НАУКИ ПРО ЗЕМЛЮ. ГЕОІНФОРМАЦІЙНІ ТЕХНОЛОГІЇ МОДЕЛЮВАННЯ СТАНУ ГЕОСИСТЕМ

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UPDATE OF THE ATLAS SYSTEMS CONCEPTUAL FRAMEWORK

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Abstract. *Over the past ten years, the Conceptual Framework with the necessary changes has been repeatedly used in projects to create various Electronic Atlases, including the Electronic version of the National Atlas of Ukraine (ElNAU), Atlas Information Systems, and even GeoInformation Systems. At the same time, both practical tools and theoretical methods changed and evoluted. Both practical and theoretical activities continue and are very actual today. However, there was no separate publication on the current state of the Conceptual Framework of subject X, where X would assume the meaning of modern systems. In order to improve, expand and simplify its practical and theoretical usages, it is necessary to fix the main updates of the entire structure: both the Conceptual Framework itself, and the subject X, to which it is appropriate to apply it. Therefore, instead of the subject X = ElNAU, subjects-systems from the set AtS = {Atlas Systems} ∋ X are considered, and the Conceptual Framework itself is presented as a system method corresponding to the system approach, with an emphasis on design, although the Conceptual Framework can also be used for the study of systems, i.e. be a research method. Over ten years, the Conceptual Framework of subject X has become a rather extensive phenomenon, which forced us to stop only at the main (at least for us) updates..*

Key words: *Atlas Systems (AtS), Conceptual Framework of AtS, Atlas infrastructure, AtS in the broder sense (AtSb).*

Introduction

Formulation of the problem

Alexander [1] gave the following definition: "A pattern is, in short, both a thing that happens in the world and a rule that indicates how to create this thing and when it should be created. It is both a process and a thing; it is both a description of a real thing and a description of the process that produces that thing." The specified definition allows to explain the main problems of the article: 1) the thing - what should the Atlas System (AtS) be, so that in a fixed context it is ensured its low-problem creation, maintenance of operation and evolution?; 2) process – what should the relevant processes be? Thus, the pattern called "Conceptual (Notional) Framework of (thing, subject) X" simultaneously describes both the thing X (subject, product) that needs to be created, and the process of its use to create, maintain the operation and evolve of X.

In 2014, the specified problems were considered using the example of the project "Electronic version of the National Atlas of Ukraine (ElNAU)" [2]. The latter was carried out with varying intensity for almost 10 years: from 1999 to 2008 and ended with the release of three mass editions of ElNAU, labeled ElNAU2000 or ElNAUonCD; ElNAU2007 or ElNAU2007onDVD, ElNAU2010 or ElNAU2010onDVD; together ElNAU2007/2010. In addition to these end-user products, an Atlas infrastructure created, which had to function for a long time in the conditions of changes in Information Technology (IT) and ensure the creation, maintenance of operation and evolution of a family of atlases. If we represent the Atlas infrastructure as an information system in the broader sense, then we will deal with the architecture best described by the ElNAU Conceptual Framework.

Nowadays, a new generation of AtS is being created. Among them are Systemic Electronic Atlases [3] and Atlas GeoInformation Systems [4]. The Conceptual Framework is also valid for them, but now the Atlas Systems.

Problems: Is it possible to fix patterns (among those found) that would simplify the creation of Atlas systems, which include "classic" AtS: Electronic Atlases and Atlas Information Systems; "non-classic" AtS: Systemic Electronic Atlases and Atlas GeoInformation Systems; and which would provide maintenance of operation and evolution of all these AtS. As of 2024, such "systemic" patterns as the ElNAU Conceptual Framework, the GeoSolutions Framework GeoSF, as well as other component patterns, which we know as Solutions Frameworks (SoFr), have found. We called the possible solutions to the problems "Conceptual (Notional) Framework (thing, subject) X", where X takes on the values we need. Note that subject X includes not only the known "classic" AtS, but also the so-called "non-classic" AtS. A well-described example of a non-classic AtS is the Atlas GeoInformation System (AGIS).

Connection with important practical and scientific tasks

The architecture of the Atlas infrastructure and its Conceptual Framework should help solve the following tasks:

1) how to restore the functionality of the ElNAU2000 Electronic Atlas, developed on IT that is not always functional today,

2) how to ensure the long-term viability of ElNAU2000 and El-

NAU2007/2010 in conditions where IT change very quickly,

3) how to update ElNAU2007/2010 without spending significant efforts,

4) how to use the experience of ElNAU2000 and ElNAU2007/2010 developing when developing new atlases, for example, the Atlas of Emergency Situations [5] and/or the Atlas of the Population of Ukraine and its Natural and Cultural Heritage (APN&CH, [6]).

5) is it possible and how to use the Conceptual Framework for scientific researches, in particular, for the classification of actual concepts and paradigms of cartography.

Analysis of recent researches and publications related to the problem

Let's focus on three groups of researches and publications interested for us. The first group mentioned in the article of 2014. It indicated a fairly large number of publications on the topic of the National Atlas of Ukraine (NAU) and its electronic version (ElNAU), for example: [7], [8], [5], [9]. At the same time, there is impression that all of them reflect separate, insufficiently agreed viewpoints on NAU and ElNAU. The problem complicated by the fact that the main work on the creation of NAU and ElNAU performed and/or organized by three leading organizations headed by the Institute of Geography. Therefore, it is quite easy to distinguish, at least, three viewpoints: geographic (Institute of Geography of the National Academy of Sciences), cartographic (State Scientific and Production Enterprise «Kartographia») and cybernetic (“Intelligence Systems-GEO”, LLC). The need to coordinate these viewpoints of among themselves was obvious.

