UDK 528.44:347.214.2:519.23:061.68:004.4
Prethodno priopćenje

Real Estate Mass Appraisal in the Real Estate Cadastre and GIS Environment

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ABSTRACT. The present paper reviews the results of real estate market analysis and influence of market and institutional background towards the real estate value. Experimental research had been founded on the statistical analysis of transaction data, linearization of qualitative variables and determination of multi-collinear links of variables by multiple regression analysis. Determination of appraisal model for apartments using procedures and methods of mass appraisal had been implemented using GIS tools within the procedure of transaction geolocation and by integrating spatial databases and the real estate cadastre database. Analysis of legal, operative and institutional component determines the structure for the real estate mass appraisal system establishing with implementation on the national level, which is to provide support for fiscal policy, management of land administration and real estate market development.

Keywords: real estate cadastre, statistical analysis, appraisal models, databases, GIS.

1. Introducton

Real estate appraisal in the Republic of Serbia holds characteristics of all countries undergoing transition, where real estate appraisal is projection of prices and values, based on the current market conditions and information available to the appraisers. Market transparency is an important condition for market economy development, and information from the real estate market available to the public shall contribute to a more secure operation of this market, increased number of transactions and greater security of the market participants. Establishing of the Real Estate Cadastre as property register under the provisions of legality, constitutive power, public availability, reliability and mandatory registration provides quality and quantitative infrastructural base for acceleration and implementation of numerous transitional processes.

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State cadastral organs hold modern databases on real estate and latest data, which is the basic prerequisite for the market value of the real estate to be objectively determined by those organs. Modern techniques and technologies of spatial and other property-related data acquisition and georeferencing will provide for development of new appraisal systems against individual appraisals, for the works to be performed in an efficient, current and complete manner for all real estate in the country, which always leads to objectively appraised values, i.e. there are always appropriate values for all the purposes required (property taxation, real estate market, spatial and urban planning, insurance, mortgages, conversion of real estate status to other forms).

Implementation of the Real Estate Cadastre and Registration Project had created possibilities for a more efficient system for managing land, real estate, property rights and encumbrances to provide support for real estate market development and fiscal mobilization of funds, through a more efficient and fair application of property tax, based on the reliable real estate records. First researches in the field of new real estate appraisal systems against the existing, traditional ones had been implemented within the pilot projects implemented in the Republic Geodetic Authority.

2. Real Estate Cadastre

Real Estate Cadastre is modern, quality, reliable and public register of real estate, containing data on: land, buildings and building separate parts (apartments and offices, other constructions), property rights and encumbrances and limitations. Basic needs of the users are related to providing property security services, business processes covering transactions processing, registration and information provision function, so the assumption can be made that the user requirements will rise regarding data content and quality (Evenett and Vines 2012).

Having in mind restrains of local economic environment, together with the fact that the country is undergoing transition, currently being in the phase of economic, property and political reforms, which should lead to capital market development, as an important segment of market economy, results of the "Real Estate Cadastre and Registration" project will contribute to achievement of defined development goal of land administration, formulated as: "*Contribute to the sustainable economic development and poverty alleviation, better environmental management, security of property rights and active real estate market through an efficient land management*". Defined development goal of land transformation obligates the Republic Geodetic Authority to strengthen its institutional capacities, making them sustainable for the future; to realize competences and responsibilities towards developmental goal, and to make results achieved in the Real Estate Cadastre establishing sustainable.

3. Real Estate Market Analysis

Real estate market in the Republic of Serbia has properties and specific traits usual for underdeveloped markets: high level of non-liquidity, heterogeneity of real estate as an investment instrument, high level of transaction costs, duration of transaction process itself and lack of data on real estate transaction prices. That is also the major obstacle and greatest methodological difficulty in efforts to objectively analyze status

of this market. Real estate market in the transitional society, without a doubt, is one of the important indicators of true liberalization of inherited economy.

Organized real estate market turns assets into capital, and real estate value may be directly determined only when buyers and sellers can acquire property in institutionally and legally regulated manner, which is procedurally simple and publicly available (Hallin and Liska 2007).

