Assessing City Green Spaces by Voluntary Geographic Information

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Abstract: Green spaces are one of the most important indicators of the urban environment quality. The quantitative information on the green areas is necessary for the calculation of a total index of the urban environment quality submitted annually to the government statistics bodies. Such information can also be obtained by means of geoinformation systems that provide multiple opportunities of their application in this area: map generating, data base building, information actualization. The article considers the application of voluntary geographic information from the web-cartographic project OpenStreetMap (OSM) and the GIS technology to assess the area of the city greenery. The authors provide an example for the use of the geoinformation system with an open code QGIS to calculate the areas of green spaces in Volgograd. The application of the method suggested allows significantly reducing the time and labor effort to obtain the indicators of urban environment planting.

1 INTRODUCTION

The increased technogenic action on the environment caused the need for more sustainable design and construction processes. Environmentally sound architectural and construction solutions at all the stages of a life cycle the city passes as a whole system are the essential prerequisite of urban development (Shadrina, 2009; Usacheva, 2017; Sidorenko, 2020; Ignatyev, 2020; Ignatyev, 2020).

Although the urban environment development was included into key strategic development areas of Russia, only a third part of Russian cities were considered comfortable by the Minstroy RF information. Thus, in 2019 the Decree of the Government of the Russian Federation approved the Method for Formation of Urban Environment Quality (March 23, 2019 No. 510-r). This method distinguished 6 spaces, and one of them is titled "Green spaces". A total of three criteria were established for its assessment:

1. A share of public green spaces of a total greenery area (%): it allows assessing the level of comfort and safety of such green spaces in general and natural planting in the city.
2. The planting level (%) which allows assessing the potential development of the public green areas as well as improving the environmental safety of citizens considering the main properties of greenery (dust, noise and CO2 attenuation, and oxygen release, sewage water filtration, etc.)
3. Greenery state (non-dimensional share).

The improvement of indicators on these criteria allows enhancing the assessment of the area "Green spaces".

While the greenery state shall be assessed after the visual inspection alone, to obtain two other criteria one may use geoinformation systems (GIS).

Although the idea of geoinformation system application for assessing the planting level is not original (the results of their application to solve these tasks have been assessed by a few authors (Goryaeva, 2015; Ivlieva, 2010; Cavajos, 2011; Popova, 2018; Sergeeva, 2021), in general, no uniform and generally accepted method for the assessment of city green spaces has been developed.

The research covered the endeavor to develop a method for assessing the city green spaces based on the voluntary geographic information from the web-

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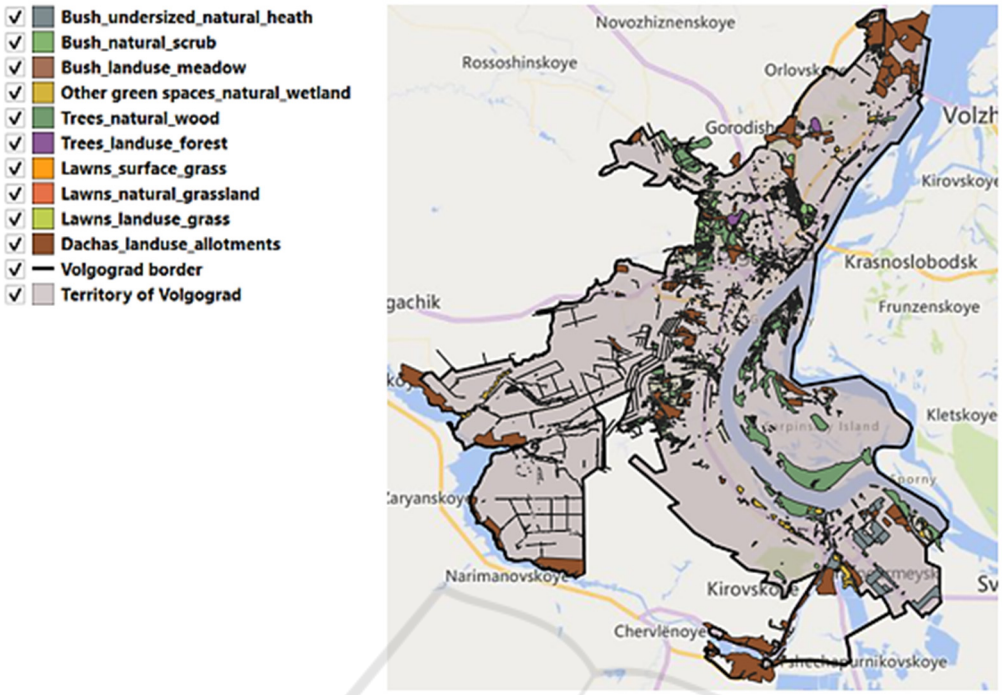

Figure 1: Vector layers for green objects, Volgograd.

cartographic project OpenStreetMap (OSMN) exemplified by Volgograd. The ultimate purpose is to optimize the process of obtaining the urban planting indicators.

