УДК : 504.5:330.15:528.8:004

Leonid Shmorgun,

Doctor of Economics, professor, professor of Public Administration and Human Sciences, National Academy of Culture and Arts, Ukraine,
st.Lavrska, 9, Kyiv 01015, Ukraine
19shmorgun51@gmail.com

Viktor Kolesnikovich,

Professor of the Departament of Tourism and Hospitality Management doctoral student of the International Ecological Institute them A.D. Sakharov of the Belarusian State University,
str. I. Kopeevicha 5, Minsk, 220114, Republic of Belarus
ums_minsk@tut.by

BLOCCHINE TECHNOLOGY IN THE ANALYSIS OF SECTORAL INFORMATION FOR THE PURPOSE OF REGULATING ANTHROPOGENIC LOAD ON SPECIAL PROTECTION NATURAL AREAS

Abstract. In order to regulate the relations between the issues related to environmental protection and the development of the tourism industry, a system of methods for organizing rational recreational nature management is needed, taking into account the specific nature of conservation of natural biocoenosis, based on a well-founded conceptual apparatus, as well as a system of classifications and regulations that make maximal use of available potential and whichsimultaneously, does not allow the depletion and loss of biodiversity.

Key words: *Resource potential management, geoinformation systems, blockchain technology, control information system, territorial information system, advisory (expert) information system, natural biocoenosis.*

To manage sectoral resources, including regulatory pressure on various types of tourist zones affecting natural areas specially protected at this stage, in order to reduce the anthropogenic load on these natural territories andutilizethe capabilities of the digital economy. There are innumerable new opportunities for resource managementin various types of tourist space, including specially protected natural areas (SPNAs). The main task in this case is the guaranteed preservation and multiplication of specially protected species of plants and animals. It seems that in the case of the formation of the information framework for managing the natural resource base, due to the complexity of both the control object itself and the description of its individual characteristics, the elimination of semantic gaps is possible only when ranking the elements of the inventory system [1]. This issue can be solved with the help of blockchain technologies from the point of view of regulating these processes in the digital transformation of society.

The purpose of this article is to adapt the existing and develop fundamentally new approaches to managing tourism and recreation resources in SPNAs based on spatial differentiation and integration of tourism and recreation resources based on GIS as a geoinformatics process. Geoinformatics is closely related to computer science. Therefore, all information resources used in computer science, such as texts, databases, information technologies and software [2], are also used in geoinformatics. Consequently, the use of blockchain technologies in GIS is an expectable fact associated with the adaptation of blockchain technologies, with the mandatory consideration of the characteristics of specific biocoenosis.

Because GIS datasets display individual objects with their geographic location and shape, just like layers on a map, their properties are stored in explanatory information for each spatial object including a description of the main biotopes. The geo-information model contains several levels of description:

– objective: related to the area of information processing; system related to the organization method and processing methods;

– basic: determined by the choice of basic data models, independent of the scope of the information model [3].

The nature of the use of industry information distinguish information retrieval and information-solving systems:

– Information retrieval systems created without systematic conversion, systematically providing information for storing and user data;

– Information systems perform all transactions.

Processing information about a specific algorithm. The consequence of the decision-making process is that they are classified according to the level of influence of existing information, and the three classes are divided into managers, consultants and researchers.

Managing IS compile and generate information on the basis of which decisions are made. These systems are characterized by the type of problems of a calculated nature and the processing of large amounts of data. An example is the system of operational planning in marketing, or in modern accounting systems.

There are also expert (advisory) ISs that generate information that is taken into account and does not require immediate action. These systems are characterized by the processing of knowledge, not data. The information content of the GIS is justified by the need for information representation of the territory from the standpoint of the needs of its development, the functioning of the economy andthe livelihood of the population.

Prior to GIS, users created a series of map layers that were used for geographic description and location characteristics. Often, they were made on projection slides, which can be superimposed on each other on alight table. Thus, it was possible to visually show the spatial relationships and the characteristic features of the territory.

Currently, blockchain technology has significantly expanded the capabilities of analyzing geographic information by the following characteristics: recognition, detailing, segmentation and identification.