Research had been focused on institutional mechanisms and methods for acquisition of real estate market data, for the purpose of establishing a unique database of market prices and linking all relevant information and attributes on real estate. Real estate appraisal is being performed in the Republic of Serbia within real estate taxation procedure, which is under competence of the Ministry of Finance, i.e. Tax administration. Baseline for property tax imposed on agricultural and forest land (for which no accounting is kept) is *five-fold amount of annual cadastral revenue* from that land, according to data of the Republic Geodetic Authority, and *baseline for absolute rights transfer tax* is contracted price, i.e. market value determined by the competent tax organ (if said organ believes that contracted price is lower than market price).

Real estate appraisal approach should be in line with the economic theory and should generate appraisals which are reliable assumptions of transaction prices. Realization of this assumption in establishing system for registration of market/transaction data integrated with the Real Estate Cadastre a spatial database.

3.1. Institutional Cooperation

Republic Geodetic Authority and Ministry of Finance – Tax administration had established successful and continuous cooperation in the first phase of real estate mass appraisal, which covers takeover of real estate transaction data from contracts on sale validated by the Tax administration. Within the process of establishing real estate market price register, which should, according to the Article 152 of the Law, contain data from real estate sales and lease contracts, validated by Tax administration, the Republic Geodetic Authority had implemented the

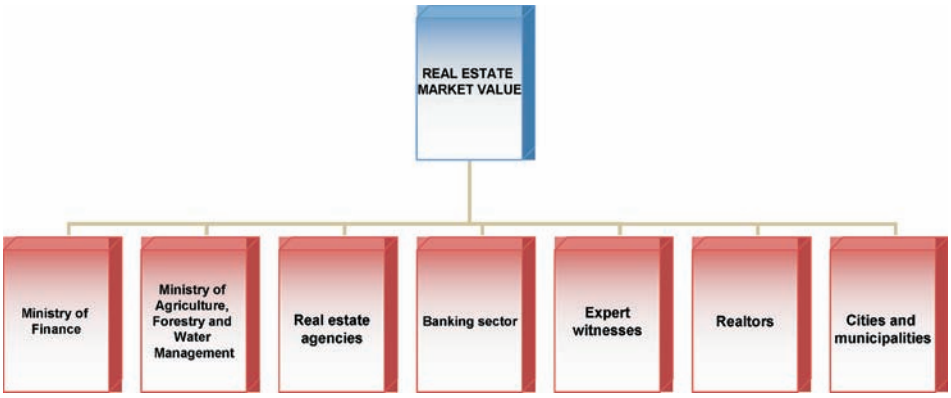

Fig. 1. *Real estate market value stakeholders.*

first phase of real estate mass appraisal procedure. Said institutions had defined structure and model of necessary data, together with the takeover method.

Institutional cooperation has the objective for the decision of tax administration on tax baselines for all types of real estate to be based on sales price data, guidelines for real estate mass appraisal and technical tools for real estate value calculation and graphical presentation. Reaching transparent, reliable and fair taxation will be provided through public available information on sales price and value of real estate for interested parties and stakeholders (Malme 2012).

3.2. Housing Real Estate Market

According to the analysis performed, it could be said that the real estate market in the Republic of Serbia is clearly subject to the laws of supply and demand and, in spite of numerous inherited and institutional problems, operates as theory envisions. The greatest influence on prices and transactions trend in real estate market during the period 2007–2011 was expressed by: autonomous supply and demand processes and effects of Government regulatory measures in that sector. Structure of supply to demand ration is a consequence of ownership and legislative transformation of housing real estate. By 1989, apartments were in 95% of cases in social (state) ownership. After promulgating the Law on housing relationships that year, which provided for buy-off of those apartments, ratio between number and status of private and socially owned apartments had begun to change, thus establishing the first real estate market.

For the period 2007–2011, total number of real estate transactions collected from the Tax Administration was 1033173.

