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SPATIAL DATA MODELING AS A PART OF INFRASTRUCTURE FOR SPATIAL INFORMATION CREATION IN POLAND

Introduction

One of the European Union strategic goals is to achieve sustainable development of its territory as well as to secure industrial and social cohesion in Europe by elimination of different factors (social, economic, historical, physical) which might have deteriorate competitiveness or interrupt EU development. Creating a new, fully integrated information infrastructure with spatial data for the whole Europe, will be one of the elements necessary to achieve previously set goals. These intentions have been presented in the Directive of the European Parliament and the Council, establishing the Infrastructure for Spatial Information in the European Community.

Main idea of the construction and maintenance of this Infrastructure is the principle of common use by all public authorities, of data collected and administrated by one of them, on the basis of their competences and continuously increasing capacity of government to implement public tasks.

To make sharing data possible within the Infrastructure for Spatial Information without any restrictions, it is necessary to provide possibility of cooperation in technical aspects for organization units, spatial data services and to ensure interoperability of

data. Useful implementation of the principles of interoperability, resulting from INSPIRE Directive, needs data harmonization based on inventory of existing data and precise planning of idea and cooperation in Infrastructure for Spatial Information. By data harmonization it is meant action on legal, technical and organizational perspectives, to achieve coherence of those sets and their adaptation to common use.

The aim of the analysis is to verify users needs, business processes and their optimalization, data identification which should be included in the infrastructure, identifying and eliminating unnecessary duplication of data, as well as optimalization in use. It means the need to create a new model, the most effectively functioning of data entities and subjects in the Information Infrastructure.

Among the activities aiming to provide interoperability of spatial data, the most important are:

1) developing of national legal basis, defining and regulating fundamental organizational, technical and semantical rules in relation to the construction, actualization and free spatial data flow;
2) creation of spatial data model, applications models and concepts based on international regulations;
3) defining the scope of the data, their specification and services of information infrastructure, ensuring their interaction;
4) creation of technical and technological basis for the exchange of spatial data infrastructure, based on current standards for information and data exchange. Development of technical rules for the acquisition, processing and use of data, including the rules of creating, updating and processing spatial data sets. Various georeference models inherits all characteristics of General Geodetic Object .

According to the Article 24, paragraph 1 of the INSPIRE Directive, member countries have to bring into use the legislative, executive and administrative regulations, necessary to execute this Directive. Draft of the spatial information infrastructure law, that is by now proceeded in Poland, is a response to this commitment. It defines the rules of developing the Infrastructure for Spatial Information including, by amendments to the Geodetic and Cartographic Law, operating principles of geodatabases, which are the basis for the Infrastructure for Spatial Information.

One of the tools supporting the Infrastructure for Spatial Information (IIP) creation is the Project called "Working out and implementing innovative methods of integration of cadastre data, base map and Topographical Database (TBD) and modernisation of services provided by Geodetic and Cartographic service", co-financed by Finacial Mechanism for the European Economic Area, implemented by the Main Surveyor

of Poland, Mazowieckie Province Government, the Mayor of the city of Płock and the County Chief Official of Piaseczno.

One of the main issues of this Project is to create an integrated model, including cartographic model, data collected in the databases, reffering to Regulation of the Ministry of Regional Development and Construction issued on the 12 July 2001 on detailed principles and mode of establishment and management of national geographic information system and elaboration drafts (projects) of new legal regulations for geodesy and cartography.

Thematic range of the model includes:

1) databases of detailed geodetic control networks;
2) databases of geodetic register of land and buildings (cadastre);
3) databases of geodetic register of utilities;
4) databases of topographic objects database included in the scope of Base map;
5) databases of Topographic Database with Digital Terrain Model for voivodeship level;
6) hydrographic and sozologic databases;
7) register of real estate prices and values

General principles of georeference data model

Draft version of Infrastructure for Spatial Information Law consolidates the importance of geodetic and cartographic data as a basis (georeference) for the construction of other spatial databases included in the Infrastructure for Spatial Information. Therefore it became necessary to set the relationship not only between internally managed data by Geodetic and Cartographic Service but also implementing solutions to enable cooperation of all units within the whole Infrastructure.

