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SDI IN MODERN CARTOGRAPHY FOR INFORMATION ON LAND RESOURCES

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Abstract. *Land is the foundation of all human social production activities and is a precious natural resource and property. Land is a non-renewable resource with a limited area. With the development of human society, the demand for land is also growing. In order to make better use of land resources, scientifically plan land use, protect land resources, obtain maximum economic benefits, and achieve sustainable social and economic development, access to land information is very important. Cartography, which originated from the production activities of human society, has a close relationship with the land. With the development of modern information technology, more and more new technologies have emerged, which has promoted the development and change of cartography, network information technology and database technology. This development has also promoted the emergence and development of spatial data infrastructures (SDI). These changes make the acquisition of land information easier, and the types and quantities of information acquired are more diversified and huge.*

Keywords: *cartography, Spatial Data Infrastructures (SDI), geodata, land resources*

Importance (topicality) of research follows from dynamics of SDI development in many countries of the world, thus trends to changing traditional approaches to land mapping are obvious. The demand for production activities originating from human society has developed with the progress of human society and is closely related to land use. In the fourth century BC, there were maps [2] depicted on rocky walls. These original maps are just a few simple line combinations, just a rough picture. Information and data are at the heart of cartography, and the primary method of accessing information is to use a variety of measurement tools. From

the 1950s, the application of electronic information technology, the emergence of computer-aided drafting technology, the emergence of cartography. Great changes have taken place, and digital mapping methods and theories are constantly enriched. Since the 1970s, the application of information network technology and database technology, the establishment of map database, and cartography have entered the digital age (Ning, J.S., 2008). Geoinformation mapping in modern world widely uses data from open sources and SDI-related information. Concerning development of NSDI in Ukraine, including launch of pilot project, current information on land resources in access from SDI services is of high importance.

Overview of recent publications.

The development of information technology and network technology has greatly enriched people's lives and changed society. In order to promote the rapid development of the information society, in February 1993, US President Bill Clinton proposed the implementation of the National Information Infrastructure (NII), establishing a high-speed information network covering the entire United States, providing information services to all US citizens, while reduce the administrative costs of the government. In order to accurately query, describe and express geo-referenced information in high-speed information networks, it is necessary to establish a spatial data framework covering the whole country. Therefore, in 1994.04.13, President Clinton signed the establishment of "National Spatial Data Infrastructure" (NSDI) Presidential Decree No. 12906. In this command, SDI is defined as: "the technology, policies, standards, and human resources necessary to acquire, process, store, distribute, and improve utilization of geospatial data." In addition to the United States, many countries and organizations around the world have also recognized the potential and value of establishing SDI in social, economic, and ecological aspects, and have begun to actively carry out research and construction of spatial data infrastructure. SDI is an information support platform that helps practitioners in different industries create and share spatial resources and data (Rajabifard et al., 2009).

The Danish SDI is based on INSPIRE principles: 1) Data should be only collected once; 2) Data should be maintained where this can be done most effectively; 3) Data should be combinable, regardless of their source; 4) It should be easy to get an overview of the available data and internet services; 5) There should be clear conditions which assure that data can be utilized by many users in many contexts. (Yomralioglu, T., Mclaughlin, J., 2017.)

The prototype of the Map of Open SDI in Europe was presented during a workshop at the INSPIRE 2017 conference. The main objectives of this workshop were to introduce the Map of Open SDI as a tool for measuring and assessing the openness of spatial data infrastructures, to discuss the relevance and applicability of the Map, and to collect input from SDI experts and practitioners on how the tool could be further improved. (Vancauwenberghe, G., Valekait, K., van Loenen, B., & Welle Donker, F., 2018).

Thus, SDI is used widely by land administrators and surveyors as a well-organized and systematized set of data on land, that correspond standards and protocols, avoiding duplicating and excessive metadata.

Aim of the paper – to define main directions of SDI use in land resources

mapping, to analyze approaches to land information organization in such infrastructures.

Materials and methods.

Comparative analysis of SDI initiatives on national and trans-national levels were examined in the study, such countries as the US, Denmark, Sweden, etc., although the most attention was payed to INSPIRE project of the EU, as well as pilot project of Ukrainian NSDI.

Results and discussion.

Although different countries and regions have proposed different SDI definitions and organizational structures according to their actual conditions and needs, in general, the basic structure of SDI is the same, they are:

1. Basic Geographic Information Database
2. Information Network System
3. Policy regulations and standards
4. Administrative organization structure system
5. Technical support system
6. Human resources and personnel training.