The achievement of these goals will be achieved by solving the following tasks:

– improvement and systematization of approaches to the allocation of various types of tourist space on the basis of their biological specifics;

– formation of a mechanism for the continuous collection and analysis of relevant information from "open sources" about tourist and recreational resources of the territories, involving the use of crowdsourcing and crowdfunding;

– creation of a knowledge base of objects of display (classification and descriptions of study methods), equipped with intelligent mechanisms for the formation of individual routes, taking into account the customer's ranked preferences;

– formation of multi-factorial, complex characteristics of a tourist area, taking into account its biological specificity, in order to optimize the use of the resource, depending on the status of the territories, taking into account the optimal and current level of anthropogenic load;

– geographic and environmental information is divided into a series of logical information layers, and not into sets of random objects; sets of homogeneous objects can be managed as separate layers.

In GIS, information is organized into separate "topics" that describe the distribution of the phenomenon and how each topic will fit into the geographic and ecological environment. At the same time, it was revealed that it is possible to use the simplest types of GIS data (points, lines, polygons and sorted lists). They can be combined depending on their location, that is, bind data sets that subsequently form a map, or explore their overlay using geoprocessing operations (for example, polygon overlaying).

In addition, GIS proposed a protocol for data sets and methods for managing them as graphic data layers.

A rationally considering territorial information system (TIS) of regions is a geographic information system designed to support the development of optimal spatial solutions based on the use of up-to-date, reliable and complex geo-information and geo-information processing methods.

The generalized goal of creating a TIS is to form the mechanism of geo-information support of life support systems and the socio-economic development of the region.

In essence, TIS is a graphical information system designed to support the processes of a single geo-information space [4].

We propose to apply the blockchain technology without changing the meaning of the proven and justified concept only by arguing that it is advisable to apply modern technologies and their unique capabilities.

For example, homogeneous areas can be identified: by delineating various areas representing the predominant type of objects, or blockchain technology implementation values for analyzing spatial data (that is, layer polygons of object types and their descriptions or blockchain identification as attribute values) Fig 1.

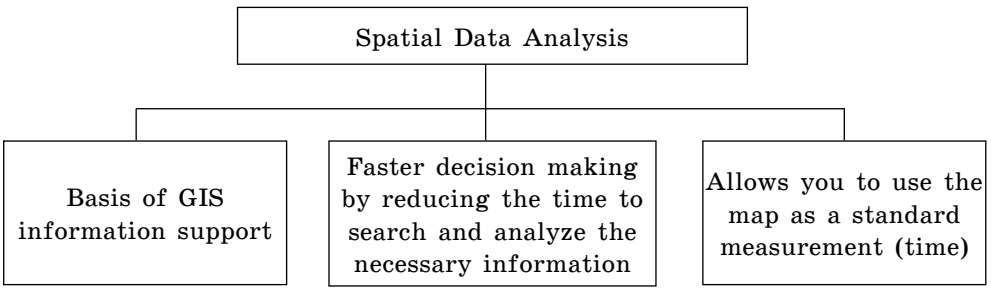

Fig.1. **Spatial Data Analysis**

The time aspect is divided into the following main compositional (complex) goals:

The short-term goal is integration and a comprehensive presentation of geo-information that is heterogeneous in thematic direction. There are three types of tasks for which information systems are created: structured (formalized), unstructured (non-formalized) and partially structured.

A structured (formalizable) task is a task where all its elements and interrelations between them are known.

An unstructured (non-formalizable) task is a task in which it is impossible to select elements and establish connections between them.

In a structured task, it is possible to express its content in the form of a mathematical model that has an exact solution algorithm. Such problems usually have to be solved many times, and they are routine. The purpose of using an information system for solving structured tasks is to fully automate their solution, i.e. reducing the role of the human factor to zero. An example of a structured task is, for example, payroll accounting [5].

The solution of unstructured tasks due to the impossibility of creating a mathematical description and development of the algorithm is very difficult. The possibilities of using the information system here are small. The decision in such cases is made by a person from heuristic considerations on the basis of his experience and, possibly, indirect information from various sources.

By the nature of the use of information, there are information retrieval and information-decisive systems:

Information retrieval systems produce input, systematization, storage, delivery of information at the user's request without complex data transformations. For example, the information retrieval system in the library, at the box office etc.

Information-decisive systems carry out all information processing operations according to a specific algorithm. Among them it is possible to classify, according to the degree of impact of the generated result, information on the decision-making process and distinguish two classes: managers and advisers.

