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NEW APPROACH TO THE CREATION OF THE COMPATIBLE INFORMATION-REFERENCE SUBSYSTEM OF GIS FOR ENVIRONMENT MONITORING

There had been considered the relevant issue of the creation of the uniform information and reference subsystem of the regional information environment monitoring system. There had been suggested the new approach to the creation of such subsystem on the basis of created optimal model. There had been adduced the example of software solution for the given approach for the geoinformation system of Vinnytsia region environment monitoring.

Keywords: *geoinformation systems, environment monitoring, database.*

1. Initial pre-conditions and task setting

Geoinformation technologies are traditionally used for the creation of the computer systems for monitoring of environment and anthropogenic influence on it. At the same time the practical direction of geoinformation systems (GIS) creation requires their creation individually for each component under monitoring (surface water; reverse water; emissions; atmospheric air; soils; place of delete of wastes; naturally-protected fund etc.), which, as a rule, it is related to the creation of the separate specialized databases and electronic maps of GIS. Experience shows that the compatible computer systems for monitoring of environment, which do not consider the peculiarities of the separate inputs of the environment and contaminating influence on it, are not widely used from the practical point of view.

Traditionally, the information-reference subsystems of the geoinformation systems for monitoring of the environment are created in a way of convenient operation with the objects of vector maps, connecting information from a database. For example, this approach in GIS of the state monitoring of surface water of the Vinnytsia region is realized as follows: clicking a mouse on the certain object on the map allows to get a suitable window with information about this object (fig. 1).

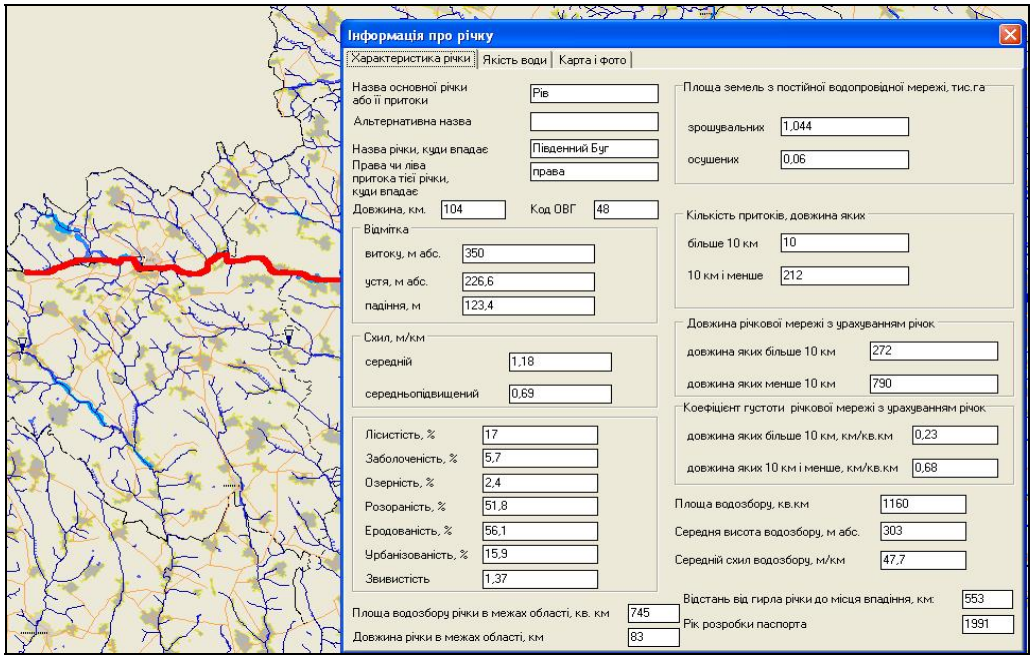


Fig. 1. Reference information on the river Riv of the Vinnytsia region

At that time, it is the necessity to collect the specialized GIS for different inputs of the environment in the unique system for forming of the complex picture of the state of environment of the region and to make the integral decisions directed on the improvement of its state in accordance with conception of sustainable development.

Consequently, it is necessary to create the new approach to the creation of suitable information-reference subsystem of the geoinformation system for monitoring of environment and contaminating influence on it, presented by the complex of the specialized geoinformation systems of different inputs for monitoring.

