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"Municipal settlements of Ukraine" database and its possible application spheres

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Abstract. With the development of geoinformation technologies and geoinformation mapping the sphere of activity of professional geographers and cartographers has been enriched by a wide application of databases (DB). They enable geographical information to be put in order in a user-friendly system. The article considers the methodological aspects of the organizations and creation of such a system – the "Municipal settlements of Ukraine" databases. The basic stages and databases forming the principles which the author designated during the creation of this specific database are highlighted. The DB structure is revealed – the list of the data included in every table is given. The ways of DB applications are determined; they consist in using DB for the creation of various cartographic studies and reference books about the municipal settlements in Ukraine. The prospects of DB development and perfection are considered.

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Contents:

1. Introduction

Geoinformation technologies are all more frequently used in various types of geographical research, including the study of municipal settlements. Deepening of research requires reliable information of a factual and encyclopedic nature, e.g. the data on an area and geographical co-ordinates, time of founding municipal settlements, etc. The absence of DB has an impact in this case. This article is devoted to filling the blank mentioned above. Its objective is to discover methodical principles of creating the "Municipal settlements of Ukraine" database as one of the main sets of geospatial data.

Problems dealing with the organization of geospatial databases are usually solved within the framework of geoinformation and cartographic research. Considerable results are obtained by the western scientists who created the fundamentals of geoinformation science: Roger F. Tomlinson, Ferjan Ormeling, Michael N. De Mers, Shashi Shekhar, Hui Xiong, V. Clinton et al. (De Mers, 2005; Tomlinson 2005; Shekhar, Xiong, 2008). Cartographic research of geographical databases is widely represented in the works of Russian scientists such as O.M. Berlyant, V.S. Tikunov, I.K. Luriye, O.V. Koshkaryov et al. (Berlyant, 2002; Ivannikov et al., 2001; Tikunov et al., 2005).

In Ukraine a considerable contribution in the sphere of geoinformation mapping was made by the Cartography Department's associates of the Institute of Geography, the National Academy of sciences. The employees of the department – L.G. Rudenko, A.I. Bochkovs'ka, T. M. Kozachenko, G.O. Parkhomenko, V.S. Chabanyuk et al. – worked out the conception of the geoinformation mapping of complex systems; directions of forming geoinformation resources are determined, the model and the database of the National Atlas of Ukraine are created. Results of this research are generalized in such monographs as the "National Atlas of Ukraine. Scientific bases of creation and their realization" (Rudenko L.G. et al., 2007) and "Geoinformation mapping in Ukraine. Conceptual bases and directions of development" (Rudenko et al., 2011).

2. The situation of spatial data infrastructure development in Ukraine

The national geospatial data infrastructure of Ukraine aims to improve the normative-legal support of geographic information activities in the country, to strengthen coordination and cooperation of public institutions with local governments and businesses and organizations of all forms of ownership in the production and use of geographic information resources in order to minimize duplication of works on collection and registration of geospatial data; to ensure the production of high-quality relevant public geoinformation resources as an important component of overall national information resources. Works on the creation of the national geospatial data infrastructure of Ukraine began with a significant lag behind European countries. The initial phase of comprehension and establishment of geoinformatics as a scientific and industrial trend ended with a scientific and practical seminar on the geoinformation system, held on November 22–25, 1993, in the city of Vinnitsa. "The concept of multi-national GIS of Ukraine" was promulgated at the seminar developed jointly by specialists of the Institute of Geography, Institute of Cybernetics, Ukrgeodescartography, and the National University "Lviv Polytechnic": L.G. Rudenko, V.S. Chabanyuk, A.L. Bondarenko, S.V. Volska, I.O. Horlenko, O.L. Dorozhynskyy, B.D. Lepetyuk, L.I. Lishchytovych, O.Y. Lytvynenko, and O.V. Oliynyk. The concept marked a decisive impact of information technology on the traditional scope of spatial data: geography, geodesy, cartography, photogrammetry, remote sensing of the Earth, ecology, urban planning and so on.

