

# Delimitation of reference geodata from land data model

## Vymezení základních geoprostorových dat na úrovni pozemkového datového modelu

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### Abstract

*The paper deals with possibility of delimitation of some reference geodata, its characteristic features and function in current land data model of Cadastre of Real Estate of the Czech Republic, inclusive the concept of some appropriate modifications. The report acquaints with definitions of used basic terms and monitoring objects. Data elements of digital cadastral map and procedure of construction of land data model feature catalogue and its attributes are described. The paper analyzes conception of the list of objects and attributes from fundamental base of geographic data with categorization according to proposal of amendment of Decree No.31/1995 Coll., performing the Act No. 200/1994 Coll., on Surveying and Mapping. The result is the comparison of this normative with proposal of infrastructure for spatial information in Europe (INSPIRE), published in the form of directive of the European Parliament (Directive of the European Parliament and of the Council establishing an infrastructure for spatial information in the Community), and the possibility of affection of the content and filling up of databases at national level.*

### Abstrakt

*Studie se zabývá možností vymezení některých základních geodat, jejich charakteristických vlastností a funkcí ve stávajícím pozemkovém datovém modelu katastru nemovitostí ČR, včetně návrhu některých vhodných úprav. Příspěvek seznamuje s definicemi použitých základních pojmů a sledovaných objektů. Jsou popsány datové prvky digitální katastrální mapy a postup konstrukce katalogu objektů pozemkového datového modelu a jejich atributů. Je analyzován návrh seznamu objektů a atributů základní báze geografických dat s kategorizací podle návrhu novely Vyhlášky č.31/1995 Sb., kterou se provádí zákon č.200/1994 Sb., o zeměměřictví. Výsledkem je porovnání tohoto normativu s návrhem infrastruktury prostorových dat v Evropě (INSPIRE), publikovaného ve formě směrnice Evropského parlamentu (Directive of the European Parliament and of the Council establishing an infrastructure for spatial information in the Community), a možnosti ovlivnění obsahu a naplňování datovýchází na národní úrovni.*

## Reference geodata, characteristic features

The issue of delimitation of reference geodata plays a crucial role in the area of geographic information systems. Rational administration and meaningful exploitation of resources are priority requirements for permanently maintainable development of society. For managing of these processes the society have to create and guarantee uniform and binding mechanisms and procedures so that tools spent to area of information systems (IS) could be invested effectively with guaranty of backflow.

Economic balances of building GIS projects calculate with costs for geodata, software and hardware approximately in relation 80 : 15 : 5. High input costs for primary collection, sequential custody and guidance including updating of geodata are often not only basic limiting factor of extension of GIS technologies in some areas of managing the society but simultaneously the most perspective area for optimisation and rationalisation of this process with maximum effect. Fundamental instrument for this process is building of national geoinformation infrastructure (NGII) [1] and warranty of functional information systems for public administration (ISVS)<sup>1</sup> with reference data registers filled with binding reference data.

Geodata are meant as a location data (direct or indirect localisation and elevation) that secure integration of thematic<sup>2</sup> and application databases. Reference geodata has an integration character and forms common basic content for most thematic or application databases exploited in spatially oriented decision making. Reference geodata secure location of reference features, they are applicable independently and they allow integration of data from many sources. Common characteristic of these data is assumption of direct location in accuracy and particularity achievable for land parcel level (not topographic level).

## Reference data funds and bases of geodata

The issue of geodata world-wide faces for searching tools, instruments and creating conditions for maximum exploitation of geodata. National geoinformation infrastructure of the Czech Republic is an order of each other linked projects that ensure and access requested geoinformation for wide circuit of users. Separate projects in the sense of NGII should be especially:

- delimitation of reference data funds of geodata and processing of analysis of their current state,
- database of reference horizontal control of the Czech Republic,
- fundamental base of geographic data (ZABAGED),
- orthophotographic imagery of territory of the Czech Republic,
- digital cadastral map (DKM),
- fundamental registers of territorial identification and real estates.

Act of Parliament No. 319/2004 Coll. that assumes a right on 1<sup>st</sup> January 2004 and amends an Act No. 200/1994 Coll., on surveying, is in § 4a set that fundamental base of geographic data (ZABAGED) is an obligatory source of data for creation of information systems for public administration containing geographic, topographic and geodetic data from all territory of the Czech Republic.

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<sup>1</sup> **Information systems for public administration** – file of information systems that serve for function of public administration.

