Computer Aided Zoning and Urban Planning

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ABSTRACT

Article is based on my PhD thesis, about creating a free, cloud based tool that allows to greatly simplify process of zoning and urban planning using combination of satellite data, altitude data and existing information about building. I analyzed existing programs and found ways to improve productivity of humans working in this sphere and decrease skills and education required for such work. The article describes flaws in existing programs and methods I use to correct deficiencies. I also tested my program and methods for measurement errors and compared results with existing methods and error margin is less than 2%. Few people that I gave to test beta version of my software were able to do tasks few times faster than in any other software. And compared to manual methods (still widespread in Russia) testers were able to increase time required for tasks from days to minutes.

INTRODUCTION

Main purpose of this project is development of a new technology that facilitates decision-making process in the field of urban planning and city zoning, in order to simplify the processing of data to make it more convenient and efficient for users.

The project is using public satellite data from Federal Agency for Cartography and Geodesy (www.bkg.bund.de), Digital Globe (www.digitalglobe.com) and Landsat project (www.landsat.gsfc.nasa.gov). Additional geodesic and other information is loaded from public databases like Wikimapia (www.wikimapia.org) and similar.

Modern computer telecommunications can provide collection, transfer, and access to a variety of urban development and spatial data on a par, and sometimes much more faster and efficient than traditional methods of gathering information. Experiments have confirmed that the rate of collection, as well as the quality of information in online databases, often much better and more relevant than the traditional methods of information storage. Automated system of zoning and urban planning analysis is technological solution that provides multifunctional tool for processing and delivery of all kinds of data needed to work in an urban setting, as well as in many related fields. Furthermore, the use of this system helps in deciding feasibility of construction of buildings and structures within a territory, in the

preparation of long-term regional development programs, when considering investments projects etc.

In current circumstances, the task of modern spatial planning and zoning urban areas is quite important and relevant. Currently, Russia is experiencing an acute shortage of such social objects like schools, kindergartens, hospitals, parking lots, etc. (Trutnev E. K. and others. (2008). Town regulation. The regulatory framework of urban planning activities in the conditions of the real estate market). Lack of infrastructure in various regions of Russia increases all the time for the following reasons:

- Growing intercity migration, and migration from all regions of the Russian Federation and ex-USSR into major Russian cities.
- In large cities such as Moscow, there is always active development of many residential areas, constructed with great speed.
- In July 2012 as part of "New Moscow project of 2011" area of the city was increased by 2.4 times and Moscow has risen from 11^{th} to 6^{th} place in the ranking of the largest cities in the world by area, although in population city retained seventh place, because on the annexed territories lives less than 250 thousand people.

No one can give a precise answer to the question – at what point in time there will be not enough objects of social security. Some analysts say that it already happened in Moscow. (Novikova R.P. (2010) E-Government and the problems of building ISOGD). For example traffic congestion situation is considered critical: according to data from Russian Public Opinion Research Center 27% of people spend 1-2 hours a day on commute, 30% up to 3 hours, 8% up to 4 hours and 2% more than 4 hours every day. Only 4% of citizens spend less than an hour per day.

International experience shows that integration of disparate spatial data at the state level in a single spatial data infrastructure through GIS technologies allows radical breakthrough in the timely provision of reliable and consistent spatial data to authorities, research facilities and even common people. (Wilner M. J., N. Naimark (2006) New Town Planning Code of the Russian Federation in relation to the relevant U.S. experience)

DESCRIPTION OF RESEARCH

This project focuses on the analysis and evaluation of urban areas for their most effective use.

The developed system of zoning and urban planning allows to perform following tasks:

1. Gathering information from different sources;
2. Structuring and analysis information of heterogeneous quality, volume and value;
3. Quick and reliable access to information;
4. Visibility and transparency of the available information.

Productive effect on change of parameters considered urban structure is possible either in the form of rigid administrative control, or as a change in operating conditions of the system as a whole, determine the content and possible changes in the behavior of (economic, social, territorial, environmental, etc.) each element and their aggregates. That is the main difference between principles of urban regulation period today from principles of the past.