IS managers produce information on the basis of which a person makes a decision. These systems are characterized by problems of a calculated nature and the processing of large amounts of data. An example would be a system of operational planning and optimal development of a sectoral resource, as well as a modern accounting system, etc.

Expert (advisory) ISs produce information that is taken into account by a person and does not immediately turn into a series of concrete actions. These systems have a higher degree of intelligence, since they are characterized by the processing of knowledge rather than data. In total, this makes it possible to formulate and achieve specific goals:

The medium-term goal is to provide the main groups of consumers with relevant, reliable and comprehensive geo-information to assess the state of the territory, the current situation and make spatial decisions;

The long-term goal is the introduction of geo-information methods for modeling, analysis and forecasting directly into the processes of developing spatial solutions in order to optimize them, increase efficiency and reasonableness and make more rational use of available resources.

At all stages of the study the execution of a full-scale environmental impact assessment is planned, as well as the allocation of segments [6] associated with the development and formation of recreational activities in order to create tourist and recreational complexes, using an integrated approach and taking into account the laws governing the formation of the tourist and recreational potential of the Republic of Belarus. Work in this area involves the adaptation of international experience and participation in the planning of global projects, taking into account the risk of overloading specially protected natural areas (SPNAs) with excess tourism.

Geographic and environmental information is processed in a GIS using three initial data structures:

Spatial object classes (individual graphic elements) (Table 1)

Table 1

Spatial objects classes

GIS	BLOCKCHAIN
Road network	Detailing
Water system	Segmentation
Administrative boundaries	Identification
etc.	Recognition

Consequently, it is assumed that the formation of new tourist attraction management mechanisms aimed at creating tourist and recreational complexes results in a territorial gene pool consisting of two aspectsof natural and artificial ("civilizational") origin. Usually GIS is used to process several different data sets, each of which contains data on a specific set of features (for example, a road network) geographically attached to the earth's surface.

GIS data sets are logical collections of various objects [6]. A data set is a collection of homogeneous features collected by topic. The technology of development of the information society ensures the implementation of the principles of "open data" by providing access to information-virtual resources that contribute to the development of new forms of tourism (cognitive, auxiliary, organizational), allowing management of the anthropogenic load on the territory (Fig. 2).

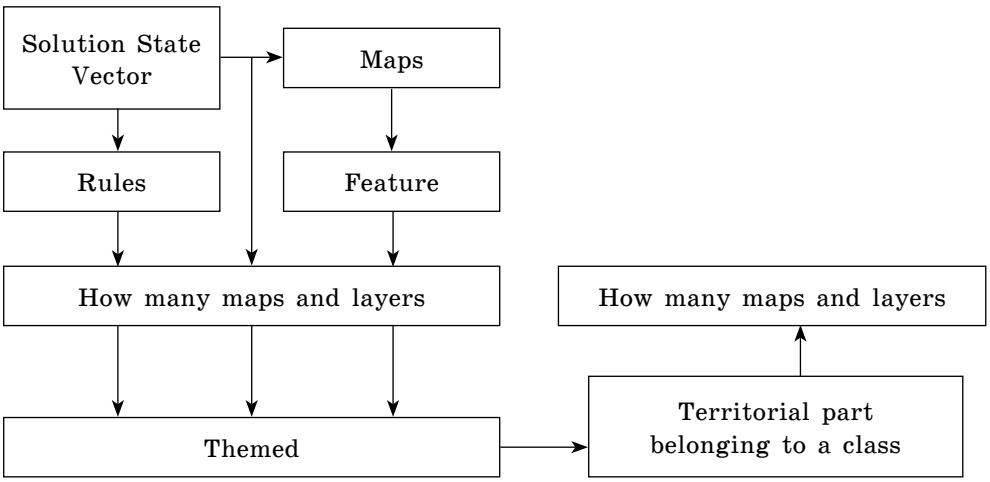

Fig.2. **State vector**

Attribute tables (in the form of descriptive attributes)

Table 2

Main parameters

	Main parameters of GIS	BLOCKCHAIN
1	2	3
1.	Geographical coordinates	Digital Cadastre
2.	Type of protected areas	Segmentation
3.	Area	Detailing
4.	Administrative affiliation	Indentation
5.	Landscape	Detailing
6.	Protected plant world objects	Segmentation
6.1.	Localization	Recognition

