The Principles of Sustainable Development of the Architectural Space of Linear Parks

Yu V Gorgorova¹, M G Sarkisyants¹, M A Sotnikova¹

¹Don State Technical University, 1 Gagarin Square, Rostov-on-Don, 344000, Russia

E-mail: yu.gorgorova@yandex.ru

Abstract. The article sheds light on the problem of a planning and spatial organisation of architectural space under the conditions of extensive urbanization. There has been found a number of natural and anthropogenic factors influencing the formation of architectural space by an example of organisation of linear parks. Some models of organisation of architectural space have been ascertained and analysed here. The authors offer an adaptive multipurpose model for integrating depressive, neglected, and not used territories with a large social, cultural, ecological, and economic potential into functional and planning structure of a city, which is seen as a necessary condition of sustainable development.

1. Introduction

The town-planning system and architectural space are formed in a certain environment, and they always include the elements of a natural complex. Environment is a major factor determining the choice of the planning concept. In this sense, the natural environment can be considered to be a complex of different town-planning resources. Their estimation is done both from a point of view of building manufacture, and from a point of view of the organisation of various industrial and nonproduction activities on those territories. The program of functioning of a town-planning system to a great extent is determined by environment and resources. Being elements of town-planning systems, natural components (the earth, water, vegetation, etc.) are in complex interrelation with anthropogenic ones; in particular, they determine natural changeability and dynamism of town-planning structures. Consideration of this dynamics is important both for realisation of social programs of designing and for protection of environment.

The term "ecology" was first offered in 1866 by a German zoologist E. Haeckel. It was used to consider habitats, species distribution areas, in particular, of animals. In XIX century, natural sciences were highly-developed, they accumulated enormous quantity of facts. The method of "binding" of these facts to the territory, which makes the essence of an ecological approach, became the most important one in systematization of diverse data in the field of natural sciences. The term "ecology" (from Greek oikos – house, nest, and logos – science) literally means «a science about a place of dwelling». In 1975, Eugene Odum gave the following definition of an ecosystem, which scientists use down to our days: «any unity that includes all the organisms, i.e., the community in a given area interacting with the physical environment so that a flow of energy leads to clearly defined trophic structure, biotic diversity and material cycles, i.e., exchange of materials between living and non-living components, within the system, known as an ecological system or ecosystem» [1].
Natural ecosystems are dynamical due to the continuous processes of metabolism in them. Public spaces – particularly, linear parks – can be compared to a natural ecosystem where various functional processes take place, and there is a constant change of human flows. The difference is in the following. Public and multicultural spaces are not capable of self-regulation, and they are not capable of resisting the changes from the outside in order to save the balance. Therefore, the primary goal of an architect during designing such areas is a rational integration of the territory into functional and planning structure of a city, and arrangement of foot, bicycle and transport traffic. Protection of a designed site against the influence of external factors by means of architectural, space-planning and engineering solutions. Comparing the structure of the organisation of architectural space with the structure of a natural ecosystem, a characteristic distinction has been revealed: in a natural ecosystem, organisms adapt to changes in the environment. Adaptation can be structural, morphological (change of the form, colouring, etc.), physiological (reorganisation of physiological processes in an organism), and behavioural (behaviour change). In the architectural environment, there should be adaptation of the environment to changes of people’s requirements, as well as political, economic, cultural, and social factors. If adaptation does not occur, architectural space dwindles, the territory becomes depressive; it becomes a centre of adverse and criminal activity.

A vivid example of decline of architectural space is the moment of transition of a society to a post-industrialisation epoch when there is a crisis of city territories: there are neglected sites of the former industrial zones, the separate factories whose technologies appeared to be inappropriate for a new technological redivision [2–4].

The list includes unused bridge constructions, undergrounds, railways and motorways, neglected or undeveloped urban areas with great urban and ecological potential.

The objective of this research is working out of architectural space’s formation technique on a depressive territory and its adaptation to modern conditions by arranging a linear park.

2. Methods and materials

Having analysed domestic and foreign experience, we established that adaptation of such environment to existing conditions and requirements of population is possible with the help of revaluation and redevelopment of existing depressive territory and its integration in functional and planning city structure. In order to achieve this goal, the following steps are necessary: the factorial analysis of the territory and the complex approach to the designing that includes the following:

1) historical aspect – time of origin and a condition of territory formation;
2) geographical aspect – location, character of terrain, features of regional shaping, designing scales;
3) social aspect – a territory demography where the object is located;
4) functional aspect – a functional purpose of the territories covering social, cultural, educational, ecological, political, and economic spheres.