Town Planning Code of the Russian Federation introduced the concepts of land use and development and zoning, as mechanisms of the system targeted urban policy in a market economy and a multiple forms of ownership. The essence of regulation is that the territory of the city is divided into zones with certain types of urban areas and use of these restrictions on their use in accordance with the planning regulations, and introduced as a regulation of the local government laws on land usage and development.

Modern understanding of zoning recorded Town Planning Code of 2004, which defines zoning as "... zoning municipalities to identify territorial zones and establishing planning regulations."

Zoning represents the activity of the division of the municipality into zones, with the establishment for each legal regime of urban use - planning regulations; zoning rules materialized in land use and development.

The objectives of development land use and development are:

1) Create the conditions for sustainable development of municipalities, environmental conservation and cultural heritage;

2) Creation of conditions for planning of municipalities;

3) Ensuring that the rights and lawful interests of individuals and legal entities, including the holders of land and capital construction projects;

4) Creation of conditions for attracting investment, including by allowing selection of the most effective types of permitted use of land and capital construction projects.

Town Planning Code sets out the scope of land use and development (in fact - objects zoning) - in the settlements, urban districts, territories of the settlements and urban districts. The Code also allows the possibility of the development of land use and development and inter-settlement territories, but only in cases of settlement planning of such areas.

Relation to the conditions of the city deserves particular attention conceptual positions:

1. Any construction as a private act functionally spatial development modifies the value of the land plot, and this change can be both positive and negative. If the construction is carried out in accordance with the social and market-oriented urban planning policy, building always increases the value of the land.

2. This change values building plots always change the value and associated territories, and in some cases very large zones.

3. Smart organized construction not only takes land, equips them, but in many cases, and releases large areas, for example, by increasing the density of buildings.

4. Any construction is temporary (for the period of construction of the building) the withdrawal of the urban areas. In this case there is one condition - if the

land market relations cannot be out of the market, and any use must be in the form of rental, sales, etc.

5. All the acts in question are associated with almost all elements of the socio-economic structure of the city. In the context of the construction of the city is associated with a large number of movements of population; with a makeover, expansion or construction of new objects of engineering infrastructure with changing patterns of traffic flow, with the changes in the system of welfare services, etc. Each of the spheres of the city with the construction of various land development will react in their own way, and give a lot of positive and negative examples.

On the basis described previously, the shortcomings of existing systems are currently a need for new systems that can meet the requirements of relevance and universality of data. (Beregovskikh A.N. (2009). Information support of urban development activities in Russia: proposals for bringing ISOGD to a three-level mind / / Management of development areas.) The developed system uses a regularly updated, public databases running smoothly since they are based on cloud technologies and the failure of one or more servers will not affect the operation of the program. The main advantage of accessibility of databases is the high level of relevance and reliability of the data, even to distant regions.

By the developed system requirements are as follows:

• Selection of a universal system that can function using external sources and information consumers.

• Low system requirements to run the program on any computer.

• Create a system that does not require special user training skills for the job.

• Demonstration of solving real problems using the system

Currently system operates like this:

1. After selecting the mode of operation, the request is sent to the server system.

2. Server generates a totals query that is sent to the site maps.google.com or similar, depenging on request.

3. Google maps site forwards the request internal company servers Google, they collect the necessary data and generating a response packet data.

4. Data from Google servers sent to the server system.

5. System server returns the requested data to the user.

For any further query or modify data cycle is repeated.

Possible exception of the cycle server system, sending packets directly to database, but in this case, any change in the program code required to re-install the new version of the client for each user and increase the load on users' machines.

The first mode "Geodesic mark" provides data on the level of land anywhere in the world relative to sea level. In the absence of data on any point, calculations made of four closest points, and then average value returned. Also, there are data points below sea level, in this case there are negative values. At this moment it is possible

to build complex route consisting and level measurement at any point of the route. (Figure 1.)