The first project where principles of the concept of a multipurpose national GIS were implemented was the creation of a radiological GIS of Ukraine. The work lasted from 1993 to 1996 and ended with the implementation in practice of the Management of radiation protection of the population of Chornobyl Ministry of Ukraine. Another significant project, the implementation of which contributed to the development of information processes in Ukraine, was a joint Ukrainian-Swedish project "Creating conditions for the implementation of the nation-

al geospatial data infrastructure in Ukraine". It was implemented during 1999–2003. The main result of the project's research part was the development of a prototype of technology and means of organizing activity in the field of geospatial data. Approval of the state scientific and technical programme of topographic and geodetic activity development and national mapping for 2003–2010 was a continuation of the development of information processes. The programme was approved by the Cabinet of Ministers of Ukraine of January 16, 2003 No. 37. One of the main objectives of this programme is to form a National geospatial data infrastructure.

Significant efforts have been focused on the development and adoption of legislation acts that became the legal foundation for the creation of the National geospatial data infrastructure. The result of these efforts was the development of the draft Law of Ukraine "On the national geospatial data infrastructure", which highlighted the main legislative principles that would ensure and regulate the establishment and functioning of NGDI. During data collection and creation of basic and specialized sets of geospatial data of Ukraine it is planned to follow European standards of geospatial data processing which were developed under the directive INSPIRE that will greatly simplify the integration of the geospatial data infrastructure of Ukraine into European information space. However, the above-mentioned law and other legislative acts aimed at regulating relations in the sphere of development, functioning and content of the National geospatial data infrastructure of Ukraine are at the stage of discussion and development. This leads to the fact that all producers of spatial data in Ukraine – public sector (land, water, forests resources, etc.), private sector (surveyors, Ukrtelecom, water utilities, etc.) and municipalities – do not interact with each other, and therefore often have problems while using and searching data for carrying out various scientific research.

Currently the realization of the project "Laying the foundations of spatial data infrastructure in Ukraine: providing a base in the Ukrainian government to support sustainable economic growth" is continuing. It is supported by the Canadian Ministry of Foreign Affairs, Trade and Development jointly with the University of Vancouver Island (Canada).

The partners of the project in Ukraine are the geographical faculty of Taras Shevchenko National University of Kyiv and World Data Center in geoinformatics and sustainable development of the National technical university of Ukraine "Kyiv Polytechnic Institute".

The main goal is to provide a basis for accelerated deployment of infrastructure of geospatial data for the government of Ukraine by implementing relevant training courses and training of public servants.

3. Basic terminological definitions and general description of the "Municipal settlements of Ukraine" database

Taking into consideration that there are many various and ambiguous interpretations of terminological definitions related to DB development, creation and arrangement the author deems it wise to explain the terms which will be used in the text.

The basic most widespread terms are:
— database (DB);
— municipal settlement;
— relational database;
— database control system (DBCS).

A database is an aggregate of data, which are organized on certain rules, which are set by the general principles of the data description, saving and manipulation by means of computer facilities (Samoilenko V. M., 2010). This definition is worth adding "and represent the state of objects with their relations in the examined subject domain".

A relational DB model is an aggregate of the tables, each of which contains a set of the same type objects. It was first described by the English cybernetic engineer Edgar Frank Codd in 1970 (http://posibnyky.vntu.edu.ua/database/gl_14.html).

A Database Control System (DBCS) is the special software which provides the users with the possibility of creating, saving, updating and searching information in a database.

Municipal settlements in Ukraine are settlements which are ratified by legislative acts as cities and settlements of municipal type (http://zakon.nau.ua/doc/?uid=1078.22194.0).

A municipal type settlement (MTS) in Ukraine is a settlement the inhabitants of which obtain their principal profit from a non-agrarian activity. This term refers to the settlements appearing near factories, plants and mines and which have a formed social infrastructure and do not correspond to the "city" category regarding the quantity of population and other parameters. MTS can appear round a remote military unit, near a quarry or mineral water spring (http://moyaosvita.com.ua/osvita- 2/chim - vidriznyayetsya - selo - vid - selishha/).