The basic geographic information database is the core of SDI. The information network system helps information collection, storage and transmission. Policy regulations and standards define unified standards and principles and provide legal support for SDI.

The administrative organization structure determines the composition of the relevant departments that implement SDI, and clarifies the tasks and responsibilities of each department. The technical support system provides technical assistance during the construction of SDI, and implements some ideas and achievements through technical means.

Human resources and talent development are very important. SDI has applied many new technologies, including many new concepts. Training talents who can understand and apply these concepts and technologies will affect the speed and development of SDI.

The navigation logic should enable novice, 'low-end' users to easily find their way around. The interface should enable novice low-end users to easily create and edit metadata records. This includes consideration of operational and navigational design, graphical and visual design, help information and assistance, the process of entering, editing and retrieving metadata records, and finally technical issues such as response and navigation speed (Rajabifard, A. Kalantari, M. & Binns, A., 2009).

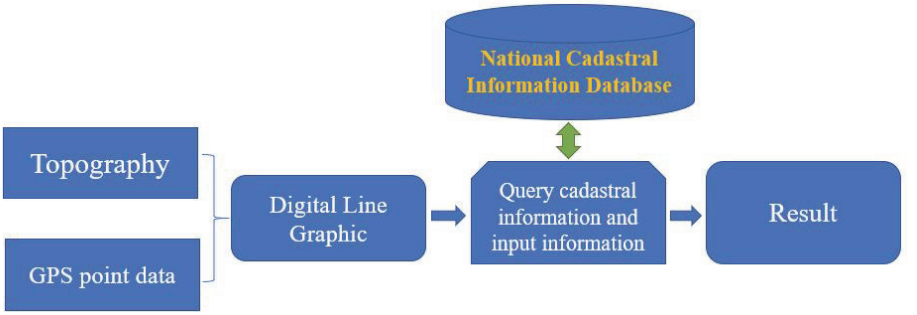

Fig. 1. Working with cadastral information systems

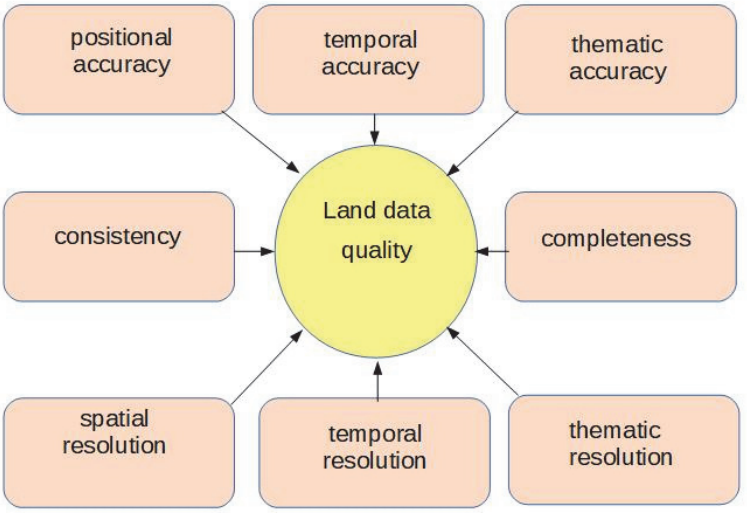

Fig. 2. Land information data and service requirements

Although Ukraine adopted the draft law "On National Spatial Data Infrastructure" by January 23, 2018, in practice, the experience of how to build and apply SDI is still very rare. We need an example to demonstrate how to apply SDI-related systems and mechanisms.

The Ukrainian public cadastre system is an important part of the Ukrainian spatial information infrastructure. Through this system, users with different authorities can obtain different land cadastre information, including land location, area, cadastre number, property ownership, and rights holder information. In addition to finding information, authorized users can upload the collected data to the cadastral system and improve the land information of the cadastral system.

As shown on Fig. 2, according to H. Veregin (1999), the following geodata quality parameters which may be addressed to land geodata quality, are assessed: spatial accuracy (or 'positional accuracy'); temporal accuracy; thematic accuracy; spatial resolution; temporal resolution; thematic resolution; consistency; completeness.

As H. Veregin (1999) mentions, standards provide models for data documentation but not a mechanism whereby users of disparate GIS packages can implement these models for database documentation. A related problem is that standards treat data quality as essentially static.

Generally, SDI standards over the world include requirements to data and metadata quality, quality of services and standardized protocols. One of examples of such approach to standardization in data on land resources is implementation of XML descriptors to land cadastral data in Ukraine.

