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CRITICAL PROPERTIES OF MODERN GEOGRAPHIC INFORMATION SYSTEMS FOR TERRITORIAL MANAGEMENT

Introduction. *The issue of the "geographic information system" (GIS) definition is important both for the theory and practice of creating modern GIS of large territories. An analysis of modern studies has shown that most of the currently publicly available GIS definitions don't meet the needs of modern territorial GIS.*

The purpose *of the paper is to prove the claim that for the management of territories in modern conditions should be used not GIS in the "narrow" sense, but GIS of the new generation, in particular GIS in the "broader" (extended) sense, for example Atlas Geoinformation Systems (AGIS), which correspond to a predetermined structure — Conceptual framework of Atlas Systems of Relational Cartography.*

Results. *The term Atlas Geoinformation System is defined as GIS of large territories of a new generation. The concept of Atlas Geoinformation System (AGIS) is described. An example of AGIS of a certain class is given. We believe that it is important and useful for practitioners to use the results of this article in the creation of GIS of large territories. Theorists will get a better understanding of the field of geoinformatics research of the next generation, which would satisfy the requirements of modern times.*

Conclusions. *Inductive and/or deductive inferences on the fairness of main critical properties in modern GIS of large territories are given. In the absence of one of the properties, we can say that there is a corresponding critical disadvantage of the GIS project of a large territory. The criticality is that in the absence of an appropriate property, the GIS project is likely to fail.*

Keywords: *Atlas geoinformation system, territory management, Conceptual framework, Solutions frameworks, critical property.*

INTRODUCTION

The article [1] substantiates the need to implement four critical properties (CP) in geoinformation systems (GIS) designed to manage "large" territories:

- CP1. Availability of education-scientific, production and management components in each large territorial GIS.
- CP2. Availability of an atlas solution (or Atlas system — AtS), relatively independent of other elements of the large territory GIS, which could work offline.
- CP3. Portal as the means of building GIS in some broader sense (GISb) with GIS in the narrow sense (GISn) and other elements, as well as to provide on-line teamwork with all elements-systems.
- CP4. GIS of large territory must have a metasystem extension, which must necessarily include meta-products and meta-processes for their creation. All elements of the system must be consistent with the particular Solutions Framework of the project in which the system was created.

In this article, we want to prove that for the management of territories under modern conditions should not be used “classic” GISn, but GIS of some new generation. For these GIS, in addition to CP1–CP4, the following critical property must also be implemented:

- CP5. The need to create in modern conditions not GISn, but GISb and, in particular, Atlas geo-information systems (AGIS), which correspond to a certain predetermined structure — Conceptual framework of Relational Cartography [2], as well as CP1–CP4.

“Classic” GISn refers to systems that are ultimately defined according to one of four approaches to the definition of GIS, oriented accordingly to: processes, applications, databases, tools [3]. A process or process-oriented approach to GIS definition has become the most popular. This is evidenced by definitions from the Russian [4], Ukrainian [5] and English [6] sectors of Wikipedia. In the late 1990s, process-oriented definition of GIS became essential to us thanks to a monograph [7], where GIS was defined as an information system (IS) designed to work with spatial or geographical data. IS, in turn, was defined as a set of subsystems that implement data collection and input processes; their pre-processing; data manipulation; data and information analysis; generating results. In particular, it was used in the Conception of Multipurpose National GIS (NGIS) of Ukraine [8].

The terms "in the narrow sense" and "in the broader sense" were defined in [9] for IS. Since GIS is an IS specialization for us, GISb can be defined through IS in the broader sense (ISb): “The totality of all formal and informal data representation and processing activity within an organization, including the associated communication, both internally and with the outside world”.

To prove the "criticality" of CP1–CP4 for the GIS of “large” territory, we used the experience of creating the Radioecological GIS (RGIS) and the experience of coordinating three large projects of the French-German Chornobyl Initiative (FGI) [1]. In general, this is the work of the decade from 1996 to 2005 and this period coincides with the life cycle of the RGIS. As a result of the Chornobyl accident in 1986, 12 of 25 oblasts of Ukraine are considered to be victims, which is why we have a “large” territory here. Our method of proof was based on the so-called "abductive" inferences [10], [11]. To remove possible objections to their correctness, it should be noted that RGIS was the first implementation of the GIS of “large” territory (or national-level GIS), and there are no other such implementations in Ukraine. Because of this, there are no other abductive inferences for or against, so we believe that in all GIS implementations, CP1–CP4 must be taken into account for managing large territories. For our part, we further analyze the current GIS-solutions available to us, which could be attributed to large territorial ones, to further verify the correctness of CP1–CP4. To this end, we use the theoretical methods of proof based on inductive and deductive inferences.

We always perceive territories through spatial phenomena and processes that allow GIS modeling. In this case, before applying such modeling, we separate spatial phenomena and processes, which in reality can be represented by spatial systems or spatial entities. An example of a spatial system is the hydrography of the Ukraine territory. In GIS, these spatial systems are often modeled by systems of map layers, and the spatial layers themselves are, in reality, appropriate to be called in the field. Examples of spatial entities are those of material cultural heritage. In GIS, these spatial entities are modeled by spatial objects. It is clear that objects of one type can form map layers, and map layers can fall into spatial objects of the same type. Because of this, geoinformatics have even decided to separate the layer and object approaches to GIS.

In the years following the creation and operation of the RGIS and associated "Chornobyl" GIS, since the middle of the first decade of the 21st century, we have been implementing GIS mainly in the commercial sectors of the national economy: oil and gas, telecommunications, banking, transport. In general, these systems should be called object GISs, even if the object of study is entities distributed by territory (systems of entities). For example, the spatial entities of the network of the national telecommunications operator "Vodafone Ukraine" (VF Ukraine) were modeled using a GIS called the VF Automated Information System (AIS) (life cycle from 2008 to 2020). It must be acknowledged that not all CP1–CP4 are valid for such object GISs. For example, the purpose of the VF AIS was to support the operational state of entities of the VF network, such as, for example, base stations. Such systems automate predefined business processes, so CP1 should not be considered, unless the "certainty" of business processes is questioned. There is no need to consider also and CP2. However, in our view, the need for CP1 and CP2 for object GIS is explained by the purpose, which in the case of territorial GIS is different from object GIS.

If we go to the heart of our study, it must be said that most common-sense GIS definitions now do not meet the needs of current territorial GIS. If we take the deeper look at the most up-to-date definitions, we will see the following. The authors of the textbook [12] adhere to the definition of GIS from the textbook [13]: "information systems providing the collection, storage, processing, display and dissemination of data, as well as obtaining on their basis new information and knowledge about spatially coordinated phenomena". Process-oriented definition is adhered to [14; p. 1]: “A geographic information system (GIS) is a computer system for capturing, storing, querying, analyzing, and displaying geospatial data”. Shipulin V. in the textbook [15; p. 29] after considering several variants, the definition goes: “GIS is a system that:

- first, there is a set of interacting five components, consisting of computer tools, software, geographic data, regulations and users;

- second, it performs the functions of input, integrating, storing, processing, analyzing, modeling and visualizing geographical information".

It seems that based on the title of the textbook [16; p. 78] Karmanov, et al. could deviate from the process-oriented definition of GIS. Yes, they initially consider different types of territorial IS, but in the section "Concept of GIS territorial management" still define GIS as "a system for management of geographical information, its analysis and mapping", that is, adhere to process-oriented definition of GIS. Interestingly, in the next section, called "GIS as a Distributed System", they de facto recognized that territorial GISs should be integral systems made of GIS of several kinds. To do this, use the ecosystem ArcGIS version 9.x, which is still: 1) dating back to the first decade of the 21st century, and the textbook cited dates from 2015; 2) as early as the first decade of the 21st century, it consisted, at least, of desktop, server-based, portal and mobile elements, each of which could be used to construct an appropriate GIS.

We can state that the definition of GIS from textbooks is different from professional and scientific definitions. Yes, the current definition of GIS for ESRI is: «A framework to organize, communicate, and understand the science of our world. A geographic information system (GIS) is a framework for gathering, managing, and analyzing data. Rooted in the science of geography, GIS integrates many types of data. It analyzes spatial location and organizes layers of information into visualizations using maps and 3D scenes. With this unique capability, GIS reveals deeper insights into data, such as patterns, relationships, and situations — helping users make smarter decisions» [17].

