Green-blue Infrastructure in Multi-storey Residential Area

Una Ile¹, Aija Ziemelniece¹
¹Latvia University of Life Sciences and Technologies, Rīgas iela 22, Valdekas pils, Jelgava, LV-3002, Latvia
una.ile@llu.lv; aija@k-projekts.lv

Abstract. Multi-storey residential areas in Latvia and their living outdoor space built in the 21st century form inadequate conditions in some of the investigated areas in the relation to the modern development trends in context of Scandinavian countries. The present research analysed the blue-green infrastructure by means of the selected criteria which determine the nature of the living outdoor space and its potential for use. The theoretical assumptions of blue-green infrastructure in the context of the Scandinavian countries were examined, and functional design of residential block of flats, use of greenery, water resource potential, socio-economic aspects, environmental accessibility solutions, transport areas and visual aesthetic quality indicators were analysed. The authors compared and analysed 27 living outdoor spaces in the multi-storey residential areas in Rīga, Mārupe, Baloži, Jūrmala and Ozolnieki. The results are obtained from the analysis of the designed matrix for the research purposes on the basis of the previously examined areas in Copenhagen and Roskilde (Denmark), Oslo and Arendal (Norway), Stockholm and Malmö (Sweden) in the time period from 2011 – 2018 and the investigated residential blocks of flats in Rīga, Mārupe, Baloži, Jūrmala and Ozolnieki. The research results characterize not only the diversity of the current situation regarding the blue-green infrastructure, but also the inadequate conditions of outdoor living space in some areas.

1. Introduction
Green areas play an important and varied role in the multifaceted development of the urban environment. Therefore the spatial structure and organization of the urban environment must provide three basic functions which form a unified spatial system: various recreational and sporting activities, sanitary as well as aesthetic design of the urban environment. In a broader context, the uniqueness and spatial arrangement of the green territory are determined by the size of the city, its economic profile, nature factors, the terrain, water presence, soil and vegetation [1]. Consequently, in order to create suitable, harmonious and pleasant green areas in the urban environment, it is necessary to create unified green zones, which would include and unite parks, squares, blocks of flats, street greenery, streets, pedestrian and cycling routes as well as watercourses. In addition, it is necessary to plan protection greenery along with the high-intensity infrastructures such as railways and production sites, as well as to promote environmental quality in urban environments protecting residential areas from pollution and noise. The creation and planning of the blue-green infrastructure must respect both nature and human needs, while satisfying economic, topographical, biological and aesthetic requirements. The analysis of the necessary aspects would lead to the high-quality blue-green infrastructure relevant to the urban environment, where the requirements are mutually interlinked providing an ecological, functional, aesthetically visual and social factors which complement each other.
Also, a compact structure, proportional population density, appropriate walking and cycling routes, as well as the urban environment of high quality are necessary for the urban environment to be alive [2, 3]. The research analyses 27 urban outdoor spaces taking into account the urban infrastructure of green areas, its hierarchical levels (group of buildings, neighbourhood in the city, residential building complex, a district, the city centre and manufacturing zones), see Figure 1. [1]

The authors researched and compared how everyday living outdoor space is organized and how it functions, what are the typical features of residential blocks of flats built in recent years, their way of use, volume, structure of functional planning, presence of water resources, socio-economic aspects, environmental accessibility solutions, transport areas and indicators of visual aesthetic quality that provide rational solutions of the spatial composition or, on the contrary, fail to provide rational solutions of spatial composition.

The matrix which was developed in the research process was used to analyse the functional zone layout, visual quality of technical solutions, density of vehicles in the parking places, accessibility of the environment, the boundaries of the visual outdoor space, the method of integrating greenery and water resources in recreational areas, as well as the connection of the residential blocks of flats with the adjacent areas creating a visual link of the blue-green infrastructure with outside residential areas.
For example, the comparison of the residential blocks of the 20th century and modern residential areas shows that the change of perception of the possibilities and potential of the outdoor space have taken place simultaneously with the development and improvement of the quality of the living outdoor space. Scandinavian examples and solutions for blue-green infrastructure planning processes and implementation strategies have been attempted to integrate into the urban environment on a different scale, however, currently many improvement and development plans in Latvia are conducted only at the documentary level. The study found that either typical simplified solutions were used in the living outdoor space in many areas without the blue-green infrastructure or the blue-green infrastructure was introduced, however, eventually, the areas were not maintained and managed at the relevant level. Thus the aim of the research is to study blue-green infrastructures in the 21st residential blocks of flats in Riga and suburban territories.

