Ecological architecture of settlements as basis for improving life quality

S G Shabiev¹, M G Danilchuk²

¹Architectural Faculty, South Ural State University, 76, Lenin Prospekt, Chelyabinsk 454080, Russia
²Department of architecture, South Ural State University, 76, Lenin Prospekt, Chelyabinsk 454080, Russia

E-mail: shabievg@susu.ru

Abstract. The article deals with the challenging issue of improving life quality based on ecological architecture which is the focus of a many-year research conducted by the researchers from the Faculty of Architecture at South Ural State University. They have been published the monographs and a number of articles, including the SCOPUS database; carried out the research and taken part in construction projects based on the ecological approach. The study shows a high form-shaping potential of ecological architecture as an effective instrument to improve the artistic expressiveness in construction. This instrument is successfully tested in eco-designing the general plan for Roshchino, a settlement near the city of Chelyabinsk. The general plan includes an architectural ensemble created with the innovative scientific developments in the field of architectural science providing a high-comfort environment with considering the established history of social and communication conditions.

1. Introduction
In current conditions, increasing anthropogenic impact on the environment causes an acute need to solve global problems. And architectural science is one of the effective areas where it plays an active role, which specifically covers many economic and environmental issues, improves the aesthetics of settlements, life quality, etc. This is proved by practice where the quality of architectural structures is the major criterion for their environmental sustainability as the most important property of buildings to meet the requirements for rational usage of natural resources and environment protection [1,2]. Energy efficiency based on the alternative energy sources, wind turbines and solar panels, is becoming especially urgent, which can change the architectural aspect of contemporary buildings and structures [3-5].

2. Body
The participation of South Ural State University (SUSU) in the Russian government project “5-100” aiming to increase the role of the leading Russian universities among the world’s prestigious universities as well as the strategic initiatives of its roadmap for this project indicate the necessity to deepen the research in the field of ecological architecture. This is very important for the Urals Region, especially for the city of Chelyabinsk which is one of the most ecologically unfriendly parts in Russia.

Architecture and urban planning went through all the stages of their development from rejecting the new styles to their strict legislative, technical, and economic regulation. As a result, the architectural
activities create “architectural projects”, and the planning activities create “urban social and engineering infrastructure” destroying the natural environment.

In the current rapidly changing conditions theoretical and practical developments in the field of architecture and urban planning implemented the new concept of "Urban Studies".

“Ecological architecture”, as a new practical direction, requires its theoretical differentiation from “Architecture”, “Urban Planning”, “Urban Studies” and other related fields.

Legislation in the Russian Federation adopts the following terms in the field of ecology. Environment is a set of environment components and man-made objects. Natural environment is a set of natural environment components, natural and natural-man-made objects. The components of the natural environment are the earth, earth interior, soil, surface and ground waters, atmospheric air, plants, animals and other organisms, as well as the ozone layer in the atmosphere and near-earth space, which together provide favorable conditions for the life existence on the Earth. Natural landscape is a territory that has not been changed as a result of economic and other activities. And it is a combination of certain types of terrain, soil, plants that were formed in the uniform climatic conditions. A natural object is a natural ecological system, a natural landscape and its constituent elements that have retained their natural properties. An anthropogenic object is an object created by man for his social needs and not possessing the properties of natural objects [6]. Architectural activity is the professional activity of citizens (architects) aiming to create an architectural object [7].

Basic concepts. A landscape is a spatial environment where the main landscape components have formed and exist without human participation. The artificial environment is a part of the entire environment. It was created by humans in the process of the historical development of social production and does not exist by itself unlike the nature. Ecology is the field studying the interactions among the living organisms, their communities and the entire environment. Anthropogenic landscape has been created in the course of the purposeful human activity in the field of architecture. It is the art of designing and constructing buildings and other structures, as well as their complexes that create a materially organized environment that people need for their living, according to their purposes, modern technologies and the aesthetic views in the society.

