Improvement issues of architectural solutions of buildings and structures for botanical gardens in context of green economical aims

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Abstract In Russia, the ways of increasing the socio-economic role of natural protected areas actively investigated. The main directions of improvement of their infrastructure are considered. They relate to the following tasks of the "green" economy: preventing the loss of natural capital, improving the quality of life, resource conservation, ecotourism development, etc. In the course of work, Russian and foreign approaches to building design and to the improvement of sites of institutions for natural protected areas were studied. By the botanical gardens examples, the possibilities of increasing the scientific and consumer properties of the territories researched. Recommendations for the formation of a diversified nomenclature of visitor centers are given. The author draws a conclusion about the need to develop representative technical standards and regulations for urban planning and architectural design for the main categories of natural protected areas.

1. Introduction
In accordance with the global concept of sustainable development, the economy should develop to focus on the requirements of the natural and cultural heritage protection. For the first time in the Russia, the issues of activity’s environmentalization raised at the Federal level in the mid-1990s. The tasks of ensuring a stable environmental situation and radically improving the state of the environment outlined in the "Concept of the transition of the Russian Federation to sustainable development" (1996). Taking into account the possibilities of nature in the implementation of economic activities proclaimed as the main condition for change. In the 21st century, the global movement of transition to a "green" economy stimulates practical steps in Russia to unite efforts in the areas of ecosystem protection (natural capital), economic reform (material capital) and the formation of a responsible mentality (human and social capital) [1]. A fundamental condition and an indicator of sustainable development of any country for the conservation of biological diversity is the growth of the territory of natural protected areas (NPA). In 2018, the area of all categories of Russian NPA exceeded 213.5 million hectares, and their share in the country's land use structure reached 12.5 % [2]. In the coming years, this figure planned to increase to 18%. Economic activity within the NPA regulated in accordance with the legislation. However, their economic potential used inefficiently. To date, the environmental impact in areas with concentration of scientific and educational facilities is not reduce. The reason is that their design solutions, as well as transport infrastructure, the level of improvement and the condition of engineering structures do not correspond to the increasing recreational load. It is
also important that the range, quantity and consumer properties of most of the available buildings and structures do not correspond to the international level in the number and comfort of services provided to local residents and tourists. The organization of scientific research is constrained also. Therefore, the search for ways to increase the attractiveness of NPA in accordance with the objectives of the "green" economy is one of the urgent problems of Russian architectural science.

2. Materials and Methods
The study was limited to the consideration of botanical gardens and arboretums in Russia. Special attention paid to the problem of their infrastructure formation. The main methods were the study of urban planning and architectural regulations, the systematization of Russian and foreign scientific and theoretical base of facilities design, the familiarization with the best practices of architectural design (Internet resources). Field observations performed. It allowed to conduct the complex analysis of town-planning, functional, composite and engineering factors and to systematize the most important innovative approaches. In addition, experimental modeling of the main types of buildings executed.

3. Results

3.1. Position of Russian botanical gardens in the national system of natural protected areas
Pursuant to Federal Law No 33-FZ of March 14, 1995 "About specially protected natural areas" in Russia there are the following categories of institutions: a) state nature reserves, including biosphere’s reserves, b) national parks, c) natural parks, d) dendrological parks (arboretum) and Botanical gardens. In addition, a group of natural monuments is distinguished. As of 2017, in Russia, among the objects of federal significance, there were 105 nature reserves, 52 national parks, 17 natural monuments, and 41 botanical gardens. In addition, numerous objects of regional importance are register: 92 natural parks, 2351 wildlife sanctuaries, 7520 natural monuments, 28 arboretums and botanical gardens, etc. [2]. The regime of special protection affects the urban development of these areas. At the same time, the tasks of organizing and conducting scientific research, environmental education and the development of educational tourism are set for NPA. In market conditions, the cognitive tourism is becoming one of the most profitable economic spheres. The improvement of tourism infrastructure with the attraction of small business resources and the development of jobs is in the context of the principles of a "green" economy [3].