Let's add the problems of producing several versions of ElNAU, as well as other atlases with variable topics. An example of such an atlas is the Radioactive Pollution Atlas of Ukraine (RadAtlas), which was published 4 times in 2002, 2008, 2011, 2014 in two variants - paper and electronic, in two languages - English and Ukrainian. The structure and content of these publications are consistent and complementary [10; p. 36]. We wrote about RadAtlas back in 2002 [11], which described the use of its "technology" in the TACIS project "Solving issues of territory rehabilitation and secondary medical consequences of the Chernobyl disaster" ENVREG9602.

The second group includes researches and publications on the solution of a similar problem by other researchers. Here we include the activities carried out by producers of either a series of atlases or several atlases with different themes. What is interesting here is the evolution of Swiss researchers, who produced several versions of the Atlas of Switzerland and came up with the concept of the Atlas Platform - "The SwissAtlasPlatform Project" [12]. By the way, in work [13] a comparison of ElNAU and Atlas of Switzerland made, where their datalogical or technological similarity proved. This means that different researchers in similar conditions find similar "meta-atlas" datalogical solutions, called Platforms, Frameworks, or something similar. It is also confirmed by the works of "cyber cartographers", who even produced the freely available Atlas Framework [14]. And it despite the fact that "cyber-cartographic" atlases belong, most likely, to "non-classic" than to "classic" AtS.

The third group includes publications about the Conceptual Framework

itself. Here it is advisable to start with the web page "Definition of the Conceptual Framework" [15]. The specified page contains answers to such questions as "What is it? What does it do? What should be in it? There are also links to interesting articles. The given Internet source quite correctly reflects the directions of understanding the Conceptual Framework of Atlas Systems. In addition to the articles recommended by the web page, it is advisable to familiarize yourself with the monograph [16] and, if necessary, with the literature used in it, which is quite extensive.

Task statement

The task of the article is to update the results of 2014 on the ElNAU Conceptual Framework, which consists in: 1) expanding the understanding of the notion of "Conceptual Framework", 2) generalizing the subject of usage of the Conceptual Framework - ElNAU - elements of the class of so-called "classic" Atlas Systems, 3) providing of the modern structure of the Conceptual Framework of "classic" Atlas Systems, 4) updating the approach to researching the concept of "Atlas Infrastructure", 5) developing concepts of its "correct" organization, usage the obtained approach and concepts to the development of the architecture of the Atlas infrastructure of classic and non-classic Atlas Systems.

Materials and Research methods

The research materials are the final and intermediate variants of the Electronic version of the National Atlas of Ukraine (ElNAU), “associated” Electronic Atlases (EA), as well as the Atlas Infrastructure. The final version is called a DVD with the content of ElNAU, which was reproduced in 2007 and 2010. The intermediate variants are the logical and operational parts of ElNAU that were produced during the implementation of the NAU project in 1999-2008. Other EAs corresponding to the Conceptual Framework are called associated. An example of such an associated EA is the RadAtlas – EA of radiation contamination of Ukraine as a result of the accident at the Chornobyl nuclear power plant in 1986. In total, about twenty such EAs were produced since 1999. Atlas infrastructure is a complex of interconnected service structures created by the developer, which make up and/or provide the basis for creating, maintaining the functionality, and updating the EAs that are being operated.

An abductive method based on significant practical experience used to create/find the first Conceptual Frameworks (for ElNAU). This method partially used in this article. In addition, inductive method used to substantiate the following Conceptual Frameworks (for other EAs). It partially used in this article as well.

Updating the structure of the Conceptual Framework and the notion of the subject of its usage

The Conceptual Framework was used "consciously" to all Spatial Information Systems (SpIS) created by us in the last ten years, and "unconsciously" - during the last almost thirty years of our professional activity. Usages that take into account what published in the 2014 article called "conscious". "Unconscious" called usages without direct mention of the results of the 2014 article. For example, starting with the

publication of the article [17]. After all, the 2014 article only recorded knowledge about the Conceptual Framework, which had been accumulated and used for several years before the publication of the article. In particular, in the article [17] it was said that the task of creating a specific National GIS (NGIS) of Ukraine should be replaced by the task of developing the NGIS class in the context of NSDI. And the NGIS class (NSDI system) is described by the NGIS Conceptual Framework, although it was not mentioned at the time. In addition, at the turn of the millennium, we discovered the so-called Solutions Framework (SoFr) of subject X, the "post-strategic" implementations of which "entered" as constituent parts of the implementation of the Conceptual Framework of the same subject X. The Solutions Framework of the projects of the Franco-German Chernobyl Initiative in English is described in works [18], [19], moreover, both as a method and as a portal tool.

In article [17], the "top" of the NGIS is defined as its management part. After the analysis of possible options, this management part was assigned to the elements of the class of Automated Cartographic Systems (ACS) of NGIS, or in modern terminology - Atlas Information Systems (AtIS) of NGIS. AtIS (or EA) ElNAU is just such a system. The similarity of the expected AtIS NGIS and AtIS ElNAU follows from the work [13].

Further, the designation SpIS is used as a unit for "classic": Electronic Atlases (EA), Atlas Information Systems (AtIS), Cartographic Information Systems (CIS), and Geographic Information Systems (GIS), as well as for "non-classic" AtS. According to [20], they are called SpIS in the narrow sense and are denoted SpISn or EAn, AtISn, CISn, GISn, and AtSn. We call, in particular, the experience of the project of first creating (2008-2009), and then maintaining of operation (2009-2022) of the GIS "Analytical Information System (AIS) MTS" (now - Vodafone Ukraine) as an unconscious usages of the Conceptual Framework.

In addition, the concept of Atlas infrastructure was introduced in the article [2]. With minor changes, it was defined as follows. Atlas infrastructure (lat. Infra - "below", "under" and lat. Structura - "building", "placement") - A complex of interconnected service structures that make up and/or provide a basis for solving a problem (task) - creating, maintenance of operations, renewal of EAn that are in operation. In the ElNAU project, these were such EAn as ElNAU2000 (ElNAUonCD) and ElNAU2007/2010 (ElNAUonDVD) [9], although these can be arbitrary AtSn. Atlas infrastructure can be understood as an information system in the broader sense (ISb), namely, as "a set of all formal and informal representations of data and actions with them in the organization, including the exchange associated with the first and second (both internal and with the outside world)" [20].