2 MATERIALS AND METHODS

To get the data on the green spaces in Volgograd, the authors used voluntary geographic information (VGI) from OpenStreetMap (OSM) (Alhamwi, 2017; Ballatore, 2012; Briem, 2019; Brinkhoff, 2016; Estima, 2013; Fritz, 2012; Gil, J., 2015; Mobasheri, 2017; Ludwig, 2021).

The OSM formal model includes a range of properties (referred to as tags) describing the geographic classes the use of which is defined by the project participants at the special website Wiki. Each mapped object is assigned a tag which unites a key and its meaning.

The research work (Ignatyev, 2021) already provided the study of tags used in OpenStreetMap to designate greenery.

However, it turned out we did not select enough “key-meaning” pairs to identify all greenery in Volgograd.

After additional study conducted for the OSM tags we obtained the following pairs:

- landuse = grass, surface = grass, and natural = grassland – grass lawns;
- landuse = meadow, natural = heath and natural = scrub – territories with scrubs;
- natural = wood and landuse = forest – territories with trees;
- landuse = recreation_ground - green spaces for public leisure except for parks;
- landuse = allotments – land lots allocated for gardens or farmlands;
- leisure =- park – parks;
- natural = wetland - other greenery.

To unload the information on the green objects in Volgograd from the cartographic service OpenStreetMap and its further processing, we used a free geoinformation system with an open code QGIS.

The research was conducted in several stages.

To unload the information on Volgograd with its boundaries and green objects from the cartographic service OpenStreetMap, we used the module QuickOSM.

To unload the information on Volgograd with its boundaries, we used the tag with the key admin_level and the value 6.

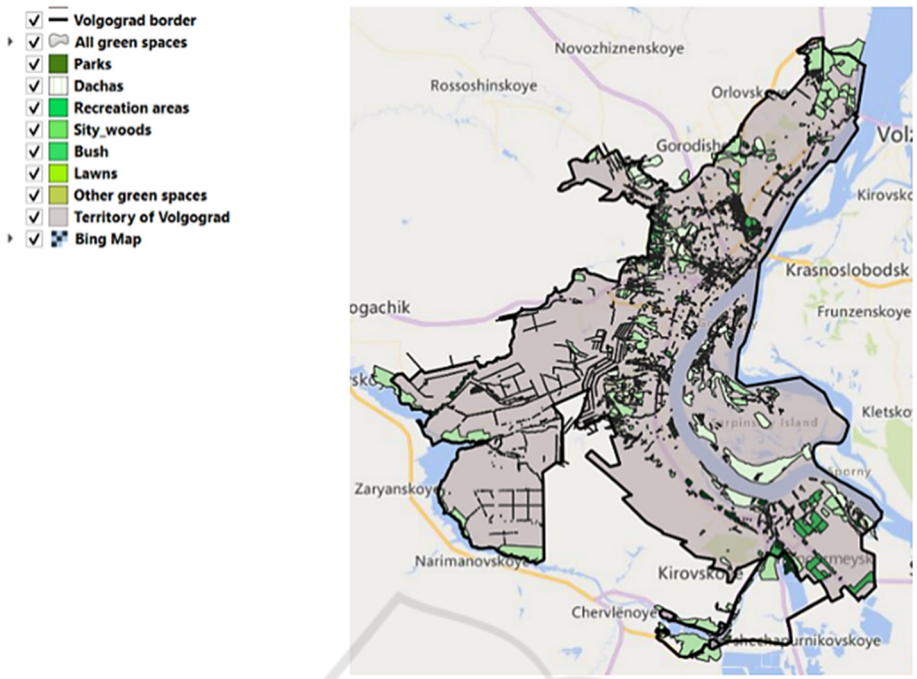

Figure 2: Layers with specific greenery types, Volgograd.

