Biotope-based approach for mixed-use office building landscape

Nadya Kerimova, *Saint Petersburg Forest Technical University,*
Valeriy Nefedov, *Saint Petersburg State University of Architecture and Civil Engineering,*
Inna Sotnikova, *Saint Petersburg State University of Architecture and Civil Engineering,*
Maria Morozova, *Landscape Architectural Bureau MOX, Saint Petersburg*

Abstract. Large-scale multifunctional (mixed-use) office buildings are significant elements of urban structure and centers of gravity for people, transportation, and business activity. Here we suggest an ecology-driven approach for designing landscapes surrounding mixed-use office buildings. Our approach aims to select and adapt the natural plant communities of North Europe for the landscapes surrounding office buildings in Saint Petersburg (Russia). Based on previous geobotanical studies we determined key native plant communities of the Northwest Russia. We suggest using five native plant communities for different functional zones of the landscape surrounding office buildings.

Keywords: native plant communities, office buildings, sustainable landscape design.

Introduction

Nowadays, cities suffer from the loss of natural biodiversity, limited interaction with natural vegetation areas, and the disappearance of authentic local identity [7]. According to the concepts of "sustainable development" and the "new urbanism," urban open space and landscapes should correspond to the local climate and the natural landscape surroundings, which implies a priority of naturalness over ornamentality [8, 11]. In the 1960s, the idea of urban green landscapes dominated by native plants was initiated in Germany, the Netherlands, the UK, and the U.S. in order to recreate the natural identity of territories. Moreover, during the last decade, leading landscape architects have progressively developed the concept of "low-maintenance planting" [19]. The concept was inspired by the ecological models of plant communities within natural biotopes.

In some applications (e.g., in green roof design), contemporary landscape architecture uses natural biotopes as prototypes for the plant lists [6]. Nowadays, landscape architects often use relevant natural plant communities to create sustainable cultural phytocenoses cultivated in highly urbanized city areas. This ecology-inspired approach to landscaping has been used in many prominent projects in the last decade. For example, meadow dry, wet mossland, woodland, and wetland plant communities were recreated in the High Line Park, in an area of abandoned railway tracks in New York City [10]. At Vuosaari Hill, a new residential district in Helsinki, Finland, the typical natural plant communities of the Baltic Sea archipelago and Lapland were implemented. Here, meadow, heather, juniper heaths, grassland, tree groves, and small wetlands biotopes successfully attract birds, mammals, and insects, including rare and endangered species [6]. A similar approach was used in the residential quarter of Babelsberg, where the roof of an underground parking garage hosts a meadow plant community [2]. In Stockholm, reed communities are widely used in the coastal areas of the residential zones. The Hammarby Model project (Hammarby Waterfront City) has implemented reed communities for secondary filtering of the rainwater collected from the surface of the inner courtyards and the roofs [20]. A birch and moss garden has been created in the courtyard of the 52–story New York Times office building (New York, NY, USA). Importantly, this garden is a precise imitation of the plant community of the Hudson River Valley, an impressive reconstruction of the natural environment at the center of the 1.5–million–square–foot building [18]. Overall, international experience demonstrates the effectiveness of these methods of introducing natural plant communities into urban green areas. Such an approach should take into account all local environmental factors such as climate, topography, and substances of anthropogenic origin. It also requires creation of the specific edaphic (soil and groundwater) and biotic conditions necessary for native plant communities.

Here, we propose an ecology–driven approach for creating landscapes for mixed-use office buildings in Saint Petersburg, Russia. Office buildings quickly become the key elements of urban structure. We offer a systemic method of selecting the native plant communities for different functional zones of the landscape surrounding office buildings.