Yang, et al. [18; p. 25] recall that, «GIS originates from several domains and refers to the system designed to capture, observe, collect, store, and manage geographic data, and to provide tools for spatial analyses and visualization [19]. GIS can help obtain geographic data to be used for decision making, such as choosing routes for emergency response». Further Yang, et al. [18; p. 26] indicate that «Coined by Mike Goodchild, the term GIS can also refer to the field of geographic information science or *GIScience* — the study of the scientifically applied GIS principles and technologies [20]. According to GIS scientists, *GIScience* involves remote sensing, global navigation satellite systems, and GIS. Additionally, in various domains, *GeoInformatics* may be applied to remote sensing, global navigation satellite system, and GIS information».

Longley, et al. in the second edition of the monograph [21; p. 16] consider, in contrast to the above definition from the first edition [19], several definitions, among which are the interpretation of GIS as a Spatial Decision Support System (SDSS). As a result of the discussion there, the definitions of Longley, et al. [21; p. 31] point to the importance of the social context, which, in their view, was beautifully expressed by N. Chrisman in his definition of GIS [22; p. 13]: «The organized activity by which people: 1) measure aspects of geographic phenomena and processes; 2) represent these measurements, usually in the form of a computer database, to emphasize spatial themes, entities, and relationships; 3) operate upon these representations to produce more measurements and to discover new relationships by integrating disparate sources; and 4) transform these representations to conform to other frameworks of entities and relationships. These activities reflect the larger context (institutions and cultures) in which these people carry out their work. In turn, the GIS may influence these structures».

Finally, GIS is synonymous with SDSS, the latter being defined as «computer-based system that combines conventional data, spatially referenced data and information, and decision logic as a tool for assisting a human decision-maker. It usually includes a user interface for communicating with the decision-maker. A SDSS does not actually make a decision, but instead assists and analyzing data and presenting processed information in a form that is friendly to the decision-maker» [23].

PROBLEM AND METHODS OF SOLUTION

Consideration of GIS definitions is not a purely academic issue. To explain the importance of this question both for theory and practice of creating modern GIS overlarge territories, let us consider the stages of GIS development in general, which, for example, H. Ottens [24] defined for Europe as follows:

1. Pioneering (innovation): 1965/70 – 1980/85.
2. Maturity (use by specialists and commercialization): 1980/85 – 1990/95.
3. Usage (widespread use and stabilization): 1990/95 – 2000/05.

In article [8], we argued that Ukraine lags behind Europe in terms of GIS development phases by at least ten years. At the same time, H. Ottens [24] considered that the countries of Eastern Europe were not less than twenty years behind. However, there are now signs that even Ukraine has entered phase 3 — the usage of GIS. At the same time, both in the world and in Ukraine, the necessity of changing the definition of GIS, which would correspond to the phase of its development, was not given due consideration. The need for such a change for the usage phase is apparent even from the analysis of the above definitions. Indeed, all four approaches to the definition of GIS from [3] relate, in extreme cases, to the first two phases of development and are, in fact, definitions of GISn. The definitions of GIS in [21; p. 16], [22; p. 13], [23] allow to depart from the definition of GIS in the narrow sense (GISn). However, Yang, et al. [18; p. 26] actually reduce geoinformation science (GIScience) to the use of a slightly extended set of geoinformation technologies. Unfortunately, this is not a mistake. We also suppose that geoinformation science has not yet been created, as, incidentally, cartographic science has not been created. There are also no serious arguments to consider GIS definitions that are different from GISn definitions satisfactory from the viewpoint of the new generation GIS – or from the GIS phase of usage [24].

We cannot provide a direct and complete argumentation for the absence of geoinformation or cartographic sciences. Let's just clarify that for [25], each science has the following components: 1) a domain of inquiry; 2) a body of knowledge regarding the domain; 3) a methodology (a coherent collection of methods) for the acquisition of new knowledge within the domain as well as utilization of the knowledge for dealing with problems relevant to the domain.

According to [26; p. 58], by theory we mean the "'rigid' representation that comes from classical logic and the theory of knowledge of the XX century. From this point of view, the **theory** *is a deductively organized set of judgments formulated in a closed system of concepts*. In other words, each theory in its exact (explicated) form should include at least the following components: basic undefined notions, derivative motions, axioms (postulates in terms of basic and derivative notions that are not derived within the framework of this theory) and theorems, ie, judgments derived by rules from certain axioms".

For partial argumentation of the lack of geoinformation and cartographic sciences, we use facts for a subset of their common domains of inquiries, bodies of knowledge regarding the domains and methodology for the acquisition of new knowledge within the domain. This subset is defined by the knowledge about Atlas GIS (AGIS) that can be obtained from the results of the monograph [2]. Since AGIS is a broader Atlas system (AtSb), the statements made in this monograph are valid, including statements about the absence (before the monograph [2]) of cartographic theory and statements about the presence of much weaker forms of scientific knowledge, which are generally called paradigms. Therefore, it can be argued that there are no geoinformation theories in the above understanding of Rozov V. [26] that could possibly be used for AGIS.

The following two examples allow for a better understanding of the above. In the monograph [2], relatively new mapping phenomena such as geo- or carto-platforms (the example is OpenStreetMap) have been analyzed. These platforms do not belong to the field of research in "classic" cartography, which is defined as "the art, science and technology of making and using maps" [27]. The same can be said about geoinformatics, which is defined, for example, as "science, technology and applied activities related to the collection, storage, processing, analysis and display of spatial data, as well as to the design, creation and use of GIS" [28]. The point here is the question of the geo-/carto- platforms themselves: are they GIS and if so, which one? Or maybe they are geo-information technologies used to create end-user GIS?

Another unclear example is the attempt to identify the geoinformation products of business firms. The monograph [2] outlines the products of MapInfo Corp.: mi-Aware (2003) and MapInfo Envinsa (2006). There these products are also called platforms. However, in the ESRI definition above, GIS is called "A framework to organize, communicate, and understand the science of our world". The term "framework" is not very clear here. Maybe the ESRI framework is a platform from former MapInfo Corp. And in general, to what definition of GIS does ESRI's definition apply?

To finish the description of the problem, let us refer to the article [29] and Abstract: “Many visions for geospatial technology have been advanced over the past half century. Initially researchers saw the handling of geospatial data as the major problem to be overcome. The vision of geographic information systems arose as an early international consensus. Later visions included spatial data infrastructure, Digital Earth, and a nervous system for the planet. With accelerating advances in information technology, a new vision is needed that reflects today’s focus on open and multimodal access, sharing, engagement, the Web, Big Data, artificial intelligence, and data science. We elaborate on the concept of geospatial infrastructure, and argue that it is essential if geospatial technology is to contribute to the solution of problems facing humanity”. In our opinion, the cited authors (by the way, very famous persons in the field of GIS) are talking about the same as we are: modern GIS is a new generation GIS, in which it is very important to use spatial data infrastructure (SDI) as one of the elements for the study territory.

The main method of our study is shown in the example of AGIS (Fig. 1.) The domain of inquiry is "large" territories in which spatial phenomena and processes are defined (Ph&Pr, which, when used in a GIS, are called domain/context). These are primarily the relational spaces defined in the studied territories or their corresponding spatial (territorial) systems, which also include the so-called spatial object systems (or models of Ph&Pr spatial entities), if Ph&Pr is some investigated spatial entity of reality. The "large" territories for us here are (for example, in Ukraine): country, oblast, community (modern association of several village councils, which are determined by the current COATOU), rayon or protected area. However, for territories smaller than the oblast, another additional integration territorial echelon (or tier/stratum) will have to be introduced.

The prerequisite of AGIS is the Electronic version of the National Atlas of Ukraine (ElNAU) [31] in broader sense (ElNAUb). The concept of "broader sense" comes from the fact that ElNAU, like any spatial information system (SpIS), is a specialization of IS, and IS in the broader sense is defined in [9]. In this case, the ElNAU, which was first produced on CD (ElNAU2000onCD) and then on DVD (ElNAU2007onDVD), is IS in a narrow sense [9] — ElNAUn. It turned out that the structure of ElNAUb is not arbitrary, but corresponds to the model, which, because of its repetitiveness in the "atlas" context, is called by the Conceptual Framework (CoFr) not only for ElNAU but also for all Atlas systems [2]. The structure of the AGIS on the example of ElNAU is shown (Fig. 2).

ElNAU Atlas GIS (AGIS) is a hierarchical integrated echeloned GIS or a system of spatial systems where the elements of each echelon (stratum) have the following meaning:

1. ωAGIS (Operational AGIS) is a set of (national) electronic atlases (EA) and other operational models. Examples of EA are ElNAU2007onDVD and a pilot version of ElNAU (ElNAU2000onCD), known as the Atlas of Ukraine [32]. An example of an operational model is the ElNAU2007onDVD master disk, which is used for producing the ElNAU2007onDVD circulation.