2. Construction of the model of interaction of GIS inputs

For the creation of the compatible information-reference subsystem of GIS there had been suggested the new approach, which implies the forming of database of metadata (BMD) in the formalized kind on the basis of databases and maps of every specialized GIS. This base helps determine the composition and place of information location on every object in the unified information-reference subsystem.

The database of metadata contains information about the structure and other features of data storage. For the construction of metadata database model it is necessary to build the model of the system, which saves the data.

Let us introduce the labeling:

$$S = \{G\}, \tag{1}$$

which means that computer system for monitoring of the environment and anthropogenic influence on it S consists of the set of the specialized geoinformation systems of different inputs for monitoring of G.

The geoinformation system G is the combination of the database B and electronic vector map M [1, 2]. In the formalized kind this combination can be presented:

$$G = [\ B \Leftrightarrow M\ ], \tag{2}$$

in which the sign «⇔» means that the databases B correspond to the objects of the map M.

Let is conduct the formalization of interaction (1).

As the model of interaction of the databases and maps in GIS substantially depends on the used software let us concentrate on the database management program MS Access and geoinformation package «Panorama» (http://www.gisinfo.ru). Backgrounding of the appropriateness of the use of these systems for the realization of the computers systems for the environment monitoring in Ukraine on the regional level it is presented in [2].

Each database B in MS Access as one computer file *.mdb is characterized by the name of this file N_B and is contained the set of tables T

$$B = [\ N_B,\ \{T\}\ ]. \tag{3}$$

Each of the tables T has the name N_T and is the set of the fields, each of which has the name P, unique only for this table, the identical names of the fields are allowed in different tables. Also each of tables T has a type of information D (numerical, text, date and others like that) and comment R which is the prompt for the user in relation to information contained in this field:

$$T = [\ N_T,\ \{[P, D, R]\}\ ]. \tag{4}$$

The basis of each map M in a GIS-package «Panorama» is the classifier. A classifier contains the set of the objects K, which can be displayed on a map (fig. 2).