The database "Urban settlements of Ukraine" was composed while working on dissertation research with the title "Mapping Analysis network formation in urban settlements of Ukraine", which aims to explore a comprehensive cartographic display of forming a network of urban settlements of Ukraine and create a modern information database on a network of urban settlements of Ukraine for improving information security of its territorial organization and creating cartographic works. Urban settlements were the framework of the settlement network at all stages of the development and formation of the modern territory of Ukraine; they have always been centres of socio-cultural and economic development of territories. The impact of urban settlements spread over the surrounding areas. Analysis of the historical development and formation of the territory of Ukraine shows significant regional differences in the development of a network of urban settlements. Composition of attributive tables and their information content are exactly conditioned by the connection to the theme of the research. Creating a database "Urban settlements of Ukraine" included observance of design stages and principles of database formation.

The planning stages provide for the following:

1. determination of the aim to create DB, its basic functions and information which it has to contain;
2. development of the table structures which DB should contain on paper carriers;
3. determination of the margins necessary in a table;
4. defining connections between tables;
5. filling DB with information.

The basic principles which we adhered to during data organization in DB are (http://posibnyky.vntu.edu.ua/database/gl 14.html) as follows:

1. Data integration, which consists in the association of separate, mutually unconnected data in a single unit, or database.
2. Principle of data integrity represents the requirement of adequacy of the information about the state of an object stored in DB: the data shall always exactly meet its properties and characteristics.
3. Absence of surplus is the state of data when every element is available in DB in a single exemplar.
4. Territorial attachment. Within the framework of the modern theory of creation and updating of the geographic information systems, information should correlate with the corresponding sets of spatial data by means of individual indexation.
5. Openness of construction architecture. DB should flexibly react to the appearance of new objects and attributive information and accordingly extend a unified classification and a system of search.
6. Perspective of free data manipulation. Within the DB framework it is important to have the opportunity of generalization, restructuring and updating of information.
7. Centralization of management, which consists in the transmission of all functions of data management to the unified complex of control computer programs – DB control system.

Databases unlike the simple sets of data have characteristic advantages in relation to the information organized in another way:

A single input and reusing of information are characteristic of DB; the entered information is used to solve many problems;

— databases exist regardless of the concrete application computer program that provide standardization of data organization facilities and independence of the application computer program from data organization;
— databases have modelling (structuring which represents a certain subject area);
— databases allow the minimum necessary level of data surplus to be set (i.e. the data are not duplicated being used by different users);
— the observance of the data presentation standards is provided in a database, which simplifies their creation and service;

— the centralized informative resources' management, the synchronous data support for all applications including the languages of queries and security protection are provided in DB.

As a result of passing these stages and observing the principles the author carried out practical DB realization with the use of DBCS MS ACCESS 2007 in a relational model. The value of the relational DB model consists in that it allows data to be grouped in rather simplified tables unlike hierarchical (or dendritic) ones in which the data are connected with each other on certain rules and form trees by their shape, or a network in which the data are given in the same form, as in a hierarchical model (Rudenko L.G. et al. 2011). It is this simplicity, visual evidence and convenient use that played a decisive role in a wide distribution of the data relational model.

DBCS of MS ACCESS 2007 is included in the Microsoft Office package and accessible for the wide circle of non-professional users of personal computers. It consists of plenty of special programs – "masters" – which carry out a dialogue with a user, when the data necessary for solving a certain problem are determined. To make the work comfortable each master has certain stages (steps). One can skip any stage or appeal to a previous one. Another important feature is the ability to work: with the various formats of files – ACCDB, MDB, ACCDE, MDE, ACCDT, ACCDR, ACCDW, MDW – and with the types of the data – text, numerical, money, logical, etc.

4. The "Municipal settlements of Ukraine" DB structure

The "Municipal settlements of Ukraine" DB is a well-organized set of geographical and statistical information about the municipal settlements of Ukraine, which number 1345 – 460 cities and 885 MTS as of January 1, 2015 (http://static.rada.gov.ua/zakon/new/NEWSAIT/ADM/zmist.html). It consists of three tables: "Regions", "Districts" and "All municipal settlements" (Fig. 1, 2), which are interconnected. Such a combination allows submitting information not only about municipal settlements but also about regions and districts to which they belong according to the administrative-territorial order.