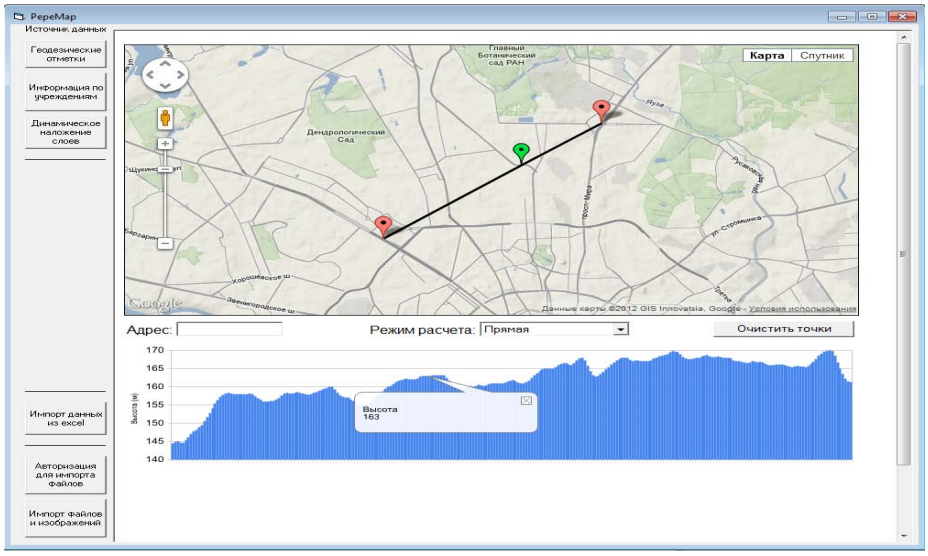

Figure 1. Level geodetic marks the interval between underground stations VDNKh and Dynamo

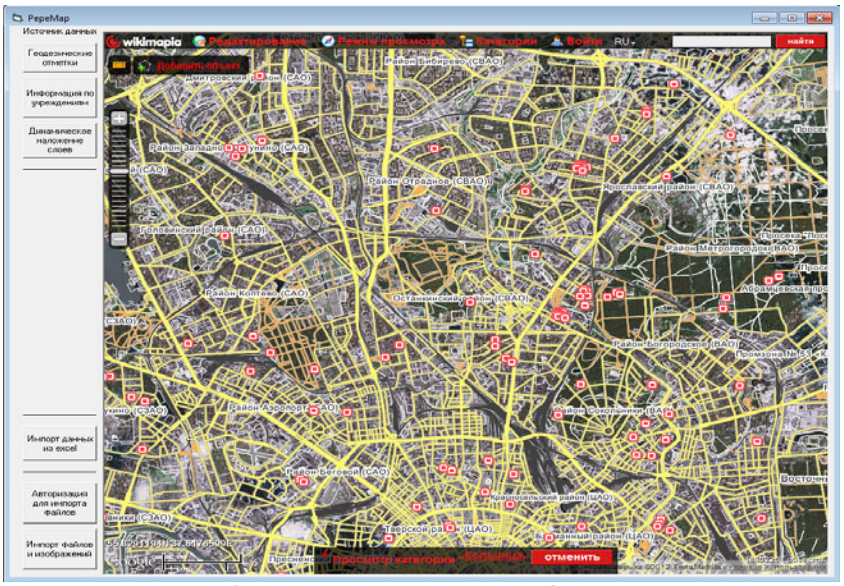

Figure 2. Results of selecting all healthcare facilities in northern part of Moscow.

The second mode "building information" allows using the "category" to see the location of all similar objects, such as hospitals, schools, kindergartens, shops, parks, etc. In the upper left corner there is a tool "line", which allows to measure distances up to 1 cm on the map contours traced the foundations of buildings, allowing you to take the exact dimensions and area of buildings (Zaleshina M. V. (2011) Information technology in urban planning: yesterday, today and tomorrow). (Figure 2.)

Also you can request building outline and additional information about building, including photos, date of construction, purpose of the building etc. (Figure 3.)