1.1 Materials and Methods
The source of methodological and informative material included an analytical review of the outdoor space for 27 residential blocks of flats that were developed in the 21st century. The quantitative research method was used to design a survey of residents and specialists to find out the current situation. The survey results were treated by means of statistical data analysis. Some specific criteria were determined by means of the intuitive method in the analysed residential blocks of flats (in districts of Riga, Marupe, Baloi, Jārmala and Ozolnieki). The comparative analysis method was used to obtain results to characterize the current varied situation in residential blocks of flats, as well as the experience of Scandinavian countries in design of residential blocks of flats, focusing on previously examined areas in Copenhagen and Roskilde (Denmark), Oslo and Arendal (Norway), Stockholm and Malmö (Sweden), see Figure 2 and 3. The monographic or descriptive method was used to analyse the results on the basis of analysed theories, findings during the research process and the research results.

2. Results and discussions
The residential area has its own physical structure and symbolic identity, especially provided by green areas, which play an important role in the development of the architecturally compositional structure of settlements. Such green spaces provide spatially and visually aesthetic quality to the outdoor living space making it unique [4]. Adequate and functional compositional planning solutions of residential outdoor space in the residential courtyards are one of the most important indicators for residents to feel comfortable in their living outdoor space. Harmony of living outdoor space is based on functional and aesthetic quality planning solutions in residential courtyards simultaneously providing a rationally arranged environment for each user [5]. In order to identify the current situation in the residential block
of flats built in the 21st century, the matrix and the sociological survey questionnaire for specialists were designed in the process of the research. The survey was carried out with 15 specialists from the fields of architecture, landscape architecture and urban planning in November of 2018. The aim of the specialists’ survey was to find out their opinion regarding the residential block of flats designed during the 21st century in Latvia. The matrix, which was created during the research according to the principles and criteria of landscape planning, included maximum criteria which were evaluated during the investigation of 27 living outdoor space areas Riga, Marupe, Balozi, Jūrmala and Ozolnieki. The matrix was developed taking account the experience of Scandinavian countries: what kind of improvement elements, landscaping, greenery and planning principles were used in comparison with Norwegian, Danish, Swedish architects and landscape architects in residential blocks of flats. The current situation of the investigated territories was analysed, conflict points and improved infrastructure of residential block of flats, functional zoning of the territory were evaluated using the matrix. The relationship between infrastructure and space becomes indifferent since the infrastructure forms a new quality in the certain condition as it is a complicated dynamic spatial structure where the relationship with the space obtains extremely diverse character, besides, many factors vary in the course of time [6]. Thus, when analysing the connection of the landscape space with the surrounding territories, different situations were identified, which emerge not only from the cadastral boundaries of the land plots, but also from the artificially created visual boundaries by residents in the living outdoor space. Some investigated areas had good overall visibility, there was a functional link between sidewalks and driving lanes with the surrounding area, for example, in Jaunā Teika, where the construction process was happening but the respective part of residential outdoor space of the improved area was one of the best solutions of outdoor spaces in Riga, which was proved by the findings from the specialists’ survey. The specialists considered that positive examples may be found in Riga, but they mentioned residential blocks of flats in other cities, such as Ventspils, Liepāja and Ozolnieki, where a developer had understood the intuitive desire of potential residents (tenants, buyers) for a greener environment with functionally diverse, comfortable, contemporary and safe outdoor space. There are places where a close cooperation between the architecture of buildings and the planning of the outdoor space prior to the design stage is apparent. The research findings from the matrix are included in Figure 4, but the specialists’ opinion regarding residential blocks of flats in Latvia in the 21st century are found in Figure 5.
| No | Territory                     | solutions of high quality / points | solutions of medium quality / points | solutions of low quality / points |
|----|--------------------------------|-----------------------------------|-------------------------------------|----------------------------------|
| 1  | Jaunā Teika / Rīga            | 34                                | 0                                   | 0                                |
| 2  | Dienvidu pakavas / Rīga       | 25                                | 8                                   | 0                                |
| 3  | Dienvidu pakavas 2 / Rīga     | 26                                | 5                                   | 0                                |
| 4  | Metropolia / Rīga             | 18                                | 8                                   | 2                                |
| 5  | Dammes Liepas / Rīga          | 13                                | 8                                   | 0                                |
| 6  | Imantas Ozoli / Rīga          | 19                                | 3                                   | 0                                |
| 7  | Skanstes Parks / Rīga         | 9                                 | 2                                   | 0                                |
| 8  | Skanstes mājas / Rīga         | 18                                | 2                                   | 0                                |
| 9  | Skanstes virsotnes / Rīga     | 15                                | 1                                   | 1                                |
| 10 | Purvciema projekts / Rīga     | 6                                 | 13                                  | 6                                |
| 11 | Residential building / Rīga    | 3                                 | 10                                  | 1                                |
| 12 | Residential area / Balviži     | 7                                 | 11                                  | 4                                |
| 13 | Residential area / Balviži     | 3                                 | 12                                  | 0                                |
| 14 | Residential area / Mārupe      | 6                                 | 9                                   | 0                                |
| 15 | Residential area/ Mārupe       | 0                                 | 9                                   | 1                                |
| 16 | Village Beberi / Priekļiems   | 15                                | 3                                   | 0                                |
| 17 | Turaldas area / Jūrmala       | 26                                | 1                                   | 0                                |
| 18 | Kado-Karīm / Jūrmala          | 18                                | 0                                   | 0                                |
| 19 | Jūrmalas Vīnis / Jūrmala      | 18                                | 5                                   | 0                                |
| 20 | Park Residences / Jūrmala     | 15                                | 3                                   | 0                                |
| 21 | Dzintaru residence / Jūrmala  | 12                                | 1                                   | 0                                |
| 22 | Sun Terraces / Jūrmala        | 16                                | 3                                   | 0                                |
| 23 | The Home / Jūrmala            | 11                                | 1                                   | 0                                |
| 24 | Avenue / Jūrmala              | 19                                | 3                                   | 0                                |
| 25 | Pine Residence / Jūrmala      | 9                                 | 4                                   | 0                                |
| 26 | Iecavkrasts / Ozolnieki       | 20                                | 4                                   | 0                                |
| 27 | Multi-sotrey-house / Ozolnieki | 7                                 | 7                                   | 0                                |