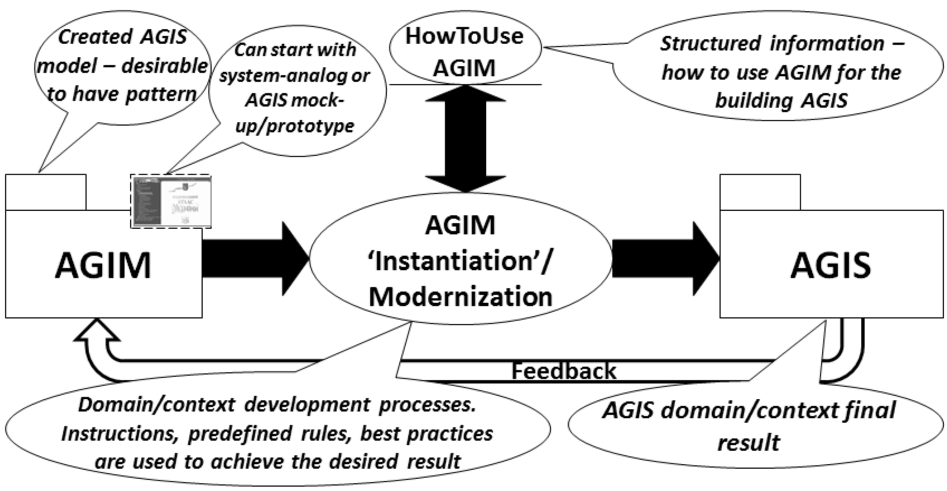

Fig. 1. The process of using AGIM to build AGIS in [30; Fig. 7.1]

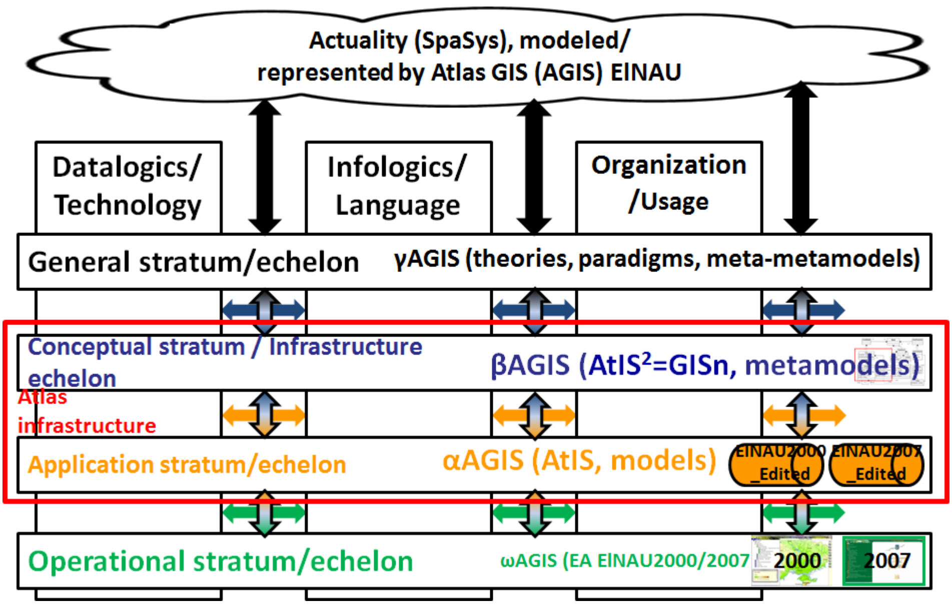

Fig. 2. Structure of the Atlas GIS on the example of ElNAU according to [30; Fig. 7.18]

2. αAGIS (Application AGIS) is a set of Atlas Information Systems (AtIS) and other application models. An example of AtIS is ElNAU2007_Edited, described in [2]. ElNAU2007_Edited is used by the developers of ElNAU2007onDVD to make the latter. An example of an application model is the AtlasSF (Atlas Solutions Framework). A description of the first and subsequent versions of AtlasSF (AtlasSF1.0, AtlasSF1.0+) is contained in [2].

3. βAGIS (Conceptual or Infrastructure AGIS) is a set of specialized GISn and other conceptual models (or application model metamodels). An example of such GIS is the internal ISGeo system, which is designated AtIS^2 and was used to develop and support EA and AtIS. An example of a metamodel is the GeoSF (GeoSolutions Framework). The standard version of GeoSF (GeoSF0) is described in [33], [34].

4. γAGIS (General AGIS) is a set of theories, paradigms, and meta-models that are used in the work with lower stratum/echelon elements. γAGIS refers to the most complex stratum/echelon of AGIS. It contains both theoretical and practical elements. An example of a theoretical element is the paradigm of Analytical Cartography [35]. Practical elements are often metamodels of conceptual models.

There are few important remarks according AGIS ElNAU shown in Fig. 2:

1. The notion of model and the relation between models/systems is quite complex. A *model* here is a simplification of a *system* built with an intended goal in mind. The model should be able to answer questions in place of the actual system [36]. We can use the record ωAGIS ► αAGIS ► βAGIS ► γAGIS ► SpaSys, keeping in mind that each relation ► is another very general "model-of" relation between the SpaSys spatial system and its models. Both the elements involved in the relation and the relation themselves need clarification. Thus, [37] distinguishes such varieties of models that are present in many shown in *Fig. 2* constructions: model-as-example (model), model-as-type, model-as-exemplar, model-as-mold.

2. The types of relations in [37]. The relations of these varieties are included in the sets of relations shown in Fig. 2 by vertical and horizontal two-way arrows:

- δ — **DecomposedIn**, **composite/part**. A *system* is very often defined as a complex set of more elementary parts. This relation represents the decomposition of systems in subsystems, and so on. For instance, the country Ukraine is a part of the planet Earth.
- μ — **RepresentationOf**, **model/sus**. A *model* is a representation of a *system under study* (sus for short). This relation is the key of modelling. Sometimes the distinction is made between specification models, which represent a system to be build and descriptive models that describe an existing system [38]. These associations could be introduced as specialization of μ if required.
- ε — **ElementOf, element/set**. This relation corresponds to the notion of set in the Set Theory. For instance, Ukraine is an element of the set of all countries.
- χ — **ConformsTo**, **metamodel/model**. This relation defines the notion of metamodel with respect to a model. A model must conform to its metamodel. In fact, χ is derived from the μ and ε.

3. The AGIS of ElNAU is called and is at present, in fact, a weak integrated system of systems or models, if the term "system" is left for the spatial system of reality, and all other structures are called models. Here we are implicitly using Model-Based Engineering (MBE, [39]). In MBE "everything is a model", and in systemology [25] "everything is a system". The concept of "weak integration" is introduced to encompass relation that exist in the IS in the broader sense but are not implemented in the IS in the narrow sense. For example, ELNAUonDVD(ωAGIS) χ▶ ElNAU_Edited(αAGIS), that matches the phrase "ElNAUonDVD conforms to ElNAU_Edited". This relation exists, but it is not implemented in any IS in the narrow sense. In other words, strong integration between systems is not implemented, so in real time (automated or dynamic) it is impossible to get one system from another — only by the developer manually. Moreover, the relation χ▶ in the above example does indeed consist of the relations μ▶ and ε▶, which further complicates the possible strong integration.

4. We pay attention to the captions Datalogics/Technology, Infologics/Language, Organization/Usage (Fig. 2). They denote, respectively, the Datalogical Level/Technological Context, the Infological Level/Language Context, the Organizational Level/World of Usage Context [2]. There are (horizontal) one-way transformation relation and reverse verification relations between the elements of these levels. We call these bilateral relations generically transformational.

5. It is necessary to emphasize additionally the necessity of using atlas models on the Operational (Electronic Atlases) and Application (Atlas Information Systems) Strata. These models somehow model real-world systems with multiple layers of maps. The preference is given to the so-called "layer" approach, when in the real world they are looking for explicit or hidden thematic fields. Compared with the more common object approach used in GIS, the layer approach greatly simplifies the model of the real system, while still being very powerful. Finally, it must take into account the fact that well-known geo- and/or carto- platforms (such as Google Maps, OpenStreetMap) have accustomed humanity to a layer approach, at least in map representation.

6. The internal nature of strata/echelons is disclosed in [40], as well as their importance and obligation for modern atlas systems. In particular, the relation between the elements of the neighboring strata is called epistemological. At the same time, the knowledge about the modeled spatial phenomenon is realized from the bottom-up — the higher the stratum, the more we know. In our case, the phenomenon is the sustainable development of the territory.