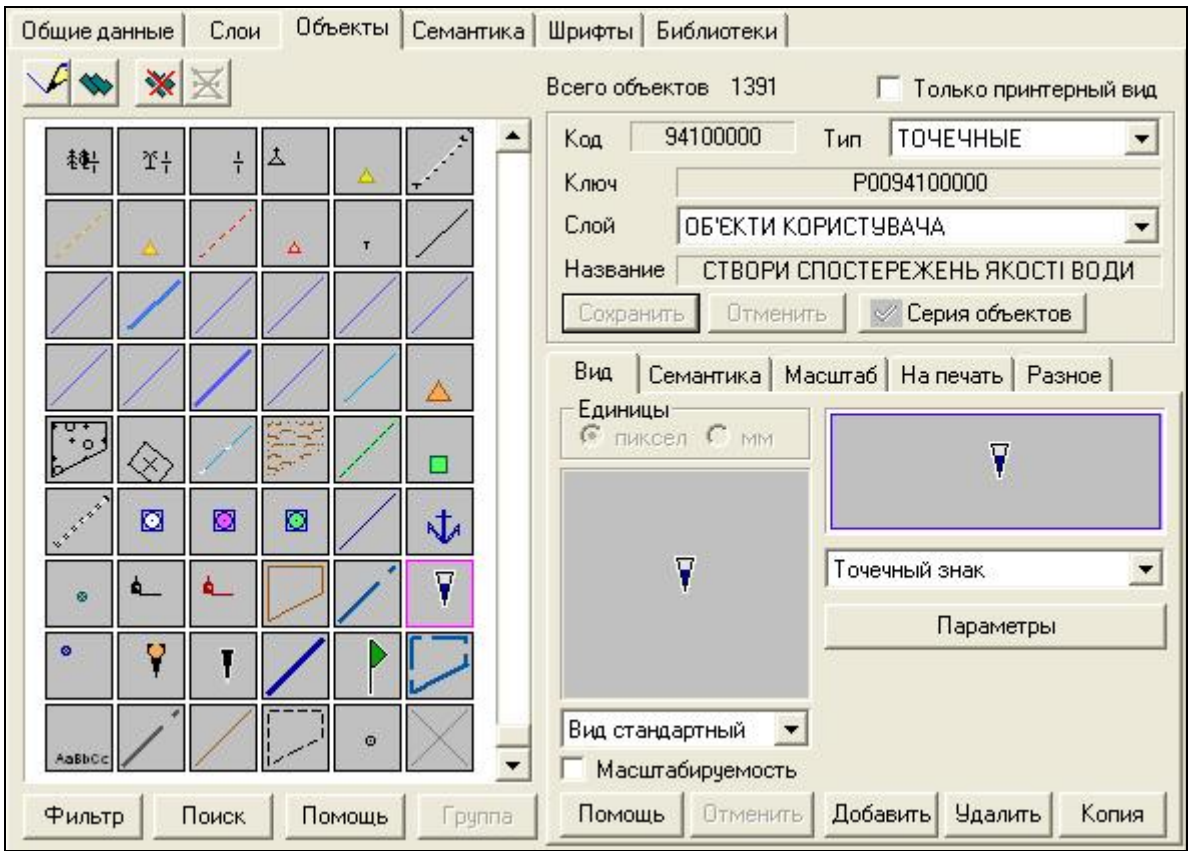


Fig. 2. Classifier of GIS-package «Panorama»

So, each map M in a GIS-package «Panorama» is the set of objects K from a classifier with the name N_K:

$$M = [\ N_K,\ \ \{K\}\ ]. \tag{5}$$

In view of the above labeling we will build the model of interaction of databases and maps of the geoinformation system for monitoring of environment and contaminating influence on it. For this purpose we consistently put models (2)–(5) in (1):

$$S = \{G\} = \{[B \Leftrightarrow M]\} = \{[[N_B,\ \{T\}] \Leftrightarrow M]\} == \{[[N_B,\ \{[N_T,\ \{P, D, R\}]\}] \Leftrightarrow [\ N_K,\ \{K\}]]\}. \tag{6}$$

For the increase of functionality of information-reference subsystem of GIS it is necessary to take into account in a model (4), as well as in models (6), the parameter of b = {0, 1}, which adopts one of two values only: b = „1” — field P should be shown to the user of information-reference subsystem GIS (for example show on a screen), b = „0” — field P not to show.

Then the model (6) will look like:

$$S = \{[[N_B,\ \{[N_T,\ \{P, D, R, b\}]\}] \Leftrightarrow [\ N_K,\ \{K\}]]\}. \tag{7}$$

3. Optimization of model of interaction of GIS constituents

Let’s optimize model (7) considering the criterion of the minimum of the model elements amount, taking into account the features of its use for the set task. At first, considering the purpose of the model (7), the parameter of D (type of information of the database table field) is not necessary in it as it gives useful information neither for the database of metadata about the location of information in the system, nor the user of information-reference subsystem about the state of the environment. With this in view let us rewrite model (7):

$$S = \{[[N_B,\ \{[N_T,\ \{P, R, b\}]\}] \Leftrightarrow [\ N_K,\ \{K\}]]\}. \tag{8}$$

Let us form the set of tables of parameters A, each of which corresponds to the to the certain

table T, contains the parameters P, R and b of this table, and its name N_A is formed by the rule:

$$N_A = \text{“Admin\_”} + N_T, \tag{9}$$

then a model takes place:

$$S = \{[[N_B, \{A\}] \Leftrightarrow [N_K, \{K\}]]\}, \tag{10}$$

$$A = [N_A, \{P, R, b\}]. \tag{11}$$

As during the computer realization the name of file means a file, that is in the model A and N_A have the same value, there is the model:

$$S = \{[[N_B, \{N_A\}] \Leftrightarrow [N_K, \{K\}]]\}. \tag{12}$$

Another simplification of model can be carried out, if all maps of the system for monitoring S shall be built on the basis of the unique classifier. Such situation is widespread in practice. The are the exceptions, when one GIS is built both for regional and local types for monitoring with the maps of different scale, but such approach is not quite correct.