<sup>2</sup> **Thematic databases** – databases created for user's applications or generated by these user's applications.

## Project of creation of digital file of geodetic information

Complete replacement of graphical cadastral maps with maps in digital form is one of the primary conditions of complex realisation and functioning of the information system of cadastre of real estates (ISKN) that belongs among the most voluminous and complicated information systems of public administration. This system should among others ensure efficient and secure process of filing up of lands and their transfers. High requirements are to be insisted on technical reliability of the system and quality of data. File of geodetic information (SGI) should be transformed with essential way so that it became a base of geodata with maximum particularity. Declared relative accuracy of current cadastral maps should be achieved and should be moved up according to needs and demands of other users of the map that represents subjects of mapping with reliable location and geometric accuracy. There is a possibility of combine legal aspects of cadastral maps with spatial elements from databases of information systems. Thereby there will be set a ground for multipurpose cadastre to which a number of European countries faces. Data maintained in ISKN should be one of important sources of information about the changes in updating of fundamental base of geographic data (ZABAGED). Digital SGI should become a main source of data for creation of cadastral layer of digital State Map 1: 5 000 (SM 5).

Methodics of DKM creation in locality of fathom map described in [4] was already submitted with intention of conceptual solution of DKM maintenance. It is obvious that complexity of process of DKM maintenance will be dependent on level (type) of revised digital cadastral map. Final solution is achieving the uniform level of DKM maintained in environment of ISKN. Time framework for this goal is not real in several coming years. Therefore it is proposed to run on successively so that priority thing is above all the uniformity of methodics of maintenance and adopting the results of survey activities for cadastre with guaranteed parameters of accuracy and also warranty of property law relations. When solving the digitalisation by stages there is a chance to fill up continuously fundamental registers of ISVS with required features<sup>3</sup> (in initial phase e.g. with cadastral unit<sup>4</sup> delimited by a component of cadastral map – adjusted cadastral border) that are delimited and guaranteed by cadastre of real estates.

In process of maintaining so created DKM the emphasis is put on quality of investigation and surveying of researched facts together with responsible completion of all revised information. Therefore technical and legal reliability of cadastral operate (KO) continuously increase. In order that results of digitalisation would be available for all survey activities that rises from current KO or are tied together with this KO eventually update it in a short time a step-by-step solution of digitalisation is proposed with priority accent on creating the seamless representation of “PK” maps on the whole territory of the country, surveying of changes in S-JTSK geodetic reference system and maintaining the DKM in the form of hybrid digital cadastral map that enables continuous specifying of rebuilt KO. Crucial is a proposal of creating and filling up of database of fixed points (DB PB) for wide extension of activities. Particular information was published e.g. in [5].

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<sup>3</sup> **Feature** – model representation of a geographic entity of real world that cannot not be divided into the units of the same class or a set of these entities with common value of attribute.

<sup>4</sup> **Cadastral unit** – technical unit that consists of descriptively closed and in cadastre commonly registered file of real estates.

## Required qualitative attributes for geodata

Generation of complex geospatial information is subjected to positioned and time defined data that are produced from various sources, institutions or even by various geosciences. System tools of GIS ensure administration of these data and generation of required complex geospatial information. This information is essential for decision-making processes of managing of permanently sustainable evolution of society and their quality. Quality of decision-making processes is dependent on quality of geodata and geospatial information. There is a set of uniform criterions for quality evaluation of geodata: **accuracy**, **resolution** (particularity), **data consistency** and **data completeness**.

- **Accuracy**

Accuracy is always fixed on basic elements of data model and is relevant characteristics of a given element. Disharmony between coded and real value of attribute of the element is called **error**. Accuracy is always only relative feature of element because it is fixed on specific description of element and on level of generalization.

**Positional accuracy** of feature is a characteristics of localization and of geometric parameters of element. For elements a positional accuracy is defined as a spatial distance between coded (modelling) position of element and its position in the real world = positional accuracy. Positional accuracy is described by means of classic statistic quantities like *standard deviation*, *mean co-ordinate error* or *mean position error* of characteristic points of element.

**Time Accuracy** expresses time limits in that the given element is valid. It is about setting a time or time interval where attributes of picked element are defined or were defined.

**Thematic accuracy** is a criterion of reliability of thematic attributes of given element and is analysed in dependence on type of rated object. Thematic accuracy analyses also suitability of insertion of objects into categories (point, polygon, area etc.)