ElNAU2000onCD and ElNAU2007onDVD are AtSn of the classic static type. They were created in the first decade of the 21st century and earlier. In the second decade of the 21st century (and beyond), we need to consider AtS (AtSn), which we might call AtSn of the classic dynamic type. Non-classic type AtS (AtSn) are too early to consider because there is no relevant theory for this consideration. Therefore, the CoFr AtSn of the classical dynamic type can be obtained from Fig. 3 (additional explanations can be found in [2] and further).

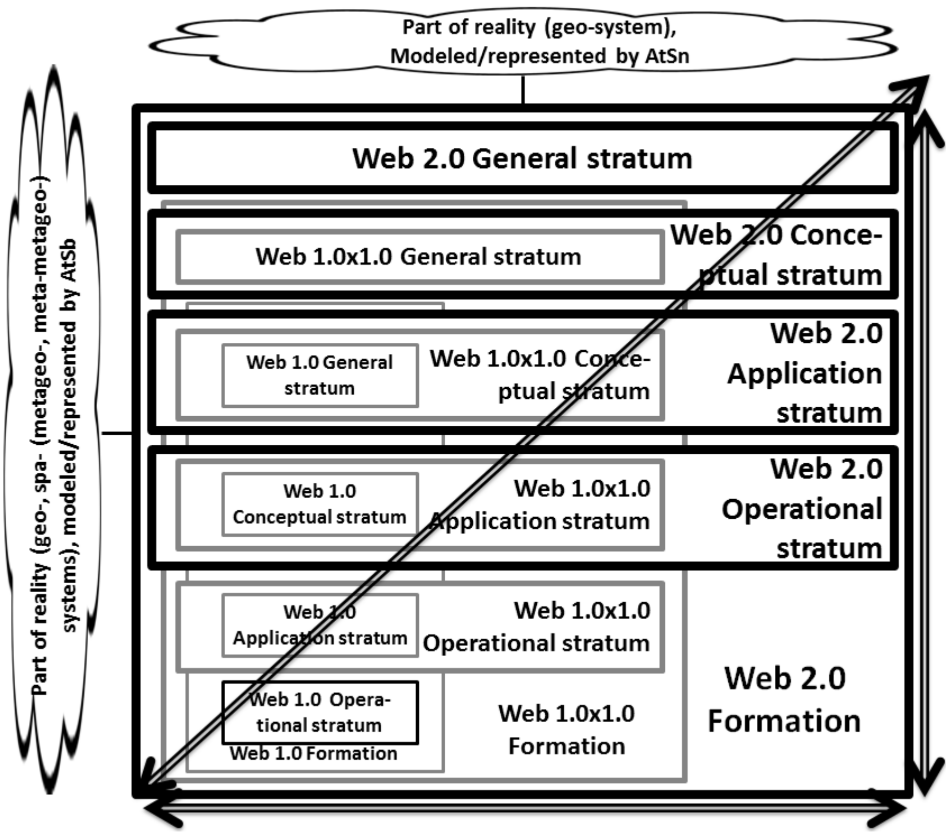

Fig. 3. Classic dynamic type AGIS (highlighted color)

Diagonal arrow in Fig. 3 shows the so-called evolutionary/devolutionary relation between classes of systems of different formations. Above we have used the term "AtS of the classic static type" to identify the class of AtS of Web 1.0 formation. The next evolutionary formation is called Web 1.0x1.0 (Web 1.0^2). It corresponds to the class "AtS of the classic dynamic type". Formation Web 2.0 has been poorly studied, so only the two previous formations are shown in green. However, elements of earlier formations are "embedded" into later formations. For example, the CoFr AtSn of the classic static type in the example of ElNAU (Fig. 2) corresponds to the Web 1.0 formation. Using Fig. 3, it is quite easy to get a representation CoFr AtS of the classic dynamic type. These five-stratum classic dynamic type CoFr (highlighted color in Fig. 3) are the AGIS models that are discussed below.

Horizontal arrows in Fig. 3 show the transformation/verification relations between the elements of the three levels: Datological, Infological and Organizational (Fig. 2). We will not stay on them further. The vertical arrows show the most important for us the epistemological/reduction relations between the elements of the four strata for the class of systems of fixed formation Web 1.0^2. We will stay on the interpretation of these relations in the consideration of AGIS further.

AN EXAMPLE OF A MODERN ATLAS GIS (AGIS)

The concept of AGIS was first introduced in a monograph [30]. It describes the concept and relation of AGIS with the Atlas geo-information model (AGIM). This relation is shown in the simplest (slightly modernized) form (Fig. 1), where, compared to [30; Fig. 7.1], material cultural heritage (CH) has been replaced with an arbitrary domain/context. In addition, the main result [30] is AGIM-CH, which can be a model of the system of sustainable development of the country in the terminology adapted to Ukraine [41].

The description of AGIS, stated above as the Critical property 5 (CP5) for GIS of large territory, begins with an example of AGIS hypothetical "large" territory (AGIS-LT, Fig. 4). The structure of AGIS-LT was developed using the method shown in Fig. 1. There, the ElNAU AtSn of classic static type (see the ElNAU image as the AGIM parameter in Fig. 1), was used as an initial model parameter. The initial model itself is an extension of the ElNAU to the ElNAUb (AtSb), which is shown in Fig. 2. Then, the evolutionary relation Web 1.0 $\nearrow$ Web 1.0^2 was used to obtain the modern structure now the AtSb of the classic dynamic type (Fig. 3). The final result of the method usage (Fig. 1) (referred to in [2] by the method of AtS Conceptual Frameworks) is shown in Fig. 4. In addition to the theoretical results from [30], during the Instantiation/Modernization of AGIM (Fig. 1), the practical experience of developing the pilot project of the AGIS Cultural heritage (AGIS-CH) was used [42]. In particular, the domain of inquiry of (physical) reality is replaced. Instead of (spatial system of) the entities of the material CH, spatial phenomena and processes of reality (Ph&Pr), which are studied under the jurisdiction of the organizational structure responsible for the territory, are shown.

Fig. 4 shows five echelons that are called strata from a system perspective. For a specific AGIS, there are three "own" echelons/strata on which there are spatial systems such as: AtIS, AtIS^2 and GIP (geoinformation platform). On the external Operational echelon EA is shown. On the external Infrastructure echelon, no SpIS are shown so as not to overload the figure with information that we do not need in this article. We hope it is easy to see that Fig. 4 corresponds to Fig. 2, and Fig. 3. The designation "GIP" is used for the Spatial Data Infrastructure (SDI), which shall exist on the Infrastructure echelon for each system of AGIS type. We did not use the term GISn here because the geoinformation platform term is better suited for this subject. Turning again to the analogy with the base map, we can say that in the Web 1.0^2 formation it is necessary not to use separate base maps, but platforms that have to dynamically connect to spatial systems of the lower echelons.

Other explanations for Fig. 4:

- Development is carried out by phases. The phases consist of stages. The green and red colors in the AGIS-LT rectangle indicate the elements that are proposed to be created in the first and second stages of the first phase, respectively.
- "SpaSys" means a Spatial system (SpS) or a Relational space of actuality modeled using AGIS-LT. In fact, this SpS includes systems of three "worlds": physical, abstract-physical, and abstract. The abstract-physical world is intended to describe the SpS that will/can be created in the form of computer systems.

The third arrow from the cloud "Actuality, ..., etc." top-down means that other information systems of Ukraine already created outside of AGIS-LT (spatial) information systems (usually referred to as UkrSys) may exist and be used. For example, these could be NCS (National cadaster system) or arbitrary AtIS (Atlas information system). This arrow also points to AGIM-LT (see below), which is an education-scientific component of AGIS-LT.

