}$ is described in the form of the values of a 4-dimensional coordinate system (three spatial coordinates *x*, *y*, *h* and time coordinate *t*).

According to this fact, the expression (1) takes the following form:

$$z_{jr} \leftrightarrow \left\langle \bar{s}_{jr}, \left\{\left(x_{jr}^n(t), y_{jr}^n(t), h_{jr}^n(t)\right), n = 1,...,n_{jr}\right\}\right\rangle, \qquad (2)$$

where $x_{jr}^n(t) \in X$, $y_{jr}^n(t) \in Y$, $h_{jr}^n(t) \in H$, $t \in T$, n_{jr} is a number of points describing the geospatial resources required for the object o_{jr}.

Each object o_{jr} belonging to certain industry functions (or planned to function) within a certain fragment of geospace gf_k, $k=1,\ldots,K$, which the authors call "geofragment". Within the space of each industrial sector (space of nature), sectoral (natural) processes take place, which provide interaction of the objects of a given space O_j within *k*-th geofragment gf_k. Let us denote the set of objects of the *j*-th space, attached to the geofragment gf_k as a subset $O_{jk} \subset O_j$.

For this subset O_{jk}, it is possible to evaluate the effectiveness of the total use of the *p*-th resource of the *k*-th geofragment by the *j*-th sector (or nature). $E_p(O_{jk})$, $p=1,\ldots,N$. In this case, it is necessary to carry out the summation of the corresponding detailed information on the resources required for the sectoral (natural) objects o_{jr} included in the subset O_{jk}.

Finally, the following results should be obtained (3).

$E_p(O_{jk}) = E^k_{jp}$, $j=1,\ldots,\grave{I}$, $p=1,\ldots,N$, (3)

where E^k_{jp} is a quantitative assessment of the efficiency of exploitation of the *p*-th resource of the *k*-th geofragment by the *j*-th sector. It can take a negative value or be equal to zero. The obtained estimates can be arranged in the following table.

Table 1. The evaluation of the efficiency of exploitation of the *n*-th resource of the *k*-th geofragment by the *j*-th sector

	Types of geofragment resources					
Spheres of life and components of the natural environment	Social	Economic	Ecological	…	Sustainable development	Total efficiency of sectors
Agriculture	E_{11}	E_{12}	E_{13}	…	E_{1N}	$\sum_{p=1}^{N} E_{1p}$
Industry	E_{21}	E_{22}	E_{23}	…	E_{2N}	$\sum_{p=1}^{N} E_{2p}$
Transport	E_{31}	E_{32}	E_{33}	…	E_{3N}	$\sum_{p=1}^{N} E_{3p}$
Construction	E_{41}	E_{42}	E_{43}	…	E_{4N}	$\sum_{p=1}^{N} E_{4p}$
…	…	…	…	…	…	…
Vegetation	E_{m1}	E_{m2}	E_{m3}	…	E_{mN}	$\sum_{p=1}^{N} E_{mp}$
Soil	$E_{m+1,1}$	$E_{m+1,2}$	$E_{m+1,3}$	…	$E_{m+1,N}$	$\sum_{p=1}^{N} E_{m+1,p}$
…	…	…	…	…	…	…
Hydrography	E_{M1}	E_{M2}	E_{M3}	…	E_{MN}	$\sum_{p=1}^{N} E_{Mp}$
Total efficiency of resources	$\sum_{j=1}^{M} E_{j1}$	$\sum_{j=1}^{M} E_{j2}$	$\sum_{j=1}^{M} E_{j3}$	…	$\sum_{j=1}^{M} E_{jN}$	$\sum_{p=1}^{N}\sum_{j=1}^{M} E_{jp}$

The authors of the article proposed to apply the model based on the principles of strategic matrix game with nature [25] for analysis of the problem of optimally coordinated diversified use of the resources of a geofragment.

To build the model, let us consider the payoff matrix compiled on the basis of the table (1) for a game with nature of the *k*-th geofragment (Table 2).

The designations of Table 2 have the following meaning:

R_p corresponds to the state of nature, which allows industrial sectors (natural processes) to use the *p*-th resource without restrictions (by 100 percent);

D_j corresponds to the decision of the decision-maker (DM) "to use the full potential (100 percent) of the geofragment resources exclusively by the industry (natural process) under the number *j*";

E_{jp} expresses the expected efficiency (positive or negative) that a DM will receive, if uses the *p*-th resource of the geofragment (by 100 percent) exclusively by the industry (natural process) under the number *j*.