In such a case it is not necessary to take into account in a model (12) the name of the classifier N_K – it is single and then a model is simplified to the following:

$$S = \{[[N_B, \{N_A\}] \Leftrightarrow \{K\}]\}. \tag{13}$$

Another simplification can be done, if to take into account that many maps on the basis of unique classifier is actually the one map. And in that case the correlation (2) is the correspondence of the records of many databases not to many maps, but only to one map, consequently:

$$S = [[N_B, \{N_A\}] \Leftrightarrow \{K\}], \tag{14}$$

$$A = [N_A, \{P, R, b\}]. \tag{15}$$

Computer realization of models (13) and (14) in MS Access differs by the fact that a model (13) means the set of tables $[[N_B, \{N_A\}] \Leftrightarrow \{K\}]$ and (14) — only one such table.

Thus the database of metadata contains the main table (for example under the name of “Admin”), built after a model (14) which sets the correspondence of objects K of the classifier of maps GIS to the names of databases B and tables of parameters A of their tables. Also the database of metadata contains the proper tables of parameters A with information about the tables fields of databases B. Model of the metadata database, which is built on the basis of model (14), (15), in the composition of the model of compatible information-reference subsystem of GIS is shown on fig. 3.

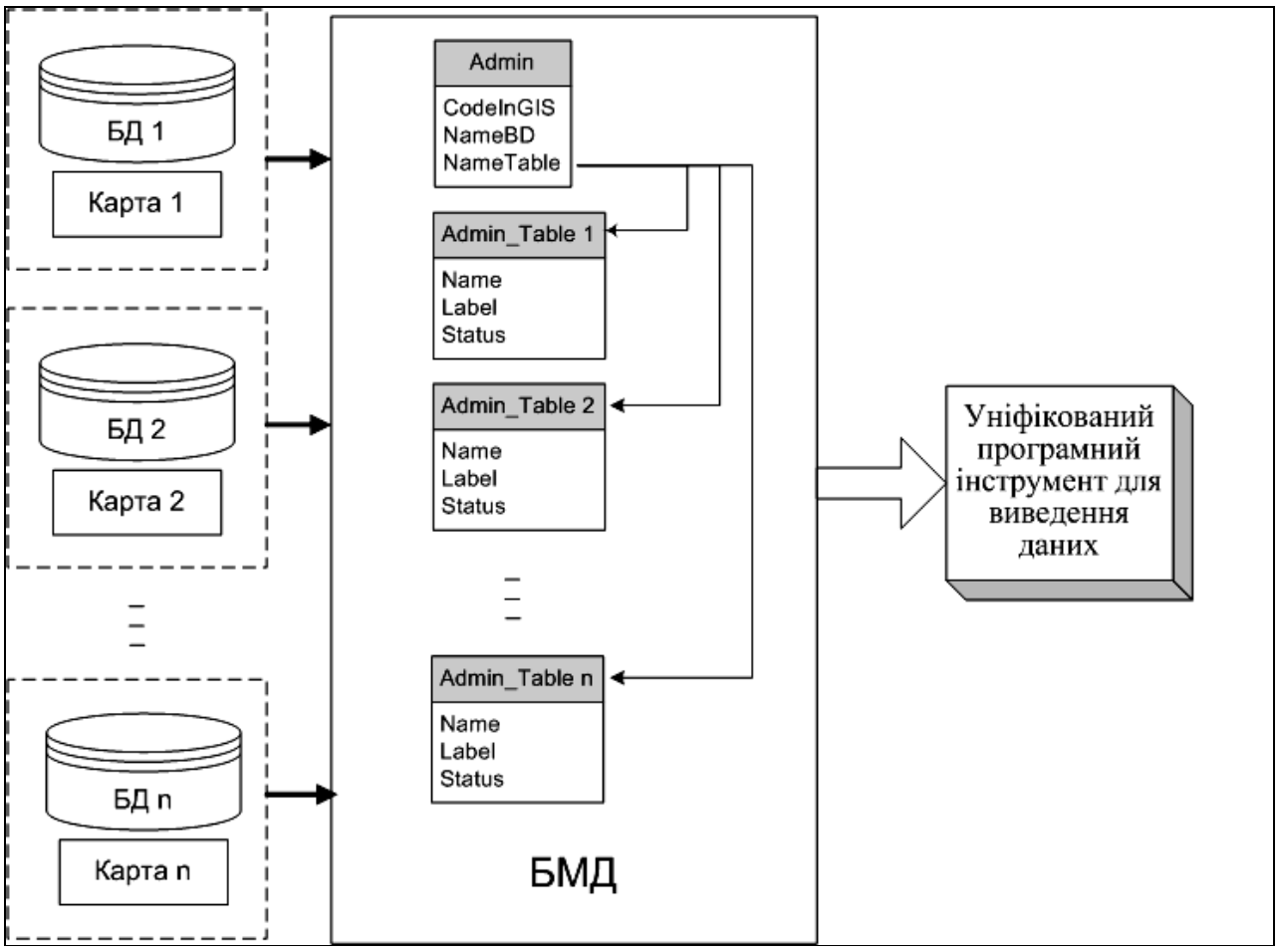


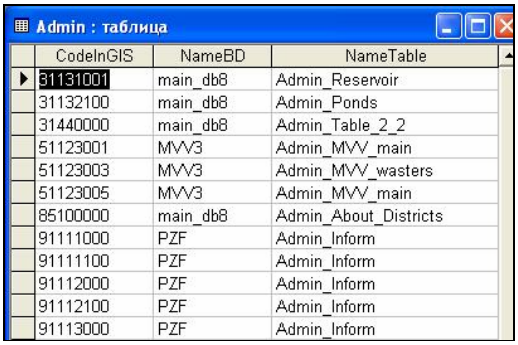
Fig. 3. Model of compatible information-reference subsystem of GIS for monitoring

It is important to note that the suggested approach can be applied only for the designing of the geoinformation systems for monitoring of environment and anthropogenic influence on it, but also for GIS of other purpose but with similar input data, characteristic features and simplifications.