Data models defined in the Project, according to the INSPIRE Directive - "In order to benefit from the state of the art and actual experience of information infrastructures, it is appropriate that the measures necessary for the implementation of this Directive should be supported by international standards and standards adopted by European standardisation bodies …. "- were developed in accordance with ISO 19100 norm rules.

Solution proposed in the Project is based on a conception of General Spatial Object, General Geodethic Model and Various Georeference Models. General Spatial Object is the basis for construction of the harmonized spatial database included in the National Infrastructure for Spatial Information. It represents any object from real world

and is a generalization of all similar objects with spatial location, contained in the Information Infrastructure in Poland. All the attributes assigned to General Spatial Object are inherited by the General Data Models, administrated by different entities of the Infrastructure for Spatial Information, so it will be possible to develop a methodology to create infrastructure in accordance with the idea of interoperability.

Data managed by Geodetic and Cartographic Service and General Geodetic Model are one of data groups set among the Infrastructure for Spatial Information project.

General Geodetic Model is a particularization of General Spatial Model (OMP). It means that General Geodetic Model inherits all characteristics from General Spatial Model, particularizing it to the proper level for the reference data. This rule is shown on the Figure 1:

General Spatial Model

Is representing any spatial object from real world on the highest level of abstraction and generalizes all objects which have spatial location from different models which are building Infrastructure of Spatial Information in Poland.

↓

General Geodetic Model

General standard for defining object classes,

identify data categories and their attributes

↓

Particular Georeference Models

Data model being constructed within the Project and administrated by the Geodetic Service, will implement the principles and rules set in the INSPIRE Directive, the draft of Infrastructure for Spatial Information Law and amended Geodetic and Cartographic Law, together with ISO norms. It was built based on comparative analysis of registers content, records and databases, kept by Geodetic and Cartographic Service and needs, purposes and responsibilities of public administration (governmental and self governmental), communes, counties, voivodeships (regions) and State Treasury. It keeps independence from computer environment and organization structure. Proposed

data model will consist of verified object database, which will ensure harmonization of geodetic and cartographic data. As a part of built model, the nationwide homogenous system of explicit, unique identifiers for reference objects was elaborated and also system of "aim of life" changes of objects over time (life cycle), in order to assure the possibility to recall the objects history for any moment.

As a data interchange format, GML language has been proposed. Moreover, designed model defines data series and series of metadata and determines rules of feeling attributes of metadata It also assumes that for data exchange between levels of data collection, spatial services WMS/WFS will be implemented.

Detailed rules for georeference data model

Interoperability data foundations:

1) data model;
2) nationwide homogenous system of explicit, unique identifiers for the objects ;
3) standardized data structures;
4) using of standardized definitions and dictionaries for the same type of objects in the resource of main component of basic spatial data infrastructure (detailed geodetic control networks, cadastre, databases of geodetic register of utilities, base map) and Topographic Database and also thematic databases or rules of transformation for dictionaries when the same objects in different resources are not based on the same dictionaries.

Within General Geodetic Object, General Spatial Object has been identified. Between General Spatial Object and General Geodetic Object there exists a relationship of attributes inheritance – General Geodetic Object despite its own attributes has also General Spatial Object attributes.

The following attributes have been proposed for General Spatial Object:

1) idIIP – attribute (homogenous, unique identifiers which will allow to identify precisely object among the IIP; will also ensure the use of object by other organizations as an explicit reference for "their" objects or attributes;
2) startObiekt: DateTime (attribute which shows the date of implementing object to the database);
3) startWersjaObiekt: Data Time (attribute showing date from when object has changed its characteristics in time);
4) koniecWersjaObiekt: DateTime (attribute showing date when the object has been transformed into other different object of real world);
5) koniecObiekt: DateTime (attribute showing date when object is placed in the

archive);

6) referencja: PowiazanieObiektow (attribute showing relations between objects);
7) geometria: Geometria (value – any feature of the object is modeled as the geometry).

