

# Types of Cadastral Maps in Slovak Republic and Accuracy of the Land Area

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**Abstract.** The technical progress has affected in all parts of science. This paper is reflecting the changes of creation and accuracy of the maps, used for tax purposes from Austria-Hungary to present. From the precision of coordinates of the break points, which are defining the running of boundary, depends the precision of the parcel area as well. This information is more important because of the prices of land in present.

## 1 Introduction

The total area of Slovak republic is round 49000 km<sup>2</sup>. This area is divided onto 7.3 million of existing lands evidenced in Cadastre of real Estates as the parcels of register C. From this number, 5.7 million have owner's folio, which means that 78% of all parcels have defined proprietary relation. The rest 1.6 million of areas that are registered in register E does not exist in terrain; they were merged because of political or historical reasons into bigger agricultural or wood units or their configuration changes trough usage in history. In the register E, there are over 8.2 million of lands and the proprietary relations were restored and are evidenced on owner's folio for register E.

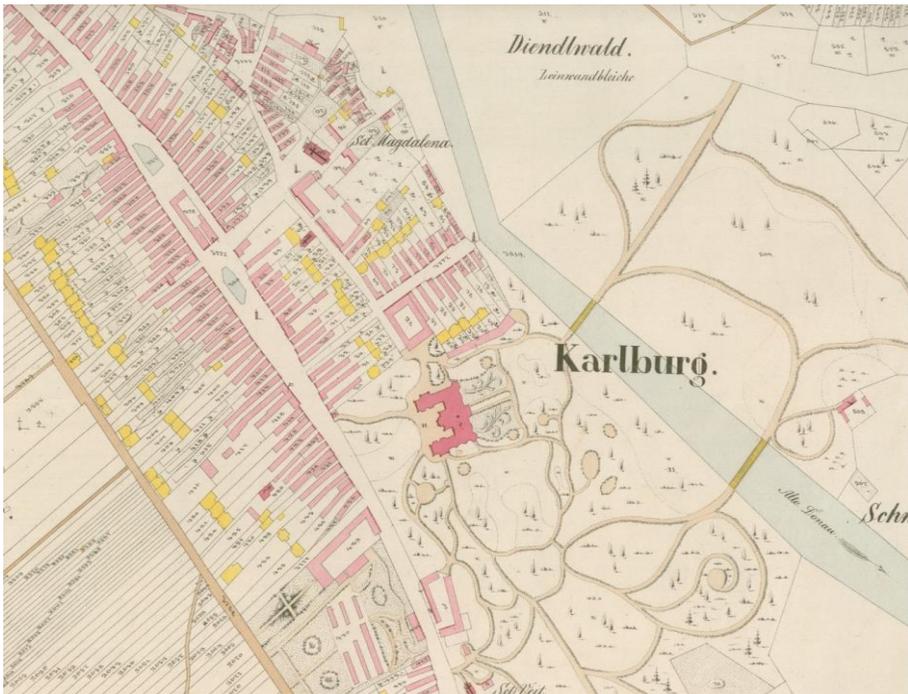
## 2 History

The area of Slovakia was till 1918 part of Austria-Hungary. In 1647, there was the first registration of land for the tax purposes. The very first ruler, who wanted to correct tax on scientific base and create stable cadastre of 19<sup>th</sup> Century in Austrian empire, was Emperor Franz I. The maps of stable cadastre are dated from 1849. Slovak region, also named Upper Hungary was part of Budapest reference system with beginning in observatory of Budin on hill Gellért Hegy, the name of system was Gellért Hegy datum.

The original cadastre maps were created manually. Most of them are colour, in the build-up area, there are differences between wooden and brick buildings, in non-build-up area are colour differences between main roads, side roads, watercourses and areas, which helps in global clarity. The information on these maps are written in Slovak, Hungarian and German, in the east side of Slovakia, there are occasions, when there are information in Russian.

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**Fig. 1.** The original map of village Rusovce from 1856

The Czech land surveyor František Horský was working on alignment of trigonometrical network by least squares method in 1863 and suggested to replace Gellért Hegy datum by stereographical projection and to align and recalculate the trigonometrical network in this new projection. The maps in stereographical geodetic datum were in Slovakia created in fathom scale. These maps were created in 1864-1875 (on the most on east part of Slovakia) and in 1886-1913 (on the most on south part of Slovakia). There is one problem, that maps in this datum have too big distortion, so they failed to satisfy the necessities of cadastre, so they were stopped to be created as well as used.

In the area of past Hungary was from 1908 established new datum called Fasching projection in fathom scale (conform universal cylindrical projection) The mapping in this projection was in Slovakia carried out until 1924, but only in less quantity.

In the Czechoslovakia was the first aim to create the united cadastre of lands. The conditions of creation were established in Cadastral law n. 177/1927 Zb. z. The maps created in the wording of this law were called the maps of Czechoslovakian cadastre of lands, these were the first maps created in metric scale.

### 1.1 Sort composition of the cadastral maps

From the perspective of original cadastral maps' division onto fathom and metric scale, 33.9% of whole Slovakia was measured in fathom scale (on the most 1:2880) in Hungarian coordinate datum. In the effect of law n. 177/1927 Zb. z. about cadastre of lands was measuring done just in metric scale, in this scale are maps of rest 66.1% of area, mapped after 1927.