**Figure 4.** The summary of the investigated areas during the research – the data from the matrix

**Figure 5.** The specialists’ opinion regarding residential blocks of flats built in Latvia in the 21st century. 1 – multi-storey residential areas with architectural and landscape solutions of high quality; 2 – multi-storey residential areas with architectural solutions of high quality, but infrastructure solutions of insufficient quality; 3 – multi-storey residential areas with architectural and landscape solutions of insufficient quality; 4 – other variants
It may be concluded from the experts’ opinion and the results obtained from the matrix that one of the residential neighbourhoods of good quality is “Jaunā Teika”, where architectural and scenic quality criteria are rationally integrated into the multifunctional outdoor space, providing a modern, easy-to-use environment for all its users. Outdoor space with carefully thought-over elements and materials provide a pleasant blue-green infrastructure, logical functional link with surrounding areas and solve the challenge of the high-quality car park by means of nearby multi-storey car parks that reduce the overcrowded number of vehicles in residential areas. “Jaunā Teika” district is the only one from the investigated territories where there is an artificially created water resource – the square with fountains that is designed following the Swedish examples of courtyards and corresponds to modern solutions and serves as a socializing place for residents. The recreational and green zone solutions are illustrated in Figure 6 and 7.

![Figure 6](image1.png)  
**Figure 6.** Recreational place in the residential block of flats for socializing in public in “Jaunā Teika” neighbourhood, 2018

![Figure 7](image2.png)  
**Figure 7.** Greenery zones in “Jaunā Teika” neighbourhood, 2018

The green infrastructure of “Jaunā Teika” neighbourhood is designed with horizontal and vertical highlights. Horizontal green planes use scrubs and perennial plantations, highlighted in different linear reliefs. However, deciduous trees and the five-leaved ivy were used for the vertical accent. Five-leaved ivy (*Parthenocissus quinquefolia*) planted on a multi-storey car park structure successfully creates visual accents in the outdoor space with its colours in the autumn period.