The following data are given for regions:
— COATOU code (Classifier of objects of administrative-territorial order of Ukraine as of January 01, 2007);
— name in Ukrainian, Russian and Roman alphabet;
— time of formation;
— area;
— amount of population on January 1, 2013;
— amount of rural districts;
— amount: of cities;
  — mts (a municipal type settlement);
  — rural settlements;
— region extension from the north to the south and from the west to the east;
— end points – northern, southern, western and eastern;
— density of municipal settlements;
- amount of the municipal settlements founded: – before the 10^{th} century;
  — 10^{th}-18^{th} centuries;
  — 19^{th} – beginning of 20^{th} century;
  — from 20^{th} century to present;
  — a region's coat of arms and flag.

The following information is presented for districts:
- COATOU code;
- name in Ukrainian
- name in Russian;
- name in the Roman alphabet;
- time of foundation;
- area;
- quantity of population on December 1, 2001;
- amount: cities;
– mts;
– rural settlements.

The following data are available for all municipal settlements:
— geographical co-ordinates are latitude and longitude;
— geographical co-ordinates in a decimal form – X, Y;
COATOU code;
— name in Ukrainian;
— name in Russian;
— name in the Roman alphabet;
— status of settlement;
— a date of subsuming;
— the first written mentioning;
— quantity of population as of 1989, 2001, 2012;
— settlement area in km^2.