Methods and Results

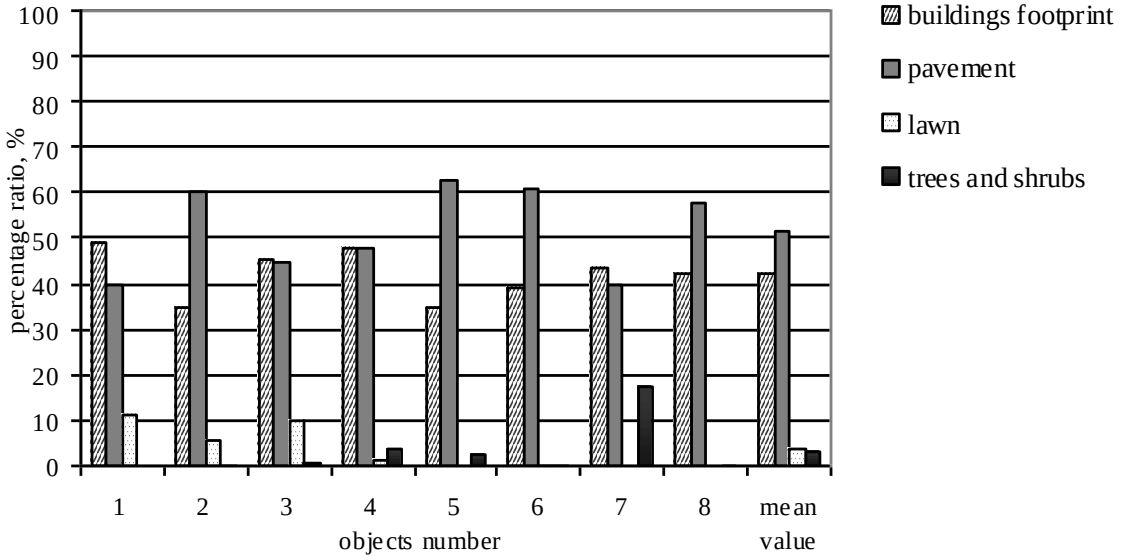

Fig. 1. The proportion (in percentages) of buildings' footprint, car parking pavement, and greenery calculated for investigated territories of mixed–use office buildings (Class A, built at 2007–2010, Saint Petersburg, Russia). Office buildings: 1–Aeroplaza, 2–Arena, 3–Atlantic, 4–Boloev, 5–Atrio, 6–Lincor, 7–Monblan, 8–Stels [Source: construction by the author's]

Saint Petersburg, the second largest Russian city, is now undergoing significant urban planning changes. Recent market analyses have shown that the development of commercial zones is one of the largest and most active sectors in the building industry. Furthermore, modern large-scale multifunctional (mixed-use) office buildings are significant elements of urban structure and centers of attraction for people; they form new open public spaces. Therefore, we have investigated the territories of the representative sample of office buildings in Saint Petersburg (Class A, built during 2007–2010) (for details of methods see N. Kerimova, 2012). We have found that the majority of buildings are surrounded by intensively exploited areas. These territories include pedestrian zones, roads, and parking lots, but they almost all lack plants, trees, storm-water management, and protected and defined zones for recreation and social interaction (Fig. 1). Thus, landscapes surrounding office buildings do not meet contemporary quality criteria for open public space [8]. Our study showed that, currently, building footprints cover the major part of the plot of land (action area). Office buildings tend to occupy surrounding open public spaces for parking purposes. Overall, our results indicated the need for systemic and normative approaches for the landscape organization of office buildings' territory in order to improve green infrastructure.

We suggest that office buildings and surrounding territories could be an important resource for green infrastructure. Therefore, we recommend different methods to define pedestrian, parking, and recreational zones using trees, hedges, storm water swales, and retaining walls. We also suggest the creation of green roofs, green terraces, green facades, and green courtyards for office buildings to improve the quality of the environment and to save resources [13, 14].