The evaluation and analysis of the multi-storey residential areas show that South Horseshoe and South Horseshoe 2 neighbourhoods were one of the examples of good practice (See Fig. 8 and 9). Moreover, specialists have recommended South Horseshoe and South Horseshoe 2 neighbourhoods as a positive example as regards the green infrastructure. The designers of the neighbourhoods have supported the presence of growing trees and rationally integrated them in the designed territory ensuring a pleasant outdoor space for residents.

![Figure 8](image3.png)  
**Figure 8.** The context of adjacent territories and visual enclosure of grown spruce trees at South Horseshoe neighbourhood, 2018

![Figure 9](image4.png)  
**Figure 9.** Green infrastructure in South Horseshoe 2 neighbourhood, 2018
In general, architects have managed to create human-scale multi-apartment residential buildings with improvement elements of high quality for the residential outdoor space. Neighbourhoods serve as the proof that the quality of the outdoor space is not just a formal requirement, but a thoughtful overall image of the functionally aesthetic component of the courtyard [7, 8].

The territory of the courtyard is also freely accessible to the residents of the surrounding houses, its two-level layout creates a special feeling of a private space. The investigated residential blocks of flats were built at the beginning of the 21st century; the investigation and analysis of the territories according to the matrix show that there are criteria with mediocre evaluation in the research of November of 2018. Mediocre evaluation criteria apply to such points as support walls, ramps, stairs and artificial slopes of impregnated roundwood palisades. It was found out that the reason for the mediocre evaluation was the staff in charge of maintenance and the irregularity of the maintenance, because weather conditions and anthropogenic load resulted in deterioration of functional solutions for residential outdoor space in these years and it was necessary to improve the visual defects (rain water pipes on the support walls, the deterioration of impregnated roundwood palisades, tightly mashed soil of sidewalk surface etc.). The investigation of the residential block of flats in Baloži, Cālīšpurva street 27 k-3 and Uzvara street 25 K-2 leads to a conclusion that there are both mediocre criteria results and low quality results, see Figure 10 and 11.

![Figure 10. The courtyard solution, 2018](image1)

![Figure 11. Children’s playground, 2018](image2)

The proportion of greenery in the territory of the residential block of flats is insignificant, the outdoor space is occupied by a large asphalted car park which does not attract visually and does not invite residents to stay in the outdoor space. Thus, from the point of view of the relations of spatial shapes that link residential space rich in objects with various elements of composition, this territory may be characterized as formal and practically useless for the recreation of its residents. This means that the image of a particular living space has a significant impact on people's willingness to stay in the investigated area; in addition, from the point of view of mutual relationship of shapes in the implemented composition, it does not achieve the planned effect, if it is not functionally usable for outdoor space for residents to spend their free time there [5]. Children’s playgrounds are situated between residential buildings creating the children's playing area which is impractical, non-functional and invisible from the windows of the buildings. The examples from the Scandinavia give evidence that terraces are designed at the level of the 1st floor as much as possible (see Figure 12). On the contrary, the investigated block fully ignores this approach.
For example, a study was carried out on activity models in newly built residential areas in Copenhagen in 2005. The research data illustrated how balconies, gardens in the front of the houses and other outdoor areas were used in the particular metropolitan context. The results showed a general tendency for outdoor activities to move from public to private. As a result, semi-private outdoor spaces located in the immediate vicinity of the 1st floor of dwellings also played a significant role in the life of residential blocks [3]. Thus, the analysis of the examples from Copenhagen outdoor space and designed neighbourhoods of Baloži, Cāliņpurva street 27 k-3 and Uzvara street 25 K-2 leads to a conclusion that the 1st floor level zone is not used for more private recreation areas, see Figure 13. Potential patio areas are filled with technical features fully eliminating the mentioned areas from private activities in the yard and the large abundance of vehicles provide mediocre quality criteria visually separating residents from residential outdoor space. There is a lack of trees in the area apart from some groups of coniferous trees and hedges in some places of the yard and entrance areas to visually separate the yard from the traffic flow in Uzvara street. The traffic flow is very dense in Uzvara street providing access to the nearby residential areas. The traffic density in the Uzvara street zone and in the territory of the courtyard causes unpleasant feelings in the residents who live in the residential blocks of flats between the investigated zones. The residents are as if on the island which is surrounded and crowded with vehicles reducing the secure movements and recreation opportunities in the living outdoor space, see Figure 14.
3. Conclusions