Table 1. *Number of real estate transactions 2007–2011.*

Transaction year	2007	2008	2009	2010	2011	Summary
Number of transactions	236904	283724	249462	130735	132348	1 033 173

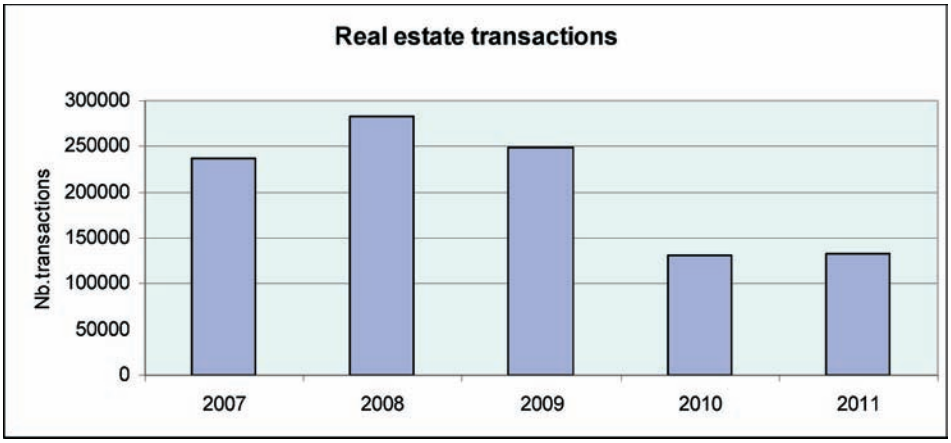

Fig. 2. *Chart of the number of real estate transactions 2007–2011.*

Table 2. *Real estate types.*

	Real estate type	Number of transactions
1	Land	554749
2	Housing real estate	410824
3	Office real estate	27668
4	Constructions	26935
5	Special-purpose real estate	12547
6	Industrial real estate	450
	Σ	1033173

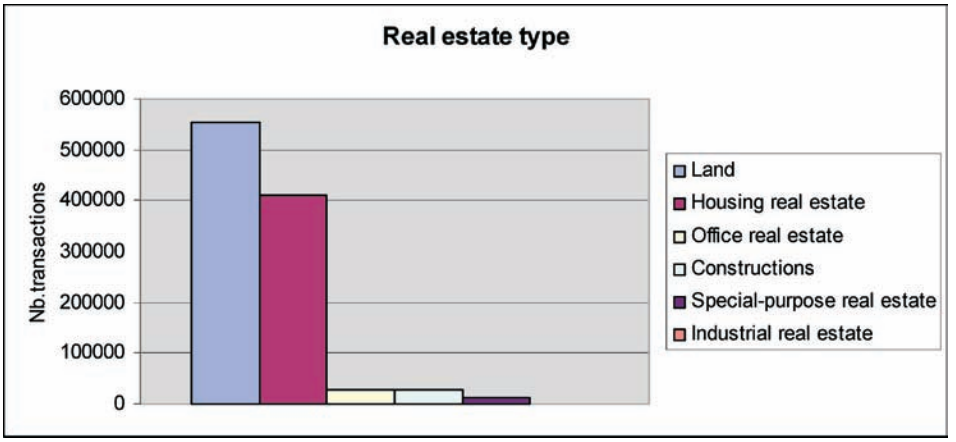

Fig. 3. *Chart of transactions per real estate types.*

The fastest market was covering apartments and single family dwellings. The majority of transactions were made in Belgrade market, having in mind the number of citizens and significant investments. Analysis had been performed for 54367 transactions for the City of Belgrade, covering 50% of all apartment transactions in the Republic of Serbia.

Transaction data were integrated with the Real Estate Cadastre data, for the purpose of controlling reliability of data on real estate and their quality. The number of quality transactions after analysis was 17901, making 33% of the total number.

Table 3. *Number of housing real estate transactions.*

Real estate	Number of transactions per year			Summary
	2007	2008	2009	
Apartments	41240	49197	36890	**127327**
Houses	38802	46303	38931	124036
Garages	4609	6072	4328	15009

Table 4. *Number of apartment transactions per cities.*

City	Number of transactions per year			Summary
	2007	2008	2009	
Belgrade	18974	20920	14473	**54367**
Novi Sad	5377	6289	4509	16175
Nis	1620	2230	1987	5837
Subotica	616	1570	1176	3362
Pancevo	964	1125	945	3034
Kragujevac	712	949	775	2436
Krusevac	544	1037	643	2224
Sabac	449	504	455	1408
Cacak	353	526	366	1245
Uzice	447	368	305	1120
Vrnjacka Banja	227	344	297	868

Fig. 4. *Apartment transactions – the City of Belgrade.*

Based on the completed data, a link was established with graphical presentation and all transactions had gotten geolocation (centroid). Databases of transactions had been created per years and data on real estate had been prepared for each municipality of the City of Belgrade.