It is recommended for General Geodetic Model, despite attributes presented above, to have also following ones:

1) rodzajReprGeom:RodzajReprGeom (geometry type);
2) uwagi: CharacterString; (remarks);
3) uzytkownik: CharacterString (attribute storing data on unit/person inserting/updating data);
4) zrodloDanychAtr: ZrodlaDanych (attribute storing information on data source);
5) zrodloDanychGeom: ZrodlaDanych (attribute storing information on geometry of data source);
6) katIstnienia:KatIstnienia (attribute storing information on object status: under construction/destroyed/stand-by mode/ etc).

General Geodetic Object is a basis for harmonization of databases collected in National Geodetic and Cartographic Resource. Various Georeference Models inherit all General Geodetic Object features. It was assumpted that various georeference models reflect in-use Polish databases, administrated by Geodetic and Cartographic Service, published in the regulation mentioned above (detailed geodetic control networks,databases of geodetic register of land and buildings (cadastre),databases of geodetic register of utilities, databases of topographic objects database included in the scope of Base map, databases of Topographic Database with Digital Terrain Model for voivodeship level, hydrographic and sozologic databases, register of real estate prices and values).

The developed data model was based on an analysis made among public administration and its executive bodies, which was to revise the catalogue of objects and its attributes and to use it to fully satisfy users. In addition, verification of catalogue of objects was conducted, which intended to eliminate incoherence in the definitions of objects, unnecessary redundancy of objects and attributes between databases – to harmonize them. The next step was to assess and justify the advisability of collecting information about objects in databases, managed by the Service and verification of its geometric records. For each data set, there is a record of metadata, which is a main source of information on this resource. It also provides the basis for data sharing and information exchange between the systems.

The implication of the main assumptions for developed data model are following rules for functioning georeference data within Geodetic and Cartographic Service:

1) databases of detailed geodetic control networks, databases of geodetic register of land and buildings (cadastre), databases of geodetic register of utilities, databases of topographic objects database included in the scope of Base Map are the base component of georeference spatial data;
2) updating georeference databases may exist on the basis of credibility and good quality documentation or by updating one database on data from other with use of generalization processes;
3) databases with the same document of updating are compatible with each other in IT systems dealing as well with INSPIRE service;
4) databases of detailed geodetic control networks, databases of geodetic register of land and buildings (cadastre), databases of geodetic register of utilities, databases of topographic objects database included in the scope of Base map are the base for current TBD actualization;
5) for the purpose of the current updating of the Topographic Database, National Register of Geographical Names and National Register of Borders are used. But also other registers maintained by public authorities like databes of building numbering order conducted by communes or ones under Mazovia Spatial Information System;
6) current update of Topographic Database is made in accordance to differential protocols together with generalization processes;
7) periodic update of Topographic Database is made based on ortophotomaps and field research works;
8) each object is implemented into database only once, there is no copy in other database;
9) communication and cooperation among georeference databases and IT tools is carried out using the services of the INSPIRE;
10) information from georeference database is accessible for other systems and data recipients, not only by network services and data flow but also by presenting part of or the whole database in a cartographic version;
11) cartographic projection is implemented by the system through the principles described in the cartographic models.

In Particular Georeference Models, object attributes are directly referred to their features in the field. This means that not every attribute can be filled in for particular real-world objects. That's why, "nil reason" rule has been implemented to the model frameworks and rules of its use have been cleared. This rule deteminate rules when filling in attribute values is not possible to fill in one of gaps e.g. due to lack of

information or no access or in particular cases when the information has nothing in common with described object.