The blue-green infrastructure in residential areas is one of the most important aspects of providing a visually aesthetic, high quality functional living space for every user. The approaches and methods of Scandinavian countries for building and preserving the blue-green infrastructure provide examples that it is possible to create modern living outdoor space of good quality in Latvia thus designing rationally thought-over and constructed residential blocks of flats.

The analysis of the results of the residents’ survey, regarding residential blocks of flats, shows that the preservation of the emotional perception and the psychological well-being of residents require aesthetically enjoyable and functionally arranged living outdoor space, which implements the residents’ desires, according to the requirements from the 21st century.

The analysis of the blue-green infrastructure of residential blocks designed in the 21st century shows that there are unevenly balanced outdoor solutions which form multiple points of conflict. It is possible to prevent the conflict points found in the research if specific territories are re-planned and built according to the principles of the blue-green infrastructure, examples of good practice, as well as ensuring involvement of residents in the planning process. The investigated 27 residential blocks of flats and their outdoor space feature a variety of factors that should be evaluated and eliminated by the designing and implementing process of other places. The blue-green infrastructure should not be confined to the administrative boundaries of the residential neighbourhood, it is also necessary to provide functional and visual links with the surrounding areas.
Acknowledgment(s)

The research was conducted thanks to the grants provided by “ITERA Latvija”, Ltd., in cooperation with the foundation “Rīgas Tehniskās universitātes Attīstības fonds”.

References

[1] J. Briņķis and O. Buka, *Apbūves kompleksa pilsētānošanas aspekts*. Riga: Riga Technical University, pp. 96, 2009 (in Latvian).

[2] N. Ņitavska and D. Zigmunde. *Zaļas pilsētvides plānošana*. Informative educational material for municipal development planners. Jelgava: Zemgale Planning Region, pp. 114, 2013 (in Latvian).

[3] J. Gēls, *Pilsētas cilvēkiem*. Riga: Janis Roze Publishing House, pp. 271, 2018 (in Latvian).

[4] A. Ziemeļniece and U. Īle. *Criteria of Architectural Composition Design in Residential Courtyards*. World Multidisciplinary Civil Engineering-Architecture-Urban Planning Symposium – WMCAUS, IOP Conference Series: Materials Science and Engineering. Prague, Czech Republic: WMCAUS, Vol. 245, p.1−10, 2017 (in Latvian).

[5] U. Īle, Compositional Planning of Residential Outdoor Space in Courtyards. Scientific Journal of Riga Technical University: Series 2. Architecture and Urban Planning, vol. 6, pp. 6−11, 2012 (in Latvian).

[6] I. Strautmanis and V. Grūbe. *Struktūras jēdziens, tās uztveres iespējas un izmantošana arhitektūras teorijā*. Architecture of Latvian SSR Cities. Riga: Science, pp. 34–46, 1979.

[7] J. Briņķis and O. Buka, *Zemes īpašumu vērtēšana un taksācija pilsētānošanā*. Riga: Riga Technical University, pp. 50, 2008 (in Latvian).

[8] H. Gūtmane, *Vadlīniju izstrāde apstādījumu struktūras un publisko ārtelpu tiklojuma nodrošināšanai Rīgā*, LU 73rd Scientific Conference University of Latvia, Faculty of Geography and Earth Sciences, sub-section - Territories, resources and planning [Online] 2018 [Accessed 08. 12. 2018] Available at: <https://www.geo.lu.lv/fileadmin/user_upload/lu_portal/projektu/gzzf/Skolotajiem/10_Helena_Gutmane_u.c._Publiska_artelpa.pdf> (in Latvian).