The following actions had been performed:

1. DCM data conversion from MapSoft to ArcGIS
2. Linking database of sales register, DCM database and REC database had been achieved using parcel number
3. Housing real estate geolocations had been appended with the address register data
4. The following polygons had been converted:
   – Cadastral municipalities
   – Map scales
   – Parcels
   – Parcel parts
5. DBM database tables had been created per
   – Contract
   – Seller
   – Buyer
   – Real estate.

Criteria for establishing market zones were:
– Price per square meter of the apartment
– Number of transactions
– Distance from the city center
– Characteristics of the area.

Price trend index had been determined:
– Per market zones
– Using the principle of Normal distribution of transactions over the market (Amengual and Watson 2007)
– Coefficient of variation.

$$C_V = \frac{SD}{X_{SR}} \times 100$$

C_V – Coefficient of variation

SD – Standard deviation

X_{SR} – Mean value

Table 5. *Market zones – the City of Belgrade.*

	Market zone 1	**Market zone 1**	**Market zone 1**	**Market zone 1**
Min	90000	70000	60000	25000
Max	170000	130000	100000	60000
Mean	127576	95061	76026	41126
Coefficient of variation	17%	17%	14%	21%
Median	126371	92924	74930	40806
Mod	120000	80000	80000	40000
Number of data	4276	6636	843	571

