UDC 911.03:008 (477)(043.5)

BOUNDARIES HANDLING AS THE MOST CORRECT DYNAMIC PRINCIPLE OF THE BEGINNING THE REGISTER OF IMMOVABLE CULTURAL HERITAGE ENTITIES CREATION

V.S. Chabaniuk, PhD in Physics and Mathematics/

E-mail: chab3@i.ua

Institute of geography of the National academy of sciences of Ukraine

O.P. Dyshlyk,

E-mail: dyshlyk@geomatica.kiev.ua

"Geomatic Solutions" LLC / ТОВ «Геоматичні рішення»

K.A. Polyvach, PhD of Geographical Sciences

E-mail:polyvach@mail.ua

Institute of geography of the National academy of sciences of Ukraine

V.I. Pioro,

E-mail:mail@prostir.museum

CO "Ukrainian Center for Museum Development"

Annotation*. The correct start of work on developing a spatial data infrastructure of the domain of immovable cultural heritage (CH) of Ukraine is to model the CH entity boundaries in the most accessible way at the moment. Created models are used together with the necessary transformations, both in separate systems from the set of CH domain systems, and in several appropriately ordered models of systems from this set. Many of the required models are organized into a hierarchy of system of systems called Atlas geo-information system: from public models of CH entities on the Internet to the State System for constant accounting or registration of CH objects under the Ministry of Culture and Information Policy (MCIP) of Ukraine. Boundaries handling includes support for the entire life cycle of the spatial characteristics of CH entity models – from random statement about the CH entity to the transformation into an object of the accounting system or even an object of the national register. It is shown that when defining boundaries, you need to be able to work with different spatial characterizations of the CH object. It is proved* *that this characterization can be started from available cartographic material, and not from the implementation of land management projects, as it is done in the case of spatial characterization of land plots. The elements of the methodics are described, which allows to carry out the necessary spatial characterization of the CH objects in practice.*

***Key words**: spatial characterization of immovable cultural heritage entities, NSDI, methodics of boundary handling, Relational cartography, Conceptual framework, Solutions framework.*

Introduction

The digital era of SDI (Spatial Data Infrastructure) of arbitrary regions or NSDI (National SDI) of individual countries began in the early 90s of the last century (**Fig. 1**) [6]. We distinguish SDI as an implemented system from the class of digital spatial information systems, and the SDI model, which can be both physical (implemented) and abstract (virtual). Rajabifard [6] and others identified three abstract SDI models and linked them to three classes of systems that form the generations of SDI or NSDI development (**Fig. 1**). The first generation corresponds to the so-called "product" SDI model. It is from them the digital era of SDI begins. The second generation corresponds to the so-called "process" SDI model, and the third generation becomes a "enabling platform" [7] and becomes a subset of the so-called "Spatially Enabled Society" (SES).

Per **Fig. 1** NSDIs in many countries around the world should have already reached the third generation of development. Digital "product" NSDI of Ukraine in the 90s of the last century was not created. Although attempts to create such a digital "product" NSDI are still observed today. For example, the product NSDI model is emphasized in the Law of Ukraine "On National Geospatial Data Infrastructure", abbreviation: Law "On NGDI" [20]. In the adopted version of the Law, its authors had to "somehow" (most likely, unconsciously) take into account the requirement of time - to have an actual process NSDI. At the same time, in addition to the product NGDI model with "some" elements of the process model, there are elements of NSDI of Ukraine, which correspond to the second and third models and do not fall under the Law. Therefore, in Ukraine it is hardly possible now to create a NGDI (NSDI), which corresponds to the first, product model, without taking into account the second and third models.

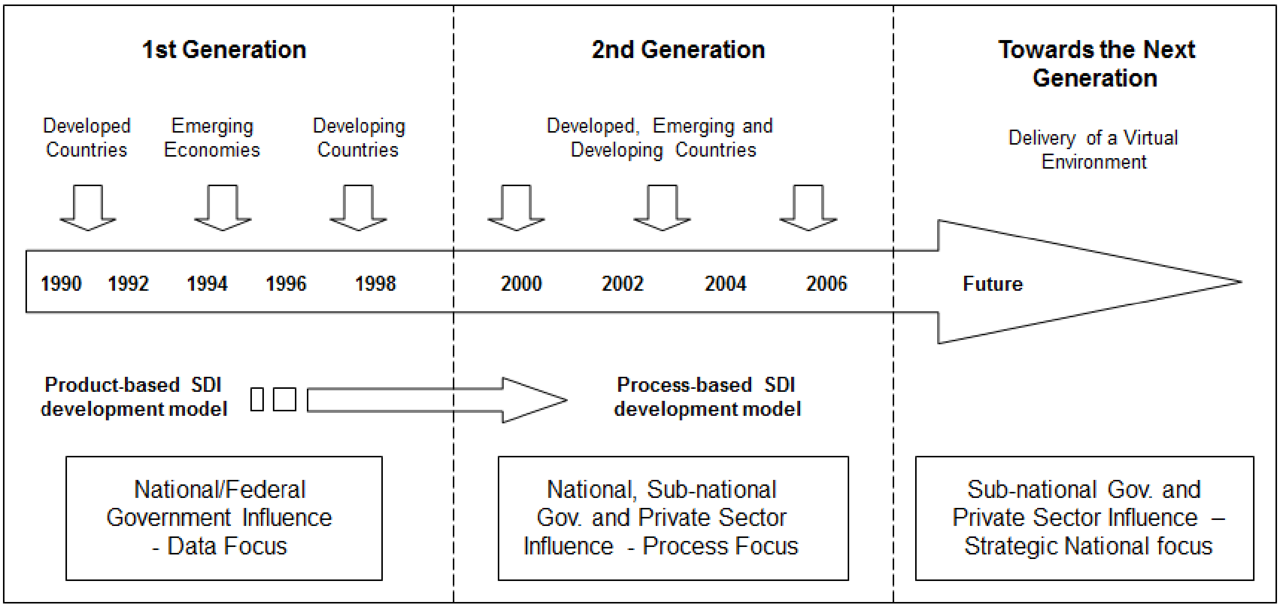

Fig. 1 - Three generations of SDI as of 2006 [6]

In works [2], [25], [22], [3], it is proved that nowadays in solving spatial problems of the national level it is necessary to work not with container, but with relational spaces of reality. In the context of the culture of the state in such spaces there are and interact with the entities of the immovable CH of Ukraine. At the same time, it is quite easy to come to the concept of a system of systems (supersystems) of immovable CH objects modeling the corresponding relational space. In general, the components of the system of this supersystem are information systems, each of which manipulates spatial data and relation. We point to only three such systems that interact in some way. Each such system is a prerequisite for the following system:

1. Let's set the search for "cultural heritage" in some a well-known browser. Looking at the found pages, we can conclude about the presence in the Ukrainian sector of the Internet, if not systems, then a certain number of digital models of a particular CH entity of Ukraine or even some of their associations. We do not provide links to such sites here, as they appear quickly and disappear no less quickly. The condition of the objects of these models is best characterized by the term "Announcement" (An) about the CH entity, as the developers of such models

"announce" their private opinion about the CH entities. These views are usually not yet confirmed by government records or registers of models of these entities, and sites do not model relational spaces. Most often, these are models of some container space [9]. Container space is associated with absolute space - the point of view of space as independent of what it occupies. Potentially infinite expanse within which everything else exists [4]. That is why here we use the term "models" and not "systems", because models are a more general term for us than systems.

2. There are systems that are best called pre-accounting systems of CH entities. Unlike "unorganized" models, which belong to the class "Announcement", these systems are formed in accordance with the mandates of organizations that operate pre-accounts of the region (oblast or country). It is because of the existence of mandates and organizations that it is advisable to use the term "system", because thanks to them it becomes possible to talk about the system. Its important characteristic is the "precedence" of the objects of the system, which can be interpreted quite broadly. According to the precedence, there must be something else that exists after it, the following. This characteristic feature of the systems includes what is hereinafter referred to as "Verification" (Ve). This means that some objects from the announcement model have been verified, become part of the system, meet the mandate and are further operated by an organization.

3. Systems that have lost the characteristics of "precedence" are called systems of constant accounting of the CH entities. This milestone is hereinafter referred to as "Constant Accounting" (CA).

It follows from the above that it is hardly worth counting on the same spatial characterization of modeling objects in all the mentioned models and systems. The greatest influence on the existing differences is due to the different origins of models/systems. The origin of models of (private) land plot in the State Land Cadastre is well known [18]. Determining the spatial characteristics of such models is performed using the so-called land management projects [19]. Its "spatial essence" is the establishment of the boundaries of the plot in nature using geodetic instruments and the State Geodetic Reference Network. In addition, the work must be performed by a certified land surveyor. Therefore, the cost of these works is significant.

The technical basis of the registration process can be a unique code of the entity or object and the spatial characterization of the object (entity) using a special coordinated point. An example of such a point is, for example, the centroid of an immovable CH entity. A special point can be determined using cartographic materials of known origin to be able to talk about accuracy. In this case, within the required entity, another special point (not a centroid) can be set and its coordinates can be determined on scanned and registered in a known coordinate system maps or map-schemes of optimal detail.

Spatial characterization of land plots of mostly private property in Ukraine has been performed for more than 20 years - since the beginning of the first decade of the 21st century. The resulting objects became the basis of the National Cadastral System (NCS) [23]. Information about these objects can be obtained with the help of a public map [21]. There, the type of ownership of such plots indicates "private property".

In addition to plots with private type of property in Ukraine there are plots with state and communal (public) type of property. This type of property includes the entities of the nature-reserve fund (NRF) and immovable cultural heritage (CH). These plots are much more complex and generally more important to society than private plots. After analyzing the experience of developing the NCS, as well as the state of affairs with obtaining and registering information about the essence of the NRF Jos A.M. [13] proposed methodological approaches to establishing the boundaries of existing and unregistered in the NCS entities (objects) of the NRF of Ukraine using available cartographic materials. Here, in order to establish the protection rights of entities with a public type of property, it is not necessary to start by defining the boundaries with the help of a land management project. It is possible to do the opposite - first to determine the legal characteristics of the public plot and only then to determine its technical (in particular, spatial) characteristics. In this case, the definition of technical characteristics can begin with a simple spatial characterization - with a unique code of the entity and its spatial characterization using a special coordinated point. Then the spatial characterization of the object/entity can be improved by using existing but known cartographic material.

Similar approaches are proposed to be applied to the CH entities. The most important difference between the results of this article and the results of the articles of Hall J. [24] and Jos A.M. [13] is taking into account the dependence on the above three prerequisites. We argue that the problems of spatial characterization of objects need to be defined and solved in each case of creating an SDI or geographic information system at the national level. Moreover, these definitions and solutions differ significantly from those used in the creation of the NCS. An example of consideration of problems of this class and their partial solution in the context of a immovable CH is offered in this work. Namely, the following are considered:

1. Unambiguous identification of the CH entity, which is modeled by the objects of a modeling system.

2. Spatial characterization of the CH object in one or another modeling system.

3. The relation between the identified objects, as well as between different models of these objects, determined by different spatial characterization of these objects.

Relational cartography and its methodology [25] were used to obtain the main results. The quoted monograph examines in detail the relation of spatial (atlas) systems, which are called evolutionary. These relations explain the evolution of a wide class of spatial (atlas) systems from Web 1.0 formation systems to Web 2.0 formation systems. The evolutionary relation is typical of all spatial (atlas) systems. In particular, it is mandatory for atlas systems at the national level, including the Electronic version of the National Atlas of Ukraine (ElNAU). In addition, in the monograph Rudenko L.G., ed. [22] the evolution of atlases systems is used in the conception of the Atlas geo-information model of cultural heritage (AGIM-CH). Therefore, further we dwell only on the first and third preconditions (see above) of the SDI of cultural heritage.

Impact of infrastructural precondition on spatial characterization of CH objects

Lets recall the definition of NSDI, which we used at the beginning of the first decade of the 21st century [11]: “NSDI consists of four components:

1) organizational (institutional) framework that defines the strategy, legal and administrative agreements for the construction, maintenance, access and application of standards and fundamental data sets,
2) technical standards that define the technical characteristics of fundamental data sets,
3) fundamental data sets, including geodetic basis, topographic and cadastral databases,
4) technological framework that allows users to identify fundamental datasets and access them.

These components form the basis for:

- administration of national and regional land resources,
- land rights and possessions,
- management and storage of resources,
- economic development,

and support the organization and analysis of spatial and related information for a wide range of social, economic and environmental purposes”.

Despite the problems with the creation of first-generation NSDI in the sense of the above "product" definition, society in Ukraine is "spatially enabling". This "enabling" is carried out primarily due to the emergence of geo-platforms for general use, non-governmental organizations, as well as components of the NSDI. By geo-platforms we mean, for example, Google Maps Platform and OpenStreetMap. By non-governmental organizations we mean organizations that develop and maintain these geo-platforms. Under the components are understood SDI, which are created by thematic components of NSDI. For example, NSDI NRF and/or NSDI of immovable CH and/or oblast SDI.