Identifiers and relationships and reference between objects

Under Infrastructure for Spatial Information there will be accessible various data from different entities and databases and objects in these databases may have different attributes. In order to use those data effectively, it is necessary to provide uniform rules for identifying Spatial Information Infrastructure objects. It was assumed that in the Infrastructure for Spatial Information objects which won't be referenced one for another may function and for such objects there is no need to set unique and stable value for identifiers.

The developed data model assumes that the same naming rules are valid for all Infrastructure for Spatial Information reference objects.

Identifier immutability is necessary to create references to IIP objects. It's unacceptable, when an Infrastructure for Spatial Information object would be used as a reference in different system, and after a while it would not be possible to identify it again. Thanks to unique and unchanging identifier, regardless from which database object comes or of what type is, it is possible to recognize it and use as reference one.

In accordance to the Directive for action support and technical solutions by international standards and standards adopted by European Standardization Bodies, in developed data model IdentyfikatorIIP has been defined in accordance with INSPIRE Generic Conceptual Model specifications. The IdentyfikatorIIP class contains three attributes:

1) namespace, which identifies data source;
2) local identifier, given by data uploader, unique among others;
3) IIP version object identifier.

The namespace is composed of two parts:

1) two-letter country code – according to ISO 3166 it is PL for Poland;
2) mark of spatial information resource to which objects belong to.

Requirement of identifier immutability is accomplished when two of them are unchangeable – namespace and local identifier. It is unacceptable situation when during data publication, new local identifiers are generated, which had been given their ID previously. The third part – object version ID is changed together with version change, which allows to distinguish versions. With the attribute changes, "object version ID" still provides clear identification of the IIP object.

IIP identifier in its structure contains elements compatible with the requirements of the INSPIRE Directive:

1) technical (elements distribution, data types, requirements);
2) essential (meaning of each ID element);
3) organizational (dealing with existing databases).

Identifier for each object must have unique value across the entire country but does not need to provide any extra information (eg. who is the information provider, what area is concerned, etc.) and its value cannot be changed throughout the life cycle.

According to the developed concept, it is proposed that the namespaces for the Spatial Information Infrastructure are managed on central (national) level.

Another very important element, which is necessary for the effective implementation of the principles of interoperability (ie. data sharing) is to identify for objects other objects, which are related to each other and there is a reference between them. In this data model on General Spatial Object level the referencja:PowiazanieObiektow attribute exists, which in a clear way presents relation among other objects. This principle allows to obtain uniform object references rules in all models, within Geodetic Model (eg. National Geographic Names Register, National Borders Register) as well as in other domain models among IIP – eg. statistics, geology. This attribute may indicate one or more objects, on spatial or non-spatial.

Another very important interoperability element is ability to reproduce the state of object at any moment in the past. Each Infrasture's object should have attributes which allow to record its cycle of life in a uniform manner.

Summary

As a result of experience and works made by Mazowieckie Voivodship to create Information for Spatial Infrastructure, regional Infrastructure for Spatial Information base has been created and is still developed. It is based on creation of new databases and systems, updating those data, data sharing and providing services to databases.

Regional base of Information for Spatial Infrastructure may be defined according to this formula:

$$W = \sum_{i=1}^{n} P_p + O + P + \sum_{i-1}^{n} F + \sum_{i-1}^{n} D + \sum_{i-1}^{n} R_t + \sum_{i-1}^{n} Z_l + \sum_{i-1}^{n} F_i$$

Pp – law regulations,

O – organization,

P – defined and standardized Infrastructure for Spatial Information procedures and processes,

F – functionality based on standardized Infrastructure for Spatial Information procedures and processes,

D – Infrastructure for Spatial Information data,

Rt – technical solutions based on international and European standards,

Zl – human resources,

Fi – financial resources.