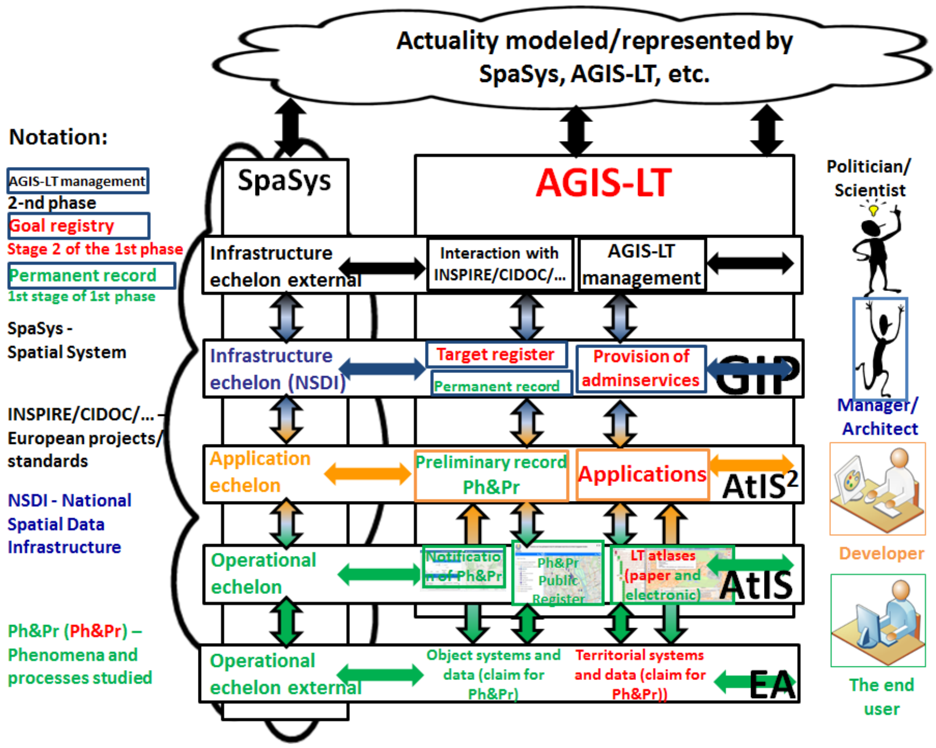

Fig. 4. Conceptual structure of AGIS-LT with the notations of the stages of the 1st phase and user echelons

"LT atlases (paper and electronic)" are shown outstanding beyond AGIS-LT, as may include second phase atlases. The atlases of the second and subsequent phases can be an essential element of the sustainable development systems of the region, which in this case is the territory domain of inquiry.

- The main elements of the second (and subsequent) phase of AGIS-LT are the "Interaction with INSPIRE/CIDOC/..." and "AGIS-LT management". INSPIRE is a well-known regional EU SDI [43]. The CIDOC Conceptual Reference Model [44] or CIDOC CRM provides an extended ontology for concepts and information in cultural and museum documentation. It is an international standard ISO 21127: 2014 [45]. "..." means that there are other European standards that should be determinative for AGIS-LT.

The first phase of AGIS-LT is the system of recording and protection of spatial phenomena and processes (Ph&Pr), managed by the responsible organization in accordance with its provisions. The first stage of the first phase of the AGIS creation project consists of those shown in Fig. 4 items (bottom-up):

1. "Object systems and data (claim for Ph&Pr)". The object is an information mapping of the Ph&Pr entity. This element is external to AGIS-LT. It is appropriate only if AGIS-LT makes significant use of AGIM-LT [30] and the latter includes the territory's SDI. It can be, in principle, any model of a separate spatial entity of the territory. The most popular such model is the use of the WGS84 coordinate system for spatial anchoring of the Ph&Pr. However, it is not yet known in this element whether the claimed substance is a phenomenon or a process to be studied by an organization in accordance with its provisions. Perhaps the entity of the object (original) in reality (actuality) is not a Ph&Pr at this time.
2. "Notification of Ph&Pr". The main difference between the "Ph&Pr notification" and the "claim for Ph&Pr" is that the notification is an element of AGIS-LT and is executed, in particular, on a datum controlled topographic map and corresponds to a known administrative-territorial division up to the address, if any. If there is electronic pre-recording or permanent recording, then the operator with verification permission practically immediately sets three options for what it is: 1) Ph&Pr is recorded, 2) Ph&Pr to be pre-recorded and dealt with later, 3) not Ph&Pr.
3. "Preliminary record of Ph&Pr". This is a set of CRUDL (Create, Read, Update, Delete, List) activities of electronic Preliminary recording of Ph&Pr. In the AGIS-CH pilot project, this is the Declaration module. It must maintain a Public register and ensure that the assets are permanently registered. It must be adapted for use in AGIS-LT.
4. "Permanent record". It is in fact a database of permanently registered Ph&Pr. To put it simply, only with such Ph&Pr can all other automatic AGIS-LT operations be performed and perform some automatic data conversion.
5. "Ph&Pr Public Register". It is currently characterized by the Public register of AGIS-CH and its website [46]. It should be noted that this Public register is an official "extract" from the Permanent record of the CH. In particular, it is designed to perform a protective function. Literally, any user must understand that Ph&Pr of the Public register are protected by a state (or organization managing the territory) and violation of that protection may result in sanctions.
6. Electronic Atlases of the territory. Here it is proposed to start AGIS-LT building by creation a dynamic, constantly updated electronic Atlas of the territory. This Atlas should be extended to AGIS-LT even in the first stage.

7. Applications1. In the 1st stage of the 1st phase this element can be geoinformation packages such as QGIS, MapInfo Pro, ArcGIS Pro.

The 2nd stage of the first phase consists of those shown in Fig. 4 items (bottom-up):

8. "Territorial systems and data (claim for Ph&Pr)". The layer is an informative reflection of the Ph&Pr field. In other words, this is still the same as "Object systems and data (claim for Ph&Pr)" with the substitution of entity/object for field/layer.

9. Provision of administrative services. Accepts different values depending on the domain/context. The responsible organization, for example, protects the "entities of the domain of inquiry" from the so-called "stalkers" in the case of the reserve or the protection of the entities of cultural heritage in the case of the organization of cultural protection. If a responsible organization exists, we can now determine the list of administrative services provided by the organization. In the future, this will include admin services related to the new vision of the territory management process, for example, scientific research from other institutions (both national and international) in the territory.

10. Atlases of the territory (paper and electronic). In the 2nd stage of the 1st phase, this element should be extended with both paper atlases and AtIS.

11. Applications 2. In the 2nd stage of the first phase, a set of applications should be implemented that realizes the basic functionality of the AGIS-LT for the Application echelon. In particular, these should be both functional and cartographic transformations of Infrastructure echelon data for use on the Operational echelon.

12. Target register. Considering the processes in Ukraine, this register should be attributed to the 2nd phase and further, as it is likely not to be created soon. First of all, we have in mind the Draft Law on National SDI, which was adopted as a basis in the first reading in 2019-Dec-04/05 [47]. A criticism of this Law is contained in [48], according to which the Law will not work for so-called protected areas (in INSPIRE terminology).

The Introduction lists all five properties of modern GIS that are called Critical (CP1–CP5) — those that, in the case of absence in resulting system, will be among the main reasons for the failure of a GIS project. At the same time [1] on the example of GIS previously created by abductive inferences, we proved the criticality of CP1-CP4 for the success of their implementation. In this article, we justify the Critical property five (CP5):

- In order to solve the problems of managing large territories in modern conditions it is necessary to create not GISn, but GISb and, in particular, AGIS.

To prove the criticality of CP5, deductive and / or inductive inferences based on theoretical constructs of Relational cartography are used [2]. In addition, the criticality of CP1-CP4 for AGIS and, thus, for modern GIS is further proved. Deductive and/or inductive reasoning is also used for proof. In general, AGIS is a modern vision of GIS that we define, describe conception (notion), and give an example of subject. Again, this vision is limited to such domain of inquiry: spatial phenomena and processes of "large" territory.

CRITICAL PROPERTY 1 (CP1) IN AGIS: EDUCATION-SCIENTIFIC, PRODUCTION AND MANAGEMENT COMPONENTS

The conceptual diagram of the AGIS-LT creation process is shown in Fig. 5. It corresponds to the general scheme shown in Fig. 1. Compared with Fig. 4, in the right part Fig. 5 shows the Atlas geoinformation model AGIM-LT, which consists of the GeoSF (GeoSolutions Framework), the AtlasSF (Atlas Solutions Framework) and Electronic atlases created with AtlasSF that can be used in AGIS-LT. For example: updated site/atlas of the Nature Reserve Fund (NRF1+ site, here is an example site for the Kyiv region), updating ElNAU to AtS of the classic dynamic type (ElNAU1.0+) etc. It should be noted that AGIM-LT on the one hand is a method of AtSn (or AGIS) CoFr, on the other — is a tool that is currently implemented as the so-called Atlas Extender (AtEx). Since some elements of AGIS-LT may already exist (for example, a topographic map of the territory), the creation of AGIS-LT can be called an extension of several "ordinary" Atlas and Geoinformation systems to GISb of special type — to AGIS-LT. AGIM-LT elements must be created BEFORE creating the appropriate AGIS-LT elements. In this sense, AGIM-LT is the education-scientific component of the AGIS-LT full version. This education-scientific component is not always shown in the diagrams, but it must always exist.

