Assessment of the state and measures to improve the natural environment of the Volgograd. Agglomeration

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Abstract. The paper describes the actual state of Volgograd agglomeration. The dynamic indicators of the pollutants emission by the industrial facilities, municipal power engineering facilities, motor vehicles, and railway transport are specified. The data on the peculiarities of the urban construction of Volgograd and its suburbs in different historical periods is presented. The data characterizing peculiarities of locations, condition of functioning of the urban transportation roads and the streets and roads network in the agglomeration is provided. The promising ways of arrangement of the existing systems of resettlement, modernization of the urban transport network, and optimization of green construction are examined. The efficiency of the environment improving and aesthetic functions by the plants is assessed. The paper states that the mandatory condition of ensuring good state and high decorative value of the vegetations in the agglomeration is the use of special watering water supply lines. Accounting for the requirements and landscape architecture and adaptive science of landscaping is justified.

1. Introduction

Recently, the group form of resettlement is becoming more and more perspective due to the intense development and modernization of all types of transport and other means of communication, which stipulates possibility of maximum keeping of environment, preventing extensive concentration of population in big cities, establishing interacting systems of residential and industrial areas on their basis [1]. Rational planning of new construction, reconstruction of existing buildings and the set of the city infrastructure can be done only when the number the urban development factors are met.

2. The natural conditions of the environment and its pollution

One of the most important is the geomorphological structure of the territory. In general the territory of Volgograd and the surrounding area has a pronounced relief and significant differences in the characteristics and location of rocks and soils.

By results of cartometric works and field surveys the territory with materials of S. K. Gorelov [2] we studied its geomorphological structure.

The territory of the Northern part of Volgograd and its vicinities ( from a beam Kotlovannaya to the small river Sukhaya Mechetka ) folded Ergeninskii and Tsaritsyno is composed of sand covered with a thin layer of loam and to a different degree eroded alkaline soils.
It is characterized mainly by gentle forms of relief. The average steepness of the slopes is to 2 degrees, the banks, beams from 5 to 11 degree. In the river of Sukhaya Mechetka a significant number of large ravines flow in.

Located to the south of the area, including the towns of Zarechny, Orlovsky and Vodostroy represent by the slopes of the steep from 2 to 2,5 degrees, in the residential area and near it from 1 to 1,5 degrees in the peripheral part of the dissected beams Kamenskaya, Peschanka, Vodyanaya and Kazennaya depth to 20-25 meters and steepness of the banks from 4 to 12 degrees.

Soils – mainly heavy-loamy and clay in a complex with solonetz on the low-power loam underlying Ergeninskii sands of the roof Tsaritsyno sands.

Located south-west of the administrative territory of Dzerzhinsky district of Volgograd, and the villages of Gorodishe and Gumrak is composed of the parent rock material composed mainly of light granulometric composition of light loam underlain Ergeninskii sands, which in turn are placed on a blurry roof of the Maikop clays. Groundwater outlets are sources of small rivers of Tsaritsa and Mokraya Mechetka, their valley, s are convenient places to create the urban recreational green space. Bank of the river of Mokraya Mechetka, and beams Biruchya, Kazennaya, Gnuysina and Talovaya shallow in the middle and lower parts steep and the vertex.

The most of the Sovetskii and Voroshilovskii administrative districts of Volgograd are located on the slopes of the steeps to 4 degrees. Soils of the site are light chestnut places saline predominantly of light granulometric composition on low-power loams and sandy-loams underlain by Ergeninskii sands on the roof of Maikop clays. Bottoms dismembering the territory of the beams Elshanka, Kuporosnaya, Naidenova and Grigorova fall in eastern area. Depth of beams up to 22 meters, slopes steeper.

The lower territory of the Kirovskii administrative district of Volgograd and adjacent areas is composed of Ergeninskii sands and Scythian clays, lying on the blured roof of the Maikop clay rocks. Soils are predominantly light chestnut in combination with solons of varying degrees of wettability. Adjacent to urban development strip width of 400-500 meters, represent by steep slopes of about 6 degrees, extend to the beam Otrada.

The section between Otrada beam and Volgo-Don shipping canal represent a wide partly swampy terrace, gradually passing into to the gentle sloped of the steep order 3 degrees. Soul light-brown, clayey, alkaline in complex with saline to a different degree washed away. Underlying rocks mainly Scythian clay, in some places Ergeninskii sands of the roof of Maikop clays.