Table 2. The efficiency matrix of multisectoral use of resources of the k-th fragment of a geospace

	R_1	R_2	…	R_p	…	R_N
D_1	E_{11}	E_{12}	…	E_{1p}	E_{11}	E_{12}
D_2	E_{21}	E_{22}	…	E_{2p}	E_{21}	E_{22}
…	…	…	…	…	…	…
D_j	E_{j1}	E_{j2}	…	E_{jp}	E_{j1}	E_{j2}
…	…	…	…	…	…	…
D_M	E_{M1}	E_{M2}	…	E_{M3}	E_{M1}	E_{M2}

In a multisectoral approach, instead of relying on just one industrial sector (natural process), it is necessary to establish optimal distribution of the resources of the chosen geofragment between all the sectors (natural processes) claiming this geofragment to achieve (100 percent) exploitation. This does not exclude the fact that a single industry (natural process) may provide optimal use of the geofragment resources.

The difference in intensity of usage of the geofragment resources by the industries (natural processes) can be reflected by a mixed strategy for formation of a multisectoral complex of consumption of these resources, which is described by a vector [26]

$$\overline{D} = (d_1, d_2, ..., d_j, ..., d_M), \sum_{j=1}^{M} d_j = 1,\ d_j \geq 0,\ \ j = \overline{1, M}. \quad (4)$$

The vector $\overline{D}$ should be associated with a percentage vector

$$\overline{D^{\%}} = \left(d_1^{\%}, d_2^{\%}, ..., d_j^{\%}, ..., d_M^{\%}\right), \quad (5)$$

where $d_j^{\%} = d_j \times 100\%$ is the percentage use of the resources of the analyzed geofragment by the *j*-th industry (natural process)?

The object selected for functioning in the chosen fragment of geospace should be a multisectoral entity, each sectoral component of which is oriented to the corresponding component of the percentage vector (5) obtained on the basis of the optimal mixed strategy

$$\overline{D}^{*} = \left(d_1^{\ *}, d_2^{\ *}, ..., d_j^{\ *}, ..., d_M^{\ *}\right). \qquad (6)$$

The optimal strategy (6) is found as the solution of the following linear programming model (7)-(11) [27].

The task limits:

$$E_{11}d_1 + E_{21}d_2 + ... + E_{j1}d_j + ... + E_{M1}d_M \geq E, \quad (7)$$

$$E_{1p}d_1 + E_{2p}d_2 + ... + E_{jp}d_j + ... + E_{Mp}d_M \geq E, \quad (8)$$

$$E_{1N}d_1 + E_{2N}d_2 + ... + E_{jN}d_j + ... + E_{MN}d_M \geq E, \quad (9)$$

$$\sum_{j=1}^{M} d_j = 1,\ d_j \geq 0,\ j = 1,...,M \qquad (10)$$

The objective function: $W = E \to \max$. (11)

The semantic content of the solution of the problem (7)-(11) is the determination of the optimal distribution of the percentage load on the geofragment resources between the industrial sectors (natural processes), providing maximum averaged efficiency of multisectoral exploitation $W_{\max} = E^{*}$.

Combination of industrial and natural spaces forms a common geospace GF in which human activity is realized, i.e.

$$\mathrm{GF} = \bigcup_{j=1}^{M} O_j, \quad (12)$$

where M is a number of industrial sectors and natural components.

The elements of this space are all geofragments $gf_k \in GP$ subjected to industrial development; they are described by a set of semantic resources $\overline{R}_k = (R_1^{\ k}, ..., R_p^{\ k}, ..., R_N^{\ k})$ and represented by geoinformation objects $\mathrm{gi}_k \in GI$ with a set of coordinates *x*, *y*, *h*, *t*. It can be expressed by the following formula:

$$\mathrm{gi}_k \leftrightarrow \left\{\left(x_k^n(t), y_k^n(t), h_k^n(t)\right), n = 1,...,n_k\right\}, \quad (13)$$

where $x_k^n(t) \in X, y_k^n(t) \in Y, h_k^n(t) \in H, t \in T, n_k$ is a number of points describing the geospatial resources of the geofragment gf_k.

In the special scientific-technical literature on geoinformatics, the characteristic feature of a geoinformation object is the presence of values of geometric parameters, such as shape, size, and location in a 4-dimensional coordinate system. In fact, these objects are semantic heterogeneities (structures) allocated in the environment and presented in the form of geoinformation.