Table 2

1	2	3
6.2.	Quantification	Detailing
6.3.	Basic biological characteristics	Segmentation
6.4.	Opportunity to visit	Detailing
7.	Protected objects of the animal world	Indentation
7.1.	Habitat area	Detailing
7.2-	Quantification	Segmentation
7.3	Features of observation (seasonality, availability of weapons ..., etc.)	Detailing
8.	Capabilities:	Recognition
8.1	Hunting	Detailing
8.2	Fishing	Detailing
9.	Natural Monuments (Inanimate Nature)	Identification
10.	Transport logistics:	Segmentation
10.1	The presence of roads (type)	Detailing
10.2	Type of transport messages	Recognition
10.3	Waterways	Segmentation
11	Accommodations:	Detailing
11.1	The presence of hotels (feature)	Recognition
11.2	Agriturismo	Segmentation
11.3	Campsites	Detailing
11.4	Equipped parking	Recognition
12.	Tourist flows:	Segmentation
12.1	Organized groups	Detailing
12.2	Independent tourists	Recognition

The design of the GIS database is based on a series of themes with data, each of which has a specific graphical representation. For example, individual elements can be represented as features (points, lines, and polygons), as bitmaps, or as surfaces using features, cross line screens, or as descriptive attributes stored in tables.

Representation of territorial objects using geo-information technologies provides an opportunity to analyze them, taking into account various target sets of factors, detailing, grouping and target management of individual researchers. Formation of key features of various types of tourist space and determining the list of objects in the system of

the selected type of tourist space is one of the planned practical results of the work.

It is assumed that the key features will form the "core of features" [6], representing the multifactor characteristics of selected objects within individual types of tourist space, which forms the basis of the forms for characterization (object description) for solving various optimization tasks, in particular, considering the optimal anthropogenic load on the territory.

In GIS, spatial data sets are usually organized as sets. The proposed structure of the sectoral knowledge base founded on corporate geographic information systems, as well as the studied integrated indicators for assessing the tourist and recreational potential of regions, can become the basis for supporting management decisions at various levels of building an e-economy during the digital transformation of the government [7] feature classes or raster-based datasets.

Raster datasets "layers" (raster-based digital elevation models)

Table 3

Raster datasets "layers"

Land	Identification
Wells	Identification
Buildings	Recognition
Orthophoto	Detailing
Digital elevation models, etc,	Identification

In GIS, homogeneous collections of geographic features are organized around topics with data such as land, wells, buildings, orthophoto images and raster-based digital elevation models (DTMs). The technology of development of the information society ensures the implementation of the principles of "open data" by providing access to information-virtual resources that contribute to the development of tourism (cognitive, auxiliary, organizational), taking into account the anthropogenic load on the territory. Distinguishing territorial objects using an interactive map of the state allows them to be analyzed taking into account various sets of factors, to drill down, then group and assign to individual researchers. An accurate and simple definition of geographic data sets is very important for the usefulness of geographic information systems, and the concept of data theme layers is an important GIS concept.