National parks, natural parks and botanical gardens (BG) have the highest potential for the development of infrastructure of cognitive tourism facilities [4, 5]. In the zones of urbanization, botanical gardens (BG) perform the leading role of biodiversity conservation. The Council of botanical gardens of Russia 141 institution registered. These facilities are mainly located in regional centers. The largest number of institutions is located in Moscow: there are eight BG. Six institutions are in Yekaterinburg and Sochi, five are in Kazan and Syktyvkar, four are in Volgograd, Novosibirsk and St. Petersburg, three are in Izhievsk and Krasnoyarsk. Two institutions works in Arkhangelsk, Barnaul, Vladivostok, Ivanovo, Kemerovo, Krasnodar, Makhachkala, Nalchik, Orenburg, Penza, Pyatigorsk, Saratov, Khabarovsk, Cheboksary, Yakutsk and Yaroslavl. It should be note, that in Russia the practice of organizing private BG is in formation period. In accordance with the Federal Law, the possibilities of infrastructure development in BG limited by the purposes and types of institution’s activity. Exposition, scientific-experimental and administrative zones can be create on their areas. A condition for the effective functioning of BG is the prohibition or restriction of such activities, which may lead to a decrease of the biosphere value of collections. In this regard, the most important economic profile of the majority of BG is research and educational services. For their implementation, the appropriate infrastructure should be generate.

3.2. Current status and key problems of infrastructure development of Russian botanical gardens
At present, some institutions are adequately equipped with infrastructure. These include the Main Botanical garden name after Tsitsin (Moscow, the Russian Academy of Sciences), the Botanical
Garden of Moscow State University "Apothecary Garden", Arboretum of Sochi national park, Botanical garden of the Great Peter (St. Petersburg) and Botanical garden of St. Petersburg State University. There are large greenhouses and laboratories. The level of improvement, the presence of pavilions and gazebos helps to attract visitors. It should be noted that in some BG, the state of the road network and the improvement of the alleys provides an acquaintance to the collections throughout the year (Rostov-on-Don, Novosibirsk, Blagoveshchensk, etc.). However, the predominant part of the Russian BG does not have buildings and structures that allow an organized effective scientific and educational activities.

A significant obstacle for the "green" economic development of BG is the "spontaneous" development of their sites. During the study, it was not possible to identify the Russian BG, which purposefully develop according to the approved concepts. In all cases, the master plans that designed in the 21st century and the associated architectural projects of infrastructure facilities are missing. They need to be developed and introduce on new biological and town-planning scientific approaches basis. For example, scientists from the Belgorod State National Research University propose to take into account the ecological role of the BG in the natural-ecological framework of the region in the development of the territory. They proposed a map of ecological-functional zoning, taking into account the influence of the city [6]. The presence of cultural heritage is duly noted in the paper devoted to the development plans of the Botanical Garden of the Crimean Federal University. It was propose to allocate four zones (exposition, reserve, scientific, and administrative-economic) with the corresponding subzones and landscape gardening [7].

Another problem in the market conditions is in management sphere. Often, the cities or institutions authorities do not understand the special environmental mission of BG. Thus, directorates of BG take a conservative position and limit the maximum visit to the territory for the population. Some do not know the regulations, the system of restrictions, seek to maximize profits. Others fear change under the pressure of funding shortages and a lack of awareness of new technologies. In particular, none of the Russian BG has an innovative laboratory building, a museum of nature, a greenhouse or a visitor center built with the use of environmental technologies. It is obvious that the lack of modern facilities, firstly, constrains the interest of nature lovers, including from abroad, and, secondly, prevents the employment of young ambitious scientists seeking a decent social status.

4. Discussion

4.1. The present status of the theoretical foundations for the development of botanical gardens infrastructure

Until recently, BG have been the subject of research and experimentation exclusively in the fields of biology, agriculture and earth sciences. Their gradual development as centres of education and enlightenment has led to changes. Now they are included into research field of representatives of pedagogical and psychological sciences (O. Vvedensky; 2002; L. Parshutina, 2005; V. Konstantinov, 2010; A. Klyukina, 2014; E. Mitina, 2014; etc.).

The phenomenon of BG standing in one row with other types of green areas, was the occasion to explore their historical evolution (E. Kolyada, 2002, 2012; E. Makeeva, 2002; O. Yellina, 2009; I. Shilina, 2008; M. Abakarov, 2009; M. Kuzybaeva, 2011; A. Veresova, 2012; U. Strugovschikova, 2014; etc.), for understanding their philosophical role (Malakhova, 2001; N. Yezhova, 2005, I. Khabriev, 2010, A. Khomyakova, 2010, D. Jaworski, 2013), to clarify their social, cultural and artistic value (Y. Zinovieva, 2000; V. Gritskievich, 2003; T. Poidina, 2006; K. Rybak, 2006; S. Veselova, 2011; O. Sapanja, 2011; O. Dranichkina, 2015; V. Chekmarev, 2015; etc.). The status of these objects as specially protected natural areas allowed a number of Russian scientists to turn to the synergetic approach (A. Klyukina, 1999; Z. Cherdymova, 2000; S. Levina, 2002; I. Moroz, 2004; N. Domanova, 2005; Y. Belozerova, 2006; T. Telichenko, 2007; A. Uvarov, 2010; T. Fedorova, 2012; etc.). It is recognize as the most effective method for developing of recommendations for strategic planning and implementation of tactics for the gradual increase in consumer value.
The analysis of works of scientists-architects shows that in the arsenal of domestic architectural science there are no works devoted to innovative methods of landscape organization and typological features of the infrastructure of BG. Nevertheless, it should be noted that this group of facilities was given attention in dissertations by N. Unagaeva (2011) and Y. Balabanova (2013).