Part behind the canal territory located on the wide terrace of the Volga, is part of the flat low-lying marine plain, composed of Khvalynsky chocolate clays. The ruggedness of the upland territory of the hydrographic network is almost absent. Soils- are light colored, predominantly saline in combination with solonets and salt marshes [3], which unsuitable without carrying out reclamation activities for the growth most tree species.

One of the most important factors is the degree and nature of environment contamination. The issues of environment condition in Volgograd agglomeration are paid much attention; however, emissions of pollutants into the atmosphere and soil are tending to increase rather than reduce (table 1).

Table 1. Weight of contaminants emissions to atmosphere in Volgograd region, thousand tons [2].

| Types of emissions                        | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|------------------------------------------|------|------|------|------|------|------|
| Total                                    | 178.2| 170.8| 172.5| 153.5| 159.9| 161.4|
| including:                              |      |      |      |      |      |      |
| solid                                    | 13.4 | 13.1 | 12.2 | 9.95 | 10.0 | 8.9  |
| gaseous and liquid, out of them          | 164.8| 157.7| 160.3| 143.6| 149.9| 152.5|
| Sulfur dioxide                           | 6.8  | 7.7  | 9.1  | 7.2  | 7.6  | 12.1 |
| Carbon oxide                             | 75.4 | 74.0 | 72.3 | 56.7 | 60.8 | 54.5 |
| Nitrogen oxides                          | 26.2 | 26.5 | 26.0 | 25.4 | 27.3 | 26.2 |
| Hydrocarbons                             | 52.6 | 46.1 | 49.4 | 51.1 | 51.2 | 56.4 |
| other                                    | 3.8  | 3.4  | 3.5  | 3.1  | 3.2  | 3.2  |
Large amount of emissions are made by Volgograd agglomeration (35.5 thousand tons in Volgograd, 54.3 thousand tons in Volzhsky). Motor vehicles make the largest “contribution” into pollution of the atmospheric air (table 2). Its share in the total volume of emissions amounts to 60.7%.

### Table 2. Contaminants emissions by motor vehicles in 2016, thousand tons.

| Cities    | SO₂ | NOₓ | VOC w/o methane | CO  | C  | NH₄ | CH₄ | Total |
|-----------|-----|-----|-----------------|-----|----|-----|-----|-------|
| Volgograd | 0.3 | 4.9 | 6.4             | 52.2| 0.1| 0.1  | 0.3  | 64.3  |
| Volzhsky  | 0.07| 1.3 | 1.7             | 12.3| 0.02| 0.04 | 0.1  | 15.4  |

Environment pollution in Volgograd region by the railway transport was much lower (only 4.4 thousand tons); it is much more environment-friendly.

The greatest harm to human health in Volgograd and Volzhsky is made by: dust, nitrogen oxides, formaldehydes, phenol, hydrogen chloride and fluoride, hydrogen sulfide. Their presence in the air reduces immunity, irritates respiratory system, and contributes to the growth of population suffering from chronic bronchitis, pharyngitis, bronchial asthma, rhinitis, and repeated ARVI [4].

### 3. Features of urban construction

Given the above, to improve the situation it is necessary to solve the problems of reconstruction such as location of streets and squares, parameters of transport facilities, placement of production facilities, vegetations, etc., besides emissions treatment.

Development of Volgograd is carried out in accordance with the socio-economic conditions of the historical period of urban construction on each site of its territory. As a result of the analysis proposed Chereshnev I. V. and Chereshneva N. In. [5], making definitions, changes, clarifications, the intensive development of the Volgograd agglomeration should be divided into separate periods taking into account the stages.

In the first period (the end of the19th century – the First World War) the residential construction was made in the area of Central district of Volgograd, workers’ settlements adjacent to industrial areas located along the Volga river. Building blocks in the central part of the city were rectangular, areas for buildings and structures amounted for 45% of the territory. Construction of the workers’ settlements was complex (simultaneous construction of industrial facilities and wooden barracks at the adjacent areas). Components of improvement and required infrastructure were almost absent.

In the second period (the 1920s – 1930s) transition was made to construction of complex residential areas (communities), large apartments designed for simultaneous living of several families. Average number of floors did not exceed 3 ones. Green construction, though chaotic, was implemented in residential areas.