Thus, such kinds of standards as SDTS or FGDC, may have applicability to SDI and modern geodata on land resources, and main benefit of their use is their flexibility.

Using remote sensing, the electronic total station and RTK technologies, geospatial information of the land is collected, and the attribute information of the target land is input according to the data. After the collected data is processed, it

is drawn into a digital map, uploaded to the cadastral system, and in the cadastre system, the associated information is searched for comprehensive analysis, and the result is finally obtained.

Conclusions.

Land resources mapping is an important task to retrieve actual and precise information on land resources properties and land use. With the development of information revolution, more and more new technologies have emerged, which has promoted the development and change of cartography, network information technology and database technology. This development has also promoted the emergence and development of SDI. These changes make the acquisition of land information easier, and the types and quantities of information acquired are more diversified and huge. Scientific planning, management, and decision-making are of great significance for realizing the sustainable development of land resources. Faced with huge data and social needs, the concept of "National Spatial Data Infrastructure" was proposed and implemented. Although different countries and organizations have proposed different SDI definitions and structures according to their own situations and developments, the basic structure of SDI is the same. The construction and application of SDI integrates the geospatial information and socio-economic attribute information of the land, providing a new and more powerful support for the protection of land resources. With the further improvement of SDI construction, more information and applications will be generated in a friendly, easy-to-use interface.

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ІНФОРМАЦІЯ ПРО ЗЕМЕЛЬНІ РЕСУРСИ В ІНФРАСТРУКТУРІ ГЕОПРОСТОРОВИХ ДАНИХ

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Анотація. *З розвитком сучасних інформаційних технологій виникало дедалі більше нових технологій на стику картогра-*

фії, комп'ютерних технологій, мережевих інформаційних технологій та технологій баз даних. Цей розвиток сприяв виникненню й розвитку інфраструктур геопросторових даних (ІГД). ІГД полегшують отримання інформації про земельні ресурси, а види та кількість отриманої інформації є більш диверсифікованими та мають вищі якісні параметри. Зіткнувшись із "великими даними" (big data) і соціальними потребами, було запропоновано та впроваджено концепцію "Національної інфраструктури просторових даних".

Незважаючи на те, що різні країни та організації запропонували різні визначення й структури ІГД відповідно до власних ситуацій та подій, типова структура ІГД однакова. Побудова ІГД та їх застосування для цілей, пов'язаних із управлінням земельними ресурсами, об'єднують геопросторову інформацію та соціально-економічну атрибутивну інформацію про землю, забезпечуючи нову і більш потужну підтримку для адміністрування земельних ресурсів. Завдяки подальшому вдосконаленню конструкції ІГД, дедалі більше сервісів та додатків із новим, великомасштабним рівнем наповнення інформації буде створено в дружньому, простому і доступному для користувача інтерфейсі.

Ключові слова: *картографія, інфраструктури геопросторових даних, геодані, земельні ресурси*

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ІНФОРМАЦИЯ О ЗЕМЕЛЬНЫХ РЕСУРСАХ В ИНФРАСТРУКТУРЕ ГЕОПРОСТРАНСТВЕННЫХ ДАННЫХ

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Аннотация. *С развитием современных информационных технологий возникало все больше новых технологий на стыке картографии, компьютерных технологий, сетевых информационных технологий и технологий баз данных. Это развитие способствовало возникновению и развитию инфраструктур геопространственных данных (ИГД). ИГД облегчают получение информации о земельных ресурсах, а виды и количество полученной информации более диверсифицированы и имеют более высокие качественные параметры. Столкнувшись с "большими данными" (big data) и социальными потребностями, была предложена и внедрена концепция "Национальной инфраструктуры пространственных данных".*

Несмотря на то, что разные страны и организации предложили разные определения и структуры ИГД в соответствии с собственными ситуациями и событиями, типовая структура ИГД одна и та же. Построение ИГД и их применение для целей, связанных с управлением земельными ресурсами, объединяют геопространственную информацию и социально-экономическую атрибутивную информацию о земле, обеспечивая новую и более мощную поддержку для администрирования земельных ресурсов. Благодаря дальнейшему усовершенствованию конструкции ИГД, все больше сервисов и дополнений с новым, крупномасштабным уровнем наполнения информации будет создано в дружественном, простом и доступном для пользователя интерфейсе.

Ключевые слова: *картография, инфраструктуры геопространственных данных, геоданные, земельные ресурсы*