The essence and features of each of the geofragments are represented by the value z_k of its characteristic property $(z_k \in Z)$ and by the set of values of semantic resources

$\overline{R}_k = (R_1^k,...,R_p^k,...,R_N^k)$. Therefore, full identification of the geofragment $gf_k \in GP$ is possible only with the help of the corresponding geoinformation object $gi_k \in GI$ included in its description:

$$gf_k \leftrightarrow \langle z_k, \overline{R}_k, gi_k \rangle, \quad (14)$$

For each geofragment gf_k, according to set of its resources $\overline{R}_k$, taking into account the geoinformation gi_k and the efficiency matrix (Table 2), it is possible to calculate the optimal solution given in the form (6) and calculated by the model (7)-(11) for management of share participation of industries and natural processes in consumption of the resources:

$$\overline{D_k}^* = \left(d_{k1}^*, d_{k2}^*,..., d_{kj}^*, ..., d_{kM}^*\right), \sum_{j=1}^{M} d_{kj}^* = 1, k = 1,...,K. \quad (15)$$

The management according to this solution provides in average a maximum overall efficiency $W_{\max}^k = E_k^*$ of using the resources of the *k*-th geofragment in conditions of uncertain level of their availability.

A component of the vector (15) d_{kj}^* expresses the share of the resources (including, first of all, the territorial resource) of the *k*-th geofragment, recommended to be used by the *j*-th industry. The territorial governing body should deny access to the resources of the geofragment to those industries (natural processes), which share is close to zero.

Figure 1 illustrates the optimization of intersectoral consumption of resources within geofragments. It is shown that on the basis of optimal control decisions (15), access to resources of the geofragment gf_1 was granted to industries O_1 and O_2 with shares of resource consumption, for example, d_{11}^*=0.6 and d_{12}^*=0.4; the shares of other industries and natural processes in this geofragment are zero. Access to resources of the geofragment gf_2 was granted to industries O_2, O_3, and O_4 with shares of resource consumption, for example, d_{22}^*=0.5, d_{23}^*=0.2, and d_{24}^*=0.3; the shares of other industries and natural processes in this geofragment are zero, etc.

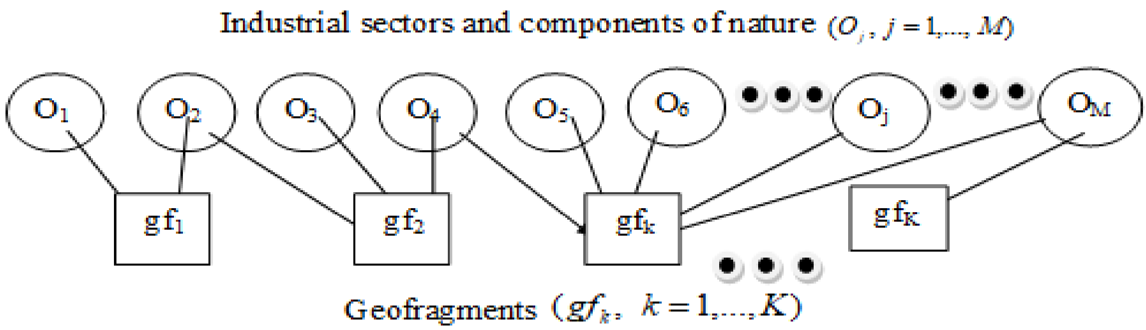

Figure 1. The scheme of optimization of intersectoral consumption of resources within geofragments

The functioning of economic and life activity sectors on the territory within the geofragments is essentially integrated (as a system). Yet, the creation and use of sectoral geoinformation spaces (SGIS) in sectoral management systems is local in nature. Taking these facts into account, the process of geoinformation support for preparation of spatial solutions for territorial management can be represented by a flowchart (Figure 2).

4. Discussion

Thus, expressions (2) and (14), Table 1 and Figure 2 show a fundamental difference in approaches to implementation of geoinformation support for the economy and human life in the compared epochs. The difference is in place and role of geoinformation and, consequently, in the paradigms of using geoinformation. At the same time, a steady expansion of the scale of geoinformation activities is observed, as well as a change in their direction and content.