The notion of ISb turned out to be very useful. It made it possible to bring the practical constructions that we used, but which went beyond the understanding of a separate end-user product - SpISn, to familiar notions from informatics. Now they can be called SpISb, if the concept of SpISn is fixed. For example, in the ElNAU project, several ElNAU end-user products (ElNAU2000, ElNAU2007/2010) and the ElNAU Project Infrastructure were created. Therefore, we can write the symbolic equation ElNAUb=ElNAUn+ElNAU infrastructure. This equation

is true for all the SpISn that we have created over the past decades. Thanks to him, the designations EAb, AtISb, CISb, GISb and, finally, AtSb, make sense. For this, it is sufficient to change ElNAU to EA, AtIS, CIS, GIS or AtS in the given equation.

Conceptual Framework of ElNAU in 2014

The Conceptual Framework of ElNAU in the article [2] was presented by Fig. 1. Constructions and/or packages of the Conceptual Framework of ElNAU (ElNAU CoFr), shown on Fig. 1, described below. Compared to the original [2], the description has made small changes:

1. Datalogic and Infologic levels of Operational and Application Strata of ElNAU were defined and described in detail in paragraphs Conceptualization of cartographic software and information provision of ElNAU.

2. Organizational level / Usage world of Operational stratum of ElNAU. Some of the materialized elements of this package are included in ElNAUonDVD. In addition to materialized elements, there are such intangible phenomena as, for example, the skills (qualification) of users working with ElNAU. Of course, skills cannot be included in ElNAUonDVD. Individuals and legal entities working with ElNAU are also somehow related to this level.

3. Organizational level / Usage world of Application stratum of ElNAU generalize and extend the package of elements of a similar level of the Operational stratum.

4. Datalogic level of Conceptual stratum of ElNAU. One of the groups of elements of this package is part of MapInfo Corp. geotechnologies. Other geotechnologies used in the ElNAU project: the isgeoMapSS Software Suite produced by the "Intelligence Systems-GEO" (ISGeo) company and

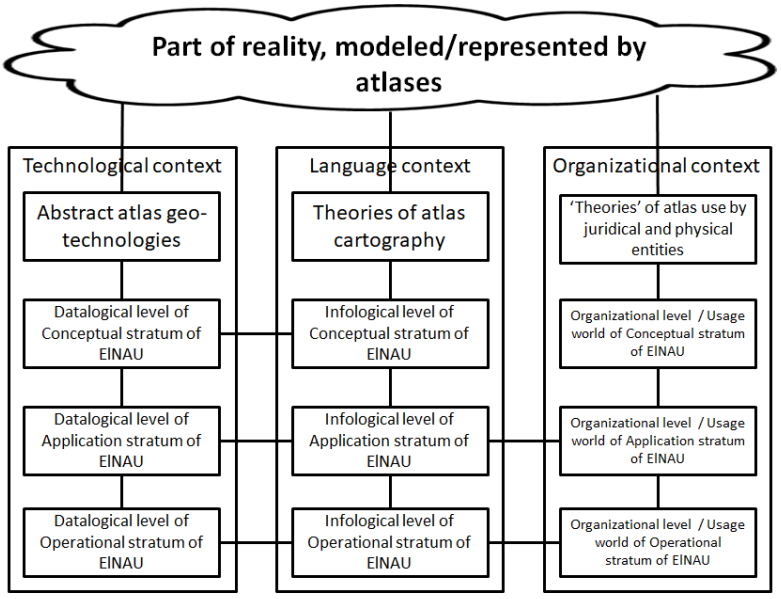


Fig. 1 – Conceptual framework of ElNAU in 2014

the Adobe software family (at least Illustrator). Adobe Illustrator along with other programs from both Adobe and other companies (for example, MAPublisher from Avenza Systems Inc.) were used by State Scientific and Production Enterprise «Kartographia» for the creation of maps of the paper version of the NAU - files that were converted into .swf format in the electronic version. All the listed technologies had to be "agreed" to create ElNAUonDVD. As a result of the agreement, a certain set of datalogical "practices" was created, allowing the production of other atlases of the same type as ElNAU.

5. Infologic level of Conceptual stratum of ElNAU is a set of mutually agreed concepts of the conceptual stratum or, in other words, infologic practices that were used in the phases of research, development and release of ElNAU. Infologic practices of the phases of maintenance and renewal of ElNAU should also be included here.

6. Organizational level of Conceptual stratum of ElNAU is a set of mutually agreed upon organizational "practices" that include a significant set of legal, economic and social elements that are relevant to the world of atlas use.

7. Abstract atlas geotechnologies. In geoinformatics, there are many different abstractions explored as elements of this stratum. Some of them could be used to create this package. The authors are not aware of any works in which this package has been systematically studied. The closest contender for this package is the "cybercartography theory" developed by the Canadian school of cartography [21], [22]. A comparison of the content of the cited monographs shows that no significant progress has been made in 9 years, although the authors may have a different opinion.

8. Theories of atlas cartograpy. Also a little researched package. Given the rather well-known crisis in the theory of cartography, this package is most appropriate to consider as a subset of the theory called the Language Concept/ Paradigm required for the construction of electronic atlases.

9. 'Theories' of atlas use by juridical legal and physical entities. The word theories shown in quotation marks to fix the very little research on the elements of this package. Some results of research in this direction given in [22].

10. Organizational, language, and technological contexts in this article indicated by terms that include the names of strata. This shows that the latter are Datalogic, Infologic and Organizational levels. They not considered separately in the 2014 article.

11. Operational, application, conceptual and theoretical (general) strata in Fig. 1 are not shown in order not to overload the figure.