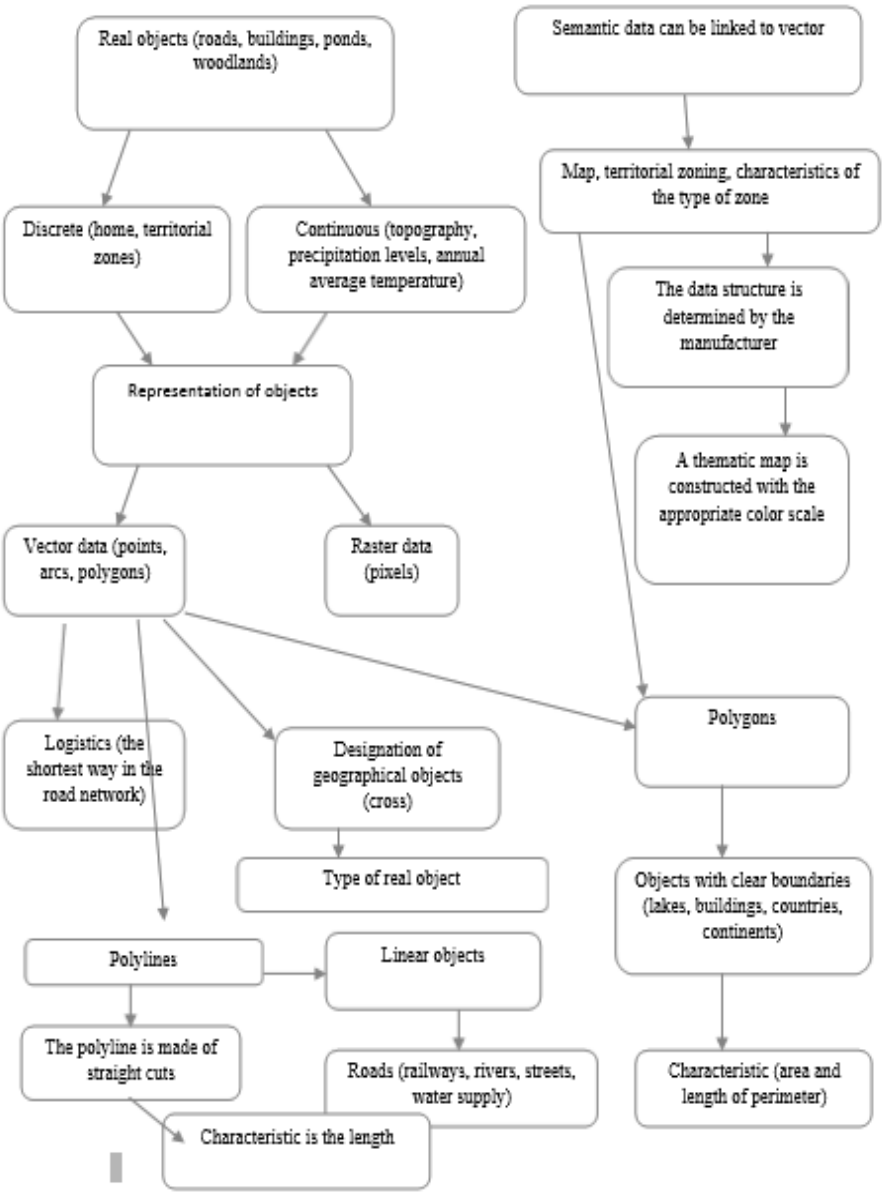

Fig.3. **Principles and algorithms for data presentation**

The formation of key features of various types of tourist space and the definition of the list of objects in the system of the chosen type of tourist space is one of the planned practical results of this work. It is assumed that the key features will form a "core of features", characterizing the selected objects within the individual types of tourist space [5], which will be the basis of the forms for characterizing the object. Each of these basic data types can be extended with additional features to maintain data integrity (for example, using topology), to model geographic relationships (network connectivity or flow), or to add extended behavior.

Many data topics are best represented as a single data set, for example, soil types or wells. Other topics, such as the road network, are best presented in several data sets (separate feature classes for streets, intersections, bridges, railways, etc.). For example, a transport network can be represented as several classes of street objects, intersections of streets, bridges, motorway exits, railroads, etc. The table below shows how the terrain can be represented using several data sets.

Raster datasets are used to represent spatially attached images, as well as continuous surfaces of heights, slopes, and aspects (Table 4)

Table 4

Graphic representation of the main parameters of the database.

Geographic representations	Characteristics	Blockchain
Streams	Lines	Detailing
Large water bodies	Polygons	Identification
Vegetation	Polygons	Segmentation
Built-up area	Polygons	Detailing
Central lines of roads	Lines	Recognition
Wells	Points	Identification
Orthophoto	Rasters	Details of
Satellite image	Rasters	Identification
Ground height	Rasters DEM	Identification
Isolines	Digital	Recognition
Elevation points	Models	Detailing
Rasters of relief with washing	Relieflines	Segmentation
Land	Polygons	Identification
Records of the value of land, etc.	Tables	Identification

This principle of organizing information layers with address decoding by means of blockchain technology can become the main universal principle of GIS, which determines the structure of geographic information systems, operations and management, as well as the application of geographic information

Thematic layers become data sets. This is a key principle of organization in a GIS database. In addition, each GIS contains many themes for a common spatial area.