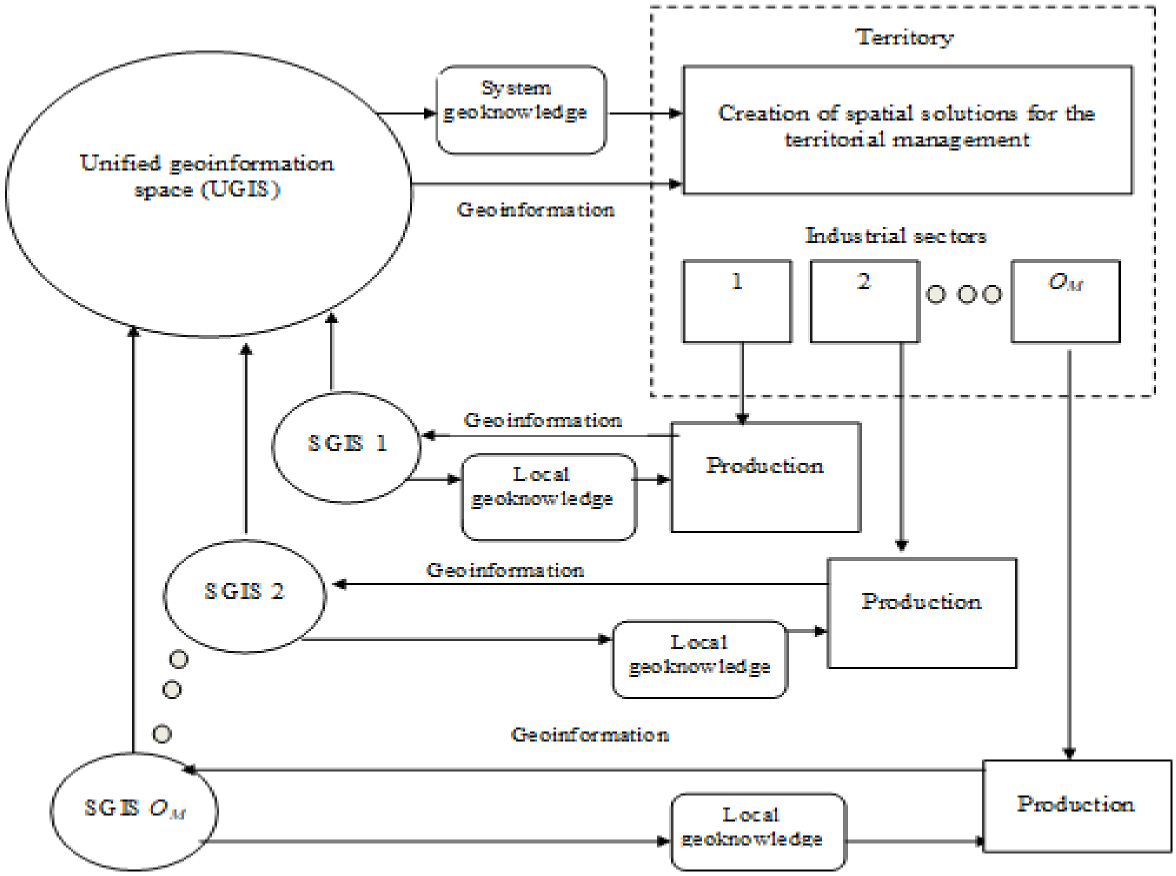

Figure 2. The flowchart of geoinformation support for spatial decision-making in territorial management

In modern conditions, the field of application of geographic information technologies is gradually expanding not only in production and commercial activities, but also in state and corporate governance. Without these technologies, it seems almost impossible to develop optimal management decisions related to the use of territorial resources. In turn, the effectiveness of geoinformation technologies largely depends on the understanding of the need for a fundamentally new approach to creation and use of a geoinformation space. This approach should be based on a set of constitutional data structured in the given coordinate system, related to topographic-geodesic, navigational, geophysical, hydrographic, geological, hydrometeorological, economic, social, and other types of specialized situations. The geoinformation space should characterize the state and dynamics of ground and water surfaces with adjoining underground, underwater, and near-Earth areas, as well as technological and infrastructure facilities located there.

It should be noted that the current literature actively discusses the development of geoinformation activities. However, not many publications reveal the concept of creating and using geoinformation space, for example, [4,6,7,28,29]. And very few works address issues related to the modern paradigm of constraction of the geoinformation space [17,22].

A distinctive feature and importance of the present study is its focus on comprehensive consideration of the new geospatial paradigm, on the analysis of previously existing approaches, and on the identification of the essence and principles of a new paradigm of construction of the geoinformation space.

5. Conclusions

The new paradigm of the geoinformation space in the territorial discourse considers it as a separate factor of territorial management and provision of vital activity of society. The basis of this factor is optimization of distribution (redistribution) of territorial resources at the level of complex interaction between industrial sectors and clusters. In this context, this paradigm is based on provision of diverse processes of intersectoral nature and intersectoral interactions of sectoral spaces and nature within common geospace. Through combination of new ideas, potential opportunities, and structural transformations, this paradigm sets the vector of formation of the modern geospatial industry and focuses on activities and services optimizing the use of territorial resources and providing system support for the needs of society. After all, the practical use of the geoinformation space constructed in accordance with the proposed paradigm will ensure the transition of territorial geoinformation activity to the level of productive power. The ability of geoinformation activity to reach this level reflects the main feature and direction of the digital economy.

6. Recommendations

The materials of the conducted studies, methodological approaches and formal-logical reasoning, obtained results and conclusions can be useful for scientists and specialists working in the field of geoinformation activities, as well as for specialists in territorial administrative structures. In addition, the content of the article can be used for educational purposes, primarily for doctoral students, graduate students, and undergraduates studying the Earth sciences.

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