A brief description of the relations between the levels and strata of the ElNAU CoFr, shown in Fig. 1:

1. Relations between operational levels. These relations are bilateral. Relations from lower (left) levels to higher (right) called transformations; the reverse relations called verifications. For example, developers of information systems, regardless of the used development processes, clearly distinguish the infologic or conceptual model of the system, as well as the datalogic model of the system. A conceptual model or diagram developed in a development stage called conceptual design. It should reflect the entities of reality modeled by the system and the relations between these entities and should not be concerned with the implementation aspects of the system. At the next stages of de-

velopment (for example, logical and physical design), the conceptual model transformed into an implementation model or a datalogic model.

2. Note that the following statements are true: 1) ElNAUonDVD = Datalogic level of Operational stratum of ElNAU + Infologic level of Operational stratum of ElNAU + part of Organizational level of Operational stratum of ElNAU, 2) ElNAU_Edited = Datalogical level of Application stratum of ElNAU + Infologic level of Application stratum of ElNAU + part of Organizational level of Application stratum of ElNAU. Note also that both ElNAUonDVD and ElNAU_Edited are automated cartographic systems (ACS) or AtIS in modern terminology.

3. Relations between ElNAUonDVD and ElNAU_Edited (relation between Operational and Application strata). This is a two-way object-class relation, that is, a classification relation (bottom-up) and an inverse relation - instantiation (top-down). Classification means that objects with the same data structures (attributes) and behavior (operations) are grouped into classes. The ElNAU_Edited class describes a set of individual objects (ACS) of ElNAUonDVD, which can be, in principle, infinite. Indeed, the 2014 article shows how the display of map semantics (colors, ranges) can change. Let's also pay attention to the fact that statistical data from 2003 were used when constructing the indicated map. It is possible to imagine ElNAU, in which the data changes and changes often, for example monthly. Each object of the ElNAU_Edited class is called an instance of the class. It has its own attribute values, but attribute names and operations are shared by all instances of the class.

4. Relations between the Application and Conceptual strata. These are relations system-metasystem or ElNAU_Edited-metaElNAU_Edited. In fact, metaElNAU_Edited practically coincides with the projection on the ElNAU of the AtlasSF Atlas Solutions Framework, described in [23].

5. Relations between Conceptual and Theoretical (general) strata. These are metasystem-metametasystem relations. Rather, we would like or we are sure that these are exactly the relations. However, at the theoretical level, we currently do not know "systemic" theories of atlas carography. At the same time, the existing theories of cartography cannot help much, since, in our opinion, they are also not sufficiently "systemic" and therefore not sufficiently formalized.

6. Relation between the Theoretical (general) stratum and reality. It is abstraction relation, and reverse relation is concretization.

Conceptual Framework of Atlas Systems in 2024

Conceptual Framework of SpISn/SpISb (AtSn/AtSb) subject/system in 2024 can be shown on the example of a choropleth map as in Fig. 2. Fig. 2 obtained using the results from Relational cartography [10] with a fixed value of the formation F1 on the evolutionary axis Z. Here, the values of the usage subject in three-dimensional space represented by the elements of the triplet (X,Y,Z), where: X=Datalogic (D), Infologic (I), Usage (U) denote elements/components of levels; Y=Operational (O – green color), Application (A – orange color), Conceptual (C – blue color), General (G – black color) - indicate elements/components of strata; and Z=F1 (Web 1.0), F1x1 (Web 1.0x1.0),

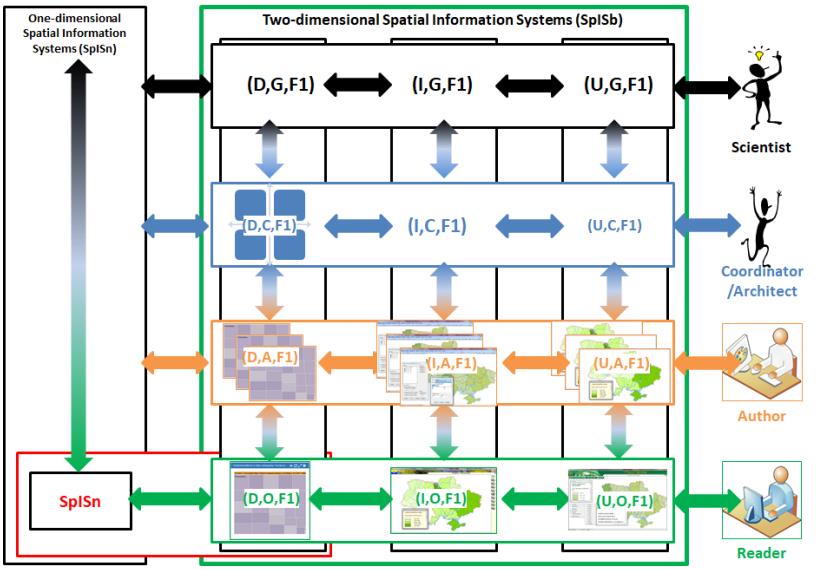


Fig. 2 – Example 1: SpISn/SpISb (AtSn/AtSb) Conceptual Framework for a choropleth map

F2 (Web 2.0) denote elements/components of formations.

Basically, it shows the 'projection' of the Conceptual Framework of a certain subject/system onto the Web 1.0 Formation. Web 1.0x1.0 and Web 2.0 formations on Fig. 2 not shown. Individual components of the SpISn/SpISb (AtSn/AtSb) subject/system on the two lower strata shown by background drawings of choropleth images. It is assumed that the subjects-examples of the ChMap(I,O,F1) choropleth map are elements/components of the SpISn/SpISb (AtSn/AtSb) systems. In the example, one of ElNAU's choropleth maps is used. It is depicted as ordinary maps (see (I,O,F1), (I,A,F1), (U,A,F1), (U,O,F1)) and as treemaps (see (D,O,F1) and (D,A,F1)).