Within the Project "Working out and implementing innovative methods of integration of cadastre data, base map and Topographical Data ase (TBD) and modernisation of services provided by geodetic and cartographic service", after completion of professional activities on integrated data model, there will be carried out further work on principles of functioning databases and georeference records. Among these works, it is decided to develop, test and bring into use certain mechanisms and IT tools providing effective and efficient implementation of the interoperability principles of spatial data sets and services in Mazowieckie Voivodship. This also means introducing topographic database update procedures from voivodship level using as a support data from county level.

Further activities under the project are:

1) develop and implement IT/ICT system providing mechanisms:
   - to manage geodetic data and source data from county level,
   - for online services for citizens and business,
   - for topographic objects databases update sharing on regional level;
2) develop and implement teleinformatics (IT) system dealing with management and topographic databases updates on regional level.

All the results obtained from the Project, once finished, may be used throughout the country. The owner of the effects will be the Main Surveyor of Poland.

Literature:

Expert works documentation of cartographic and geodetic data model realized among the Project "Working out and implementing innovative methods of integration of cadastre data, base map and Topographical Data ase (TBD) and modernisation of services provided by geodetic and cartographic service".

Abstract

This paper focuses on the data modeling and its role in building the Information for Spatial Infrastructure. It is based on Mazowieckie Voivodship experience and effects from the Project "The development and implementation of innovative methods for the integration of cadastral data, maps and Topographic Database and modernization of public services provides by National Cadastral and Cartographic Service". This project is being co-financed by Fianacial Mechanism for the European Economic Area, operated by the Main Surveyor of Poland, Mazowieckie Voivodeship Government, the Mayor of the city of Płock and the Prefect of Piaseczno.

Paper describes the range of data which have been modeled and rules adopted in the process of modeling.

Developed data model will be implemented into the regulations of amendments to the Spatial Information Infrastructure Law and Cartographic and Geodetic Law. It means databases of detailed geodetic control networks, databases of geodetic register of land and buildings (cadastre), databases of geodetic register of utilities, databases of topographic objects database included in the scope of Base map as well as topographic objects in the 1:10 000 scale, towns, streets and addresses record, national borders record, territorial units, hydrographic and sozologic thematic elaborations and the conduct and update various databases within the national geodetic and cartographic resource and detailed logical principles and organizational procedures of data exchange at the county (powiat) and voivodeship (region) and country level will be made.

Abstract / Streszczenie

Niniejszy referat dotyczy aspektów modelowania danych i ich roli w budowie Infrastruktury Informacji Przestrzennej. Oparty jest o doświadczenia Województwa Mazowieckiego oraz efekty Projektu *„Wypracowanie i wdrożenie innowacyjnych metod integracji danych katastralnych, mapy zasadniczej i Bazy Danych Topograficznych oraz modernizacja usług publicznych świadczonych przez służbę geodezyjną i kartograficzną*", współfinansowany z Mechanizmu Finansowego Europejskiego Obszaru Gospodarczego, realizowany przez Głównego Geodetę Kraju, Samorząd Województwa Mazowieckiego, Prezydenta Miasta Płocka, Starostę Piaseczyńskiego.

Referat opisuje zakres tematyczny danych, które podlegały modelowaniu oraz zasady przyjęte w procesie modelowania.

Opracowany model danych stanowić będzie merytoryczny wkład do aktów wykonawczych nowelizowanego Ustawą o infrastrukturze informacji przestrzennej, prawa geodezyjnego i kartograficznego tj. rozporządzeń dotyczących osnów geodezyjnych,

ewidencji gruntów i budynków, geodezyjnej ewidencji sieci uzbrojenia terenu oraz w bazy danych obiektów topograficznych objętych treścią mapy zasadniczej, obiektów topograficznych o szczegółowości 1:10 000, ewidencji miejscowości, ulic i adresów, państwowego rejestru granic i powierzchni jednostek podziałów terytorialnych kraju, opracowań tematycznych – hydrograficznych i sozologicznych oraz organizacji i trybu prowadzenia, aktualizowania poszczególnych baz danych w ramach państwowego zasobu geodezyjnego i kartograficznego.