In the first NSDI generation, the main "product" should be fundamental data sets. As Ukraine has chosen the European path of development, the fundamental data of both the NSDI of Ukraine as a whole and its individual components must agree with the INSPIRE data. The data about of the immovable CH entities of Ukraine should belong to the data set “9. Protected areas" when it comes to agreeing with Europe.

As a concrete example of national INSPIRE compliance let's take the Law on National Information Infrastructure (NII) of Poland [1] (for us it is NSDI, not NGDI). This Law is already stated on the second page that the Minister is responsible for the protection of the monuments of the immovable CH, competent in matters of protection of cultural and national heritage: “c) the minister over culture and national heritage protection, with regard to the theme of spatial data referred to in Chapter 1 item 9 of the Annex hereto, in the part concerning the protection of immovable monuments within the meaning of the Act of 23 July 2003 on the Protection and Care of Monuments (Dz. U. [Journal of Laws] No. 162, item 1568, as amended)”. Here, item 9 cooperates with the INSPIRE fundamental data set “9. Protected areas”. Data set “6. Land plots (cadastral zoning)” is a separate set of the same level as set 9.

The application of INSPIRE to the NSDI of Ukraine agrees with the proven in the monograph Chabaniuk V.S. [25] structural principle C1: "Design, not improvement". Simply put, it means that the lower stratum model (NSDI of Ukraine) should be designed taking into account the higher stratum model (INSPIRE). The need to use INSPIRE draw attention, in particular, Dyshlyk O.P. [12], and Tarnopolsky A.V. [23].

Another important principle for us - the dynamic principle D3: "The correct beginning - ‘Orientation on the boundaries of the basemap Conceptual framework’" [25] - is applied and detailed for the SDI of CH in this work. According to Petrovska O.P. [17] “the word *borderline* is used for the name of the line that divides the territory of the state. To define a strip, a division of any territory of a general nature, the word *border* is used, and the word *boundary* is used in both meanings. We use the term "boundary", which is most appropriate for our targets.

Impact of relational approach to space on spatial characterization of CH objects

Relational space is a viewpoint on space as a product of relations between entities. Space in this viewpoint arises at the same time as the entities in it, which contrasts with the absolute (container) space. Associated with post-structuralist geographies [4].

In 2017, the authors took an active part in the Scientific research work (SRW) "Standardization of metadata and data exchange in the context of creating an electronic information resource of cultural heritage objects (entities) and cultural values" [15] of the Ukrainian Center for Cultural Research (UCCR) MCIP of Ukraine. To organize research of the spatial properties of the CH entities and cultural values and the corresponding spatial characteristics of the modeling objects was used shown in **Fig. 2** scheme. It shows the abbreviated names of milestones in red, where you want to perform the transformation of the spatial characteristics of the CH entities (objects). The most typical coordinate systems are indicated in parentheses for the names of these milestones.

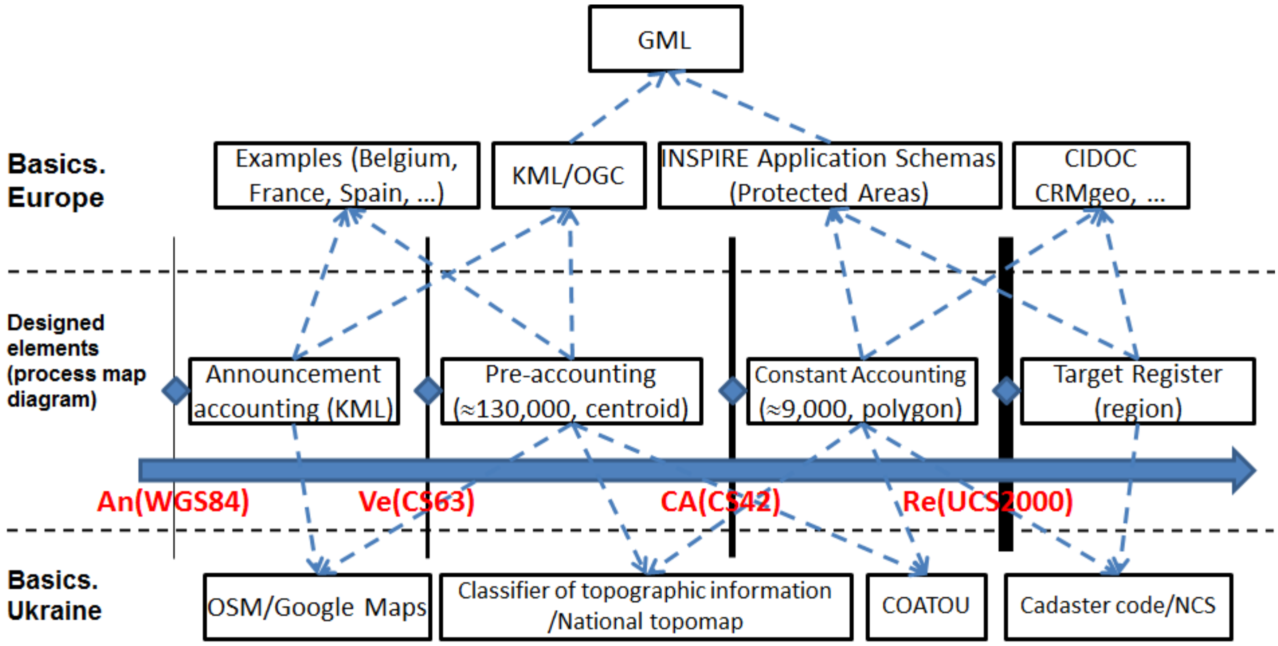

Fig. 2 - The scheme of the research of the spatial characteristics of the CH objects in the SRW1

Explanation of the scheme:

- The scheme of the research of the spatial characteristics is constructed with use of the process diagram developed by the SRW1 team (see "process map diagram" at the left). This diagram shows the development process or life cycle of the objects of modeling the CH entities and cultural values. The diagram shows the most important milestones of the state of the spatial characteristics of the CH entities/objects. In the context of this article, it should be noted that the process diagram is actually one of the processes of the process SDI model. That is, the CH entities/objects are not just elements of the appropriate set of fundamental data (product SDI model) - they must satisfy the relevant processes (process SDI model).
- Abbreviations: GML - Geography Markup Language, KML - Keyhole Markup Language, OGC - Open GIS Consortium, CIDOC - ICOM's International Committee for Documentation (abbreviation used in French - Comité International pour la Documentation), CRM - Conceptual Reference Model, OSM - OpenStreetMap, COATOU - Code of Objects of Administrative and Territorial Organization of Ukraine, NCS - National Cadastral System.
- Rectangles denote the main spatial elements that have been researched or created in SRW1.
- Dotted arrows show usage relations. For example, INSPIRE Application Schemas use GML.
- The solid arrow shows both the direction of the registration process and the recommended sequence of creating information databases of possible accounting and/or registration information systems. The thickness of the vertical lines indicates the complexity of the implementation of the information system (component) to be created in each of the four milestones (shown in blue diamonds). That is, the difficulty of reaching each subsequent point is doubled compared to the previous one.
- An, Ve, CA, Re - abbreviations of milestones names according to Announcement, Verification, Constant Account, Target Register. At these milestones, the life cycle processes of the CH entity/object begin, which ensure the formation of appropriate

models/systems. Titles: 1) Announcement Accounting (KML) models are not yet a system, but models of CH entities (see above); 2) Preliminary accounting (Pre-accounting) system (≈130,000, centroid), 3) Constant accounting system (≈9,000, polygon), 4) Target register system (region). The notions of "polygon" and "region" here differ in attributive information. The region has attributes that transform the CH object from constant accounting into a nationally recognized CH object.

- WGS84, CS63, CS42, UCS2000 - coordinate systems that best match the spatial characteristics of CH entities/objects at life cycle milestones and systems at these milestones. Thus, CS63 is a well-known coordinate system (CS) in the Soviet Union in 1963, which for a considerable period of time was used for civilian purposes, including accounting systems. In particular, many topographic maps and diagrams were made in CS63 and corresponded to the spatial characteristics of the objects of accounting systems.

In the time that has passed since the implementation of SRW1, the Ukrainian-speaking scientific community became available results published in late 2018 on the structure and dynamic of spatial information systems [22], [25], which include electronic information resources of CH entities/objects and cultural values. To explain the most important details of this new knowledge, we return **Fig. 2** on 90^0, we will update it and use the mentioned results of 2018. In fact, we used the Conceptual framework of carto- and geo-information systems [25]. The result of these actions is **Fig. 3**.

In **Fig. 3** SpaSys denotes the Spatial System of actuality, which is analogous to the CH relational space. It is also a “protoplast” of Atlas geo-information system (AGIS) [22] - a system of CIS/GIS class in the broader sense (CISb/GISb). Both the ProSys actuality system and its AGIS model are two-dimensional supersystems or systems. The entry (GIE) means that the AGIS depends on the GeoInfo Extender. These systems may coincide if AGIS is absent and there is nothing to "extend". AGIS is a supersystem, as it consists of closely related systems, such as the site "Public Register of CH", "Notification", atlas "Population of Ukraine and its CH", Preliminary and Constant Accounts, Target Register, Emulation of INSPIRE/CIDOC/…». "Notification" is an accounting system of CH announcements, which is built in a way that allows you to start the verification process. "Emulations INSPIRE/CIDOC/…" here means European-level systems in Ukraine or for Ukraine that will one day be created. So far, they are "emulations" of future systems. The more general part of the actuality modeled/represented by ProSys, AGIS and UkrSys is shown above. This part of actuality includes “protoplasts” of one-dimensional systems that are part of UkrSys (Ukrainian Systems). Examples of such one-dimensional systems are the NCS and the National Atlas of Ukraine. Both systems were created without taking into account the properties of each other. UkrSys is a set of one-dimensional systems, which include these systems.