Classic cartographies study mainly the elements/maps of the lower strata of the Conceptual Framework. For example, ChMap(I,O,F1) denotes a set of choropleth maps of Infologic level, Operational stratum, Web 1.0 Evolution formation. It is the ChMapN(I,O,F1) elements of this set that correspond to the representations of a classic cartographer, who generally thinks in terms of paper map categories. The best analogy for this map is a choropleth map displayed on paper.

It is convenient for us to show two-way relations between components/elements of "horizontal" levels in the text with the symbol ↔ (⇆), two-way relations between components/elements of "vertical" strata with the symbol ↕ (↓↑, ⇵). Two-way relations between formations are indicated by the symbol ⤢, one-way evolution relations between formations by the symbol ↗ (⇗), one-way devolution relations by the value ↙ (⇙). On the graphic diagrams, one- or two-sided horizontal and vertical relations are shown by volume arrows (⇔,⇳,⇦,⇨,⇧,⇩,➔,🡻,🡹), of different

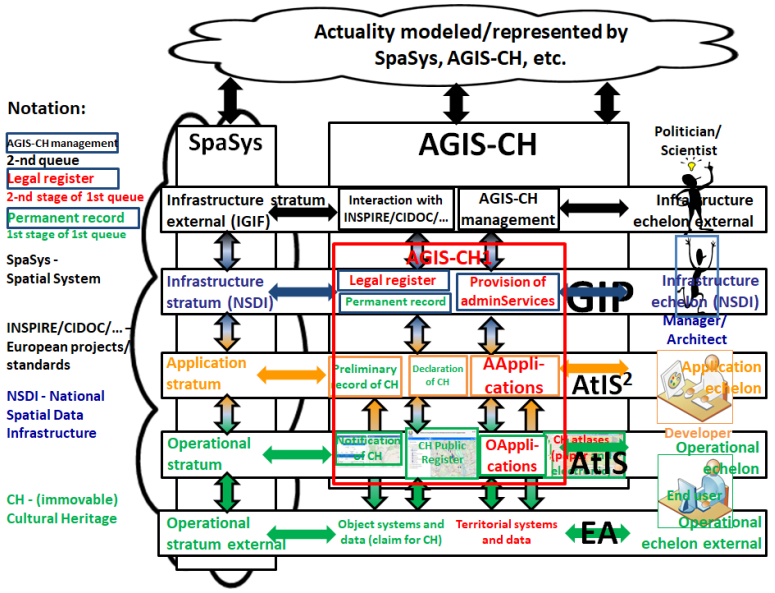
colors. Volume means that the relations shown as volume is actually a set of few relations. The color depends on the value of the members of volume relations.

Fig. 2 shows such two-way vertical relations, which are valid in general, with some adjustments, and for the one shown on Fig. 3:

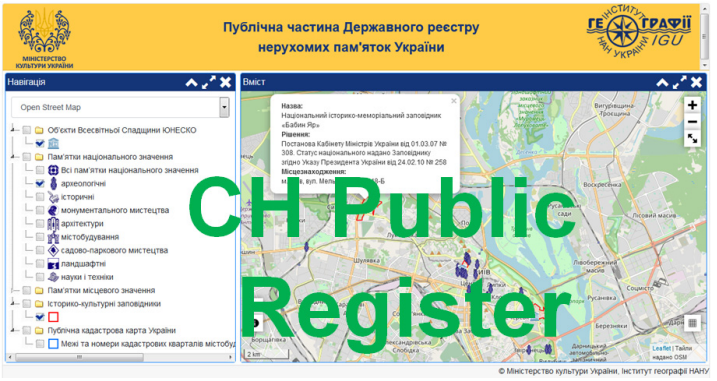
- in black on Fig. 3 from "Actuality that is modeled ..." to modeling systems ProSys, AGIS-CH, and AGIM-CH (included in the Atlas Extender AtEx).
- in alternating colors from black to blue from the components of Infrastructure echelon external (IGIF) to Infrastructure echelon (NSDI).
- changing colors from blue to orange from the components of Infrastructure echelon (NSDI) to the components of Application echelon.
- alternating colors from orange to green from the components of Application echelon to the components of Operational echelon.
- in green from the components of the Operational echelon to the components of the external Operational echelon.

For the second example of the presentation of Conceptual Framework of the subject/system of the SpISn/SpISb, we will use the non-classic Atlas system. We mean Atlas GIS of Cultural Heritage (AGIS-CH). Comtents of its first queue AGIS-CH1 is shown in Fig. 3. The latter is described in our works, starting with [24].

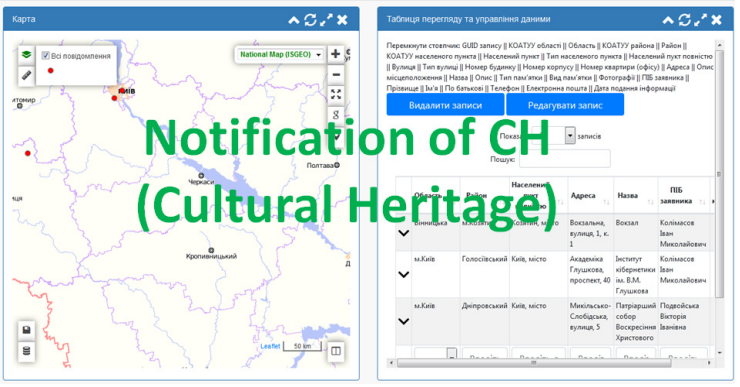
In work [25], we concluded that in many practical projects it is necessary to analyze the dualisms "product-process", where the "product" is the creatable SpIS, and the "process" is an activity, which result can be some final SpIS. For example, when creating the final GIS - the National Spatial Data Infrastructure (NSDI), it is also necessary to analyze the Spatial Infrastructure Activity (SpIA) of its creation. It is also possible to represent the SpIA