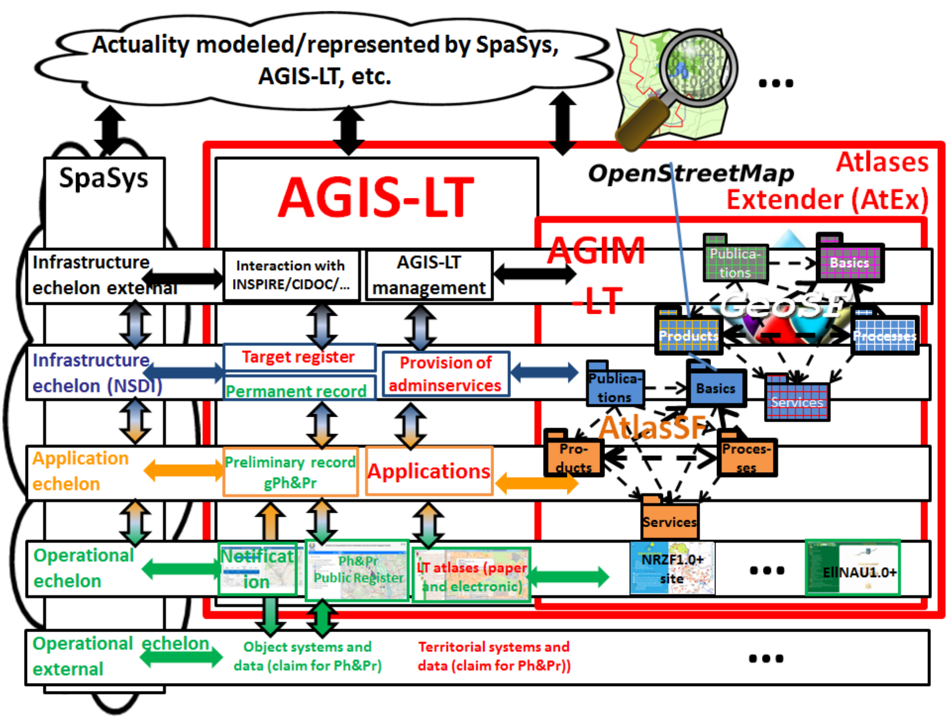

Fig. 5. Conceptual scheme of AGIS-LT creation

Production and management components are parts of AGIS-LT. Conditionally speaking, at the first phase the production component is the left-hand column of elements that implement the main process of recording and monitoring of the Ph&Pr state. It starts with the element "Notification" and ends with the "Target Register" element. The Target register should interact with the National Spatial Data Infrastructure (NSDI) and adapt the relevant European project materials. The management component is the right-hand column of elements that implement two management processes.

The first management process is the Ph&Pr protecting. It should be implemented first of all in the project of creation of an AGIS type system. The second process is called "AGIS-LT management", which is shown as a separate element in *Fig. 4* and *Fig. 5*. This process consists of many elements. They should be implemented at the second phase of the AGIS creation project, after implementation of at least permanent recording of Ph&Pr. The "AGIS-LT management" process is also covered in the next section.

CRITICAL PROPERTIES 2 (CP2 - ATLAS) AND 3 (CP3 - PORTAL) IN AGIS

Critical property 2 (CP2): Availability of an atlas solution (or Atlas system — AtS), relatively independent of other elements of the large territory GIS, which could work offline. The name of CP2 is not very good because it allows for several interpretations. In the form the "relative independence" of the atlas solution means that it must be able to work separately from the full AGIS. This means, in particular, that the atlas solution must work offline when the Internet connection is disconnected (or lost). When connected to the Internet, synchronization with the full AGIS must take place and the atlas solution should work online. In essence, "relative independence" has several meanings related to the essence of AGIS. Consider the options.

The answer, perhaps, to the main question is — why the ATLAS GIS. This adjective is included in the GIS class name due to the following chain of conclusions. The first is the claim that National Atlases (NA) are the simplest, most complete, well-known, and at the same time, sufficiently developed models of a country. The datalogical similarity of Ukraine and Switzerland NA was proved in [49]. Thus, there are similarities also between the NA of Ukraine versions, created at different times (for example, between ElNAU2000 and ElNAU2007). There is also a similarity between the NA of Ukraine and the model of sustainable development of Ukraine, which is determined by the Decree of the President of Ukraine №722/2019 “On the sustainable development Goals of Ukraine for the period up to 2030” [50]. This statement follows from the proof of the similarity between the NA of Ukraine and the balanced model of sustainable development of Ukraine [30], since the Decree №722/2019 model corresponds to the model of sustainable development in [41]. It follows that the maps of Ukraine's NA, such as the model of sustainable development, can correspond (model) to the indicators of sustainable development from [41].

Thanks to such transformations, the NA of Ukraine has the opportunity to "weigh" each "indicator", since it may correspond to some "indicator" map. We can get a numerical rating of each indicator map and this estimate will be uniform for all atlas maps. For a "zero" approximation of the estimate, it is possible to first "weigh" each map by one number. From individual map estimates we can get a numerical estimate of the atlas as a whole. This assessment will be an assessment of the level of sustainable development of the country at the time the atlas was created. Thus, a relatively independent atlas solution in AGIS is required in order to be able to obtain an estimate of the level of sustainable development at this point in time.

An atlas solution of the AGIS Operational stratum is not enough for normal operation. In order to be able to analyze both structural and thematic indicators of the AtIS of the Operational stratum, it is necessary to have an AtIS of the Application stratum, which will be dynamic for the AtIS of the Operational stratum. In Fig. 4 $AtIS^2$=AtISxAtIS was used to designate the AtIS Application stratum. This means that we can change all the components of the AtIS of Operational stratum while remaining, however, in the same class of AtIS. For example, we can change the structure of an AtIS contents tree and move a map from one section to another if the map theme belongs to a new section. We may, for example, change the method of classifying a choropleth map if the new method allows us to better model the field of a spatial phenomenon or process from reality. Spatial information systems of Conceptual stratum are also needed, among them GIP is important (Fig. 4).

In choosing the best option for prioritizing AGIS over blocks of sustainable development, two fairly obvious theses were used, which in mathematics are called theses "from the opposite":

1. All 17 sustainable development goals cannot be simultaneously achieved [41], although their achievement should improve the economic, social and environmental aspects of Ukraine as part of humanity and our planet. Moreover, it is not possible to reach at the same time about 300 indicators [41], which measure the progress of the 17 target areas.

2. Most of these indicators in [41] are in one way or another related to economic aspects. Given the real economic situation of Ukraine, these indicators cannot be prioritized.

However, if you follow these two theses, then what? We will analyze several options to optimize [41] for Ukraine. The remaining options are shown in *Fig. 6*.

Each of the selected options should be a multigoal-oriented system according to [25]. We will not build here a generalization of AGIS using the G. Klir apparatus. However, with the application of generalization, it is possible to create a whole-directional AGIS, which will consist of three elements: generating, seeking and implementing of the goal. The goal seeking element can be formed by the culture indicators. For this purpose, [41] proposed to extend by the indicators of culture [30]. The number of these indicators will be relatively small, but they will determine the characteristics and limitations of achieving the goal. All other indicators will form a goal implementation element. AGIS will be applied and developed iteratively, most likely in years. During each iteration, the main steps of the empirical study, which are shown on Fig. 7.