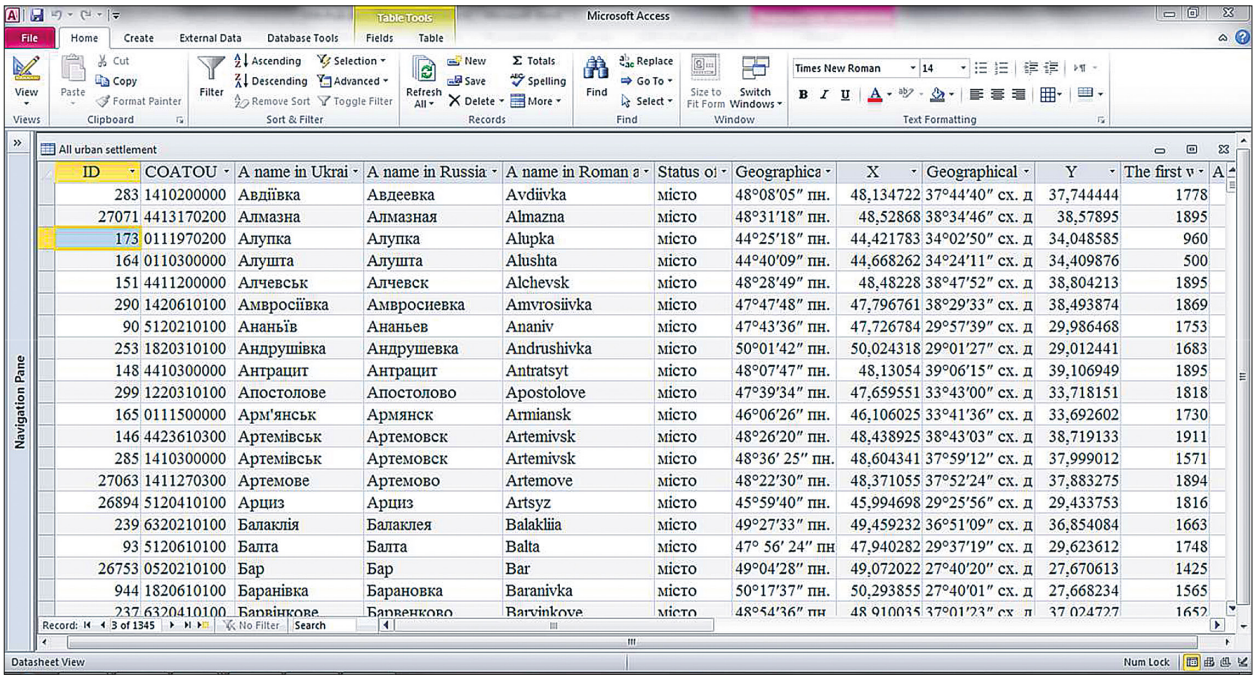

Fig. 1. A working window of the 'Municipal settlements of Ukraine' DB

Source: Authors' own work

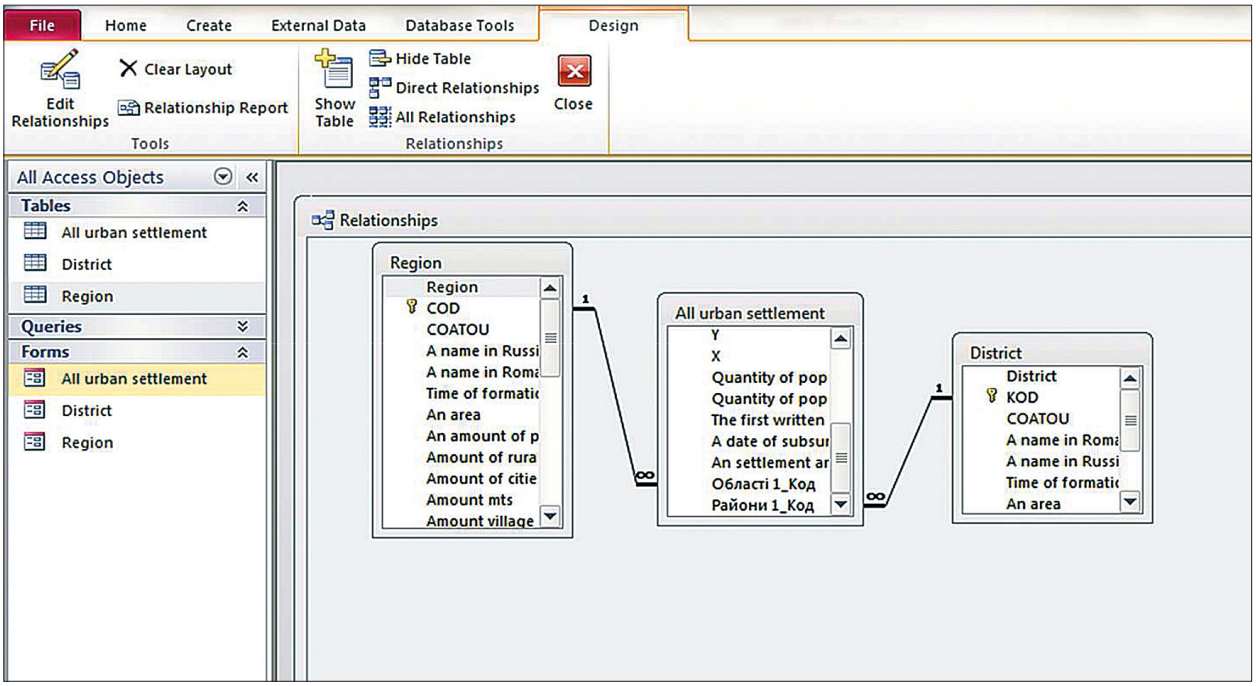

Fig. 2. Relationships between tables in the DB

Source: Authors' own work

While filling information in databases, information sources that are generally accepted in Ukraine and materials of official statistics were used. Data on the population of regions, cities and urban-type settlements were obtained from official statistical reference books annually published in Ukraine.

The areas of cities and urban-type settlements were taken from the registration cards of set-

tlements posted on the website of the Verkhovna Rada of Ukraine. The ability to verify the certainty of the data is non-available, since there is no legal base that regulates the establishment of areas of settlements of different rank. Today the composition of the system of the administrative and territorial structure of Ukraine is predetermined by Article 133 of the Constitution of Ukraine.

Resolving other issues of the territorial system of Ukraine is implemented in accordance with the Constitution of Ukraine, the Land Code of Ukraine, laws "On fundamentals of urban planning", "On local self-government in Ukraine", "On the capital of Ukraine – hero city Kyiv", the principle on the procedure of resolving issues of administrative and territorial structure of the Ukrainian SSR approved by the Decree of the Verkhovna Rada of Ukrainian SSR of March 12, 1981 and other legal acts, which often contradict the fundamental law and each other. To ensure the resolution of issues on territorial structure and of contradictions that often occur is the aim of the law "On administrative-territorial structure of Ukraine." However, to date, only a draft is available.

