Architectural and landscape organization of Norra Djurgårdsstaden in Stockholm

V Dormidontova

Department of landscape architecture, Bauman Moscow State Technical University, 5/1, 2 Bauman Str., Moscow 105005, Russia

E-mail: v.dormidontova@mail.ru

Abstract. The article discusses the architectural and landscape organization of the district of energy-efficient houses Norra Djurgårdsstaden in Stockholm. Since the end of the 19th century, the Norra Djurgårdsstaden district, with an area of more than 2 thousand hectares, has been part of the industrial area of the Royal Seaport. At the beginning of the 21st century, it was decided to modernize this area and destroy previous industries. Construction began in 2011 as part of the Living City strategy, which envisaged a balanced integrated design and construction of housing, trade, offices, services and public places. The strategy of resource management and responsibility for the climate meant that the city should develop in the direction of a resource-efficient and non-toxic future free of fossil fuels. Using the energy characteristics of buildings, monitoring the amount and recycling of construction and household waste, as well as soil restoration, has significantly reduced the impact on the environment. It was revealed that the architectural and landscape organization, based on the principles of individualization of “spaces of movement” and “spaces of being”, ensured maximum contact with nature, conservation of biodiversity, ecological, visual and social value of streets and courtyards.

1. Introduction

The compensating role of nature in the city as a factor of environmental sustainability has been considered by many scientists since the end of the 20th century [1-7]. The cities are undergoing great changes in the process of modernization, and the ecology of urban space goes beyond the scope of one science. Modern ecologists, sociologists, philosophers, architects, urban planners, landscape architects develop humanistic design principles that provide a comfortable environment for citizens and careful nature management [8,9]. In this regard, the reconstruction and revitalization of post-industrial territories has become one of the urgent problems of modern cities. Over the past decade, a number of remarkable parks have been created in the former industrial territories, which have expanded the arsenal of compositional techniques of landscape architecture [10-14]. At the same time, technological capabilities and techniques for reducing the energy consumption of buildings are being developed [15-16]. Vast territories exempted from industrial use open up opportunities for the experimental construction of new comfortable residential areas using environmentally friendly materials and energy-efficient technologies [17-20].

The purpose is to identify methods and techniques of architectural and landscape organization.
2. Theoretical part

The Norra Djurgårdsstaden district is located 3.5 km from the center of Stockholm and is part of the huge industrial area of the Royal Sea Port, covering an area of more than 2 thousand hectares. This area, together with the port, began to turn into one of the largest industrial areas of Stockholm since the 1880s. Direct access to the Baltic Sea was one of the reasons for the construction of the port of Vertachamnen in 1884. To begin with, this harbor was mainly used for transporting coal used as fuel for local gas plants. At the beginning of the 21st century, it was decided to modernize this area and destroy previous industries.

The construction of this residential area, as a phase of the development program of the port and industrial areas of the city, focused on the environment, began in 2011 (Figure 1). By 2025, in Stockholm, in the place of storage facilities and industrial territories, it is planned to build 12 thousand new houses, create 35 thousand jobs, 600 thousand square meters. Meters will be allocated for commercial space [21]. It is estimated, “... that 30% of the energy will be generated by renewable sources. By 2030, the district will completely abandon the use of fossil fuels. Bike infrastructure will be developed here, as well as a project for sharing cars. Public transport will be represented by the metro, biogas buses, electric hybrids, ferries and trams”[22].

![Figure 1. District Norra Djurgårdsstaden. Fragment of the plan.](image)

The first residential buildings began to be built in May 2011, and in October 2012 the first families already moved to the district. Now 5100 houses have been built in Norra Djurgårdsstaden, 77,055 m² of green spaces have been created, including 16,700 m² of green roofs, 700 m² of rain gardens, 137 m² of flower beds. The public green zone accounts for 26% of the total area of completed stages. In total, almost 50,000 m² of green parks were built, which means about 18 m² per apartment, 100% of the inhabitants have parks in two hundred meters accessibility [21].

A high-quality green structure on state land is critical to providing ecosystem services. Water features and landscaping play a significant role in the area. In addition to the recreational impact, providing the ability to relieve stress, landscaping brings other benefits. Green infrastructure strengthens the environmental sustainability of animals and plants, purifies air and water, reduces noise, creates a favorable microclimate and reduces the risk of flooding. Creating multi-functional green zones allows nature to perform work instead of technical systems, such as drains, pipelines and
pumps. This stormwater management system consists of green roofs and gardens, lush plant beds, tree pits along ditches and wetlands.

All rainwater from public lands and surplus water from neighboring lands go through inlet wells to flower beds with bio-carbon soil, which retains water and ensures good plant growth. The flower beds stop the water and slowly direct it to Husarviken. During heavy rains, dams and wetlands absorb water that could otherwise cause flooding. Parks and other green areas can absorb large amounts of water. Planted trees provide shade, regulate temperature and reduce the effects of heat waves. Green spaces also provide an opportunity for relaxation, tranquility and proximity to everyday nature [23].

The Norra-Djurgårdsssten district is being built as part of the Living City strategy, which involves balanced integrated design and construction of housing, trade, offices, services and public places. In addition, one of the main principles of this strategy is resource management and climate responsibility. Thanks to a resource management strategy and responsibility for the climate, the city should develop towards a resource-efficient and non-toxic future free of fossil fuels. Resource flows should be circular and contribute to minimal impact on the environment and climate, therefore the Living City strategy gives a special role to the use of energy characteristics of buildings, control of the quantity and processing of construction and household waste, as well as soil restoration.