To further integrate plants, landscapes, and office buildings we use a holistic approach. This implies an intensive cooperation of building architects and landscape architects right from the beginning of a new project. Since the layout of buildings and facilities heavily influences plants' well being, architects have to adapt buildings' form, facilities, and configuration for sustainable planting and for ecosystem services. It is possible nowadays to extend green areas with the help of innovative technologies; i.e., greenery can be integrated with architectural objects and included into the inner and outer spaces of buildings. Overall, the holistic approach improves the quality of the open space as well as urban environment sustainability. To further develop the holistic approach, we introduced the concept of a Green Buffer Space of an architectural object. The Green Buffer Space is the space that is created by means of landscape architecture within the structure of the building, spreads around it, and provides environmental, functional, and architectural interactions between the building and the landscape. Initial modeling of Green Buffer Spaces allowed us to define main functional zones: an entrance zone, pedestrian-transit zone, car parking zone, and recreational zone. We have developed a more detailed theoretical spatial model of Green Buffer Space that effectively introduces greenery into particular functional zones of office buildings (Fig. 2).

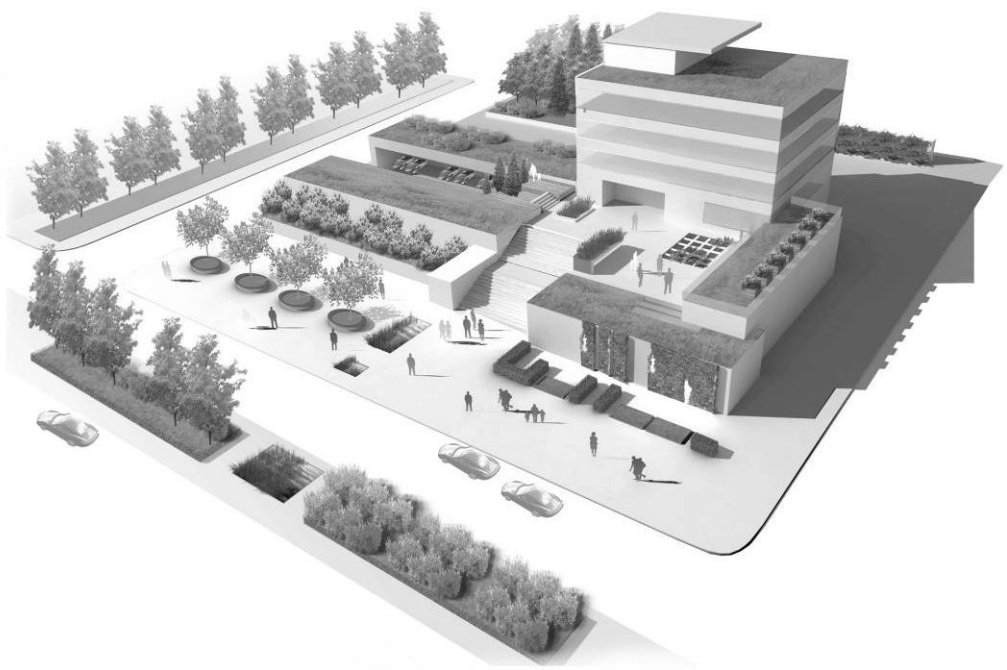

Fig. 2. The theoretical spatial model of the Green Buffer Space of an office building reflects a holistic approach that effectively integrates plants, landscapes and buildings and demonstrates multiple ways to introduce trees, shrubs and lawns into architecture object [Source: construction by the autor's]

In order to improve the greenery sustainability, we propose to add an additional *ecological* zone, a "Green Island," into the Green Buffer Space of office buildings. Green Islands are zones that should be environmentally friendly to plants, insects, and birds, and free from any functional purposes, e.g., have no recreational or transportation functions [14]. We suggest developing Green Islands, by analogy with the natural biotypes, as areas populated by native species under "differential control" [5]. This idea is quite similar to the "low-maintenance planting" concept. The Green Island is designed as an area with a particularly high vegetation capacity for the free growth of the plants. Importantly, the plant list of the Green Island changes over time depending on the survival potential of the particular species and due to spontaneous invasion by native plants. Overall, the Green Island is a sustainable green area where the activity of a landscape architect is considerably minimized. This approach creates favorable conditions for the formation, development, and successful operation of the micro ecosystem that can serve as a habitat for insects, birds, and edaphic flora, as well as a resource for soil nutrients. Furthermore, according to the *continuity* and *connectivity* principles of urban design, the Green Islands should be connected with green corridors and other urban green areas in order to create an integrated green infrastructure.

