## Introduction

The adoption of the Law of Ukraine "On the National Spatial Data Infrastructure" (hereinafter – NSDI) and the Resolution of the Cabinet of Ministers "On Approval of the Procedure for the Functioning of the National Spatial Data Infrastructure" laid the legal framework for the development of a modern system of production, supply and use of geospatial data in various fields of activity.

The preamble to the Law of Ukraine "On the National Spatial Data Infrastructure" defines that the creation of NSDI "is aimed at ensuring effective decision-making by public authorities and local self-government bodies", satisfying the needs of society in all types of geographic information...". The realization of this task is possible only if interoperable geospatial data are produced and made widely available in the NSDI environment.

One of the key entities of the National Spatial Data Infrastructure is a geospatial data holder – a state authority, local government body, individual or legal entity that orders, receives and/or owns geospatial data and metadata. It is important to note that although the holder does not directly produce geospatial data, it plays the complex role of a customer. The responsibilities of data holders in the field of NSDI include:

1) ensuring the ordering, creation, use, updating, publication and other actions with geospatial data and metadata for the relevant industry, area or territory;
2) ensuring the relevance, reliability, validity, completeness, accuracy, openness, and interoperability of geospatial data and metadata;
3) providing access to their geospatial data and metadata, and information interaction with other data holders, including through geoportal services.

The main technical problems of the available geospatial data of different holders are:

- inadequate information and technological level of geospatial data, which does not correspond to the level of development of modern geographic information systems, international standards of the ISO 19100 series "Geographic Information / Geomatics", Open Geospatial Consortium standards and requirements of the current legislation of the National Geospatial Data Infrastructure;
- low level of interoperability of core reference and thematic geospatial data, which is a significant obstacle to their integration in the NSDI (Kin et al., 2022);
- lack of specification – a detailed description of geospatial data, which is also a significant obstacle to their effective use;
- lack of metadata on geospatial data, which does not allow searching and preliminary assessment of the content and quality of the required geospatial data.

Therefore, the training program "Fundamentals of interoperable geospatial data creation for the development of NSDI" was developed, which became the basis for special short-term programs and professional (certificate) training programs – program codes: SP/2023/001, SK/2023/001 to solve these problems of geospatial data formation,

## Method and/or Theory

This curriculum was developed following the Resolution of the Cabinet of Ministers of Ukraine "On Approval of the Regulation on the System of Professional Training of Civil Servants, Heads of Local State Administrations, Their First Deputies and Deputies, Local Government Officials and Deputies of Local Councils" of February 6, 2019, No. 106. The curriculum was approved by the decision of the Academic Council of the Kyiv National University of Construction and Architecture (Minutes No. 6 of 17.03.2023) and approved by the State Service of Geodesy, Cartography and Cadastre.

The initial program consisted of 4 modules:

1) Regulatory support, institutional framework and architecture of NSDI.
2) Methodological basis for developing specifications for geospatial data sets.
3) The technology of geospatial data modelling.
4) Methodology of preparation and procedure of metadata registration on the national geoportal.

Each module contained:
1) lecture notes and presentations;
2) a study guide;
3) methodological instructions for practical work;
4) test questions.

Video lectures are available here: https://www.youtube.com/playlist?list=PLt4QhLAtzbr-h5cfo6iKvBt28Vm0W1dqM.
The tutorial is available here: https://land.gov.ua/navchalnyj-posibnykosnovy-stvorennya-interoperabelnyh-geoprostorovyh-danyh/.