According to the strategy, it is important that energy is used as efficiently as possible and is extracted from renewable energy sources, such as photovoltaics on roofs, in order to reduce climate impact and minimize resource use. Buildings in the Royal Seaport approach buildings with zero energy consumption, and they produce renewable energy in the form of solar energy. Energy requirements are about 40 percent lower than conventional buildings. Low-energy buildings have an effective climatic envelope, are well insulated and tight, and are also equipped with energy-efficient installations. A significant part of the energy needed at home is used for cooking, washing and storing food. Therefore, all apartments are equipped with household appliances as standard [24].

The sequence of residential neighborhoods in the western part of Norra-Djurgårdsssten is located between the main street formed by Jaktgatan and Lövångsgatan and the river. Traffic and pedestrian flows are separated, almost do not intersect. Underground parking lots have been arranged for residents of the district, guest parking has been taken out into the driveways between the blocks.

The main street stretches from Storangstorget, the central square in the south, to Husarviksparken, a park along the promenade in the north, and is an important link in the area, as it connects residential buildings with Husarviken Bay and the natural landscape of Norra-Djurgården.

The street is designed for movement at different speeds, and also provides space for relaxation. With a width of 25 meters, it consists of three parts in the longitudinal direction - an automobile road, an ordinary sidewalk adjacent to houses, and an asymmetrically located understated green strip 6.5 meters wide. This green elongated surface controls the storm water on the street, directing them to the bay, and contributes to the safety of cars free of urban space in a large part of the street where the pedestrian path remains protected inside (Figure 2).
The green space is landscaped with wooden paths of a complex trajectory, interrupted by recreation areas (Figure 3). Here, walking surrounded by flowerbeds, you understand how indifferent design can provide maximum contact with nature in a minimum space. Trees and shrubs, together with high and low perennials, contribute to the conservation of biodiversity, and the street gives ecological value in combination with visual and social.

An old Scandinavian proverb says: "People come to where there is people." The architectural and landscape organization of the main street of the Norra- Djurgårdsstaden district contributes to overall sustainability and strengthens both environmental and social values. The abundance of plants, aesthetic and functional elements of improvement contribute to a healthy lifestyle, encouraging citizens to walk, meet, meet, socialize, spend leisure time together and enjoy life and nature in the new area. “Life among buildings makes it possible to be among other people in a rather simple, ingenuous way. You can walk along the main street on the way home or linger and sit on a bench near the front door to stay among people for a short time ... Being among people, seeing and hearing them, receiving impulses from them implies positive events. This is an alternative to loneliness ”[25].

Internal courtyards are protected from the street by houses and are organized according to the principle of free flow of spaces. From residential areas you can go to the main street with ordinary planting of almond trees or to the bank of the river, stretching from the opposite side (Figure 4). But you can transit the entire area inside through the courtyards without ever going outside.

The architecture of residential and office buildings is functional and concise, but each building is individually volumetric-spatial composition, plastic or coloristic solution of the facade. However, diverse volumes are consecutive participants in a single gradually opening spatial composition. Prevailing residential buildings of average number of storeys. Color is used to a limited extent, for example, to highlight the dominant in the spatial composition of the area (Figure 2). Each house has a unique staircase design. The terraces of the apartments of the first floors go directly onto the street, separated from one another by a trellis with a sheared forsythia bushes (Figure 5).

Each yard is also individual. The set of materials and forms is the same - gravel and sand mixture, crushed stone, plants, cor-ten steel; pergola, wood flooring, small forms. But the decisions are different. On one of the wooden decks imposingly sculpted the Turkish seals. You can sit on them (Figure 6). Pergola composition - an elegant response to the metro-rhythmic division of the architectural environment. A wonderful labyrinth is made of willow (Figure 7).

The elements of the artistic composition are different types of paving, table grids, storm drainage trays and grooves (Figure 8), flowerpots for landscaping balconies. Improvement materials are contrasted in color, texture, their combination reveals and serves as a graphic frame for the planning composition (Figure 9).

Bicycle parking is located in the courtyard, being included in the general composition of rhythm and color, as well as container platforms with garbage collection. The entire garbage chute in the new quarters is underground. Access to the trash chute hatch is for residents only, by card. Residents send
sorted waste to underground pipes, where garbage is automatically packed in containers and, using a vacuum, sent outside the area. This allowed abandoning garbage cans and trucks.

![Figure 6. Pergola.](image1)

![Figure 7. Labyrinth.](image2)

![Figure 8. Design of a drainage tray](image3)

![Figure 9. Contrast textures and colors](image4)

3. Conclusions
This new district continues to be built, but houses and courtyards are incredibly well-groomed already now. Not only there is no construction waste, but in front of the houses, residents have already placed narrow strips of mini-gardens, planted berry bushes, currants and strawberries. Yards are given not to cars, but to landscaping and playgrounds.

The new district is built on an old industrial site. The land of the old gas plant of the early 20th century has little environmental value. However, the location of the area between the forested cliffs and the natural and cultural landscape in Norra-Djurgården, which is also part of the National City Park, necessitated the creation of new ecological trails. The district's green street system, combined with a fine grid of parks, has created a green structure that plays a significant role in strengthening and visualizing environmental ties.

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