One of the methods of formation of architectural space on a depressive territory and its adaptation to modern conditions is arrangement of a linear park. The concept and classification of a linear park as a landscape and an architectural object has rather recently appeared; it is applied, basically, to the planted trees’ spaces with the extended form which are located in the urban environment, in the urbanised territories with high degree of anthropogenic influence (former tracks, transport highways (main pipes), the underground and so on).

Application of the given method is recommended to the neglected and undeveloped natural territories with great urban and ecological potential. Integration of territories into functional and planning structure of a city, with the help of architectural space of linear parks that are capable of transformation and adaptation.

We have generalised the experience of formation of planning structures of urban riverside territories and have revealed principles of a lay-out of riverside territories taking into account their composite qualities. The considered model of functional zoning of riverside territories is constructed
by one planning principle and differs in their spatial organisation that falls into three subtypes: "linear", "profound" and "central" which can exist separately or in different combinations.

The "central" model can be applied to the central riverside territories in which recreation areas are situated along water area in the form of separate cells, and they form a complex spatial structure [10].

The "profound" model can be applied to formation of riverside territories in which recreation areas are situated perpendicularly to water areas of a water object in the structure of an urban area, linked with green corridors along the water.

The "linear" model can be applied to creation of planning structures of riverside territories, at an arrangement of urban development and recreation zones along the water area repeating its contour [10-13].

The "integrated" model is based on a combination of three types of the spatial organisation of territories, it represents an example of formation of riverside zones into structural units, with the functional zones of different types, united by an integrated recreation zone of riverside territories [14-17].

3. Results and discussion

The developed techniques and methods have been applied in the project on development of riverside territories of the river Temernik in the city of Rostov-on-Don, for the river with adjoining territories represents a depressive territory with great urban and ecological potential [18]. For adaptation of the given territory to existing requirements of the city and its inhabitants, there was offered a creation of an urban and ecological model which effectively performs the set functions and can be implemented through the following stages:

1) the territory analysis for estimating current ecological status, for revealing of available functional and specific connections, for working out of models of town-planning development of the territory with the account of ecological and functional factors of territories;

2) association of isolated territories. Restoration of an anthropogenous framework in the structure of a natural one [16].

After analysing the approved scheme of the general plan on formation of a natural framework of the territory and city recreation zones, creation of a green framework of the city was offered: a linear park along the river and gully of the Temernik, local (central) park zones, the green corridors connecting the city.

The offered linear park is unique by its location as it will stretch along 18 km of the water resource located within the city. The composition decision consists in the arrangement of land pedestrian avenue and terraced sites arranged locally, along all the park, on a mark of +8.000 m. On the territory, it is considered to plant a big number of different types of trees that will allow improving a condition of the urban airshed of Rostov-on-Don; the arrangement of art spaces, observation decks, recreation areas, entertaining and leisure-time centres will allow making a linear park to be a key multicultural, leisure-time, multipurpose part of the city. In the places without necessary space, creation of «a park on the water» is offered. As an example, on the territory of the Rostov Sea, due to the use of a modular system, a multilevel park rising over the water is designed. For its creation, it is offered to use natural porous materials which do not prevent evaporation of water and do not pollute it. Taking into consideration that there is clay and silicate dampproofing on the bottom of the Rostov Sea, it has appeared impossible to drive in piles or other constructions. The most suitable constructive decision is the use of high-strength guy cables. Such a technique of architectural formation allows involving a large area and dissolving human flows without difficulty, increasing variability of recreation centres, connecting the banks.

3. Development of linearly-cross-section connections. Creation of an integrated network of the rivers and canals on territory of Rostov-on-Don (a water framework of the city), with the account of the most problematic zones stimulates the increase in width and depth of a channel of the river. Its partial self-cleaning happens due to the increase of a current speed, interrelation of areas and far located rivers and reservoirs through underground canals, made for creation of an integrated network.
of water supply of the city and for an increase of the level of ecological stability. Creation of an integrated network of green plantations, local park zones, green corridors connecting the city and cooperating with linear and central structure (a green framework of the city).