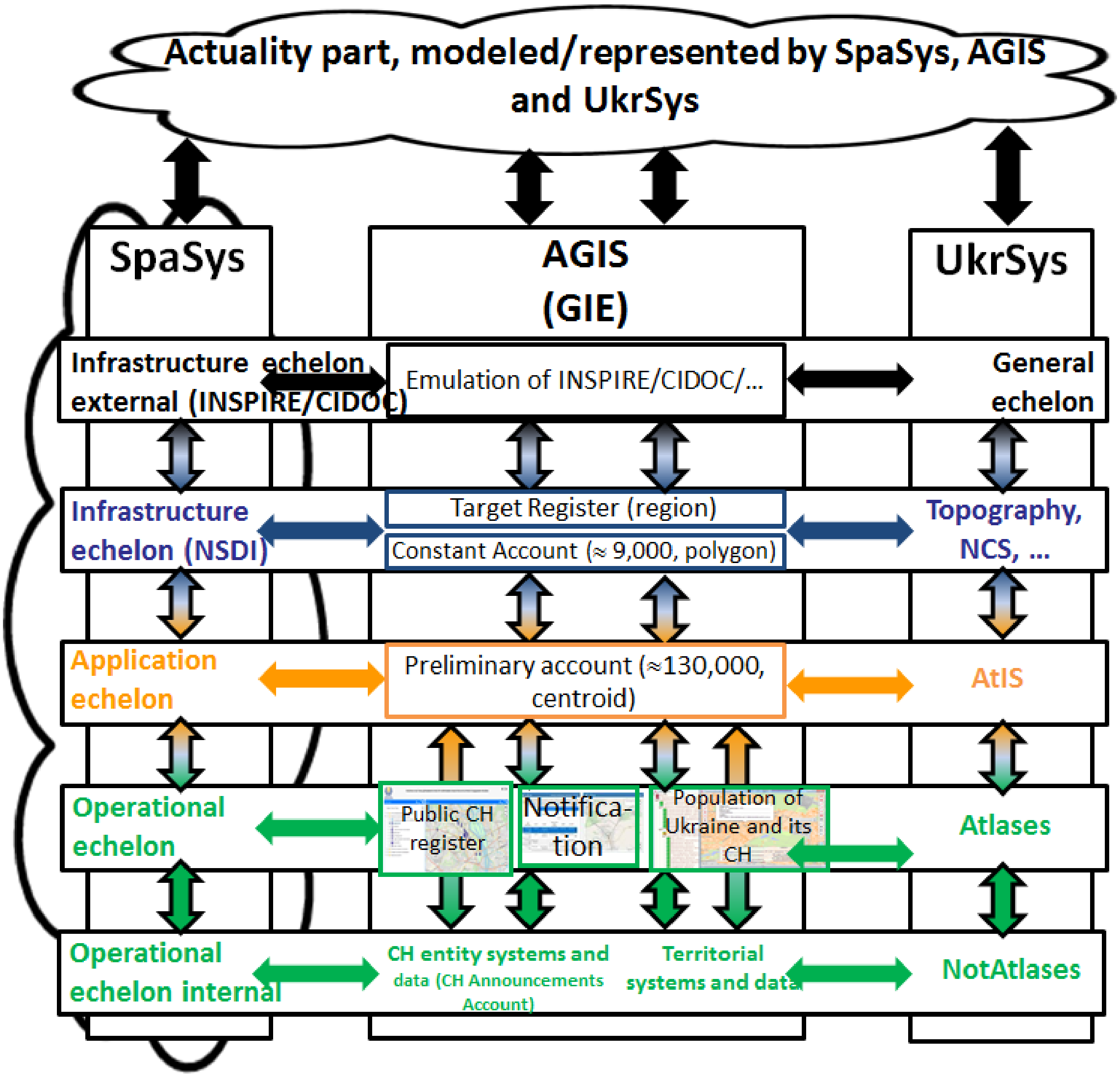

Fig. 3 - The scheme of the research of the spatial characteristics of the CH objects in SRW1 from the viewpoint of Relational cartography [22], [25]

The differences between two-dimensional and one-dimensional systems are very important for understanding the subject of this work. In other words, in each given context, two-dimensional ProSys may not define, but simulate actuality with one-dimensional UkrSys systems, as evidenced by the black arrows at the top. However, **Fig. 3** proposes to define in actuality the spatial system ProSys and to model it first of all by means of AGIS(GIE). One-dimensional UkrSys can also be used for the development/construction of AGIS(GIE). Two-dimensional spatial systems represent relational spaces, and one-dimensional - container spaces. Relational spaces are much more powerful and useful than container spaces. Therefore, two-dimensional systems are more useful, more adequately modeling reality.

Differences between two-dimensional and one-dimensional CIS (Carto-information systems) are considered in [25]. Namely, the Relational cartography described there deals with the relations that exist in the so-called extensions of the usual for the end user Carto- and/or Geo-information systems in the narrow sense (CISn and/or GISn). Mock-ups of software systems developed to verify the results [22] prove that the tasks of building GeoInfoExtenders (GIE) in the context of culture are quite correct. Their main and at least currently studied element is the Application echelon - an intermediate practical echelon between the Infrastructure and Operational echelons of the CISb/GISb Conceptual framework (CoFr). In the work of Rudenko L.G., ed. [22] is described the conception of such a system - AGIS of sustainable development on the basis of CH, which is CISb or GISb. As a rule, the main goal of the Application echelon is ‘professional’ data conversion, mainly from the Infrastructure echelon. The Application echelon currently consists of four transforming subsystems: 1) Map Queries, 2) Functional, 3) Cartographic, 4) Application Solutions framework (SoFr) and/or Conceptual SoFr.

Map Queries subsystem, Functional and Cartographic subsystems are designed for use by experts in a cultural context. It is these users who provide ‘professional’ data transformation. Each of the subsystems automates three processes: 1) creation, 2) maintenance, 3) use.

Application and/or Conceptual SoFr may or may not be part of the final system. Sometimes these SoFr are called the Front-end and/or Back-end of the Atlases platform or GIE Platform. Recall that each SoFr 'works' between two adjacent echelons with their elements [25]. Therefore, it should not be considered equivalent, for example, to the Application SoFr and the Front-end of the system created with its help, as the Front-end is most often associated only with the Operational echelon.

Application and Conceptual SoFr are intended for use by developers of the final system. If the final system of the end user has to be Operational, Application SoFr are used. If the final system of the end user has to be Application, then some subset of Application and Conceptual SoFr is used. If the final system of the end user has to be Infrastructure, then Conceptual SoFr are used. Therefore, in the first case, the extender is called AtEx (AtlasExtender), in the second and third - GIE (GeoInfoExtender). In the case of AGIS, it is necessary to use GIE, as the end users of AGIS work in each of the three echelons: Operational (Electronic atlases), Application (Atlas information systems - AtIS) and Infrastructure (GIS).

In **Fig.4a**, the corresponding picture (fig. 20) from [8] is shown. Compared to the original, the colors were changed and NSDI was used instead of SDI. **Fig. 4a** reflects the view point of Steudler et al. about the central role of cadastre in NSDI, SES (Spatially Enabled Society) and, finally, in sustainable development.

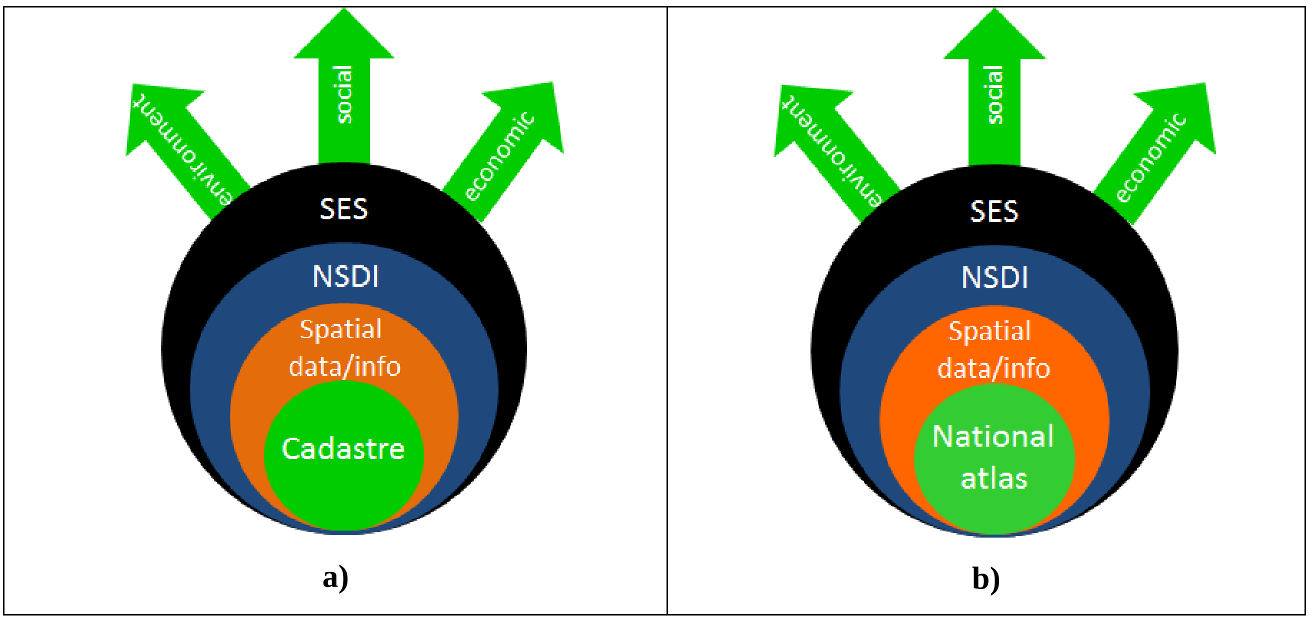

Fig. 4 - a) Cadastre as the core of NSDI, SES and, finally, sustainable development [8], b) The use of fig. 20 to the National Atlas /