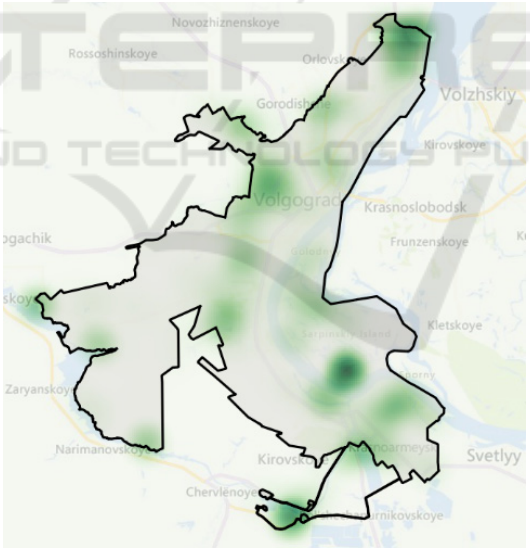

Figure 3: Heat map of greenery distribution, Volgograd.

Using the abovementioned tags, we unloaded and saved the information on all green objects in Volgograd in the form of a permanent layer (Fig. 1).

The table of each layer attributes was added a calculated field area intended for storing the area value of each polygon.

After that we cleared all the data and deleted the objects with zero area values.

Further, the layers obtained were united by the specific greenery types (Fig. 2).

These layers were united into the layer “All green spaces”.

Using this layer, we generated a heat map of greenery distribution (Fig. 3). In the process of its generation the points were weighed on the field area,

i.e., on the polygon areas containing the information on the green spaces.

To obtain information on the distribution of apartment blocks and the number people living there, we used the data unloaded from the service Reforma ZhKKh (Housing and Utility Reform) presented in the csv format. This file contains variable data on the apartment blocks located in Volgograd including their addresses, coordinates and the number of people living there.

The thorough analysis of the file showed that some of the blocks have no data on their residents' number.

This flaw was eliminated. We calculated those 26 square meters is an average living space per a person living in the apartment block in Volgograd. Using this value, we added the missing information to the field containing the data on the number of residents in the apartment blocks.

The availability of coordinates allowed mapping these blocks onto QGIS as a dot layer shown in Figure 4.

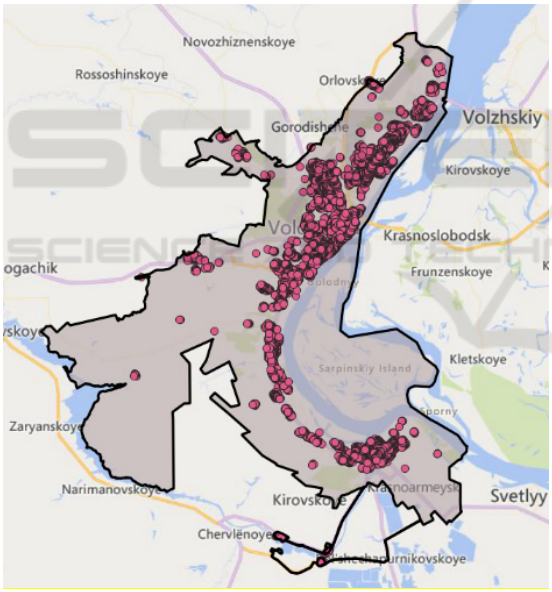

Figure 4: A dot layer with the apartment blocks location, Volgograd.

3 RESULTS AND DISCUSSION

The software solution we obtained allows calculating the following indicators used to get the index of urban environment quality:

1. The general city area (Fig. 5) applied to calculate the criterion "Planting level".

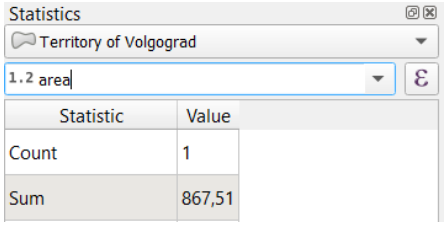

Figure 5: The general area calculated, Volgograd.

2. The area of city territories covered by greenery (Fig. 6) applied to calculate the criteria "Planting level" and the "Share of public green spaces of a total greenery area".

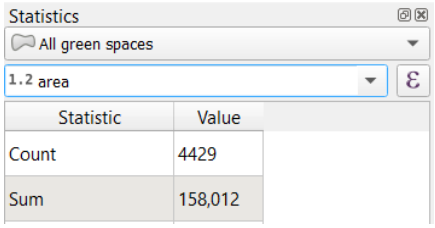

Figure 6: The calculated area of city spaces covered by greenery, Volgograd.

3. The area of public spaces (Fig. 7) applied to calculate the criterion "Share of public green spaces of a total greenery area".