4. Creation of technical systems for the control and monitoring, qualitative redistribution of resources on the territory of the city for achievement of ecological balance, prevention of ecological catastrophes and the extreme situations connected with the natural and anthropogenic phenomena. (Drainage system: drainage of territories with high level of subsoil waters, a derivation of subsoil waters to a surface by means of a well, and creation of artificial canals (underground, surface) for the purpose of minimisation of flooding and formation of landslips, strengthening of bearing ability of soils, for reduction of possible polluting substances in the water, a channel capture in the underground ferroconcrete canal (area of Northern Cemetery). Due to such redistribution of water, there will be a possibility of creation of various reservoirs on the territory of existing parks and squares.

4.1 Arrangement of local purification plants for clearing and filtration of soil water before falling into the river.

4.2 With the account of the analysed schemes of the approved general plan on water supply and city water outlet, there is offered the construction of sewage inlet chambers and hosepipes by a method of upraise shaft, with the provided system of the sluices connected with rain water disposal and central water drains of the city, for the control over the level of surface waters, flood waters and sewage.

The above-mentioned measures will allow removing surface waters from the city streets and will provide unloading of sewer systems in case of an extreme situation (an atmospheric precipitation, flood waters etc.). It will be achieved with the help of use of sluices which will allow lowering surface water in sewage inlet chambers, from where the water will be gradually (for a certain time interval) dumped into the central collector. It will allow avoiding impoundment of residential areas, flooding, high waters and such consequences which were in Rostov-on-Don as a result of high level of atmospheric precipitation in the summer of 2016. The system will also help maintain a stable water level in the river Temernik, no matter the external conditions (precipitations, high waters etc.). The project provides sluices and hosepipes along the all length of the river – in increments of 2 km.

4.3. Also it is proposed silt deposits’ processing into agricultural fertilizers.

4.4 It is offered to use a biological module for effective and ecological river water purification.

5. Creation of linear and cross-section connections with engineering and transport function. Transport infrastructure creation and replenishment. New pedestrian recreational and communication connections’ implementation with dwelling territories (transport and communication structure of the city).

5.1 Monorail line organization, which will allow connecting several planned districts of the city: Voroshilovskiy, Oktyabrskskiy and Leninskiy, providing the citizens an opportunity of comfort and quick transportation. Also there will appear a possibility of easy access to the main objects of urban value: main railway station and the stadium “Rostov-arena”. Monorail track is planned along the riverbed, which will allow going through the urban territory without affecting a housing system and not carrying out a demolition of buildings and houses.

5.2 River and navigation canal and the monorail line arrangement allows creating transport ways, which will help relieve the city highways as well as there will appear an opportunity of touristic routes organization and excursion trips realization by the most important places, coinciding with the cultural and historical structure of the city. One of the proposed routes runs through Temernitskoye site, on the territory of which a monument of architectural heritage Surb-Khach is situated.

5.3 Cycle track arrangement with solar panels’ coating, which will carry out the supply of park with electrical energy.

5.4 Access ramps and lifts’ arrangement with special covering for physically challenged people.

6. Contact publically significant spaces’ organization with rest and population entertainment service function. Sports areas are also provided (sport structure of the city). That stimulates leading healthy lifestyle, improving health and psycho and emotional state of people [19-20].
4. Conclusion
Small rivers and riverside areas play an enormous role in supporting ecological balance in the general urban territory with rational functional and planning organization; they are capable of having a positive impact on the condition and life of landscapes of the adjacent territories. The depressive natural territories’ adaptation to the modern conditions of functioning is able not only to stabilize the social and economic situation, but also to improve the ecological condition in the region, that is an indispensable requirement for sustainable development. Therefore, the complex approach is required while forming the architectural environment, for creating the possibility of multifunctional use of the territory, being able to adapt to the ambient conditions and meet the people’s needs – that is actual “nowadays”. For revaluation and redevelopment of the existing depressive territory and its integration into the functional and planning structure of the city, it is required: factor by factor analysis of the territory and a complex approach while designing, covering: social, economic, ecological, cultural, historic, geographical and demographical aspects. Applying all the above-mentioned methods we will obtain a territory that is adapted to the contemporary needs, possessing definite characteristics and meeting the required criteria, capable of transformation when external (political, economic, social etc.) and internal (functional zoning alternation, depending on the year change, conducted activities, for instance, exhibitions, fairs, etc.) conditions change.