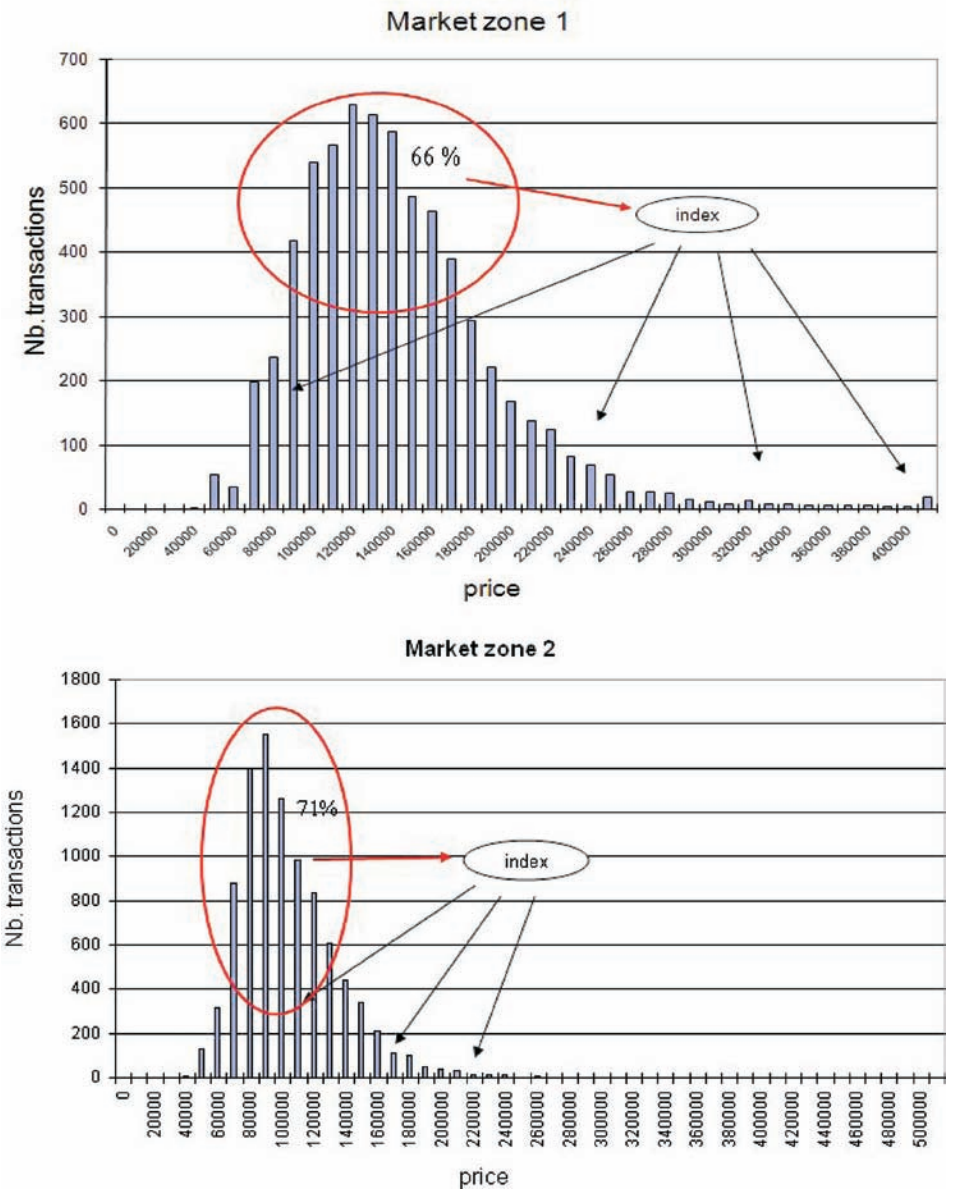

Table 6. *Indexes of market zones.*

Market zones	Number of transactions	Number of quality transactions	Price index
1	6509	4269	66%
2	9343	6629	71%
3	1313	842	64%
4	736	858	89%