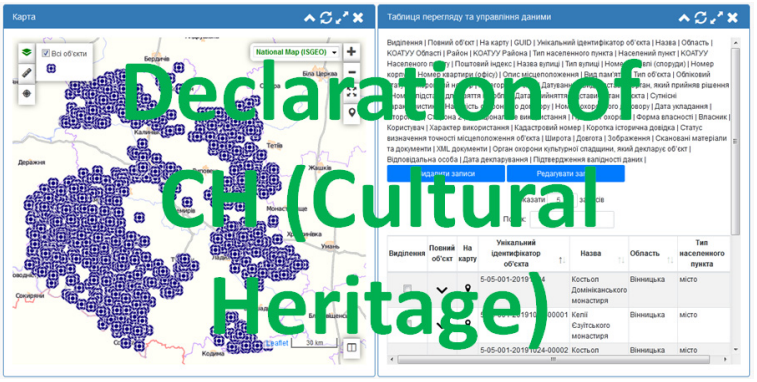
a) Schematic diagram of AGIS-CH



b) Interface of CH Public Register from Fig. 3a



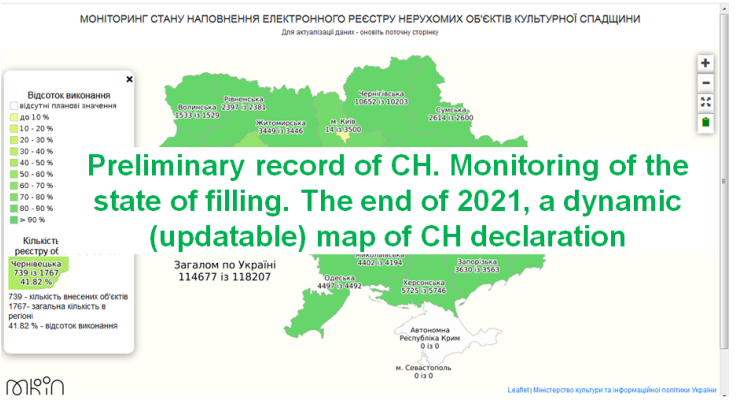
c) Interface of CH Notification from Fig. 3a



d) Interface of CH Declaration from Fig. 3a

as a system. We discovered that the association of information products of a certain class corresponds to a defined structure, also described by the Conceptual Framework. This Framework is an architectural pattern, which also characterized by the dualism "product↔process".

e) APN&CH interface from Fig. 3a



f) Map of state of filling the CH Preliminary record from Fig. 3a

Fig. 3 – Example 2: The current structure of a particular system – the 1st queue of AGIS-CH [24; Fig. 8]

Conceptual Framework as a system method

We have already used the Conceptual Framework both in the design of systems and in their research. For example, the static and dynamic principles of the creation of the NSDI [10] were formulated for the design of the system represented by a certain description, and not for the system that has not yet been created. It is recommended to use the principles in real designing. Another example is the analysis of the structures of the creation projects of many EAs, which must be done for a better understanding of them. This is an example of usage to research. In general, a method is defined as "a specific way of doing something" or: Method (from ancient Greek Μέθοδος - a way of research or cognition, from μέτα- + ὁδός "way") - a way to achieve some goal.

In contrast to the area of knowledge (subject area) or research, the method is authorial, that is, created by a specific person or group of persons, scientific or practical school. Due to their limitations in terms of action and results, methods have a tendency to get old, turning

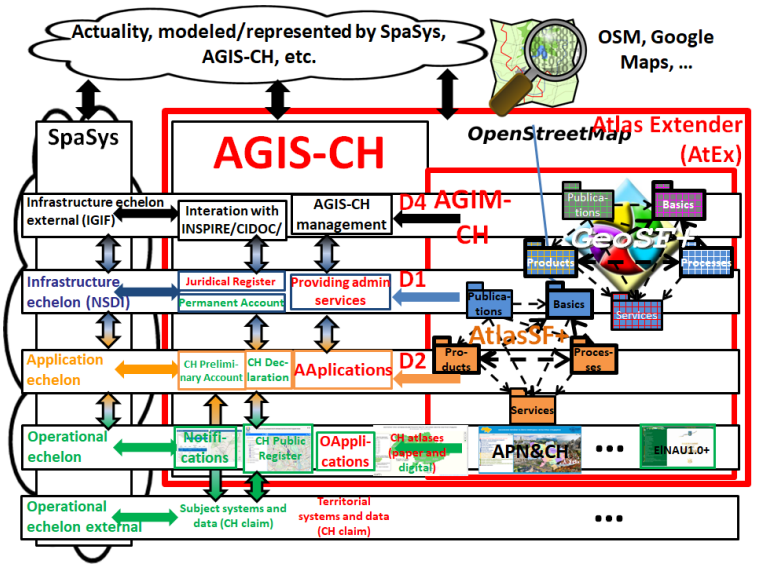


Fig. 4 - AGIS-CH as a result of three system design methods usage

into other methods, developing in accordance with time, achievements of technical and scientific thought, and the needs of society. A set of homogeneous methods usually called an approach. The evolution of methods is a significant consequence of the development of scientific thought.

According to van Gigch [27], we distinguish scientific and systematic approaches to dealing with the subjects being studied. Both used in the design and in the research of subjects, among which there are systems. Van Gigch called the scientific approach an improvement. It used mainly when the subject already exists and you need to improve some of its properties. In the initial phases of creating a subject, it is advisable to use a systematic approach, in which design methods are important.