Transliteration of Ukrainian names of regions, districts and urban settlements in the Latin alphabet is performed according to the decision of the Cabinet of Ministers of Ukraine No. 55 of January 07, 2010 "On the harmonization of transliteration of the Ukrainian alphabet into Latin" – the decision of the Cabinet of Ministers of Ukraine of January 27, 2010 No. 55 On the harmonization of transliteration of the Ukrainian alphabet into Latin").

The presence of a significant amount of historical database information such as time of the emergence of urban settlements, date of formation of administrative units – regions and districts – is caused by the objectives of the study, one of which is the study of the formation of the modern network of urban settlements of Ukraine. The issue on the first written mention evoked many discussions, because now there is no clear opinion on the origin of all settlements that are mentioned in database. The author took some of these data from the decision of the Cabinet of Ministers of Ukraine dated July 26, 2001 No. 878. On the approval of the list of historical settlements of Ukraine and other data from Yaroslava Vermenych's research work "Urban History of Ukraine: problems of the initial dating" (Vermenych., et al. 2010). This work contains a "Comparative table of the dates of founding or the first mention of cities and urban-type settlements", which shows a data on the dates of foundation and the first mention of cities and urban-type settlements collected from twelve different sources. The result these data generalization was chosen the date that was repeated in most of the twelve sources, on the basis of which the table was created.

The number of urban areas founded in different time periods contained in the table "Regions" is personally determined by the author based on the data of the first written mention. Information on the extreme points and length from west to east and north to south, which is contained in the same table, is obtained as a result of her own measurements by means of topographic maps, and from written sources – atlases of particular regions.

DB functioning is not deprived of system and programmatic problems. It is predetermined by the necessity of constantly updating DB information, maintaining it on a proper working level, i.e. detecting and solving errors arising during work, by defending from unauthorized access. To solve all the above-mentioned problems the permanent participation of specialists who will ensure the uninterrupted operation of the created DB is needed. At this time the provision of an operational DB is undertaken by the authors.

5. The DB application field

Today the DBs are widely used in various fields of geographical research. Basic directions of the created DB application are as follows:

1. Studies on the territorial planning of different grades (territorial plans of administrative regions and districts of Ukraine, general layouts of settlements, landscape planning, etc.).
2. Advanced and practical studies on regional planning where there is always a necessity for information about municipal settlements which, as a rule, present a framework of planning decisions.
3. Educational and enlightenment activity on determination of the state and prospects of developing municipal settlements.

4. Geopolitical studies on determining the value of municipal settlements as poles of influence or increase.
5. Creating electronic or paper cartographic products of various types and purposes (complex and thematic atlases, series of maps and their distinct types). For their creation both commercial GIS such as ArcGIS or MapInfo GIS and free GIS – QGIS and others – can be used possessing stable versions and obtaining increasing application. The example of such database application is shown in fig. 3. When creating a map, data of the attributive table "Regions" were combined with a vector layer from OpenStreetMap and uploaded to ArcGIS Online cloud server, which allows publishing, storing and sharing spatial information (maps, location data, etc.). Using data from OpenStreetMap is caused by a lack of formal, legally approved vector data sets in Ukraine. Private companies that create vector cartographic products are oriented to the customer and develop databases and vector data sets according to the objectives.
6. Working out of logistic schemes of movement of commodities and people.
7. Creation of the thematic municipal settlements' DB – economic, ethnographic structure of population, etc.