In order to create a Green Island similar to the natural biotope, we suggest an ecological approach. We propose to select a specific plant list from the native plant communities of Northwest Russia. The selection criterion has to be based on a similarity to the local urban environment and the natural biotope. More specifically, for a particular Green Island, we recommend selection of the natural plant community that inhabits areas with similar climatic and natural settings.

In our study, the native plant list of indigenous species was determined by previous geobotanical studies of the natural preserves of the Northwest Russia [1, 21]. This approach allows estimation of the regional plant biodiversity that has been preserved in the protected areas. Saint Petersburg is located in an area of coniferous and deciduous forests of the European type that are characterized by southern boreal coniferous forest formations such as (dark and light) coniferous, parvifoliate, and flood-plain forests [4]. Spruce, sorrel, and bog moss pine forests (e.g., birch, aspen, alder, and mixed parvifoliate swamp forests) are widespread in Northwest Russia. The most expressive and characteristic landscapes are dry pine forests on sandy coastal dunes, spruce forests with deciduous (or broad-leaved) trees on the hills, partly swamped birch forests, spruce and alder grassy forests, lowland swamps, and reed bushes grown in the coastal areas of seaside terraces. In this article, we suggest using the aforementioned plant communities as prototypes for the specific plant lists for the Green Islands of office buildings.