In the third period (1943 – 1955), the center of the city was covered with 4-7-floor buildings with individual apartments of high comfort (so called Stalin-era buildings). In the other areas 2-3-floor buildings were constructed with sufficiently comfortable apartments. Required infrastructure was developed; large areas were allocated for plants, flowers and lawns.

The fourth period (1955-1975) was marked both in Volgograd and Volzhsky and other satellite towns with the typical industrial construction using prefabricated reinforced concrete. The main requirement to design of residential areas was economic effect of the architectural and planning decisions, which specified reduction of apartment area and as a result their comfort. In order to compensate the limited residential area of apartments in the five-story Khrušchev-era buildings, the complex building of micro-districts, their landscaping, arrangement of children’s areas, etc. were planned. Since 1964, the gradual transition to construction of residential buildings with apartments of larger areas (though smaller than at the third stage) began. The line building, when building ends look at the traffic road, is widely used. The plants and children areas took sufficiently large areas, though
quality of green construction was poor, without regard of the terrain, soil conditions, hydrogeology, etc.

The fifth period (1975-1990) was characterized with transition from construction of typical buildings to construction of building blocks. Micro-district was the main structural and planning object of the city development. Reduction of areas covered with main roads took place; they were located at the perimeter of the large developed area. Areas for relax, play, schools and pre-school facilities were allocated (micro-district of Krasnoarmeysk and Dzerzhinsky districts, areas of Spartanovka and Tulaka, etc.). Demolition of one-story buildings grew up; 9, 12, 14 and 16-story buildings with rather comfortable apartments were constructed at the free areas. At the same time amount of waste lands went up (installation of metal garages without any control and regulation). The period is characterized with low quality of green construction, as considerable part of planting operations was done during Saturday voluntary work days with the young plants available, insufficiently decorative and resistant to unfavorable conditions of dry step area for trees for bushes. Problems connected with plants watering became critical. Plant growing was done without regard to the requirements of landscape architecture.

The sixth period (1990 – present time) is characterized with orientation of the quality indicators of residential buildings on the customer demands. Multipurpose residential buildings with well-developed infrastructure, improvement of the area, including parking lots for building residents, are widely spread. Starting at the second half of 1990-s, significant construction of elite residential buildings is done inside the building blocks of 5-story buildings in the central districts of the city and in the centers of peripheral micro-districts (infill construction). Introduction of 20-25-story buildings between existing buildings takes place [4]. As a result, the population density is growing to the values exceeding the regulatory ones. The number of personal vehicles is growing, shortage of places for their parking is getting normal; parking is often done between trees and bushes. Reduction of public areas of plants and deterioration of their condition take place. At the same time, intense construction of the areas adjacent to residential areas with comfortable cottages takes place.

In the last decades of the period the cottage construction is getting slow and complex construction of the areas with the buildings of little number of floors and economy class apartments, with the children play areas, kindergartens, schools, etc. is getting widespread at the city outskirts. Significant areas are allocated to plants, the results of our studies, however, green construction is carried out mainly in accordance with simplified schemes without the use of methods of landscape architecture, with insufficient number of lawns and flower beds.

One of the critical factors that determine peculiarities of approaches to reconstruction of residential and industrial areas is arrangement and condition of the city transport main roads and the street-road network. The urgency of establishing of the best landscape-transportation areas is supported by the fact that its group settlements are far from each other, and in the process of their growth and development the intensity of movements of population is growing.

Linear structure of Volgograd construction and linear-group transport system is characterized with increased operational loads on the road network. The situation is worsen with the fact that in the last 10 years the level of motorization was increased for 6 – 7% and amounted to 350 vehicles per 1000 people in 2016. Significant disadvantage of the public transport is the fact that the routes of buses, trolleybuses, trams and electric trains are not combined in the uniform transport network. Frequently stops are located irrationally; their major part does not comply with the regulatory requirements. Movement of shuttles is not regulated. Besides, electric transport fleet is obsolete; level of wear and tear is very high (96 – 75%) [6]. The only change is significant updating and increase in number of the bus fleet in the last two years.

The level of loading of the traffic way and city roads above 0.75 took place at 37.7% of their length. In rush hours about 40% of the cross roads of the main roads are characterized with the loading level above 0.90… 0.95. As a result the average speed of motor vehicles amounts to 33.9 km/h. 40% of the area of construction is located in the area of acoustic discomfort, 25% – in the area of increased air contamination; 32% – at the distance above 500m from the public transport stops [6]. The situation
is worsen with systematic falling behind the required indicators of repair of the asphalt-concrete coating of the roads, 26.6% of the traffic way does not any hard coating [7].