However, there are several statements that do not allow us to agree with the described opinion of Steudler, et al., especially in the context of culture in Ukraine:

1. Structure **Fig. 4a** is valid not only for the cadastre, but also for national atlases - **Fig. 4b**. In general, the (N)SDI-Spatial data/info-ApplicationX chain is a standard way to use (N)SDI. That is, ApplicationX=Cadastre is not the only use of NSDI.
2. In the monograph [25] **Fig. 5** is given. There is pointed to an alternative to centralized systems (the monograph uses the term "map in the center/mapcentric") - distributed systems.
3. To take into account the spatial characteristics of the CH objects, a centralized approach is economically impossible in Ukraine in this period. If we start the constant accounting of ≈130,000 entities with a fairly expensive “nature” survey, we can get a result in which most of the CH entities will be destroyed due to their insufficient protection, and not due to lack of relatively accurate spatial characteristics. Applying the cost estimates of the land management project, we will have an estimate of 0.5 - 1.5 billion UAH only for the spatial characterization of the CH entities/objects. It is hardly realistic in the current conditions in Ukraine, even if we take into account the reduced cost of spatial characterization of point objects.
4. The entities of the immovable CH is significantly different from (private) land plots, which are the core of the land cadastre. First of all, they differ in their purpose. The purpose of the CH entities is collective for: the country, oblast, district, united territorial community, etc. The purpose of private land plots is individual.

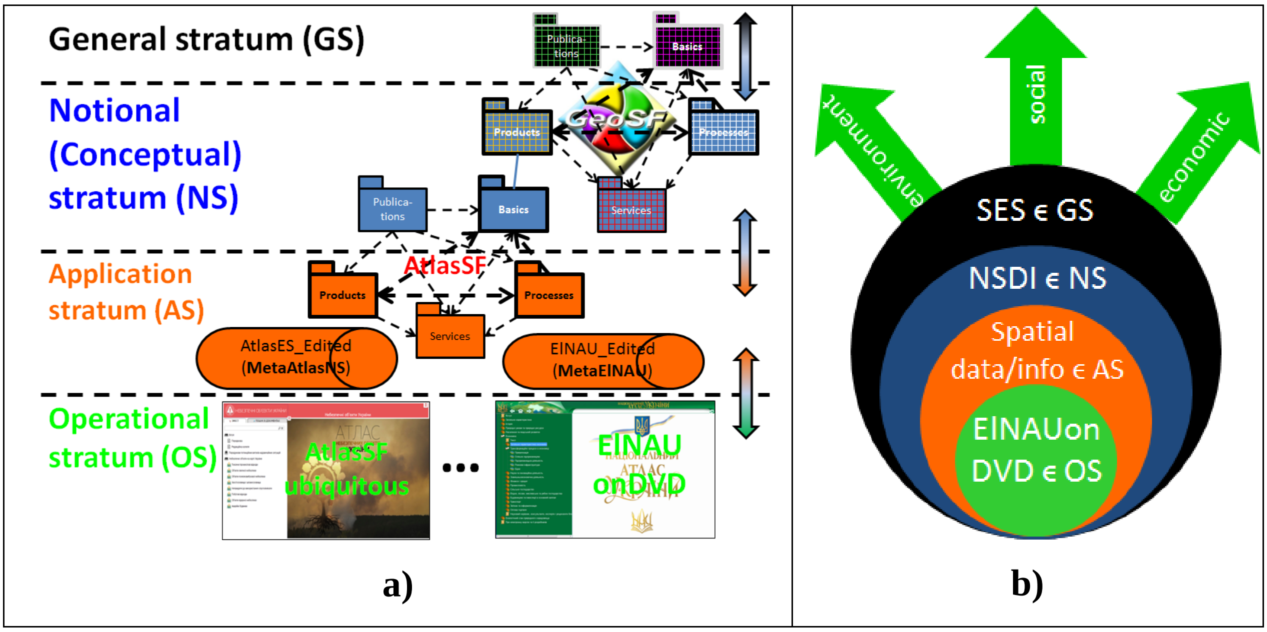

Fig. 5 - a) Simplified AtS CoFr, b) Simplified representation of ElNAUonDVD CoFr in notation of Vienna diagrams

Spatial characterization of CH objects

We use abstraction, according to which all the entities of actuality consist of spatial and non-spatial properties. Entities are modeled by information objects, in which the spatial properties of the entity are called spatial characteristics. The spatial characteristics of the CH objects are understood quite widely in this work. They are the characteristics of different models of real entities, created for one purpose or another, as well as with one or another accuracy. Here are some examples of spatial characteristics:

1. Spatial coordinates of an object in a particular coordinate system. In this case, point objects are modeled by points, linear objects – by broken lines, area objects – by polygons.
2. An object is defined by a point in a particular coordinate system. This can be the centroid of the object or an arbitrary coordinated point that must be within the object.
3. Spatial characteristic is an arbitrary description, which at the same time unambiguously defines the object.

In nonmaterial cultural objects, the spatial characteristics can be much more complex than those described above. However, they are not considered in this work. The concept of spatial characterization has much in common with the defined in the textbook “spatial localization” by Bugaevsky L.M. and Tsvetkova V.Ya. [10]. There, the *spatial localization* of data is the process of correlating different types of information to a spatially defined system. Such a system can be a Cartesian coordinate system; geographic coordinate system; classification set of territorial objects, etc. Localization can be performed by using special classifiers or based on reference to the selected coordinate system.

Attributive is localization, which is carried out on the basis of classification of object characteristics (properties of entity) or its location in the set system of classifiers. An example of such an approach is the classifiers used in official statistics. *Positional* is localization, which is carried out on the basis of binding points of the object to the coordinate system. *Positioning* is the process of binding points of an object to the coordinate system. An example of positioning can be the process of binding objects to the coordinate grid when constructing drawings in CAD (Computer-Aided Design).