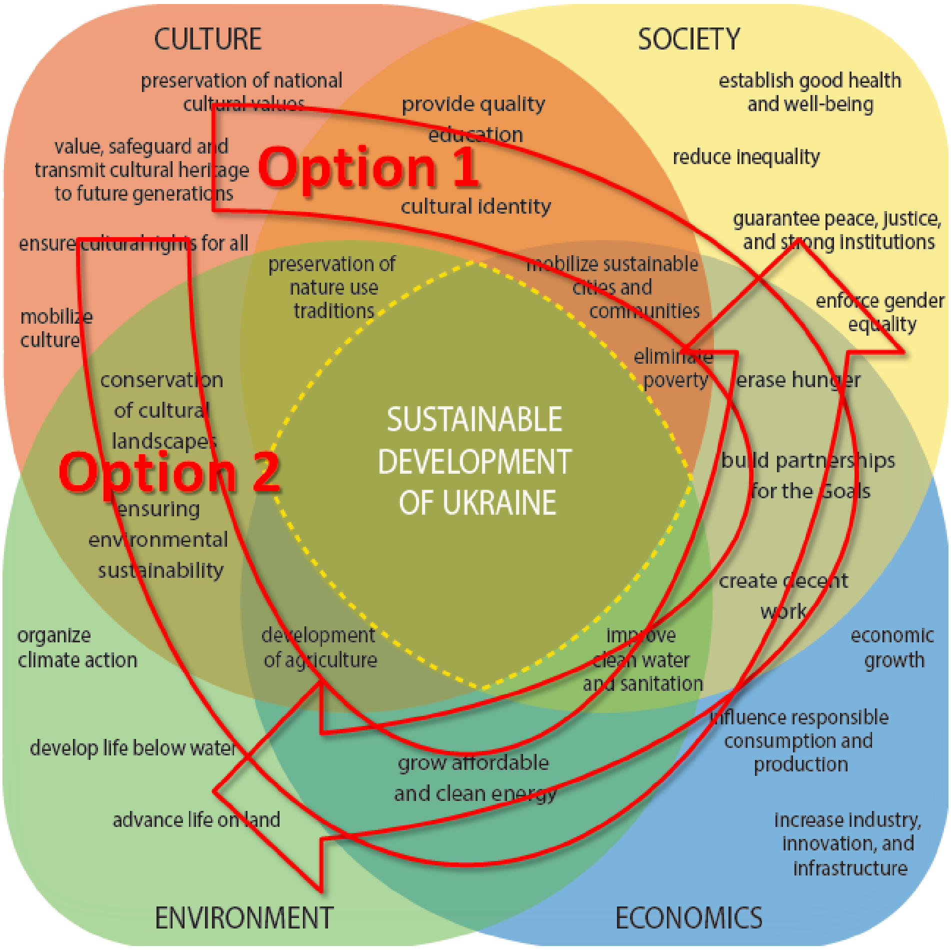

Fig. 6. Two main options for optimal achievement of goals [41] in Ukraine

It should be said that the approach described above is not so unique. We use works [51], [52], [53] and others for arguments of this statement. We cannot focus on the differences between the two approaches. If we consider the similarities of approaches, then we should point to Fig. 8. There are quite obvious analogies between Inventory Fig. 8 and elements of Inventory echelon Fig. 4, between the Spatial analysis Fig. 8 and the elements of the Application echelon Fig. 4. The analogy between Decision making is a little less obvious and the elements of the Operational echelon Fig. 4, Management Fig. 8 and the elements of the AGIS-LT management.

In conclusion CP2 analysis we make three important notes:

1. At the beginning of the CP2 analysis we have described in fact the main steps of empirical research with the help of the AtIS Operational and then the Application strata, and so it is possible to continue further with the elements of the Conceptual stratum.

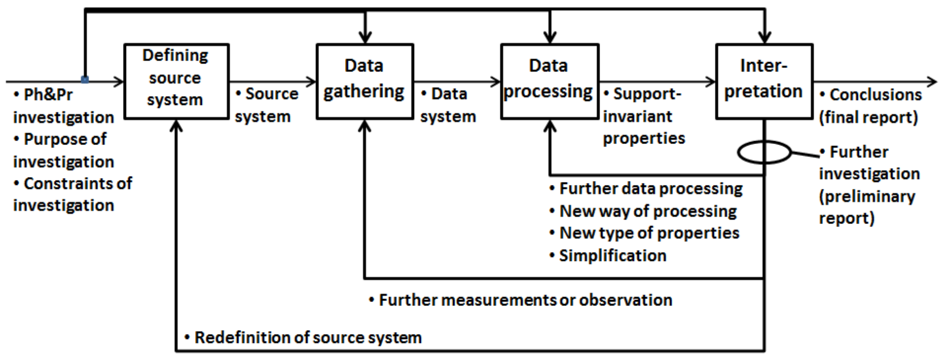

Fig. 7. Main stages of empirical research on Ph&Pr using AGIS [25]

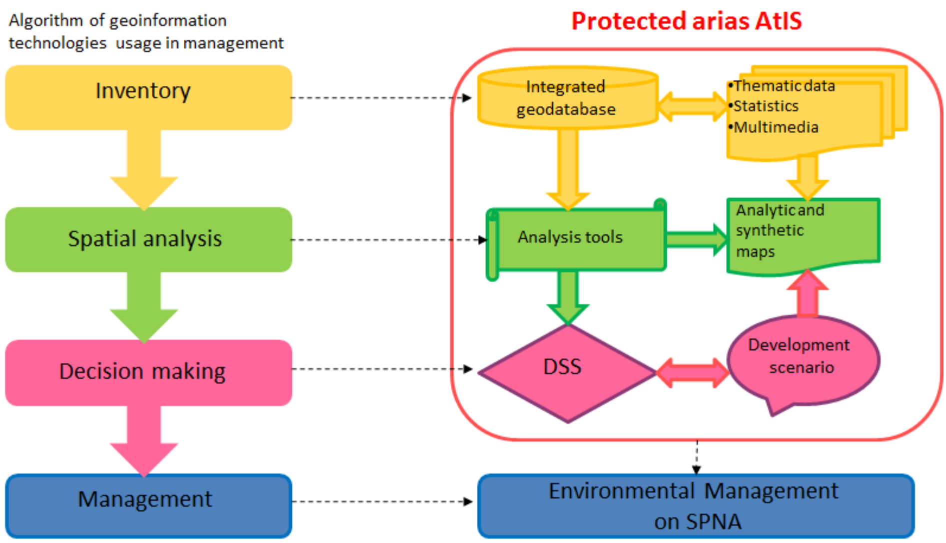

Fig. 8. Conceptual diagram of the sustainable development AtIS in [53; Fig. 9]. DSS — Decision Support System

2. The process of managing the sustainable development of a large territory that is a country is described. This is obviously the case for the unification of countries, which is the Russian Federation. This is also true of any other large territory. This is because no one will argue that the territory of Ukraine, the protected area or the territory of the community must be constantly developed. Perhaps, in this case, only the AGIS-LT model will be simpler than the model [41].

3. We consider the criticality of the atlas solution to be proven for any modern GIS of large territory management.

Critical property 3 (CP3): Portal as a means of building GIS in some broader sense (GISb) with GIS in the narrow sense (GISn) and other elements, as well as to provide on-line teamwork with all elements-systems. At the end of the first — at the beginning of the second decade, a project was underway in the Netherlands, which is appropriate to call the "National Atlas of the Netherlands as a metaphor for the National SDI". This name derives from the title of the thesis [54]. To explain the term "metaphor" in the context used [54] indicates that designers have long used metaphorical references in user interfaces to facilitate the understanding and use of content by the latter. Moreover, familiarity and understandability of the original content are critical when choosing a new metaphor. And users in many countries are familiar with atlases because they are most likely to use them in high school.

The following substantiates the idea [55; p. 29] that the map is a metaphor in its own right, because with the help of the map the cartographers suggest that the reader believes that points, lines and polygons located on paper (or on the screen) are equivalent to a multidimensional world in space and time. However, to fully understand this view, readers should refer directly to the reflected real world. Following the dissertation [54], several articles [55], [56] etc. were published. They focused on the identified phenomenon — ElNAN as a metaphor for the Netherlands NSDI. What is important to us is the argument that the authors of this phenomenon used to prove the need to use National atlases in conjunction with NSDI.

In the context of this article, perhaps the first article on the subject should not be forgotten [57], which states that in some countries the use of portals to search for geospatial data sets was the result of the implementation of Spatial Geodata Infrastructures (SGI). The authors of the article cited highlighted two disadvantages of existing portals: inappropriate navigation tools and a lack of supports for users' understanding. Therefore, the article proposes a new approach to developing portals using atlases as metaphors. It allows you to use the atlas not only to access a set of thematic maps, but also to find sets of data.

«Within the atlas, an information structure plays an important role in organizing the content. Metadata published by providers are incorporated into this structure as metadata summaries. Based upon the topical relevancy of the data, each metadata summary is linked to a specific map within a particular topic. These summaries can be represented as symbols to support discovery tasks, either loosely or strictly defined. Browsing can be used to deal with the first via navigations and map interfaces. Searching can be used to deal with the second via explorer and search presentation interfaces…».

In the previous citation the usage of the portals (geoportals), in particular for SDI, was taken for granted. However, it should be noted that the issue of geoportals was discussed in detail, a year or two before. For example, the first issue of Computers, Environment and Urban Systems in 2005 was devoted to the issue of geoportals. The articles of the issue described both the causes and the main features of geoportals.