In the context of Atlas Systems, we apply three design methods that are simultaneously system methods. They allowing to create one or another required subsystems or the entire system: 1) AtlasSF application SoFr, 2) GeoSF conceptual SoFr, 3) Conceptual Framework of classic and non-classic Atlas systems X. Fig. 4 shows a specific example of the application of all three methods, which correspond to three dynamic principles, to the creation of the AGIS-CH Atlas System. Dynamic principles mentioned formulated as follows [10]: 1) D2 – Application frameworks as constructors of user applications, 2) D1 – Conceptual frameworks as constructors of infrastructure echelon/conceptual stratum, 3) D4 – Conceptual Framework of NSDI as a constructor of Spatially Enabled Society in Ukraine. AtlasSF+ is an actual version of the AtlasSF 1.0, used in the creation of ElNAU. GeoSF+ is an actual version of the notational GeoSF GeoSolutions Framework, described in works [18], [19]. The essence of the used systemic methods/design patterns shown on Fig. 5 on the example of Atlas GeoInformation Models (AGIM) and Systems (AGIS) [4].

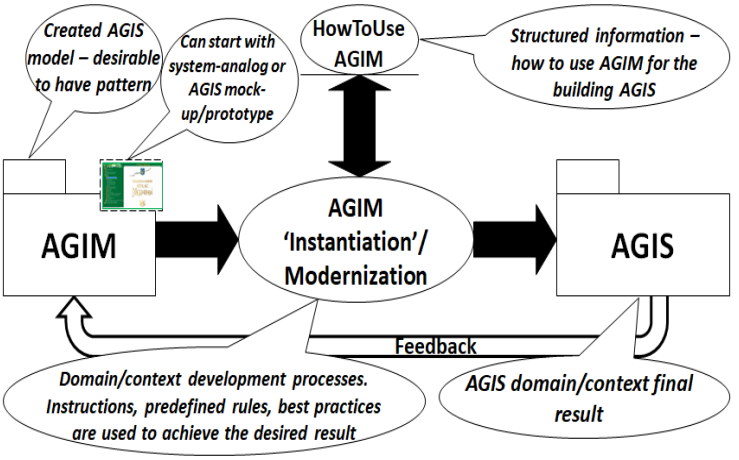


Fig. 5 - The essence of the system method/framework pattern

Thus, the Conceptual Framework is a pattern that applies to many subjects. We are especially interested in subjects that can be represented by systems. Regardless of the context of the usage subject, defined or not defined as a system, three types of relations are repeated in the pattern: transformational, epistemological, and evolutionary [10]. The range of values of the Conceptual Framework can be represented by a three-dimensional space that unfolds along three axes depending on the three specified types of relation. Although we usually consider subjects in a two-dimensional plane with a fixed value of the subject on the third, evolutionary axis.

Rationale of the main research results

Currently, there are several rationales for the main results of the research of Conceptual Framework X, where X can be ElNAU or an element from a set of Atlas Systems, and the Conceptual Framework corresponds to the context of the research. The first rationale called "abductive". It used in the article of 2014, where, on the example of a specific implementation of ElNAU - ElNAU 2007/2010, it is clearly shown what levels and strata are. Due to volume limitations, we present only the main ideas of Rationales 2 and 3 called "inductive."

Rationale 2 (inductive). It presented in the monograph [10]. There for inferences about the levels of the Conceptual Framework, the work [28] and further researches in this direction used. For inferences about the strata of the Conceptual Framework, the work [29] and further researches in this direction used.

Rationale 3 (inductive). There are many studies that are more general than those used in Rationales 2 and 3. We cannot dwell on them in detail, but we will focus on Model Based Engineering (MBE). In this case, the Conceptual Framework itself and the method of Conceptual Frameworks are elements of MBE.

Rationale 1 (abductive). In the 2014 article Conceptual Framework defined by two terms: "concept" and "framework".

Concept (from Latin conceptio – understanding, system) - a certain way of understanding, interpretation of some phenomena, the main point of view, the

guiding idea for their coverage; guiding idea, constructive principle of various types of activities.

According to [30], a sample or pattern is a typical solution to a typical problem in a given context. A Framework is an architectural pattern that offers an extensible template for applications in one specific field.

The concept of pattern borrowed by the computer industry from construction, from a monograph [1]. Alexander found that by focusing attention on structures designed to solve similar problems, it is possible to find similarities between different (building) projects, which characterized by high quality. He called these similarities patterns.

Alexander defined the concept of a pattern as "solution a problem in context." Each pattern describes a problem that occurs in a given environment over and over again, and then proposes a principle to solve it in a way that can be applied repeatedly, each time obtaining results that do not repeat each other.

Four components that, according to Alexander, should be present in the description of each pattern:

- Pattern name.
- Designation of the pattern and description of the problem it is designed to solve.
- Method of solving the task.
- Limitations and requirements that must be taken into account when solving the problem.

Alexander accepted as a postulate that any architectural problem faced by the designer can be solved with the help of patterns. He then went further and claimed that using multiple patterns together would help solve complex architectural problems.

In work [31], one of the architectural patterns from the field of geoinformatics - the GeoSF GeoSolutions Framework considered in detail. From a modern viewpoint, it is the Notional SoFr, mentioned above.

The term "ElNAU" in the 2014 article denoted the field of scientific and practical activity of a certain group of organizations and individuals, which ended with the release of three mass editions of ElNAU, as well as the creation of other, unknown to general public, products (results) and production processes, which combined with the term "atlas infrastructure".

ElNAU Conceptual Framework was determined using ElNAU variants that were developed in three successive phases of product evolution: 1) development, 2) release, 3) use.

A cybernetic viewpoint on ElNAU and Atlas Systems in general

In the 2014 article, the substantiation of the correctness of the ElNAU Conceptual Framework began conditionally "from left to right", from the "cybernetic" elements of the so-called Datologic level to the elements of the Organizational level with a fixed value of the so-called Operational stratum of knowledge about ElNAU. Simply put, it was Software and Information provision of a specific implementation of ElNAU - EdNAUonDVD. This viewpoint on ElNAU called Cybernetic. At the same time, the current phase of ElNAU development was the phase of use, which followed the phases of development and release.