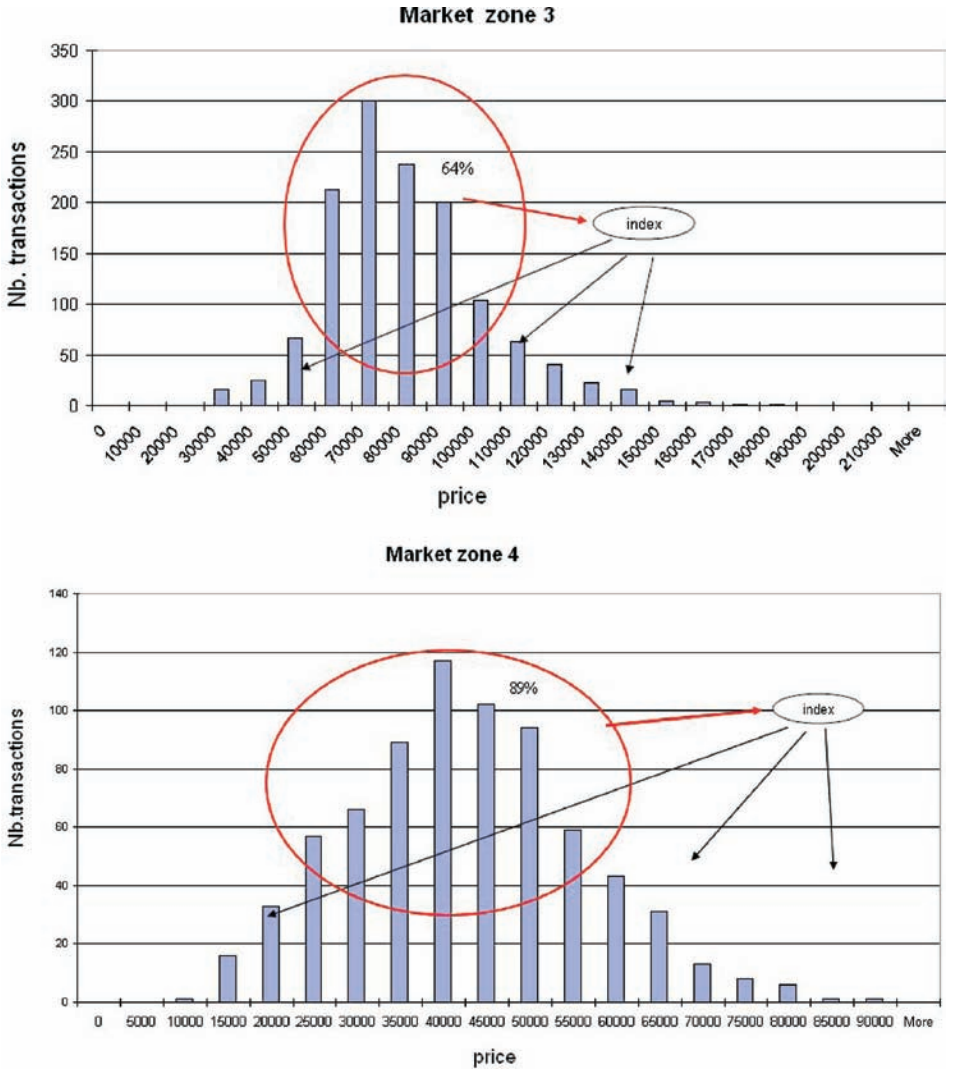

Fig. 5. *Transactions and price indexes chart.*

Value of the Coefficient of variation $C_V < 30\%$, indicates homogeneity of transaction dataset.

Real estate mass appraisal involves general estimation of real estate value and valuation of a particular real estate, based on the data from general appraisal. General real estate appraisal involves determination of appraisal model for various types of real estate (Stock and Watson 2002).

Within the general appraisal of apartments, top and bottom threshold of apartment prices in Belgrade had been examined by analyzing data from transactions

and alternative data (sales offers advertized over the internet), and the following facts had been accepted:

– lower threshold approximately 50 000 RSD/m^2
– upper threshold approximately 400 000 RSD/m^2.

Within the procedure of general real estate appraisal, it is necessary to determine a representative or typical real estate, to be the reference for the model (Bai 2003). The following had been analyzed to determine a typical apartment on the territory of the City of Belgrade:

– Transaction data (sales contracts)
– Real Estate Cadastre data
– Market data (sales offers advertized over the internet).

Analysis of data from the Real Estate Cadastre and transactions had established that the typical apartment has the area of 45–60 m^2.

Analysis of data from the Real Estate Cadastre and data from alternative data source – sales offers advertized over the internet had established that a typical apartment is on 1st – 3th floor (URL 1, URL 2, URL 3).

Based on the building age data for the CM Zvezdara, it had been established that a typical apartment is of *medium age*.

To establish value level, the following transactions were used:

– groups of apartments with living area of 45–60 m^2 – a total of *4500* transactions for Belgrade.

It was defined that the price difference between two value levels is:

– ≈ 20% for high-priced apartments
– ≈ 30% for low-priced apartments.

Table 7. *Value levels – the City of Belgrade.*

Level No	**Summarized price RSD/m^2**	**Number of transactions 45–60m^2**	**Difference between neighboring levels in %**
1	50 000 – 65 000	191	30
2	65 000 – 85 000	640	31
3	85 000 – 110 000	1294	29
4	110 000 – 135 000	1170	23
5	135 000 – 160 000	709	18
6	160 000 – 190 000	314	19
7	190 000 – 230 000	134	21
8	230 000 – 280 000	37	22
9	280 000 – 340 000	8	21
10	340 000 – 400 000	3	18
	Summary:	4500	

4. Mathematical Model for Apartments

To determine mathematical model for the apartments using real estate mass appraisal procedure, we need to define: market zones, value levels, value zones, typical real estate, relational tables and diagrams.

To analyze transactions, the following Real Estate Cadastre databases had been utilized: alphanumerical database of the Real Estate Cadastre, digital cadastral maps database, address register database and orthophoto of the City of Belgrade; to define geolocation for each transaction for the chosen central city municipality CM Zvezdara.

The value zones had been defined based upon:
– Prices (value levels) for typical apartment
– Location
– Characteristics of the environment (natural and constructed)
– Market information (sales offers advertized over the internet).

Having in mind limited number of transactions for a typical apartment, decision on value zones definition had been significantly influenced by other criteria listed (Hallin and Liska 2007). Three zones had emerged with different location, average prices, trading level, and natural and constructed environment properties.