In the context of the formation of new economic attitudes, the importance of BG as a place of work and rehabilitation of people increased. This circumstance has allowed to transfer the problem of its development, organizational and functional optimization to economics and law (D. Khashimov, 1999; A. Krotik, 2003; A. Shecoldikhin, 2006; N. Lagutkina, 2006; Salova L., 2009; S. Lupacheva, 2013; etc.). However, only in the XXI century botanical gardens began to be considered as potential subjects of "green" economy in Russia (T. Fedorova, 2010) [8].

4.2. Design trends and main types of infrastructure facilities for botanical gardens

The best foreign experience in the formation of the infrastructure of BG studied in this research. Its comparison with the tasks of development of Russian institutions allows us to offer the systematization of objects.

In total, four architectural-typological groups identified. The first group includes real estate. These are public buildings and facilities – offices, conservatories and greenhouses, laboratories, information and visitor centers, museums, etc. The second group includes demonstration facilities and small architectural forms (pavilions, observation towers, gazebos, kiosks, toilets, etc.). The third group includes design objects (signs, stands, park furniture, lamps, fences, etc.), line and flat structures (observation platforms and observation points, roads, sidewalks, trails, bridges), as well as elements of the artificial landscape (plant collections, decorative lawns, flower beds, etc.). The fourth group includes transport and engineering facilities (berths, retaining walls, pumping and treatment plants for water supply and sanitation, security systems, electricity, heat supply, climate control, etc.). All of them contribute to the stable functioning of institutions, increase the attractiveness of BG and increase the flow of visitors. The high quality of work allows to improving the comfort of employees and visitors and provides to carry out research and excursions in adverse climatic conditions [9].

Each of the architectural-typological groups has a spatial specificity. Objects can be either monofunctional or multifunctional. This is due to the wide interpretation of complex management based on the requirements for functional zoning of the territory. Therefore, in each of the zones, the number, density and equipment of objects of a certain purpose can vary both in space and in time.

Note that in many countries, on NPA, including BG, the construction of buildings that comply with the principles of "green" economy and have minimal impact on the environment is encouraged [10, 11]. Attention is focusing on improving energy efficiency, including the use of alternative energy sources, on the use of local natural materials, on landscaping surfaces of roofs and facades. In recent years, of particular importance is the humanization of the environment of BG [12, 13]. They have become a favorite place for people with disabilities. The creation of a barrier-free environment is an essential condition for the socialization of the disabled, the elderly, young children and pregnant women. The use of universal design methods allows them to overcome the difficulties of moving over rough terrain [14].

4.3. Architectural features of the buildings for botanical gardens visitor centers

Visitor centers (VC) highlighted from the many types of buildings and structures that built on the territory of modern BG [15]. They are forming on the diversified typology basis, and expanded commercial opportunities provided for institutions, while more services exerted to visitors. In them various administrative divisions, leisure, educational and health zones placed. Platforms for additional functions, such as parking for motor vehicles, a cafe and outdoor exposure, animal enclosures, children's play and sports grounds, etc., organized in the surrounding site. The premises of the building may be provide for rent to entrepreneurs.

The following tasks of the VC are the main ones: a) familiarization of visitors with the activities of the BG before the tour or souvenir service or after its completion; accommodation and demonstration
of the museum exhibition; b) trainings with lectures and practical classes for schoolchildren, students, volunteers and nature lovers; c) scientists interaction; popularization of research and achievements, transfer of scientific-theoretical and practical experience; d) catering, sanitary services. In line with purposes and profile, the VC can be divide into following three basic functional types: sightseeing, educational and research. Their mix in various combinations allows achieve integrated solutions. Therefore, the second group includes multifunctional (combined) visitor centers, which may be get by conjunction of two basic types. The third group consists of universal visitor centers, where each of all three basic functional types or its parts may be place [16].

4.4. Pilot project of infrastructure development for the Botanical garden of Samara University

The results of the study were use in experimental modeling. Conceptual proposals for the development of the infrastructure of the Botanical garden of the Samara University were developed. Currently, this institution characterized by problems of spontaneous improvement, lack of infrastructure facilities and poor quality of architectural solutions of existing buildings and structures.