References
[1] Odum E 1975 Fundamentals of Ecology (Moscow: Izdatel'stvo mir)
[2] Jacobs J 2011 The Death and Life of Great American Cities (Moscow: Novoe izdatel’stvo)
[3] Jacobs A B 2014 Great streets (Moscow: Iskusstvo XXI vek)
[4] Sarkisyants M G 2018 Multicultural city spaces: evolution and features of designing Science, education and experimental design at the Moscow Architectural Institute: Abstracts of the reports of the international scientificpractical conference of faculty, young scientists and students (Moskov: Moscow Architectural Institute) 2 517–8
[5] Litvinov D V Gradoeological principles of development of coastal zones: the example of large cities of the Volga Region (St. Petersburg)
[6] Nefedov V A 2002 Landscaping and environmental sustainability (St. Petersburg: Polygraphist)
[7] Fedtsov V Drjagilev L 2003 Ecology and wildlife management economy (Moscow: RDL)
[8] Sarkisyants M G 2016 About formation of parks in again-under-construction residential districts In the collection: Architecture, design and art in culture space» the South Russian forum «FARDIZ» (Don State Technical University, Academy of Construction and Architecture, Rostov-on-Don) 32-4
[9] Bobryshev D V 2011 Regularities of the functional-planning organization of the valley complex of a major river as a factor of sustainable development on the example of the Irkutsk agglomeration Vestnik of the Irkutsk State Technical University 7 pp 22–8
[10] Bobryshev D V, Vershinina S E 2014 Integration of riverside territories into functional and planning structure of a city as a necessary condition of their sustainable development Bulletin of Irkutsk State Technical University 12 pp 103-7
[11] Bespalov V and Kotlyarova E 2017 Bases of the scientific conception of the “green frame” designing in urban areas for providing ecological safety of the urban environment IOP Conf. Series: Earth and Environmental Science 90 012072
[12] Bol'shakov A 1991 Ecological basis of a town-planning (Irkutsk: Izdatel'stvo IrGTU)
[13] Kramer D A, Neruda M and Tikhonova I O 2012 European experience of revitalization of small rivers Journal of Biology, Ecology, Natural Science, Earth Sciences 2
[14] Nikanorov A M, Horuzhaya T A, Minina L I and Mironova T V 2009 Influence of a megacity on the water quality of a large river (on the example of Rostov-on-Don) Vestnik of the Southern Scientific Center vol 5 4 pp 45-51
[15] Gorgorova Yu V and Sarkisyants M G 2017 Modern trends in the design of the architectural environment of urban embankments In the collection: Construction and Architecture-2017
School of Architecture, Design and Arts Materials of the scientific-practical conference. 
Ministry of Education and Science of the Russian Federation (Don State Technical University,
Academy of Construction and Architecture, Rostov-on-Don) pp 90–5

[16] Sotnikova M A 2018 Urban and ecological potential of riverside territories of small rivers (on
an example of the river Temernik, a city of Rostov-on-Don) Science, education and
experimental design at the Moscow Architectural Institute: Abstracts of the reports of the
international scientificpractical conference of faculty, young scientists and students (Moskow:
Moscow Architectural Institute) 1 352–3

[17] Gorgorova Ju V and Sarkisyants M G Sotnikova M A 2018 The principles of sustainable
development of architectural space of the Temernik River embankment in Rostov-on-Don IOP
Conf. Series: Earth and Environmental Science 177 012035

[18] Ignatova N A 2009 Evaluation of the toxicity of waters and bottom sediments of
anthropogenically polluted ecosystems by the method of biotesting (on the example of the Lower
Don basin) (Rostov-on-Don)

[19] Gorgorova Yu V 2014 Seasonal transformation of urban space as one of the ways to increase its
attractiveness Scientific Review 11-3 pp 693–6

[20] Gorgorova Yu V 2017 The Humanization of the Urban Environment in Conditions of
MultiStory Development (in the example of the Canary Wharf business district in London)
Inženernyj vestnik Dona (Rus) 4 URL: ivdon.ru/uploads/article/pdf/IVD_103_gorgorova..
pdf_1322bc0573.pdf