Among the reasons for the emergence of geoportals were the following: 1) "maturing" of GIS — the transition from GIS of individual groups to corporate, 2) implementation of National SDI, 3) the need to use geoinformatics in electronic governance, 4) the development of information technologies.

Among the main features of geoportals were: 1) organization of content and services such as directories, search tools, community information, support resources, access to data and applications, 2) direct access to application services and metadata records from regular on-line GIS applications, 3) development of elements of service-oriented software architectures.

Thus, the appearance of CP3 in the created by us GIS of large territories, is hardly to say a coincidence. Full confirmation of the criticality of CP3 is provided in the sources cited above.

CRITICAL PROPERTIES 4 (CP4 – SOLUTIONS FRAMEWORK) AND 5 (CP5 – CONCEPTUAL FRAMEWORK) IN AGIS

In this section, we first present the conceptual structure of AGIS class system (Fig. 9), which summarizes all that has been said before, and also includes the CP4 — Solutions Framework (SoFr). Two SoFr — AtlasSF and GeoSF — are shown in Fig. 5. The more correct entries are αAGIM (AtlasSF, …) and βAGIM (GeoSF, …), since both αAGIM and βAGIM consist of a much larger number of application and conceptual SoFr, respectively. We have only shown SoFr that have already been created and used in any version. These SoFr may be enough for beginning the realization of some AGIS. In addition, there are also operational and general SoFr. At the same time, Fig. 5 shows us that each SoFr "works" between the elements of two adjacent strata, with the main triad of SoFr being Products-Processes-Basics(Products, Processes), and the usage of SoFr is always performed from the elements of the epistemically higher to the lower strata.

GeoSF SoFr is derived from ProSF (Project Solutions Framework) SoFr. ProSF was used in [1] to formulate CP4. It describes the use of ProSF SoFr for three projects of the so-called French-German Chornobyl Initiative (FGI). At the beginning of the first decade of the 21st century, we found that the activities of geoinformation enterprises (geo-enterprises) could be divided into project and everyday activities. In order to put NSDI into practice in Ukrainian geo-enterprises, we have adapted ProSF to GeoSF. GeoSF SoFr (standard version — GeoSF0) was implemented as a portal intended for introduction into business processes of the geo-enterprise.

Let's explain the abbreviations of the “2-dim AGISb” elements on Fig. 9:

- The letters D, I, U from above indicate the levels: D — Datalogics, I — Infologics, U — Usagelogics. The letters G, C, A, O on the right indicate the strata: G — General, C — Conceptual, A — Application, O — Operational.
- XYM, where X = D, I, U; Y = G, C, A, O; stands for XY M(odel). For example, DCM stands for Datalogical (D) Conceptual (C) Model (M).
- The structure of “2-dim AGISb” corresponds to the structure of the Conceptual Framework (CoFr) of Relational cartography [2].
- There are two meanings of M: AGIS and AGIM. Between AGIS and AGIM there exists relation χ (conformsTo).

Unfortunately, Fig. 9 is very ambiguous, but we haven't prepared better yet. The ambiguities (not all) are:

- If we replace the value M=AGIS with M=AGIM, then we will have the same conceptual structure, but for the AGIM model.
- The entry AGISχ▶AGIM means that this relation is valid also between the corresponding elements of both structures. That is, an AtCχ▶AtlasSF record is valid. This entry corresponds to the general scheme of Fig. 1. Moreover, AtS can be created using AtlasSF.
- Atlas general systems on the right reflect the results of [58] usage. These results, in particular, argue that, in addition to modeling Object stratum models, the success of an AtIS or GIS creation project must necessarily metamodel and create metamodels. These metaprocesses and metaproducts are elements of the aforementioned higher metasystem of metaAtIS or metaGIS and, at the same time, Metastratum.

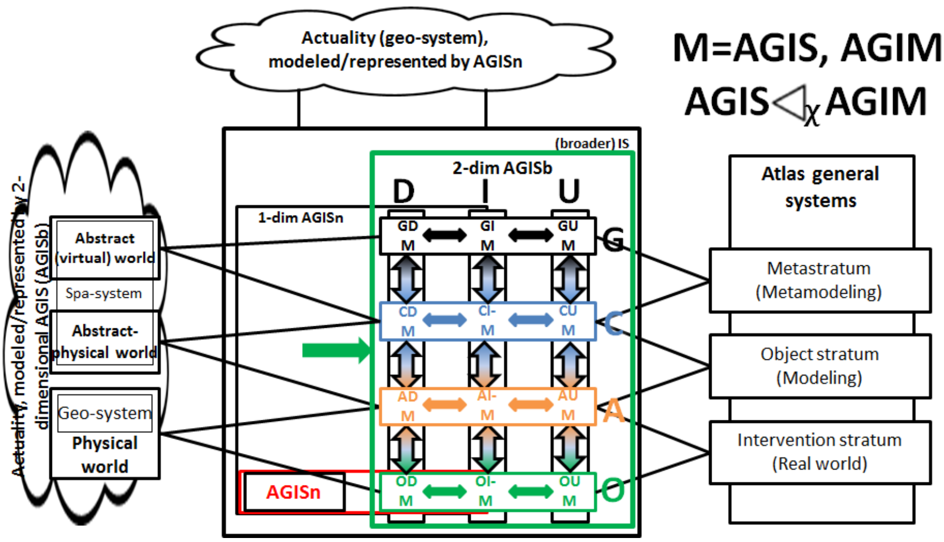

Fig. 9. Conceptual structure of AGIS class systems

- Writing AGISn in a red rectangle and a green arrow from one-dimensional to two-dimensional IS means that the former can be converted to the second.

Better to describe CP4 and CP5 we are not able due to the limited size of the article. Additional evidence for the validity of SoFr and CoFr for a large range of spatial systems is contained in a monograph [2]. This range of systems includes AGIS, as these systems are considered in the monograph as AtS (AtSb) class .

CONCLUSIONS

Above, in addition to the abductive reasoning of the [1], inductive and/or deductive reasoning about the validity of the Critical properties (CP) of CP1–CP4 in modern GIS of large territories are given. The validity of CP5 is also given. In the absence of one of the CP1–CP5 properties, we can speak about the corresponding critical disadvantage of the project of creating GIS over a large territory. The criticality is that in the absence of a suitable property, the GIS project is likely to be a failure.

Due to the formulation and proof of CP1–CP5, we believe that: 1) the term “Atlas geoinformation system” (AGIS) is defined as a GIS of large new-generation territories, 2) the conception of AGIS is described, 3) an example of AGIS of a certain class is given. We believe that practitioners will use the results of this article to create GIS of large territories. Theorists will also gain a better understanding of the next generation of geoinformatics research that would meet the demands of today. With this understanding it will be possible to create a geoinformation theory that will correspond to a "rigid" view of it in [21, p. 58].

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КРИТИЧНО ВАЖЛИВІ ВЛАСТИВОСТІ СУЧАСНИХ ГЕОІНФОРМАЦІЙНИХ СИСТЕМ ДЛЯ КЕРУВАННЯ ТЕРИТОРІЯМИ

Вступ. Питання дефініції «геоінформаційної системи» (ГІС) є важливим як для теорії, так і для практики створення сучасних ГІС великих територій. Аналіз останніх досліджень показав, що більшість загальнодоступних наразі означень ГІС не відповідають потребам сучасних територіальних ГІС.

Метою статті є доведення твердження, що для керування територіями у сучасних умовах мають використовуватися не ГІС у «вузькому» розумінні, а ГІС деякого нового покоління, зокрема, ГІС у «розширеному» розумінні, наприклад, Атласні геоінформаційні системі (АГІС), які відповідають певній наперед визначеній структурі — Концептуальному каркасу Реляційної картографії.

Результати. Визначено термін «Атласна геоінформаційна система» як ГІС великих територій нового покоління. Описано концепцію Атласної геоінформаційної системи (АГІС). Наведено приклад АГІС визначеного класу. Вважаємо, що практики будуть використовувати результати цієї статті у створенні ГІС великих територій. Теоретики отримають краще розуміння галузі досліджень геоінформатики нового покоління, яке задовольнятиме вимоги сучасності.

Висновки. Наведено індуктивні та/або дедуктивні умовиводи щодо справедливості основних визначених критичних властивостей в сучасних ГІС великих територій. За відсутністю однієї з таких властивостей можемо говорити про відповідний критичний недолік проекту створення ГІС великої території. Критичність полягає в тому, що у разі відсутності відповідної властивості проєкт створення такої ГІС найімовірніше буде провальним.

Ключові слова: *геоінформаційна система, керування територіями, Концептуальний каркас, Каркаси рішень, критична властивість.*