The trends in environment developing are given in the table 1.

| The environment                  | 40-30 thousand years BC | The evolution of human nature control | 3 thousand years AD |
|----------------------------------|-------------------------|--------------------------------------|--------------------|
| Natural environment              | Artificial landscape    | New type of landscape                |

Based on the definitions, we can conclude that not every natural landscape is suitable for human living. To provide favorable human environment, it is necessary to create anthropogenic objects or-
ganically associated with the natural landscape. Architectural field is an activity to create anthropogenic objects that form an anthropogenic landscape.

The urbanization process means that artificial landscapes are actively replacing the natural ones in the environment. The humans should create anthropogenic landscapes that are similar to the natural landscapes and do not interfere with their self-restoration. “In the natural environment the humans are the instinctive animals, and in the artificial one they are a part of it. A new world appears, where there are no shocks typical for the pre-crisis society. From the materialism standpoint, this is the end of the historic development. There is a widening gap between the technical progress and the ability of a human to control it. Nowadays, the system has crossed the threshold of complexity ”[8].

The anthropogenic impact on the transfer of landscape components from one spatial environment to another (natural and artificial ones) significantly affects the changes in both human habitats. In strategic plans for the environment development, one should define the fundamentals of ecological architecture, such as creating a viable anthropogenic landscape in various habitats.

The architectural faculty of South Ural State University (SUSU) has conducted a long-term research and experimental projects on environmental issues. As a result, the regional school of ecological architecture has been developed. It is headed by two professors of architecture. The results of a thirty-years research have been presented in the programs “Smart City” and “Smart Home”, several monographs and numerous articles were published in Russia and abroad, including the Scopus database. The research ideas have been implemented in practice when designing the structures of various typological specificity. In 2001-2003, the reconstruction project of the main building of SUSU complex, based on the environmental approach, was awarded the first-degree diploma and the special prize at the contest for the best constructed structures in the Ural Federal District in the city of Yekaterinburg [9]. Various scientific aspects of eco-settlements have been studied by many scholars around the world but this is still not enough to create a full-fledged structure with ecological architecture [10-18].

The purpose of the study is to conduct a research and to develop a project of an autonomous eco-settlement based on the scientific approach in specific climatic conditions of the Southern Urals for the village of Roshchino, 20 km from Chelyabinsk [19,20].

The major tasks of the project are to apply the alternative sources of electricity and autonomous water and gas supplying systems, an automated life supporting system using SMART and GREEN technologies, resource and energy saving protection materials, which needs to develop a new architectural ensemble based on the synthesis of architectural, urban planning, engineering and technological aspects followed by constructing eco-settlements in Russia and other countries.

To solve these problems, we used such methods of architectural science as: theoretical analysis and generalizing the world experience from science literature and Internet resources, the pre-project studies of the future construction site using geo-information systems, on-site survey of the best examples in Russia and abroad, environmental improvement and gardening of public spaces and building surfaces, multivariate design based on digital architectural models of town planning solutions in the general construction plan using a supercomputer.

The results of the theoretical and experimental research show a high form-developing potential of ecological architecture. It is an active means of improving the artistic expressiveness of buildings, which was tested in the planning project of the residential area in the village of Roshchino. Innovative techniques of urban planning for the general construction plan to improve life quality are proposed. The project allows the possibility to place wind energy systems and solar panels on the roofs of the residential buildings. The studies were carried out together with an industrial partner.

The figures below show the principles of pre-project analysis, classifications of the environment and the structure of the existing landscapes and proposals for developing a landscape ensemble (Figure 1-5). Changing a lay out of the main street will increase the traffic capacity, which will significantly reduce the technogenic effect and develop a safe anthropogenic environment.