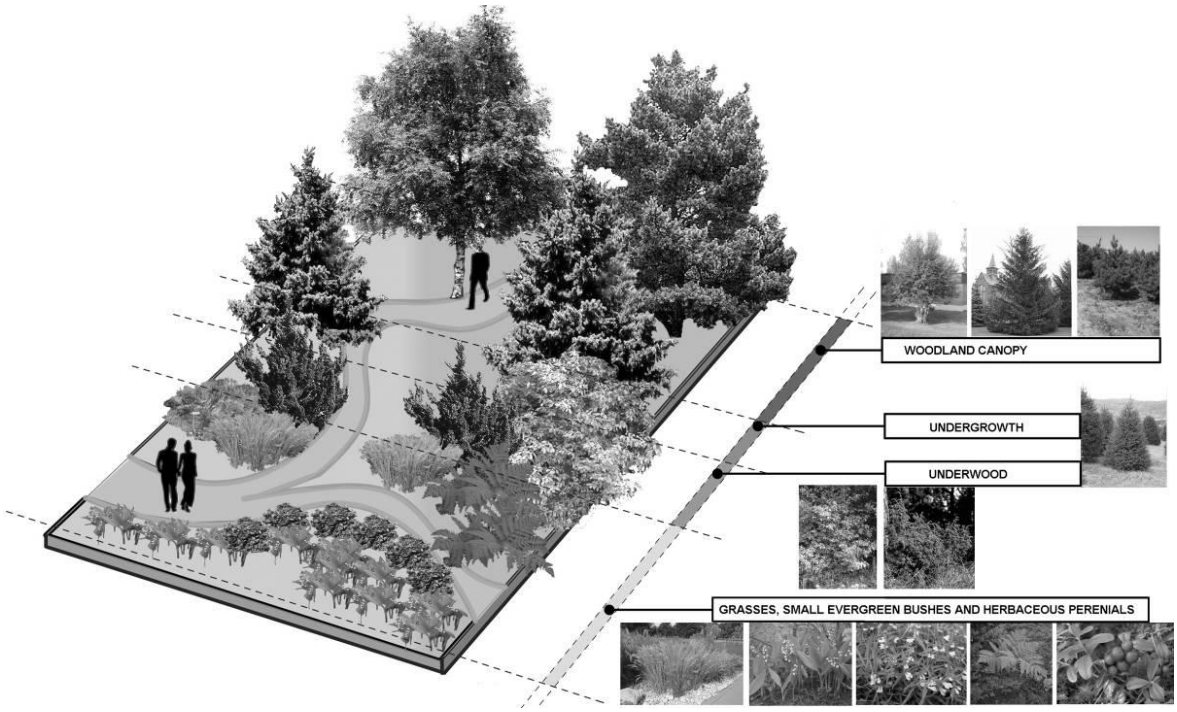

Fig. 3. Example of the "pine grassy woodland" biotope that is based on reference natural plant communities to construct a comfortable Green Island for peri-urban territories surrounding office buildings [Source: construction by the autor's]

The main forest species in Northwest Russia are common spruce (*Picea abies*) and Scotch pine (*Pinus sylvestris*). The second-growth forest stands are dominated by white birch (*Betula pubescens*) and silver birch (*B. pendula*) as well as by European aspen (*Populus tremula*) and black and white alder (*Alnus glutinosa, A.incana*). As for shrubs, the various species of willow (*Salix*), buckthorn (*Frangula*), and elder (*Sambucus*), aiten (*Juniperus communis*) are represented [3, 21]. However, a recent analysis of the urban greenery in Saint Petersburg showed that, traditionally, deciduous species such as European white elm (*Ulmus laevis*), Wych elm (*U. glabra*), ash-leaf maple (*Acer negundo*), Norway maple (*A. platanoides*), little-leaf linden (*Tilia cordata*), European ash (*Fraxinus excelsior*), balsam poplar (*P. balsamifera*), and English oak (*Quercus robur*), are planted in residential areas. These species are non-indigenous: They either grow on the border of the natural area, or are of foreign origin. According to the latest monitoring of greenery in Saint Petersburg, these species are not disease- and injury-resistant and are highly sensitive to climatic conditions [15].

At the same time, native species such as white birch (*B. pubescens*) and silver birch (*B. pendula*), and numerous species of willow, alder, and rowan, are the most disease- and pest-resistant and well adapted to rough urban environmental conditions. However, nowadays, among all native species, only white and silver birches are relatively popular in urban greenery. The coniferous trees such as spruces and pines constitute no more than 9 % of all arboreal species. Overall, native arboreal species could be used much more widely in the green landscapes of Saint Petersburg [3, 9]. We suggest using the "pine grassy woodland" biotope as a reference model to construct green areas for peri-urban territories surrounding office buildings (Fig. 3).

Urban greenery also has a decorative function. Therefore, we recommend selecting native species that have the highest decorative qualities such as attractive flowers, textures, forms, and shapes, and other esthetic characteristics. In order to achieve decorative effects (e.g., morphological similarity, etc.) or to improve composition, we suggest using cultivars and natural-looking invasive species. In addition, it is also important to consider the tolerance of the urban environment. Being aware of the fact that it is impossible to reconstruct an exact replica of the natural biotope, it is important to use dominant (key) plants that mostly define the formation of the biotope and create the necessary conditions for other plants. This approach creates green zones with basic plant communities (key native plants) and also promotes re-introduction of rare and endangered species.