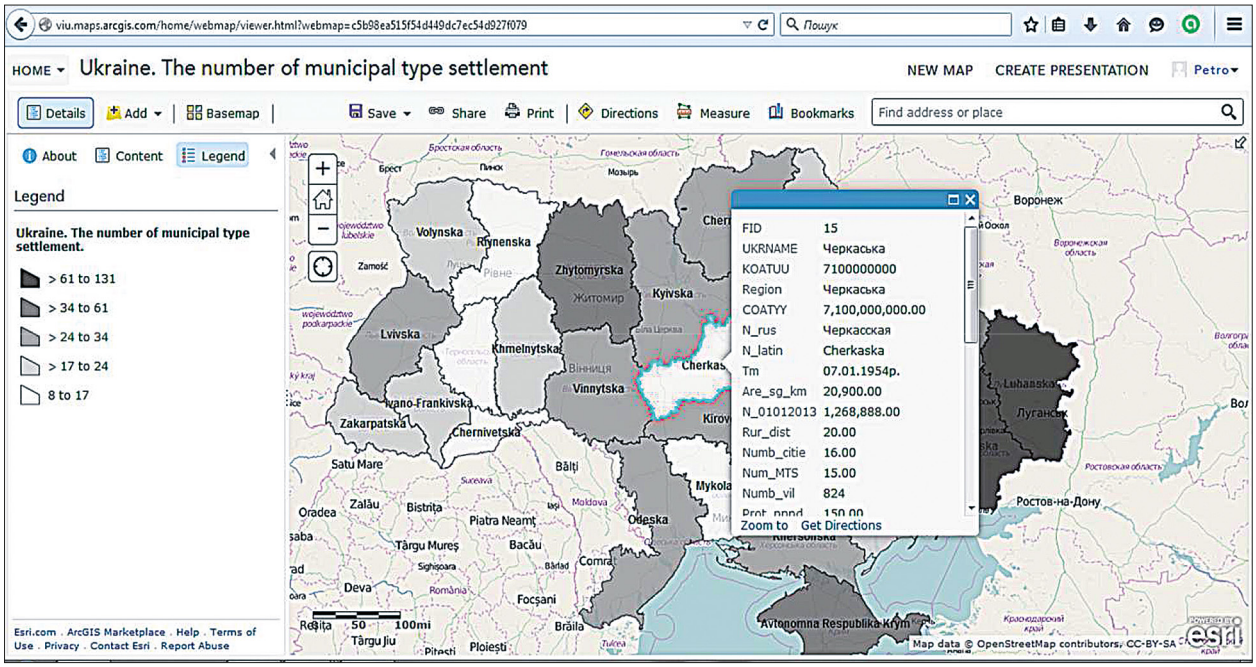

Fig. 3. Example of maps created on the basis of ArcGIS Online cloud server using 'Municipal settlements of Ukraine' DB

Source: Authors' own work

6. Conclusions

Analysis of works related to the spatial data infrastructure of Ukraine revealed significant progress in this direction. It is proved by the successful implementation of the joint Ukrainian-Swedish project "Creating conditions for the implementation of the national geospatial data infrastructure in Ukraine". European experience and traditions of the formation of national geospatial data bases is widely used in order to simplify as much as possible the integration of Ukraine into the European information space and to ensure completeness of information content.

Creation of the "Municipal settlements of Ukraine" DB is an important contribution in the geographical science of Ukraine: the essence, principles and ideology of their forming using the example of municipal settlements, which in most cases

present the basis of all research, have been considered. Geographical and statistical information (the area of every municipal settlement, district, region; extreme points of every region are determined; time of formation of every district; quantity of population) which for municipal settlements is given in relation to different sentinel periods is first collected and systematized; it enables the dynamics of population changes to be traced, which is impossible without the observance of principles and stages of DB planning.

The main problems the author encountered while researching the database were the poor quality of official statistics on the area and the date of emergence of urban settlements, and the lack of legally approved vector data sets that led to the use of vector data from OpenStreetMap for map construction. Also, legislation of Ukraine relating to administrative-territorial structure requires improvement and significant arrangement.

Notwithstanding the problems DB has considerable prospects for development. It is related to the fact that a database is the nucleus of accumulation and automated mapping of information about the history and population of municipal settlements of Ukraine, which is necessary in making administrative decisions at different territorial levels, when forecasting and planning the state development. One of the DB further work directions is increasing its informative gap-fillingness, foremost with graphic materials – coats of arms and flags of municipal settlements, as well as with alternative cartographic works. The addition of the DB created should be a scheme of data monitoring according to certain tasks, especially during population enumeration, the results of which contain much more information.

The need to update the DB with toponyms, hydronyms, and local names of parts of settlements, rivers, hills and to create cartographic works of different territorial levels on the DB basis is obvious.

A particular direction deals with preparing and launching Internet projects providing general access to information about the municipal settlements of Ukraine, development of thematic types of products, intended to upgrade school and higher education, highlighting and solving the socially meaningful problems of modern state development on the basis of the DB. The printed products or separate maps which were manufactured to order can be included in this.

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