- **Resolution**

Resolution of features is dependent on selected data model and expresses amount and values of details different in space, time and theme. Resolution is limited above all by level of generalization (simplification) of given feature or phenomenon.. It is obvious that two bases of geodata with the same accuracy and different resolution have the same quality.

**Space resolution** expresses value of still estimated spatial details or minimum size of the feature. In case of picture interpretation of element the space resolution is expressed by size of pixel of the raster.

**Time resolution** is qualified by minimum time duration of event (phenomenon). It is dependent on type and character of examined phenomenon.

**Thematic resolution** matches to accuracy of insertion to given category of feature. For setting the categories thematic resolution represents delimitation of two related categories.

- **Data consistency**

Data consistency represents the level of conflicting or pro-multiple data for description of given feature or phenomenon. Data consistency implicates final reliability and quality of generated information.

**Space data consistency** is tested by topological functions of GIS and by ability of generating these data from syntax features.

**Time data consistency** is given by a condition that only one event might occur in a certain time on certain place.

Interaction of temporal and spatial links of generated information is dependent on **thematic consistency** of attributes.

- **Data completeness**

Disharmony between data saved in databases and data required for description of generalized representation of an object is defined as a parameter of **data completeness** that can be rated from space, time and thematic content aspects.

## **Creation of DKM feature catalogue**

One of the basic data funds for filling up and updating of databases of infrastructure for spatial data at national level is the digital cadastral map (DKM) that is created in process of digitalisation of file of geodetic information (D-SGI). Content of cadastral map<sup>5</sup> as a part of SGI is set by Decree No. 190/1996 Coll. where particular specification of individual subjects is mentioned. Structure of DKM is described in the regulation “Struktura a výměnný formát digitální katastrální mapy a souboru popisných informací katastru nemovitostí České republiky a dat BPEJ version 1.3 (from 24<sup>th</sup> November 1999 reference 5270/1999-22)”. This regulation together with Decree No.190/1996 Coll. create the background for proposal of DKM feature catalogue.

The first step in creating of catalogue was selection of subjects of DKM content from above mentioned sources. The second step was the uniform identification of subject of DKM content by means of combination of codes of map symbol, description, category of land use, form of land exploitation, type of building, form of building exploitation, type of real estate protection and form of real estate protection (see picture 1).

Some subjects of DKM content can be comprehended directly as a feature. But some of them, as e.g. municipal border, do not fulfil above noticed definition of feature. The third step was finding of appropriate names of features for these subjects of DKM content or finding generate-able combinations of subjects of cadastral map (building (feature) → building-site  $\cap$  inner lines in parcel (subjects of DKM content)). Examples of some subjects and assigned features are on picture 1.

Final step was the distribution of features into spatial data themes that correspond with proposal of INSPIRE. Final proposal of feature catalogue was prepared in the form of 3 annexes.

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<sup>5</sup> **Cadastral map** – planimetric map at large scale with geonames that display all real estates and cadastral units that are subjects of cadastre. Real estates are displayed in cadastral map by projection of its borders to projection plane, they are marked with parcel numbers and with symbols of kinds of real estate; buildings are displayed by projection of its external outlines.

CODE						SUBJECT OF CONTENT OF DKM	FEATURE	
Code of map symbol	Code of description	Type of land use	Form of exploitation of land	Type of building	Form of exploitation of building			Type of real estate protection
2.18							inner line	
4.02			1-4	6			masonry, concrete or iron building	building
4.03				19			wood building	
2.19							parcel border	
2.01							state border	territory of Czech Republic
2.03							region border	region territory
2.04							district border	district territory
2.05							municipal border	municipal territory
2.06							cadastral territory border	cadastral unit
2.19							parcel border	parcel
18							parcel number (definition point) of land parcel	
28							parcel number (definition point) of building parcel	

Picture 1. Examples of some features and form of coding

## Proposal for a Directive of the European Parliament

Dilemma of fundamental funds of geodata is nowadays intensively monitored also in the process of preparing the European project INSPIRE (Infrastructure for Spatial Infrastructure in Europe). So-called reference data (equal to core data) delimited as data needed for identification of location of a physical feature (natural or artificial) and serving for visualisation of other information in geospatial context are defined in these bases. Reference data are applicable independently and serve as an objective reflection of the real world. On other site they are characterized as "data providing an unambiguous location for a user's information, enabling the merging of data from various sources and providing a context to allow others to better understand the information that is being presented". It is expected that each country of EU will have to continuously ensure accessibility of following reference data:

- coordinate reference systems,
- geographical grid systems,
- geographical names,
- administrative units,
- transport networks,
- hydrography,
- protected sites,
- elevation,
- identifiers of properties,
- cadastral parcels,
- land cover,
- orthoimagery,
- buildings.