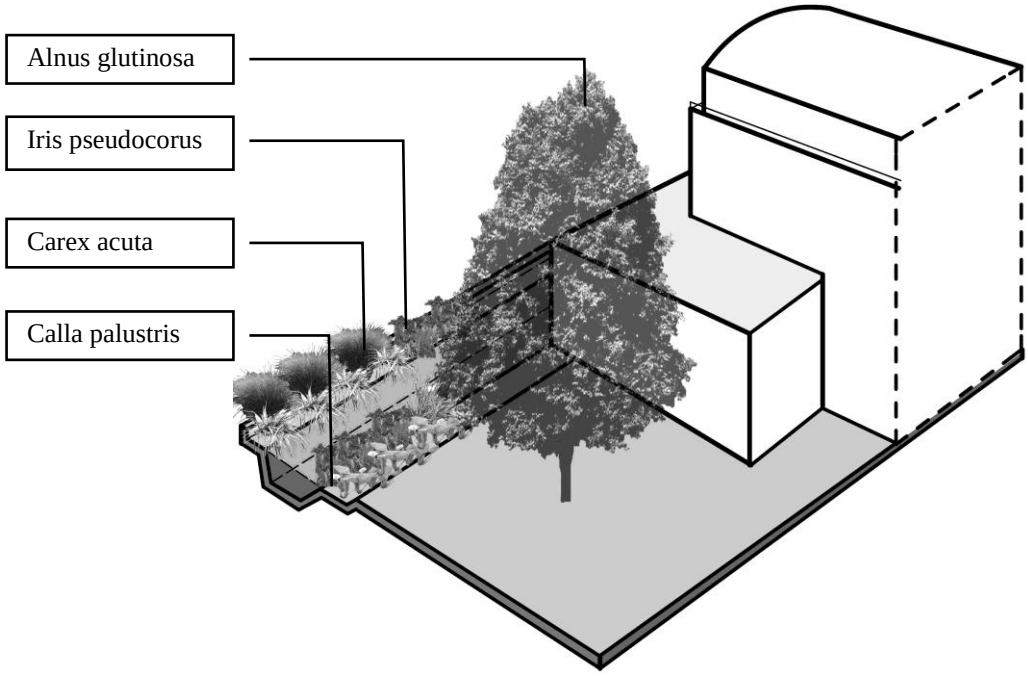

Fig. 4. "Black alder marsh" planting model for the Green Island of an office building
[Source: construction by the author's]

A typical example of a basic plant community for unexploited flat roofs is a "meadow dry," that is, a meadow dry community (*Agrostis capillaris*, *Festuca ovina*, *Achillea millefolium*, *Pilosella officinarum*, *Jasione montana*, *Sedum acre*) that is typical of dry, open habits. The predominantly stress-tolerant robust plants of the meadow dry community ensure vegetation sustainability. Importantly, some species of meadow dry communities are rare (*Jasione montana)* and under protection in the Saint Petersburg region. Considering the fact that at the roof level the air is less polluted, a wider range of plant species can be employed. Thus, the greenery zone of the Green Island becomes a platform for the preservation of rare and endangered plants. Adding native species with a high tolerance capacity and high ecological amplitude as well as natural-looking decorative plants, we can achieve the natural look, long-term decorativeness, and sustainability of the plant community.

In Saint Petersburg there is a high annual rainfall and groundwater level that cause excessive soil humidification. Therefore, the dense vegetation and low insolation requirements of wetland plant communities make them especially suitable basic plant communities for the recreational areas near office buildings. Wetland plant communities can also be selected for green spaces in the courtyards, green protective shields for pedestrian-transit zones, and Green Islands near water and drainage devices.

Birch grooves are widespread, and the most expressive and functionally grounded forest formations in northwestern Russia. Birch is one of the most common species that is capable of growing in marshland as well as on the roofs of abandoned buildings. It usually grows on sandy or turf-rich plains. It easily adapts to changing environment, partially sheds its leaves in the dry season, and steadily grows during the cyclic inundation. In addition, due to its large leaf surface area, birch performs as an effective drainage regulator, and improves the vertical water circulation in a closed circuit of buildings. Therefore, the birch forest is considered to be the most promising prototype of the basic plant community because of its sustainability, great decorative qualities, and ecological functions.

Shallow storm water reservoirs are essential elements of sustainable landscapes. They are used for collecting, filtering, and reusing the rainwater gathered from impervious paving and roof surfaces, and can become a habitat of swampy plant communities. We suggest using grass and sedge marsh communities as one of the basic natural communities for storm water swales. This community includes wild calla (*Calla palustris*), yellow iris (*Iris pseudacorus*), slim sedge (*Carex acuta*), and blister sedge (*C. vesicaria*) [1, 21]. Intertidal coastal (littoral) plant communities, such as reed and rush plant communities, distributed along the coastal terraces, have a great potential for forming natural biological filters for the drainage system using the "bioplateau" method (Fig. 4) [16].