During the mass appraisal, formulas are used to establish relational table for value calculation. They are used over formulas to calculate value due to a very easy understanding and calculation of the real estate value. Clearness provides comparability of a real estate with another real estate with different age or quality. Likewise, adjustment, i.e. calibration of model for the general market gets much simpler and facilitated for the model creators.

Relational table is a table containing influence of area and age, expressed in mutual relation. One relational table is being formed for each value level.

Rows in table show groups of areas, and columns show age groups. By intersecting rows and columns, the coefficients are determined, expressing joint influence of the two factors. Average value of the price reduced to date is being calculated for each group of transactions belonging to the intersection of certain groups, as divided per area and age (Greon and Kapetanios 2012). For a typical group per area and age, we accept the coefficient 1, and other coefficients in the table are being calculated against the average value of prices within this group.

For the group that has none or insufficient transaction, we had performed simulation, by reading the average value from the chart (price per m^2 charts had been produced for each age group). If value could not have been read from the chart, an appropriate average of prices from neighboring level had been adopted (Breitung and Pigorsch 2012).

Table 8. *Value of area factor.*

Area interval /m^2	Mean	Number of transactions	Factor value
15–29	125214	2,570	1.10
30–44	116536	5,520	1.02
45–59	113942	4,707	1.00
60–89	120669	4,089	1.06
90–150	137970	970	1.21

Table 9. *Value of building construction year factor.*

Age code	Mean	Number of transactions	Factor value
1	122859	590	0.99
2	120609	687	0.98
3	122597	71	1.00

1 Old buildings
2 Medium-age buildings
3 New buildings

Table 10. *Value of floor factor.*

Area interval /m^2	Lower than 1^{st} floor	1^{st} – 3^{rd} floor	Above 4^{th} floor
15–29	0.91	1.00	1.03
30–44	0.86	1.00	1.03
45–59	1.00	1.00	1.01
60–89	0.90	1.00	0.98
90–150	0.77	1.00	1.03

Using descriptive statistics, transactions dataset had been analyzed to define range, distribution and quality of transactions for further analysis. Determination of mean apartment prices per market zones, which were under normal distribution (variation coefficient of 14–21%) of total number of quality transactions, had been performed for a typical apartment.

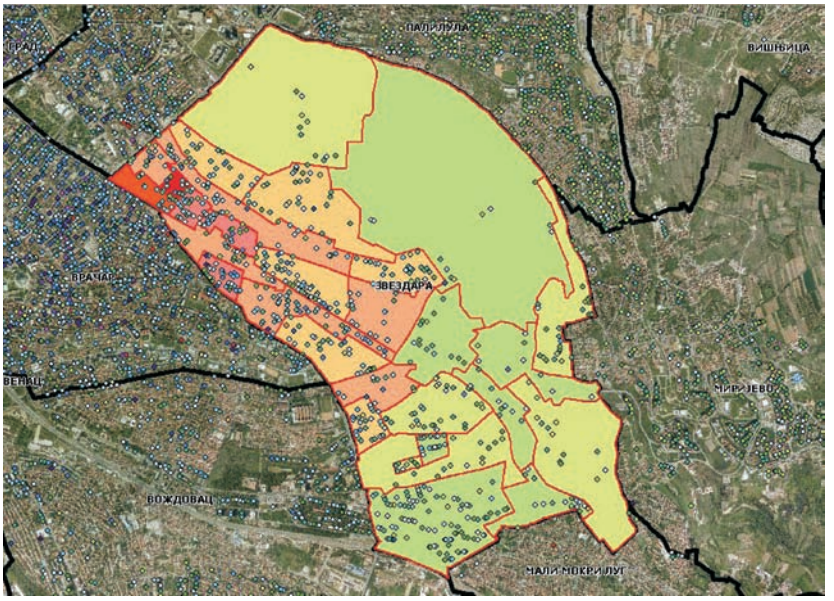

Fig. 6. *Transactions on orthophoto – CM Zvezdara.*

$$V_Z = \{c_1, c_2, c_3, \ldots, c_n\}$$

V_Z – Polygon (graphical presentation)