Then the so-called "Conceptualization of ElNAU" was carried out. First - cartographic IS, then cartographic software. It was nothing more than an "abductive" search for information and software "concepts" used in the speci-

fied implementation. The corresponding paragraphs of the article [2] called Conceptualization of cartographic IS (What does the cybernetic viewpoint hide?) and Conceptualization of cartographic software (What does the cybernetic viewpoint hide?). "Abductive" here means "flowing from existing practice." All we had to do was find the concepts used in practice. Conceptualization of ElNAU ended with the paragraph Conceptualization of the organizational level. Instead of repeating the material of the 2014 article, let's make two very fundamental remarks related to the essence of the subsection:

Remark 1. At the time of writing the article already existed and was used in practice the Solutions Framework, which was called the AtlasSF Solutions Framework. In the ElNAU project, which has been going on for about ten years, three revisions of AtlasSF version 1.0 have been used [10]. This means that when writing the article in 2014, we did not "search" for the used "concepts". We used AtlasSF 1.0 both in the development, release, and interpretation of the ElNAU use phase. That is, we looked for and found confirmation of the AtlasSF SoFr concepts in a specific ELNAU project thanks to the AtlasSF Framework.

Remark 2. In the article [2], the abduction of one specific implementation was used for the conceptualization of ElNAU. In [29], he performed a similar work for a family/group of quite general information systems, which included those of interest to us, ElNAU and an instance of AtS. We called it above the inductive method of proving the existence of a hierarchy of Datalogic, Infologic and Organizational levels of information systems, which included ElNAU and Atlas Systems. This is the main difference between the understanding of levels and strata - we are talking about the levels of each individual system or the levels and strata of a group/class of systems. Here, in addition to relations between levels, relations between strata (knowledge) about information systems are meant. It is known from the theory of Relational Cartography [10] that these relations called "vertical" or Epistemological - "up" and Reduction - "down".

Conclusions. Usefulness of Conceptual Frameworks of ElNAU and Atlas Systems

The article presents the results updated for ten years about the Conceptual Framework, which is now a subject not only of ElNAU and Electronic Atlases (EA), but also of "classic" Atlas Systems (AtS). This completes tasks 1), 2), 3) from the Introduction. It is also shown how to complete tasks 4), 5) from the Introduction. Namely, the subjects of EA or AtS should be "consciously" extended (broaded) and the Conceptual Framework should be applied to the extension. This shows how to: 4) update the approach to the research of the concept of "Atlas Infrastructure", 5) develop the concepts of its "correct" organization, the application of the obtained approach and concepts to the development of the architecture of the Atlas infrastructure of classic and, then, non-classic AtS.

Practical usefulness of the ElNAU/AtS Conceptual Framework:

1. It must be used in EA/AtS development projects if one of the following conditions is met:

1.1. The EA/AtS will be used and maintained for more than three years.

1.2. The subject of the EA/AtS is

diverse and require coordination of knowledge from different fields of activity.

1.3. The team of the EA/AtS development project is heterogeneous in terms of the specialization of individual participants. For example: geographers, cartographers and cybernetics.

1.4. The subject area of the EA/AtS is little researched.

1.5. The project team does not have sufficient qualifications (executing a similar project for the first time).

2. It is appropriate to use in the development of large Automated Cartographic Systems or Atlas Information Systems.

3. It is possible to use in the development of large GeoInformation Systems that adhere to "layered" approaches to the organization of information cartographic provision.

Scientific usefulness of the ElNAU/AtS Conceptual Framework:

1. It helps to identify under-researched areas of activity, in fact, it determines the program of scientific research. Some of the opinions about these researches expressed in the description of the ElNAU/AtS Conceptual Framework above.

2. It can be used as a universal research tool for all national atlases and Atlas Systems.

3. It is a prototype of the Conceptual Framework of System Cartography.

Conclusions from the results of 2024 regarding the Conceptual Framework of Atlas Systems:

1. If to use it at the beginning of the project to create Atlas System X, it would be possible to prevent many problems, both technological and, ultimately, economic.

2. It helps to identify under-researched areas of activity, in fact, it determines the program of scientific research.

3. It can be a "classification" basis for all AtS.

4. Usage to System Cartography will help to reconcile most paradigms of cartography, and also, perhaps, become a certain unifying integral theory of modern cartography.

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ОНОВЛЕННЯ КОНЦЕПТУАЛЬНОГО КАРКАСА АТЛАСНИХ СИСТЕМ

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Анотація. *За минулі десять років Концептуальний Каркас з потрібними змінами неодноразово використовувався у проектах створення різних Електронних Атласів, включаючи Електронну версію Національного Атласу України (ЕлНАУ), Атласних Інформаційних Систем, і, навіть, Географічних Інформаційних Систем. При цьому змінювалися і розвивалися як практичні засоби, так і теоретичнні методи. Обидві практична і теоретична діяльності продовжуються і є дуже актуальними нині. Однак не було окремої публікації про актуальний стан Концептуального Каркаса предмета Х, де Х приймав би значення сучасних систем. Для покращення, розширення і спрощення його практичних і теоретичних застосувань потрібно зафіксувати головні оновлення усієї конструкції: як самого Концептуального Каркаса, так і предмета Х, до якого його доцільно застосовувати. Тому замість розглянутого раніше предмета Х = ЕлНАУ розглядаються предмети-системи з множини АтС = {Атласні Системи} ∋ Х, а сам Концептуальний Каркас представляється як відповідний системному підходу системний метод, з акцентом на проектуванні (метод проектування), хоча Концептуальний Каркас може використовуватись і для дослідження систем, тобто, бути методом дослідження. За десять років Концептуальний Каркас предмета Х став досить розгалуженим явищем, що змусило зупинитися тільки на головних (як мінімум, для нас) оновленнях.*

Ключові слова: *Атласні Системи (АтС), Концептуальний Каркас АтС, Атласна Інфраструктура, АтС у розширеному розумінні (АтСш)*