In addition to the aforementioned plant communities, we also selected a number of additional basic plant communities with great potential that are out of the scope of

this article. We note that the proposed ecological method of plant list selection based on natural biotopes also requires pilot tests in the urban environment. The pilot tests will reveal the most sustainable species and combinations of plant communities. Overall, our approach enables effective integration of greenery with mixed-use public buildings, improves green infrastructure sustainability, and creates a healthy urban environment. Furthermore, our approach demonstrates that office buildings are important resources for urban green infrastructure.

Summary

Based on the principles of sustainable landscape design, new urbanism, and a new environmentally-friendly approach, this article suggests creating new sustainable green areas in the buffer zones of office buildings. For each specific area of the office building, we recommend a specific native plant community. The native plant communities are selected based on the similarity between the urban environment and the natural habitat of the community. The proposed guidelines for the selection of *basic plant communities* can be effectively used in the landscape design of the territories surrounding office buildings.

Combining esthetic principles with the ecological approach, one may reconstruct the native sustainable environment by creating more natural green areas in the urban environment. As a result, there will be more powerful and natural connections between all elements of the ecosystem that will ensure the sustainability of cultural phytocenoses. This approach will not only improve the biodiversity of the urban environment, but will also make it possible to identify Saint Petersburg as the most northern megalopolis in the world, and emphasize the unique features and natural beauty of the boreal flora of the southern taiga. Last but not least, it will help the population of the region to appreciate the beauty of northern landscapes and rediscover their relationship with local nature.

References

1. **Andreeva, E. N., Volkova, E. A., Gimelbrant, D. E.** etc. *Yuntolovskiy regional complex natural reserve*. SPb.: SPbGXFA, 2005. p. 52–92.
2. **Baller, H.** *The city as a biotope: Recent projects in Berlin and Potsdam* [online 20.03.2012.]. http://www.bwk.tue.nl/biotope-city/index.php/essays/the-city-as-a-biotope-recent-projects-in-berlin-and-potsdam.
3. **Buligin, N. E., Firsov, G. A., Togersen, K. T.** etc. Conifer greenery planting in Northwest Russia and North Sweden (Hvoinie v ozolenenii Severo-Zapada Rossii I Severnoi Shvecii). *Izvestia SPbGLTA*, Saint Petersburg: LTA, 2000, No. 4(10) p. 3.
4. **Buligin, N. E., Yarmishko, V. T.** *Dendrology.* SPb.: Nauka, 2000. p. 83–98.
5. **Clement, G.** *Le jardin en mouvement.* Paris: Sens et Tonka, 2007, p. 308.
6. **Dunnett, N., Kingsbury, N.** *Planting green roofs and living walls.* London: Timber Press, 2008. p. 174.
7. **Ignatieva, M., Stewart, G., Meurk, C**. Low Impact Urban Design and Development (LIUDD): matching urban design and urban ecology. Lincoln: *Landscape review*, 2009, No. 12 (2). p. 61–73.
8. **Gehl, J.** Public Spaces for a changing public life. Munich: *Topos*, 2007, No. 61, p. 16–22.
9. **Gerasimov, A. O.** Sustainability of conifer plants on the streets of Saint Petersburg. PhD thesis. Ustoichivost hvoinih porod v ulichnih posadkah Sankt Peterburga: Diss. kand. s.-h. nauk / SPbGLTA. SPb. 2003.
10. **Gerdts, N.,** The High Line. New York City. *Topos*, 2009, No. 69. Munich: Callway, p. 16–23.
11. **Goncharenko, N.** «New urbanism»: a city for people (Novii urbanzm: gorod dlia cheloveka). Moscow: *Lanschaftnaya architectura and design*. 2009, No. 3(26). p. 30–33.
12. **Kerimova, N.** *Landscape organization of territories surrounding office-public centers in Saint Petersburg*. Ph.D. thesis. Moscow: Moscow State Forest University, 2012. p. 157.
13. **Kerimova, N., Nefedov, V.** Landscape organization of green buffer space of office centers of Saint Petersburg: problems and solutions. *Contemporary Landscape Design: new approaches and dimensions*. Saint Petersburg: Politechnicheskii University. 2010. p. 35–36.
14. **Kerimova, N., Sotnikova, I.** Biotope-based landscapes for Office Buildings. *Scales of Nature. IFLA International World Congress.* Zurich. 2011. p. 491.
15. **Koviazin, V. F., Shabnov, V. M., Martinov, A. N.** etc. *Monitoring of soil/plant resources of Saint Petersburg ecosystems (Monitiring pochvenno-rastitelnih resursov v ecosistemah Sankt Peterburga)*. SPb.: Politehnicheskii universitet. 2010, p. 206–266.
16. **Kulibaba, V. V.** Approaches to restoration of aquatic-paludal biotopes of Lakhta Bay (Principy vosstanovlenia vovno-bolotnih biotopov lahtinskogo rasliva) *Yuntolovskiy regional complex natural reserve*. SPb. 2005, p. 181–184.
17. **Magnusson, M. M.** Hand crafted biotopes in the middle of Helsinki. *Topos,* 2010, No. 71. Munich: Callway, p. 114–115.
18. **Oberlander, C., Hitelaw, E.** New York Times building: a garden at its heart. *Landscapes/Paysages*, 2008. Vol. 10, No. 2, p. 21–22.
19. **Schmidt, C.** The challenge of plants. *Urban green*. Basel: Birkhauser, 2010, p. 72–79.
20. **Tornbjorn, A**. Utopia in green and blue. *Topos*, 2009, No. 69. Munich: Callway, p. 64–70.
21. **Volkova, E. A., Hramcov, V. N., Isachenko, G. A** etc. *Complex environmental mapping of gulf of Finland coast (luga bay region)*. SPb: SPbGXFA, 2001, p. 54–70.