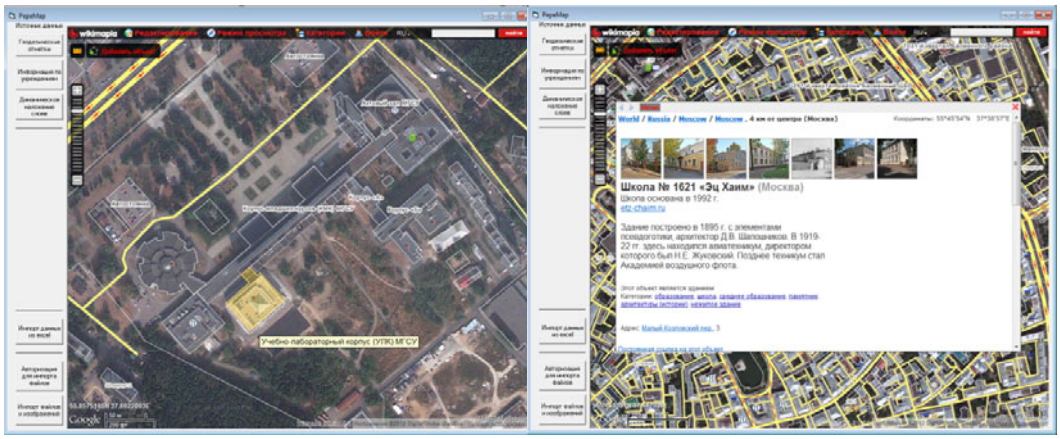

Figure 3. Requesting information about Moscow State University of Civil Engineering to get building outlines (left) and requesting additional information about building. We can see year of construction, additional photos, history of the building, lead architect and more (right).

The "Dynamic overlay layers" mode imposes on that empty-card template data from tables google fusion tables. As an example of a table layout districts of Moscow in Figure 4.

It is possible to overlay any information on this map, for example topographical survey, heat mapt, wind rose, precipitation, etc.

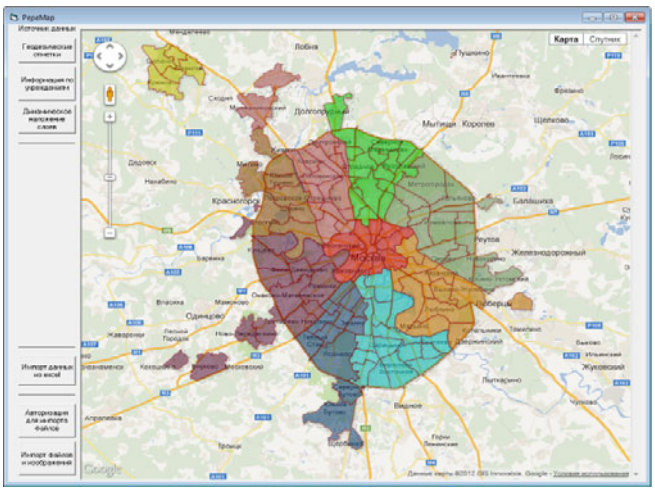

Figure 4. Using overlay with information about Moscow districts layout.

This basic system has been made to calculate approximate amount of time and money that are possible to save even on starting stages of city zoning and planning by using modern technologies.

An experiment was conducted in which the two different methods had been used to collect the information necessary for preliminary analysis of construction site. In the first method we used standard state requests to get elevation data, building info, etc. Second method was using this system based on public databases, satellite data, etc. Physical measurement of test site with opisometer and dumpy level (digital electronic level) was used to provide check sample. The Table 1 below shows obtained results.

Table 1. Physical measurement of test site

Task	Currently used method	Proposed method
Obtaining elevation data.	Request to city hall, basic information provided in 5 work days, detailed information in 15 work days. If request denied, denial message provided in up to 15 work days.	Depends on amount of required data. Approximately 10 minutes to get complete information on 1 sq. km for non experienced user.
Obtaining information on borders and general information about building.	Request to city hall information provided in 33 work days for free. Also available online request through nationwide government system ~$1700 for one request and ~$12700+ for unlimited requests. (Average salary in Russia for 2013 is $770)	Instantly.
Topographical survey.	Up to 1 month for existing data. Up to 6 month for new survey + covering of all expenses required.	Simplified and less detailed version with only main communications (water, electricity, gas, etc.) provided instantly.
Complete information about land lot and adjacent territory.	Limited to free requests and existing information set of data was obtained in 63 days.	Information was obtained in few hours.

As result of experiment it was found that current excessively bureaucratized system is heavily outdated and all current computer aided zoning and urban planning systems almost entirely based on early 90s software.

CONCLUSION

Current situation in zoning and urban development (in Russia) is severely outdated and it is important to revise current methods. Even most basic methods and

tools shown in this paper let you save considerable amount of time and effort for everyday tasks in zoning and planning.

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