The theme set works as a set of layers. With each topic you can work as with a set of information that is independent of other topics. Each has its own idea (in the form of a set of points, lines, polygons, surfaces, rasters, etc.).

Since the layers are spatially attached, they overlap and can be combined in a general map display. In addition, GIS analysis tools such

as polygon overlays can aggregate information from several layers of data to identify and work with derived spatial relationships.

Any effective GIS database will inherit these general principles and concepts. Each GIS requires a mechanism to describe geographic data in these terms, as well as extensive tools for using, managing, and providing general access to this information, as well as improving resource management. The process of transition of the region's economy to sustainable development should be based on the regional digital economic model which, in turn, should take into account the potential of the region (including natural resources) and its socio-economic specifics [8]. The use of blockchain technologies allows us to combine and accelerate the decision-making process in the formation and control of anthropogenic load on SPNAs.

The principal novelty of the studies conducted to date:

1) the conceptual and theoretical foundations of the analysis of the tourist and recreational potential of any territorial biocoenosis have been determined, taking into account international experience in the field of tourism and digital transformations;

2) systematized approaches to the study and assessment of tourist and recreational potential in altered conditions;

3) metric indicators were built and the mechanism for collecting material on the tourism resources of the studied areas, including SPNAs, was determined;

4) a theoretical substantiation of the methodology for the study of substances of artificial ("civilizational") origin has been developed;

5) blockchain and GIS technologies in the optimization of tourism activities in order to preserve biological potential;

6) blockchain technology in the analysis of sectoral information in order to optimize the anthropogenic load on SPNAs and preserve their biological potential.

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Леонід Григорович Шморгун,
д.е.н., професор, професор кафедри арт-менеджменту та івент-технологій, Національна академія керівних кадрів культури і мистецтв,
вул. Лаврська, 9, м. Київ, 01015, Україна
19shmorgun51@gmail.com

Віктор Павлович Колеснікович,
к.г.н., доцент кафедри менеджменту туризму та гостинності, докторант Міжнародного екологічного інституту ім. А. Д. Сахарова Білоруського державного університету,
вул. І. Копієвича, 5, м. Мінськ, 220114, Республіка Білорусь
ums_minsk@tut.by

Блокчейн-технології при аналізі галузевої інформації з метою регулювання антропогенного навантаження на особливо охоронні природні території

Анотація. Для регулювання взаємозв'язків між проблематикою збереження довкілля і розвитком туристичної галузі необхідна система методів організації раціонального рекреаційного природокористування. Вона має спиратися на обґрунтований понятійний апарат, а також систему класифікацій та регламентів, що дозволить максимально використовувати наявний потенціал і водночас не допустити його виснаження і втрати видового різноманіття біоти.

Ключові слова: *управління ресурсним потенціалом, геоінформаційні системи, блокчейн-технологія, керуюча інформаційна система, територіальна інформаційна система, радна (експертна) інформаційна система, природні біоценози.*

Леонид Григорьевич Шморгун,
д.э.н., профессор, профессор кафедры арт-менеджмента и ивент-технологий,
Национальная академия руководящих кадров культуры и искусств,
ул. Лаврская, 9, г. Киев,01015, Украина
19shmorgun51@gmail.com

Виктор Павлович Колесникович,
к.г.н., доцент кафедры менеджмента туризма и гостеприимства, докторант Международного экологического института им. А. Д. Сахарова Белорусского государственного университета,
ул. И. Копиевича, 5, г. Минск, 220114, Республика Беларусь
ums_minsk@tut.by

Блокчейн-технологии при анализе отраслевой информации с целью регулирования антропогенной нагрузки на особо охраняемые природные территории

Аннотация. Для регулирования взаимосвязей между проблематикой, связанной с охраной окружающей среды, и развитием туристической отрасли необходима система методов организации рационального рекреационного природопользования. Она должна опираться на обоснованный понятийный аппарат, а также

систему классификаций и регламентов, позволяющий максимально использовать имеющийся потенциал и в тоже время не допустить его истощения и потери видового разнообразия биоты.

Ключевые слова: *управление ресурсным потенциалом, геоинформационные системы, блокчейн-технология, управляющая информационная система, территориальная информационная система, советующая (экспертная) информационная система, естественные биоценозы.*

Стаття до редакції журналу надійшла: 3.11.2018 р.