Project INSPIRE monitors creating of functional information system which will enable the choice of user-needed databases at the European territory (metainformation respectively catalogue services) and their publication to user or direct exploitation and modification as information and data services. As a part of INSPIRE solving of dilemma of reference data

(their delimitation), conditions of access to data and conditions connected with their exploitation and standardisation is also explicitly monitored.

Proposal for a Directive [8] emanates from the recommendations of INSPIRE working groups. Proposal set the licensing and pricing policy for geodata sharing mechanism. Furthermore it guarantees the right of the public to discover datasets and related services on metadata base for free. Viewing of these data and following functions: display, navigate, zoom in, zoom out, pan, overlay of data sets and visualization of legend and of all content of metadata is also ensure for free. Download and copy of data sets or their parts will be paid.

The proposal includes the list and brief description of spatial data themes that should be part of infrastructure for spatial data. Sixty themes were defined in the initial proposal of INSPIRE. These themes were chosen during conferences, meetings and consultations of working groups but also by involved organizations and member countries. Regarding to high costs of their implementation a working group for re-examination the scope of themes was created. Its proposals are described in the Scoping Paper [3]. Reduction of themes proceeded in a very short time (2-3 months). The choice was made only by the working group and the member countries and involved organizations had no chance to affect the content of infrastructure. In proposal for the Direction of the European Parliament the content was changed again. Now, there are 31 themes divided into three groups.. Spatial data themes from the third group containing mostly thematic data referred especially to the environment were not included into the feature catalog.

## **Comparing DKM feature catalogue and object catalogue ZABAGED with requirements of INSPIRE**

In July 2004 the above mentioned Proposal for a Directive of the European Parliament [8], containing spatial data themes that should be a part of the national level of INSPIRE, came in force. A comparison of requirements for this proposal with above mentioned DKM feature catalogue and object catalogue of ZABAGED was carried out. Results of comparison are noticed in the following table.

Spatial data themes	Appearance in		Notice
	DKM feature catalogue	object catalogue of ZABAGED	
Coordinate reference systems	yes	yes	Systems for uniquely referencing spatial information in space as a set of coordinates (x, y, z) and/or latitude and longitude and height, based on a geodetic horizontal and vertical datum.
Geographical grid systems	no	no	Harmonised multi-resolution grid with a common point of origin and standardised location and size of grid cells.
Geographical names	yes	yes	Names of areas, regions, localities, cities, suburbs, towns or settlements, or any geographical or topographical feature of public or historical interest.

Administrative units	yes	yes	National territory divided into units of administration for local, regional and national governance. The administrative units are separated by administrative boundaries. Also includes the boundaries of national territory and the coastline.
Transport networks	yes	yes	Road, rail, air and water transport networks and related infrastructure. Includes links between different networks. Also includes the trans-European transport network as defined in Decision 1692/96/EC and the future revisions of this decision.
Hydrography	yes	yes	Hydrographic elements, both natural and artificial including rivers, lakes, transitional waters, reservoirs, aquifers, channels or other water bodies, where appropriate in the form of networks and linked with other networks. Includes river basins and sub-basins as defined in Directive 2000/60/EC.
Protected sites	yes	yes	Area designated or regulated and managed to achieve specific conservation objectives.
Elevation	no	yes	Digital elevation models for land, ice and ocean surface. Includes terrestrial elevation, bathymetry and shoreline.
Identifiers of properties	yes	no	Geographic location of properties based on address identifiers, usually by road name, building number, postal code.
Cadastral parcels	yes	no	Areas defined by cadastral borders, with specific legal status of ownership.
Land cover	yes	yes	Physical and biological cover of the earth's surface including artificial surfaces, agricultural areas, forests, (semi-) natural areas, wetlands, water bodies.
Orthoimagery	no	yes	Geo-referenced image data of the Earth's surface, from either satellite or airborne sensors.
Buildings	yes	yes	Geographical location of buildings.