$$C_{sr_z} = \frac{\sum_{i=1}^{n} C_{it}}{n}$$

C_{sr_z} – Mean for typical apartment (price /m^2) in the value zone

C_{it} – Individual prices at time moment t

n – Number of transactions

$$C_{sr_z} = V_z$$

$$V = V_Z \times F_{GI} \times F_S \times F_p$$

Model variables

V – Apartment value

V_Z – Zone value

F_{GI} – Construction year factor

F_S – Floor factor

F_p – Area factor

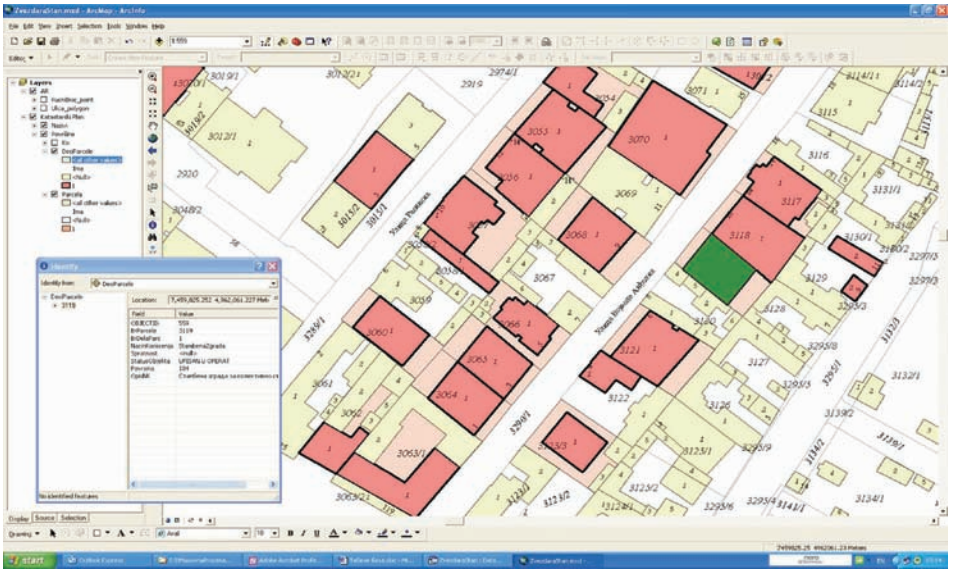

Fig. 7. *Geolocated apartment transactions.*

5. Conclusions

In the legal system of the Republic of Serbia, real estate appraisal is being regulated by legal and normative procedures and, depending on appraisal purpose; market value of real estate has different "rulebook" definitions. Development of real estate mass appraisal system should provide professional description of mass appraisal system on the national level and to additionally affirm appraisal as part of integrated system of Real Estate Cadastre, with application in the Republic of Serbia. Further research should provide for establishing national database of market values, development and reform of legal framework, supporting efficient real estate mass appraisal, based on the market information.

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Masovna procjena nekretnina u katastru nekretnina i GIS okruženju

SAŽETAK. U radu je prikazan pregled rezultata analize tržišta nekretnina i utjecaja tržišne i institucionalne pozadine na vrijednost nekretnina. Pokrenuta su eksperimentalna istraživanja statističke analize podataka o transakcijama, linearizaciji kvalitativnih varijabli i određivanja višestrukih kolinearnih veza varijabli uz pomoć višestruke regresijske analize. Određivanje modela procjene za stanove, koristeći postupke i metode masovne procjene, provedeno je upotrebom GIS alata unutar postupka geolokacije transakcije i postupkom integracije prostornih baza podataka i katastarske baze podataka o nekretninama. Analiza zakonskih, operativnih i institucionalnih komponenata određuje strukturu za sustav masovne procjene nekretnina kojom se ustanovljava provedba na nacionalnoj razini, a koja bi trebala osigurati podršku fiskalnoj politici, upravljanju zemljištem i razvoju tržišta nekretnina.

Ključne riječi: katastar nekretnina, statistička analiza, modeli procjene, baze podataka, GIS.

Primljeno: 2013-03-01

Prihvaćeno: 2013-04-23