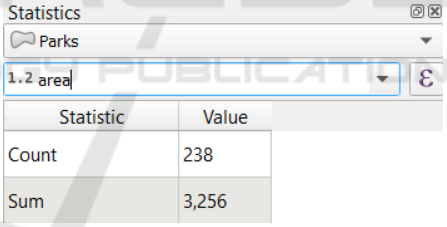

Figure 7: The calculated area of public spaces, Volgograd.

Additionally, as the solution developed allows calculating a total area of spaces covered by each type of greenery, it can be applied for unveiling the potential improvement of green spaces. For example, Figure 8 showed the area of so-called urban forests that can be improved and included in the category of the area of public spaces.

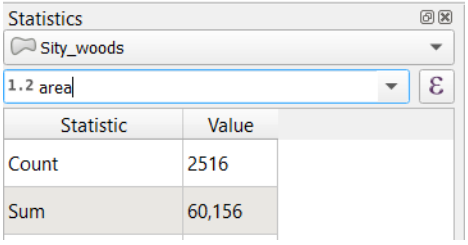

Figure 8: The area of urban forests, Volgograd.

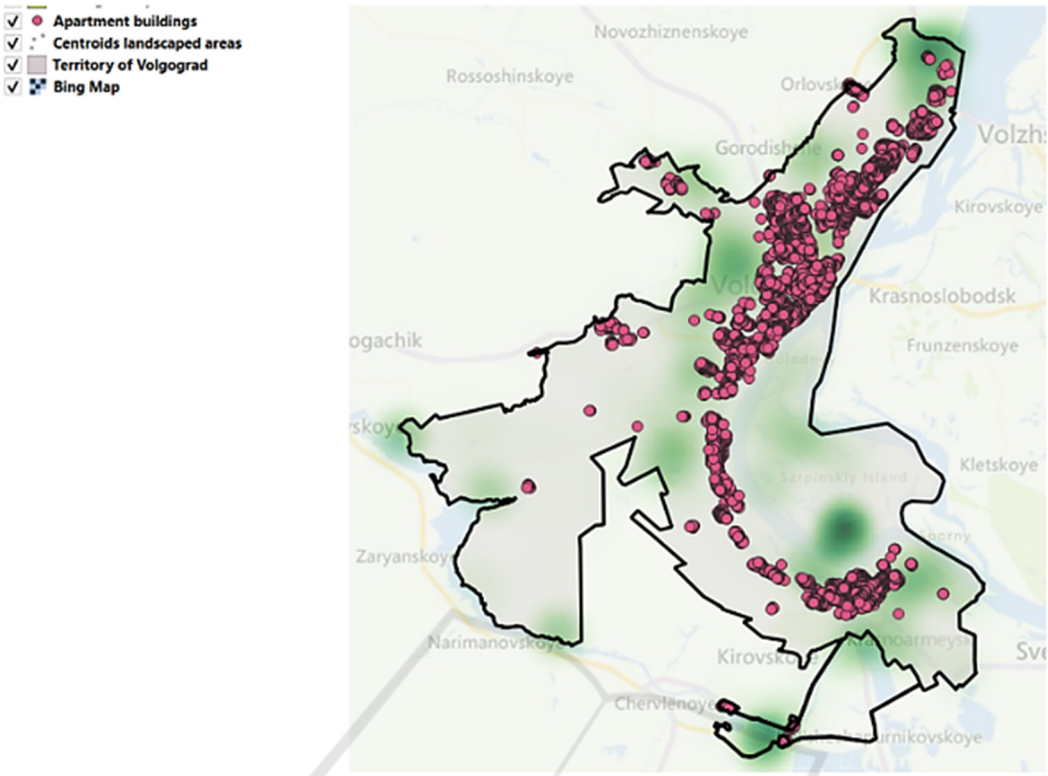

Figure 9: The aligned heat map of greenery distribution and the layer of apartment block location, and the layer showing Volgograd boundaries.

To add more, by aligning the heat map of greenery distribution with the layer of apartment block location (Fig. 9), one can define residential areas that should be provided the access to green spaces in the first place.

4 CONCLUSIONS

It is the first time the voluntary geographic information from the web-cartographic project OpenStreetMap was applied for Volgograd to assess the area of city green spaces. The method suggested allows using these data to calculate indicators for obtaining the criteria “Planting level”, “Share of public green spaces of a total greenery area” used to get the index of the urban environment quality.

As the solution developed allows calculating a total area of spaces covered by each type of greenery, it can be applied for unveiling the potential improvement of green spaces.

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