4. Software development for GIS of the state monitoring of environment and anthropogenic influence on it in the Vinnytsia region

The developed theoretical basic of new approach were successfully applied during the development of the compatible information-reference subsystem for GIS of the state monitoring of environment and anthropogenic influence on it in the Vinnytsia region [3].

The database of metadata is developed in accordance with the model of the system S in a kind (14) (fig. 4) and set of tables of parameters A (fig. 5).



Admin : таблица

CodeInGIS	NameBD	NameTable
31131001	main_db8	Admin_Reservoir
31132100	main_db8	Admin_Ponds
31440000	main_db8	Admin_Table_2_2
51123001	MVV3	Admin_MVV_main
51123003	MVV3	Admin_MVV_wasters
51123005	MVV3	Admin_MVV_main
85100000	main_db8	Admin_About_Districts
91111000	PZF	Admin_Inform
91111100	PZF	Admin_Inform
91112000	PZF	Admin_Inform
91112100	PZF	Admin_Inform
91113000	PZF	Admin_Inform

Fig. 4. The main table of metadata database

Admin_Inform : таблица

Name	Label	Status
Name	Назва об'єкта природно-заповідного фонду	☑
Square	Площа	☑
Pidstava	Підстава, на основі якої заснований об'єкт	☑
Charact	Коротка характеристика об'єкта	☑
Users	Користувач	☑
Location	Розташування	☑
Tape	Тип	☑
Class	Клас	☑
District	Район, в якому розташований об'єкт	☑

Fig. 5. Table "Admin_Inform" with parameters of table "Inform" of database PZF.mdb, that contains description of the fields of the basic informative table of the naturally-protected fund database of the Vinnytsia region

As for all the fields of table "Admin_Inform" with parameters of table "Inform" of PZF.mdb database is parameter b = 1 (see the field of “Status”) (see fig. 5) the information-reference system displays information that is contained in all fields of table (fig. 6).