The maps in metric scale can be divided onto: 12.1% of area measured between World War One (1914-1918) and World War Two (1939-1945), in very good standard. 16.4% of area were mapped in the wording of methodises for the technic-economical map in 1971-

1986 and the coordinates of lands' break points were calculated from the measurement. After 1986 were mapped the rest of area which presents 23% of area, the lands' break points were documented as well with high accuracy and these maps presents the best cadastral map with the highest precision and the most sufficient content. These maps were mapped in the class of required precision of survey n. 3 (0.14 m) sometimes n. 4 (0.26 m) (forests with use of photogrammetry method).

### 3 Current situation

Nowadays, according to the UGKK SR (The Geodesy, Cartography and Cadastre Authority of Slovak Republic) legislation in force, there can be used the measuring with GNSS. This technology allows first time in history of cadastre of real estates processing of high precise data of lands' break points measurement processed just in terms of European Terrestrial Reference System 1989 (ETRS89). [5] Fixed steps of transformation from ETRS89 to S-JTSK03 and to S-JTSK makes using of GNSS so there is possible to reconstruct each and every new measured break point back into terrain without any undesirable deformation in the vectorial cadastral map. To ensure a functionality of whole system, UGKK SR unelaborated an amendment of generally legally binding legislative regulations and a whole series of related technical regulations. From 30.1.2013 there is available the sectoral transformation service that allows the transformation between ETRS89, S-JTSK03 and S-JTSK. This transformation is allowed to be built in the GNSS rover. In the same time there is a possibility to free download of an appropriate conversion interpolation table to each computer.

The screenshot shows the 'Transformačná služba ETRS89 - S-JTSK' web application. The header features logos for GÚ, UGKK SR, and OPIS, along with the text 'MINISTERSTVO FINANCIÍ SLOVENSKEJ REPUBLIKY Sprostredkovateľský orgán OPIS' and 'TVORIME VEDOMOSTNÚ SPOLOČNOSŤ Európa'. The main interface includes a 'Formát vstupných údajov' dropdown set to 'Transformácia bodu jednotlivito', a 'Vstupný súradnicový systém' dropdown menu with options like 'S-JTSK (JTSK)', 'S-JTSK (JTSK03)', and 'ETRS89-LatLonh', and a 'Výstupný súradnicový systém' dropdown menu. There are also input fields for 'Vstupné súradnice', 'Výstupné súradnice', and 'Validácia vstupu', and a 'Výsledok validácie' section.

Fig. 2. The conversion interpolation table

On the base of these changes was established new category of accuracy. It is characterized by quality of every cadastral map break point of detailed planimetric survey, the way of its' creation, the coefficients for calculation of areas quality and the values of coefficient for checking the precision of points' displaying.

**Table 1.** The definition of points' quality code. [1]

Code	The point of detailed planimetric surveys' quality
1	The point defined numerical in system S-JTSK from § 55 par. 4 (mxy = 0, 08 m)
2	The point defined numerical in system S-JTSK without real placing; this code cannot be used in the occasion, if it is necessary to signalize the point in terrain or if the point is signalized yet (mxy = 0, 08m)
3	The point defined numerical in system S-JTSK defined via geodetic terrestrial method without connecting to used geodetic base (mxy = 0, 14 m).
4	The point defined non-numerical in system S-JTSK defined via geodetic terrestrial method without connecting to used geodetic base (mxy = 0, 26 m).
5	The point defined non-numerical, the coordinates are defined by using cartometry (mxy is non-defined).

On the base of points of detailed planimetric survey are vectorial cadastral maps divided to:

- VKMč- numerical vectorial cadastral maps, where the accuracy of break point quality code is from 1 to 3,
- VKMn- non-numerical vectorial cadastral maps, where the accuracy of break point quality code is from 4 to 5.

**Fig. 3.** The current vectorial cadastral map of village Rusovce

## 4 The lands' area

The lands' area is presented by the area of land projection into reference plane in square meters. The area is defined by using Euler formula from coordinates of break points of boundaries. The value of area is rounded to whole square meters.

The difference between the area identified in the file of survey data and the area defined in the file of descriptive information is judged by the value of permissible deviation calculated from formula:

$$m_p = a\sqrt{P} - b ; \quad (1)$$

where a and b are the coefficients, which are taking into account the scale of map and P is the area of parcel evidenced in the file of descriptive information. [1] The values are defined for numerical and non-numerical cadastral map and are possible to see in table number 2 and 3.

**Table 2.** Coefficients a, b used in different scales for numerical cadastral map. [2]

VKMč		
Map scale	a	b
1:1000	0,42	0,4
1:1250	0,53	0,5
1:2000	0,84	0,8
1:2500	1,05	1,0
1:5000	2,10	2,0

**Table 2.** Coefficients a, b used in different scales for non-numerical cadastral map of old analogue map. [2]

VKMč		
Map scale	a	b
1:1000	0,84	0,8
1:1250	1,05	1,0
1:1440	1,21	1,2
1:2000	1,68	1,6
1:2500	2,10	2,0
1:2880	2,42	2,4
1:3600	3,02	3,0
1:5000	4,20	4,0
1:7200	6,05	6,0

## 5 Conclusions

In present age are all break points of detailed planimetric survey defined in coordinates intended by terrestrial method. The position criteria are defined in relation with point intended by method GNSS and transformed from geocentric coordinate datum ETRS89 into coordinate system S-JTSK, which is used in cadastre of real estates. This acceptable variation is defined for terrestrial measurement on 0.24m and after its' exceeding it is necessary these coordinates to adjust.

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