The general plan shows public spaces in the village and preserving the natural landscape in the courtyard spaces. Social and household facilities in the residential areas are located in the ground floors and on the roofs of the residential 5-storey complexes and in the courtyard spaces where the
natural landscape is preserved. The buildings have perimeter location and adapted to the natural landscape. The courtyard spaces are connected with village boulevards, avenues and squares. Public facilities are located on the ground floors of the residential 5-storey complexes and on the red lines of streets, roads and village spaces. The central boulevard and the residential complexes are connected with cycling and ski routes. It also connects the school sport facilities with an inter-settlement park that is designed on the preserved landscape.

**Figure 1.** Location plan of the village Roshchino on the map of the Chelyabinsk region.

**Figure 2.** Existing plan for the village Roshchino Sosnovsky district of the Chelyabinsk region.

**Figure 3.** Urban planning analysis for the existing landscape environment of the village Roshchino.

**Figure 4.** Urban planning proposal for the landscape ensemble of the village Roshchino.

**Figure 5.** General plan for the eco-settlement of Roshchino.
3. Conclusion
The innovative approach to constructing an architectural ensemble of artificial, natural and anthropogenic landscapes is applied in designing the eco-settlement of Roshchino. The life quality is improved using the latest developments in energy efficiency as well as considering the prevailing social, historical, cultural, natural and communication conditions to form of the anthropogenic landscape.

References
[1] Shabiev S G 2018 Environmental sustainability as a criterion for assessing the quality of modern architecture objects Science of SUSU: materials of the 70th scientific conference. Section of social sciences and humanities (Chelyabinsk: SUSU Publishing Center) pp 12–16
[2] Kazantsev P A 2008 Basics of ecological architecture and design (Vladivostok: FER publishing house) p 118
[3] Tabunshchikov Yu A, Brodach M M, Shilkin N V 2003 Energy efficient buildings (Moscow: ABOK-PRESS) p 200
[4] Gibilisko S 2010 Alternative energy without secrets (Moscow: Eksmo) p 308
[5] Bazhenov A V 2014 Eco-settlement as part of the settlement system. Science, education and experimental design Trudy MARHI pp 363–365
[6] Federal Law No. 7-FL of January 10 2002 (July 29, 2018) Environmental Protection
[7] Federal Law of November 17 1995 No. 169-FL (July 19, 2011) Architectural Activities in the Russian Federation
[8] Project Russia. The third book. Third Millennium 2009 (Moscow: Eksmo) p 448
[9] Register R 2006 EcoCities:Rebuilding Cities in Balance with Nature (New SocietyPublishers) p 368
[10] Gale I 2012 Cities for People (Moscow: concern "KROST") p 276
[11] Sukhinina E 2017 Aspects of sustainable design of eco-cities focused on international environmental standards Moscow Architectural Institute (State Academy) pp 351–352
[12] Nefedov V A 2002 Landscape design and environmental sustainability (St. Petersburg) p 295
[13] Germanovich In 2011 Alternative energy sources of wind, sun, earth, water, biomass (SPb: Science and technology) p 320
[14] Yurzinova I L 2014 Eco-cities: current situation and prospects. Economy. Taxes Right (Moscow) pp 71–73
[15] Herzberg L Ya, Budilova E 2016 Eco-village as a promising form. Institute of Socio-Economic Problems of Population Russian Academy of Sciences (Moscow) pp 16–25
[16] Wong Tai-Chee 2011 Eco-city Planning: Policies,Practice and Design (Netherlands: Springer) p 295
[17] Suzuki H, Dastur A, Moffatt S, Yabuki N, Maruyama H 2010 Eco2 Cities Ecological Cities as Economic Cities (World bank publications) p 392
[18] Ribak I 2016 Eco-city: a myth or reality? Novosibirsk State University of Architecture and Civil Engineering: Bulletin of science and art pp 257–262
[19] Dekterev S 1992 Architecture of residential buildings in the Urals (Yekterenburg: Publishing house of the Ural Institute of Architecture and Art) p 258
[20] Kolyasnikov V A Urban ecology in the Urals. Author. diss. doc arch. MARCHI p 62

Acknowledgment
The work was supported by Act 211 Government of the Russian Federation, contract №02.A03.21.0011.