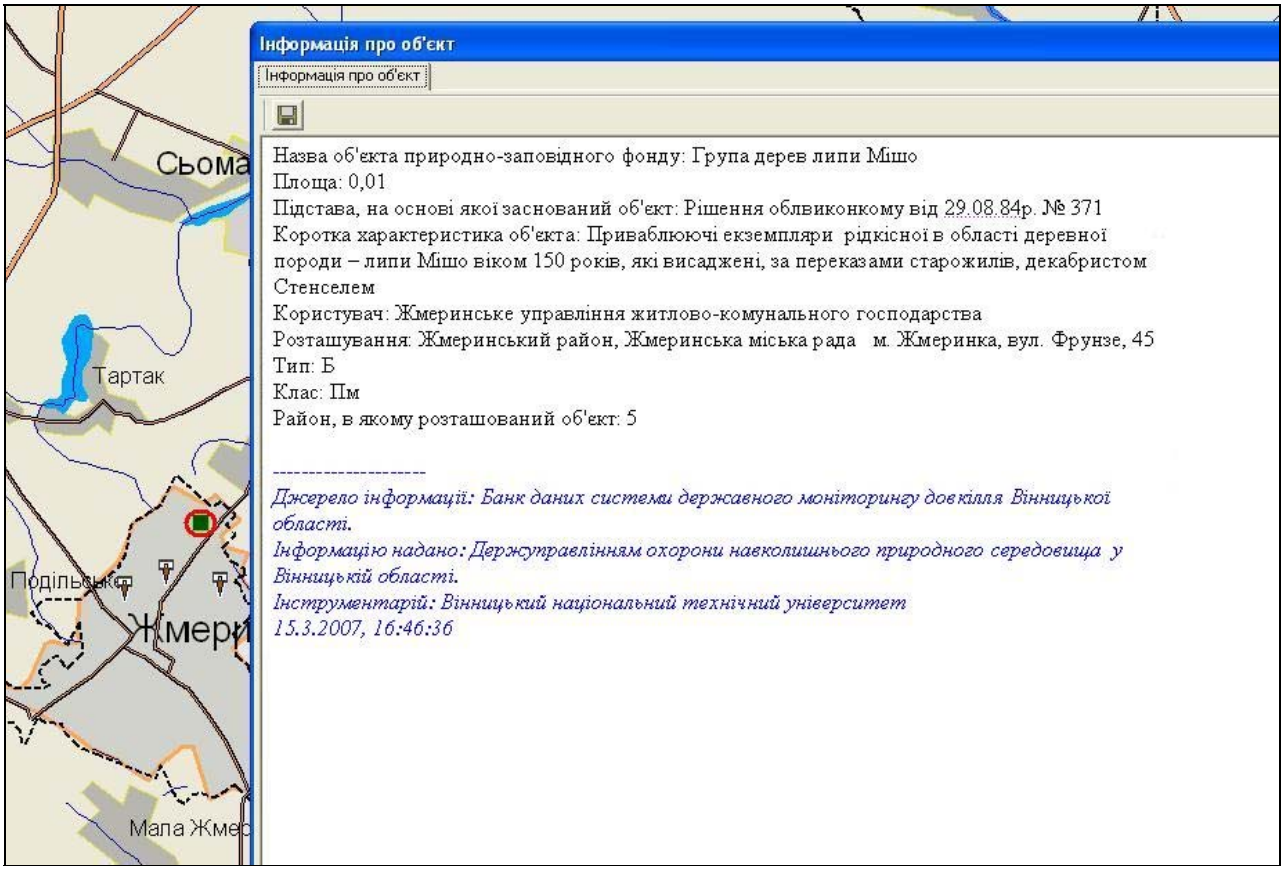


Fig. 6. Result of work of information-reference subsystem
(an object is chosen, labeled by a square, is circled on the map)

Fig. 7 demonstrates the example of parameters’ adjusting of information-reference subsystem when it is necessary to show not all the information of an object (see the field of “Status” — b is evened both «1» and «0»).

Admin_Inform : таблица

Name	Label	Status
Name	Назва об'єкта природно-заповідного фонду	☑
Square	Площа	☑
Pidstava	Підстава, на основі якої заснований об'єкт	☐
Charact	Коротка характеристика об'єкта	☑
Users	Користувач	☐
Location	Розташування	☐
Tape	Тип	☑
Class	Клас	☑
District	Район, в якому розташований об'єкт	☑

Fig. 7. Table "Admin_Inform", in which not all the fields are marked as such to be reflected by the information-reference subsystem

5. Conclusions and advantages of the developed approach

The developed approach has such basic advantages before the other variants of the realization of the information-reference subsystems of GIS for environment monitoring:

1) universality, speed and comfort of addition of the arbitrary specialized geoinformation systems for monitoring of environment and anthropogenic influencing on it;

2) possibility of suitable management by composition of information shown by the information-reference subsystem.

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