Table 1. Comparison DKM, ZABAGED and INSPIRE

## Resume

A range of problems, as e.g. ambiguous or to date unspecified correlations, slow realization of projects or absence of required data on the whole territory of the Czech Republic, is



connected with the delimitation of reference geodata. Furthermore it is about first of all the level of reached particularity and accuracy of reference geodata, homogenisation of current geodata and repeated financing of geodata acquiring in the same category that have integrated character and create common fundamental content of most thematic or application data bases used in space oriented decision-making processes of public administration and apart of it. The mechanism of continual updating and consistent complying with the International Standard ISO 19100 – Geographic information is also not satisfactorily solved.

It is inevitable to enforce fundamental principle that reference geodata present in the competence of public administration a strategic national source with extra value that is given by relative high costs of its acquisition, updating and administration financed mostly from the state budget. Therefore it is necessary not only to co-ordinate the protection of these data (personal data, data important for state defence etc.) but also to stand up for the uniform data representation of each needed real world element.

When comparing the DKM feature catalogue and object catalogue of ZABAGED with proposal for Directive of the European Parliament [8] it is obvious that we are able to fill up most of reference data from the land data model excepting spatial data themes orthoimagery, elevation and geographic grid system that must be completed from other sources. Objects from ZABAGED do not include spatial data themes: geographical grid system, identifiers of properties and cadastral parcels. Spatial data themes identifiers of properties and cadastral parcels can be extracted only from the land data model. It also enables to determine uniformly other features like administrative units, protected sites and buildings with maximum accuracy, particularity, data consistency and complexity.

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Příloha II	DKM								GEOPRVEK
	KÓD								
	Kód mapové značky	Kód popisu	Druh pozemku	Způsob využití pozemku	Typ budovy	Způsob využití budovy	Kód typu ochrany nemovitosti		

Výškops	neobsahuje
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Identifikatory vlastnictví	obsah souboru popisných informací KN
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Katastrální parcely	2.19						hranice parcely		parcely
	18						parcelní číslo (def. bod) pozemkové parcely		
	28						parcelní číslo (def. bod) stavební parcely		

Pokryv území	3.01	2					orná půda		orná půda
	3.02	3					chmelnice		chmelnice
	3.03	4					vinice		vinice
	3.04	5					zahrada		zahrada
	3.05	6					ovocný sad		ovocný sad
	3.06	7					trvalý travní porost		trvalý travní porost
	3.08	10					lesní pozemek		lesní pozemek
		11					vodní plocha		vodní plocha
		13					zastavěná plocha a nádvoří		zastavěná plocha a nádvoří
		14					ostatní plocha		ostatní plocha
		1					skleník, pařeniště		skleník, pařeniště
		2-10					školka		školka
		2					školka		školka
		3					plantáž dřevin		plantáž dřevin
		0 a 1					sportoviště a rekreační plocha		sportoviště a rekreační plocha
	7.01	24					dobývací prostor		dobývací prostor
		4					les jiný než hospodářský		les jiný než hospodářský
		10					lesní pozemek, na kterém je budova		lesní pozemek, na kterém je budova
		5					lesní pozemek, na kterém je budova		lesní pozemek, na kterém je budova
	8.04	11					zamokřená plocha		zamokřená plocha
		12					společný dvůr		společný dvůr
		13					zbořeniště		zbořeniště
	3.14	19					zeleň		zeleň
	3.15	21					hřbitov, urnový háj		hřbitov, urnový háj
		25					skládka		skládka
		14					dráha		dráha
		18					ostatní dopravní plocha		ostatní dopravní plocha
		22					kulturní a osvětová plocha		kulturní a osvětová plocha
		23					manipulační plocha		manipulační plocha
		26					jiná plocha		jiná plocha
	27					neplodná půda	neplodná půda		
7.03						ložisko slatin a rašelin	ložisko slatin a rašelin		

Ortho foto	neobsahuje
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<b>Příloha III</b>	<b>DKM</b>								<b>GEOPRVEK</b>
	<b>KÓD</b>								
	Kód mapové značky	Kód popisu	Druh pozemku	Způsob využití pozemku	Typ budovy	Způsob využití budovy	Kód typu ochrany nemovitostí		
Předmět obsahu DKM									

<b>Budovy</b>	2.18					vnitřní kresba		<b>budova</b>
	4.02		1-4	6		budova zděná, betonová, kovová		
	4.03			7				
				8				
				9				
			10					
			11					
			12					
			13					
			14					
			15					
			16					
			17					
			18					
			19					
2.19					hranice parcely			