Here are two important notes to make:

- In the supersystems discussed above and below, one way or another, the minimal elements of the component systems are not objects (entities), but their integration into layers. The object (entity) does not disappear, because it is an element of the layer. Layers are models of actuality fields, and the CIS/GIS approach itself is called layered or field-based. It is deliberately opposed to another known approach to CIS/GIS - object. The best model in layered approach is a map. In other words, we hold the statement “everything is a model” instead of the statement “everything is an object”. Some models we call systems, although the statement “everything is a system” is also true for us. For example, in actuality, systems are defined that consist of entities and relations between them and are understood as a whole.
- Almost every map consists of basic and thematic layers. The base layers form the base map. The base map consists of four subsystems [2]: 1) topographic, 2) administrative-territorial, 3) index-cadastral, 4) images obtained from moving platforms. The structured system of the basic map [2] is constructed by means of

(system) entity «a_8: Boundaries» which is «classification grouping» according to [14]. In this group, the entities (objects) of classification are «settlement, city (municipal), district, regional, national boundaries. Often the boundaries show specialized landholdings (parks, airports, military bases and wildlife reserves)».

The model of properties system or system entity «a_8: Boundaries» belongs to the topographic subsystem of the base map. The same subsystem includes the model of the system entity «a_1: Mathematical elements, elements of the planimetric base and elevation datum», which is also a classification group in [14], [2]. According to [14] objects (entities) of classification of system entity a_1 are «Benchmarks (Astronomical points, Points of state geodetic network, Points of a survey network (points of local network), Points of a leveling network, Height points (signed points), Boundary pillars (boundary marks), which have the meaning of landmarks)».

Elements of the methodics of CH objects boundaries operating

Methodics is a set of means and techniques for carrying out any work. In more detail: *methodics* is a document that includes a description of a problem, object, subject of research, its goals, hypotheses, tasks, methodological bases and research methods. In addition, the creation of research methodics includes planning, namely, development of a time schedule for the planned work [16].

Methodics of CH objects boundaries operating is characterized by software products used in the milestones An(WGS84), Ve(CS63) and CA(CS42) **Fig. 2** - The scheme of the research of the spatial characteristics of the CH objects in the SRW1. At the time of writing, point An(WGS84) uses freely available products such as Map Marker [5]. The construction of electronic «Preliminary Account» begins with verification (Ve(CS63)) using the web application «Object Notification». This process includes many subprocesses. One of them is called «declaration». Spatial characterization during the construction of electronic «Constant Account» (control point CA(CS42)) is carried out using the software product QGIS on the client. The HeritageShapeEditor web application is used to spatially characterize individual CH objects. All software solutions are based on the open library Proj.4.

In addition to the mentioned software products, the methodics is based on detailed information support. As subsystems of the basic map of Ukraine are used: 1) topographic - vector National map of Ukraine produced by «Intelligence systems-GEO», LLC and topographic database OSM, 2) administrative-territorial – COATOU, available in «Intelligence systems-GEO», LLC addresses and address database OSM, 3) index-cadastral – publicly available data NCS, 4) images obtained from moving platforms – any available materials. The methodology also includes instructional materials that allow the use of this methodics in practice.

References

1. ACT of 4 March 2010 on spatial information infrastructure. Available at: (http://ggim.un.org/knowledgebase/Attachment272.aspx?AttachmentType=1).

2. Chabaniuk, V.S., Dyshlyk, O.P. (2016). Atlas Basemaps in Web 2.0 Epoch.- The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Volume XLI-B4, 2016 XXIII ISPRS Congress, 12–19 July 2016. Prague (Czech Republic), 611-618.

3. Chabaniuk, V.S., Rudenko, L.G. (2019) Relational geospatial technologies: background theory, practical example and needs in education 63-83, in de Miguel González, R., Donert, K., Koutsopoulos, K., eds. Geospatial Technologies in Geography Education. Springer, 219.

4. Cresswell, T. (2013). Geographic Thought: A Critical Introduction (Critical Introductions to Geography). Wiley-Blackwell, 298 .

5. Map Marker. Available at: https://www.mapmarker.app/.

6. Rajabifard, A., Binns, A., Masser, I., Williamson, I.P. The role of sub-national government and the private sector in future SDIs. International Journal of Geographical Information Science, 20 (7), 727-741.

7. Steudler, D., Rajabifard, A. ed. (2014). Spatially Enabled Society. FIG report No. 58. The International Federation of Surveyors (FIG), 68-72.

8. Steudler, D., ed. (2014). CADASTRE 2014 and Beyond. FIG report No. 61. The International Federation of Surveyors (FIG), 73-84.

9. Wikipedia. Available at: https://en.wikipedia.org/wiki/Container_space.

10. Bugaevskii, L.M., Tsvetkov, V.Ja. (2000). Geoinformazionnye sistemy: uchebnoe posobie dlya vuzov [Geoinformation systems: study guide for universities]. Moscow, Russia: Zlatoust, 222.

11. Dyshlyk, O.P., Markov, S.Ju., Chabaniuk, V.S. (2003). Karkas georishen' jak sposib pobudovy natsional'noi infrastruktury geoprostorovyh danyh [The framework of geosolutions as a way to build a national infrastructure of geospatial data]. Research and technology collection: Engineering geodesy, 49. Kyiv: KNUBiA, 73-94.

12. Dyshlyk, O.P., Dorosh, A.Y., Tarnopolskyi, A.V., Tarnopolskyi, E.A. (2018). Infrastructura geoprostorovyh danyh v Ukraini: Stan ta metodologichni problemy zakonodavchogo regulyuvannya [Infrastructure of geospatial data in Ukraine: State and methodological problems of legislative regulation]. Land management, cadastre and land monitoring, 1, 33-43.

13. Jos, A.M. (2017). Metodychni pidhody do vstanovlennya mezh isnuyuchyh objective PZF Ukrainy [Methodical approaches to establishing the boundaries of existing NRF facilities in Ukraine]. Materials of scientific-practical seminar. Series: «Conservation Biology in Ukraine», 1. Kyiv, 240.

14. Klasyficator informazii, yaka vidobrazhaet'sya na topografichnyh kartah masshtabiv 1:10,000, 1:25,000, 1:50,000, 1:100,000, 1:200,000, 1:500,000, 1:1,000,000 (1998) [Classifier of information displayed on topographic maps at scales of 1:10,000, 1:25,000, 1:50,000, 1:100,000, 1:200,000, 1:500,000, 1:1,000,000]. GUGKK , 53.