4. Necessary measures for the reconstruction and improvement of the building

The urban development concept of Volgograd agglomeration development (Concept of Big Volgograd) [6, 8] included closing of transportation system of agglomeration in semi-ring around the building area that resulted from development of Volgograd and its satellite towns and ensuring the best formation of the group settlement by means of transition of linear planning structure of agglomeration into the radial-circular one. The proposed directions of reconstruction were correct; however, their implementation is very slow.

Taking into account the above mentioned, the urban development shall be based on the following directions of transportation development of agglomeration settlements: establishing city and suburban high-speed railway transport reducing interval of electric trains movement to the level of the 1980-s of the last century, at least; increasing the length of the speed tram line; construction of new line of the above ground electric transport, construction of new bus routes, etc.

Many researchers [9-11] determined that one of the most critical directions of the urban space arrangement is resolution of the issue of increasing quality of the landscaped development and utility areas. They shall ensure the maximum possible level of comfort for population of all settlements of agglomeration. The most important role is played by the city vegetations. In order to provide for required result, the green areas shall be numerous and well-distributed. Besides, Volgograd agglomeration requires organic link of the landscaping system with the above mentioned historic peculiarities of settlement, including availability of significant diversity of construction and transportation systems, as well as with the set of landscape factors (geomorphological structure, soils, peculiarities of hydrogeology, etc.).

The effectiveness of nature management and aesthetic functions of plants depends on their condition [12-16]. Our research has established that in the conditions of the Volgograd agglomeration, the limited quality of growth, development and longevity of plants is a general deficit of soil moisture [17,18]. As a result, the condition and aesthetic value of the major part of the city plants is low. At the same time, even at the areas of saline and alkaline clay soils unfavorable for trees and bushes, the long-term, highly decorative plants such as weeping birch, silver spruce, horse chestnut, weeping willow, Norway maple, and western arborvitae (arboretum of the Volga-Don navigation channel, plants along the main stairs of Mamaev Hill, park next to the administration building of Volzhsky pipe plant) were planted as a result of required soil washing prior to planting and systematic watering after planting. In this respect, the main condition for ensuring the well-being of green spaces is the creation and rational operation of irrigation water pipes.

In the modern urban development, mandatory requirement to landscaping operations includes their design using landscape and architecture approaches [12,17,18]. Composition of each facility shall comply with the planning situation. In order to achieve architectural effect the set of means for terrain leveling, further establishing, growing and regulation of plants shall be used [19,20].

The used method of landscape architecture shall be determined by the functional area of every agglomeration micro-district. Natural conditions and nature of building of each area support aesthetic objectives of the landscape architecture. Individual layout of each residential area of agglomeration shall be established as a result of creative approach to resolution of the designing tasks with regard to development of its construction.

Green construction in Volgograd agglomeration shall be done with regard to the peculiarities of growth of plants in the urban conditions of the dry step area:

- rapid growth of young trees;
- stabilization of growth of different types of trees at 3-8 years old, after which plants growth is slowed down;
- trees are characterized with rapid development, early flowering and fruiting, which results in the trees high decorative effect;
• in case of insufficient moisture of soils, the duration of period of satisfactory condition of plants is 2-3 times less than in the moderate area [21].

The outlined directions and measures of the landscape and architectural improvement of agglomeration areas, the state in the gradual reconstruction of the building of the modernization of the transport network of the installation, can significantly enhance the attractiveness and state of the urban environment.

5. Conclusion

1. Environment condition of Volgograd agglomeration is characterized with sufficiently high contamination differs significantly depending on the type of building system, terrain, location of motor roads.
2. Industrial and civil construction in different periods was significantly differ in terms of the number of floors and location of buildings, distance between buildings, scope and types of improvement and landscaping operations at the built-up sites.
3. Transportation network existing at the agglomeration main part does not comply with the grown requirements to its technical ecological specifications and requires gradual upgrading.
4. The most important method of the agglomeration environment improvement is the green construction; measures developed for its implementation and regulation of the vegetation functioning shall equally take into account both requirements of the adaptive science of landscaping and landscape architecture.

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