The task of the pilot project was to develop a solution that promotes the positioning of the BG as an ecological center. To attract tourists, it was propose to create a pedestrian bridge connecting the site with the nearest parking places for public and private transport, to improve landscaping and develop infrastructure. Preliminary designs for new buildings and structures have been develop. The visitor center, research laboratories, multifunctional pavilions, cafe and shop of seeds and seedlings designed in accordance with the requirements of "green" standards. The overpass network above the ground, observation tower, several places with small architectural forms for recreation serve to ensure a comfortable stay of employees and tourists in the territory (figure 1).

Figure 1. The example of a pilot project (final qualifying project). Proposals for the development of infrastructure for the Botanical garden of Samara University (student – E. Yurchenko, supervisor – prof. T. Vavilova, Samara State Technical University, Russia).

5. Conclusions

Intensification of activity in NPA can appear only with a systematic approach and the presence of comprehensive programs for improve the infrastructure of each area. Their role in the country's sustainable development must be took into account. In Russia, the need to develop special standards and regulations for urban planning and architectural design for the main categories of protected areas has matured. Botanical gardens are focal points of biodiversity conservation in an urban environment. In them, synergistic architectural and town planning approaches that meet the objectives of improving
the effectiveness of scientific and educational activities of institutions in the context of the objectives of the "green" economy should be used. The nomenclature, number, size of buildings, as well as the nature of the improvement should be determined purposefully, based on analysis the regional and urban uniqueness of each BG. Administrative, research, educational, service, transport and engineering groups of objects are basic. They can combined as a part of multifunctional buildings. The leading role belongs to greenhouses, laboratories and visitor centers. The use of "green" standards is a prerequisite for spatial and architectural design of facilities.

References
[1] Bobylev S 2017 Sustainable development for future generations: economic priorities The world of new economy 3 90–96
[2] Environmental protection in Russia 2018 Statistical compendium (Moscow: Federal State Statistics Service) p 125
[3] Yashalova N and Ruban D 2013 Prospects of development of ecological tourism to promote a green economy Bulletin of Ural Federal University. Series Economics and Management 6 98–106
[4] Vavilova T 2016 Future development of architectural typology of objects to protected areas Innovative project 1 (3) 106–109
[5] Dolgaleva L and Galanin A 2005 Botanical gardens and parks as a factor of sustainable development of ecological tourism Proceedings of the far Eastern state technical University 140 118–123
[6] Lopina E, Statsenko E, Kornilov A and Tokhtar V 2012 Geoecological study of the Belgorod national research university botanical garden functional zoning Scientific statements of Belgorod state University Series: Natural Sciences 21(140) 174–178
[7] Repetskaya A 2009 Functional zoning of the territory of the Botanical garden of Tauride national University Scientific notes of Tauride national University V I Vernadsky Series: Biology, chemistry 3 (22) 119–129
[8] Fedorova T 2010 Development of entrepreneurship of botanical gardens of Russia Social and Economic Phenomena and Processes 6(22) 183–185
[9] Vavilova T and Bakhareva Y 2018 IOP Conf Ser Mater Eng 463 032081
[10] D’Amato D, Droste N, Allen B, Kettunen M, Lähtinen K, Korhonen J, Leskinen P, Matthies B and Toppinen A 2017 Green, circular, bio economy A comparative analysis of sustainability avenues J Clean Prod 168 716–734
[11] Pan S, Gao M, Kim H, Shah K, Pei S and Chiang P 2018 Advances and challenges in sustainable tourism toward a green economy Sci Total Environ 635 452–469
[12] Noriah O, Noralizawati M, Mohd H and Mohd A 2015 Exploring Human Oriented Design in Selected Botanical Gardens in Malaysia Proc Soc Behv 201 191–200
[13] Nikonova G and Vavilova T 2018 Buildings and structures of Botanical gardens as a factor in increasing their social role Architecture and Design: History, Theory, Innovation Proceedings of the International Scientific Conference 3 179–183
[14] He H and Chen J 2012 Educational and enjoyment benefits of visitor education centers at botanical gardens Biol Conserv 149(1) 103–112
[15] Wassenberg C, Goldenberg M and Soule K 2015 Benefits of botanical garden visitation: A means-end study Urban For Urban Gree 14(1) 148–155
[16] Vavilova T and Chakina I 2016 Prospects of development of ecological tourism infrastructures in protected natural areas Urban construction and architecture 3(24) 97–102