15. Standartyzaziya metadanyh ta obminu danymy v konteksta stvorennya elektronnogo informaziynogo resursu objektiv kulturnoi spadschyny ta culturnyh zinnostey (2017) [Standardization of metadata and data exchange in the context of creating an electronic information resource of cultural heritage sites and cultural values]. UTSKD, SRN 0117U006630, 303.

16. Novikov, A.M., Novikov, D.A. (2007). Methodology. Moscow, Russia: SINTEG, 668.

17. Petrovska, O.P. (1986). Border, boundary. Kultura slova, 30. Linguistic Institute named for O.O. Potebni. Kyiv: Naukova dumka, 103.

18. Pro Derzhavnyy zemelnyy kadastr № 3613-VI (2012). Vidomosti Verhovnoi Rady, 8. Available at: https://zakon.rada.gov.ua/laws/show/3613-17.

19. Pro zemleustriy: Zakon Ukrainy vid 22 travnia 2003 roku za № 858-IV (2003). Vidomosti Verhovnoi Rady, 36. Available at: https://zakon.rada.gov.ua/laws/show/858-15.

20. Pro nazionalnu infrastructuru geoprostotovyh danyh: Zakon Ukrainy №554-IX (2020). Vidomosti Verhovnoi Rady, 37. Available at: https://zakon.rada.gov.ua/laws/show/554-20#Text.

21. Public map of Ukraine. Available at: https://map.land.gov.ua/kadastrova-karta.

22. Rudenko, L.G., ed. (2018). Kulturna spadschyna v Atlasniy geoinformaziyniy systemi stalogo rozvytku Ukrainy [Cultural heritage in Atlas geoinformation system of sustainable development of Ukraine]. Institute of geography NANU. Kyiv, 172.

23. Tarnopolskyi, A.V., Malashevskyy, M.A., Tarnopolskyi, E.A., Palamar, A.Ju. (2018). Deyaki aspekty pobudovy infrastructury geoprostorovyh danyh [Some aspects of building a geospatial data infrastructure]. Molodyy vchenyy, 2 (54), 28-31.

24. Holl, J., Chabaniuk, V.S., Berezhna, N.V. (1998). Programne zabezpechennya shvydkoi reyestrazii prav vlasnosti: praktychnyy pidhid [Software for quick registration of property rights: a practical approach]. Visnyk geodezii ta kartografii, 3, 46-53.

25. Chabaniuk, V.S. (2018). Relyaziyna kartografiya: Teoriya I praktyka [Relational cartography: Theory and practice]. Institute of geography NANU. Kyiv, 525.

В.С. Чабанюк, А.П. Дышлык, К.А. Полывач, В.И. Пиоро

ОПЕРИРОВАНИЕ ГРАНИЦАМИ КАК ОДИН ИЗ САМЫХ ПРАВИЛЬНЫХ ДИНАМИЧЕСКИХ ПРИНЦИПОВ НАЧАЛА СОЗДАНИЯ РЕЕСТРА СУЩНОСТЕЙ НЕДВИЖИМОГО КУЛЬТУРНОГО НАСЛЕДИЯ

Правильным началом работ по созданию инфраструктуры пространственных данных домена недвижимого культурного наследия (КС) Украины является моделирование границ сущностей КС наиболее доступным на данный момент способом. Созданные модели используются вместе с нужными трансформациями как в отдельных системах из множества систем домена КС, так и в нескольких соответствующим образом упорядоченных моделях систем из этого множества. Множество нужных моделей упорядочивается в иерархию системы систем, которая называется Атласной гео-информационной системой, от публичных моделей сущностей КС в Интернете до Государственной системы постоянного учета или регистрации объектов КС, за создание которой отвечает Министерство культуры и информационной политики (МКИП) Украины. Оперирование границами включает поддержку всего жизненного цикла существования пространственных характеристик моделей сущности КС - от произвольного заявления о сущности КС к превращению в объект системы учета или даже в объект общегосударственного реестра. Показано, что при определении границ нужно уметь работать с различными пространственными характеризациями объекта КС. Доказано, что эту характеризацию возможно начинать с имеющегося картографического материала, а не с выполнения проектов землеустройства, как это делается в случае пространственной характеризации частных земельных участков. Описаны элементы методики, позволяющей осуществлять нужную пространственную характеризацию объектов КС на практике.

Ключевые слова: пространственная характеризация объектов недвижимого культурного наследия, НИГД, методика оперирования

границами, Реляционная картография, Концептуальный каркас, Каркас решений.

В.С. Чабанюк, О.П. Дишлик, К.А. Поливач, В.І. Піоро

ОПЕРУВАННЯ ГРАНИЦЯМИ ЯК НАЙПРАВИЛЬНІШИЙ ДИНАМІЧНИЙ ПРИНЦИП ПОЧАТКУ СТВОРЕННЯ РЕЄСТРУ СУТНОСТЕЙ НЕРУХОМОЇ КУЛЬТУРНОЇ СПАДЩИНИ

Правильним початком робіт по створенню інфраструктури просторових даних домену нерухомої культурної спадщини (КС) України є моделювання границь сутностей КС найдоступнішим на даний момент способом. Створені моделі використовуються разом з потрібними трансформаціями як у окремих системах із множини систем домену КС, так і у кількох відповідним чином упорядкованих моделей систем із цієї множини. Множина потрібних моделей упорядковується у ієрархію системи систем, яка називається Атласною геоінформаційною системою: від публічних моделей сутностей КС в Інтернеті до Державної системи постійного обліку або реєстрації об’єктів КС, за які відповідає Міністерство культури та інформаційної політики (МКІП) України. Оперування границями включає підтримку всього життєвого циклу існування просторових характеристик моделей сутності КС – від довільної заяви про сутність КС до перетворення у об’єкт системи обліку або навіть у об’єкт загальнодержавного реєстру. Показано, що при визначенні границь потрібно вміти працювати з різними просторовими характеризаціями об’єкта КС. Доведено, що цю характеризацію можливо розпочинати з наявного картографічного матеріалу, а не з виконання проектів землеустрою, як це робиться у випадку просторової характеризації приватних земельних ділянок. Описано елементи методики, що дозволяє здійснювати потрібну просторову характеризацію об’єктів КС на практиці.

Ключові слова: просторова характеризація сутностей нерухомої культурної спадщини, НІПД, методика оперування границями, Реляційна картографія, Концептуальний каркас, Каркас рішень.