INFORMATION ABOUT AUTHORS:
Nadya Kerimova. **Nadya Kerimova**, PhD (in Landscape Architecture), Assistant of professor at the Faculty Landscape Architecture, Department of Parks and Garden Construction of Saint Petersburg State Forest Technical Academy, Institutskii per., 5, 194021, Saint Petersburg, Russia, Tel. +7 92 19 03 31 49. E-mail: kerimovanadya@yahoo.com
Valeriy A. Nefedov, Dr. Arch., Professor of Saint Petersburg State University of Architecture and Civil Engineering, 2-nd Krasnoarmeiskaya str., 4. 190005, Saint Petersburg, Russia. Tel. +7 92 19 35 89 55. E-mail: valerynefedov@yahoo.com
Inna Sotnikova, PhD Arch., Assistant of professor at the Faculty of Architecture, Chair of Urbanism and Urban Design, Saint Petersburg State University of Architecture and Civil Engineering, 2-nd Krasnoarmeiskaya str.,4. 190005, Saint Petersburg, Russia, Tel. +7 81 25 75 05 28. E-mail: sotnikoffa@bk.ru
Maria Morozova, Landscape Architect, Landscape Architectural Bureau MOX, Saint Petersburg, Gorskoe sh., 9, pos. Levashovo, 194361, Saint Petersburg, Russia, E-mail: morozova_archi@inbox.ru

Kopsavilkums. Lielmēroga daudzfunkcionālās (dažādas nozīmes) biroja ēkas ir svarīgs elements pilsētas sturktūrā un ir cilvēku, transporta sistēmas un biznesa gravitācijas centrs. Šeit, plānojot ainavas dizainu, kas aptvers šīs daudzfunkcionālās biroja ēkas, ir ieteicams pielietot ekoloģiskas nozīmes un rakstura plānošanas metodes. Mūsu metodes mērķis ir atlasīt un pielāgot Ziemeļeiropai raksturīgo dabisko augu kopumu Santpēterburgas (Krievija) biroja ēku apkārtnes ainavu plānošanā.