**Results**

The developed training courses were appointed for two groups: "Managers" and "Specialists".
The "Managers" group includes directors, deputy directors of specialized departments, heads of departments, deputy heads of departments, and heads of departments.
The "Specialists" group includes deputy heads of departments, heads of sectors, chief, leading, senior, and junior specialists.
There were 8 lectures and consultations for the "Managers" group, and the students' knowledge was assessed in the form of an entrance and final test. The total number of credits is 0.5 ECTS.
There were 16 lectures, 12 practical classes, and consultations for the "Specialists" group.
The students' knowledge was assessed in the form of practical assignments, pre- and post-tests. Total number of credits – 2 ECTS.
The participants received certificates of advanced training with the appropriate number of ECTS credits upon successful completion of the course. The knowledge gained after successful completion of the course is necessary for their further active work in the development of NSDI and improvement of the quality level of geospatial data, which will allow them to start a new stage of development: integration of interoperable geospatial data between different data holders and producers.
The manual covers the general organizational and methodological principles of creating interoperable geospatial data for NSDI, namely:
- development trends, general structure and components of the National Spatial Data Infrastructure, legislation in the field of NSDI, standardization of geographic information and architecture of the National Geoportal (Rajabifard et al., 2006; Crompvoets et al. 2018);
- general concept of geospatial data interoperability, including types and basic properties of geospatial data, geospatial databases, types and features of geoinformation products, reference model of geospatial data interoperability, principles, methods and means of ensuring geospatial data interoperability (Yeung and Hall, 2007; Toth et al., 2012; Karpinskyi et al., 2021);
- methodological bases for developing specifications for geospatial datasets, requirements for the structure and content of specification sections, methods for developing a feature catalogue of geospatial datasets and methods for determining quality requirements for geospatial data (Devillers and Jeansoulin, 2006);
- rules and technology for modelling geospatial data, tools for conceptual modeling of geospatial data using the UML language and requirements for ensuring the compatibility of geospatial datasets (Jakobsson, 2006; Lüscher, 2011; Kent and Hopfstock, 2018);
- purpose and structure of metadata of NSDI geographic information resources, profiles and elements of metadata of geographic information resources, the life cycle of metadata of geospatial data and geographic information services, methodology of preparation and procedure of metadata registration on the national geoportal (Fig. 1) (Brodeur et al. 2019).
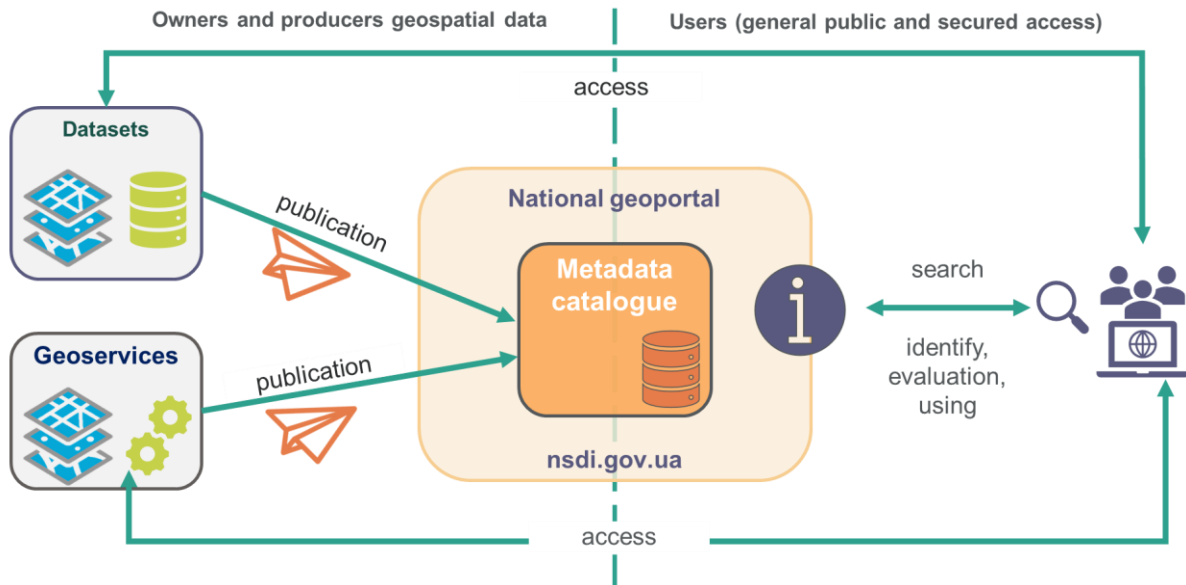
**Figure 1** *Scheme of the main functions of metadata published on the pilot version of the national geoportal (Karpinskyi et al., 2022)*

The main purpose of the manual is to develop competencies and knowledge of officials performing the functions of geospatial data holders sufficient to organize and manage the processes of creating interoperable geospatial data, specifications and their metadata.

The manual is intended for civil servants and specialists of local self-government bodies, whose official duties include ensuring the fulfilment of the functions of geospatial data holders, implementation and use of modern geoinformation technologies in management decision-making systems; students and postgraduates studying in the speciality 193 "Geodesy and Land Management" and other specialities whose educational programs contain components on geospatial data and their use in the environment.

330 managers and specialists of central and territorial executive authorities improved their skills in the area of "development of the National Spatial Data Infrastructure" and received the relevant certificates based on the results of the training course "Fundamentals of Interoperable Geospatial Data Creation" with the support of the USAID AGRO Program.

**Conclusions**

The acquired knowledge and skills allowed managers and specialists of executive authorities to organize work on creating metadata of geospatial data and geoinformation services, which they own; develop structures of geospatial databases, for example, the State Forest Cadastre, the State Water Cadastre, the Geodetic Data Bank, the State Land Cadastre, the State Cadastre of Natural Medicinal Resources, the State Register of Immovable Monuments of Ukraine, the State Cadastre of Natural Resorts, the State Cadastre of Natural Areas of Ukraine, State Cadastre of mineral deposits and occurrences.

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