Green Roofs in Russia: Classification and Typology

T V Kireeva
Department of Landscape Architecture and Garden Construction, Nizhny Novgorod State University of Architecture and Civil Engineering, Nizhny Novgorod, 603950, Russia

E-mail: tkireeva2005@yandex.ru

Abstract. The proposed Green Roof Classification is a foundation, upon which Russia will develop its green architecture and natural urbanism. The classification uses four generic features that branch into multiple subfeatures; in an association with an expanded typology, it forms a dually structured whole. For the first time ever in Russian science, the classification presents a clear-cut definition of each class and type of green and accessed roofs. The classification flowchart is a visual toolkit designers, construction workers, and developers could use to create and promote green roofs. The Green Roof Classification should become part of the curricula for bachelors and masters in Landscape Architecture and Architectural Design.

1. Introduction
Rooftop gardens have evolved over their centuries-long history while giving rise to and preserving sustainability principles. Amusement gardens have been on the stone vaults of the Kremlin since the 16th century, a Russian version of ‘Hanging Gardens of Babylon’ and a landmark of Russia’s garden and park architecture [1]. Over time, the entire Moscow came to fancy the secluded gardens, green ‘private quarters’ of a kind; the concept evolved towards expansive terraces and green rooftops of outbuildings [2], a foundation for rational use of urban estates; this, along with the esthetics, was the key factor of green roof evolution in Russia.

However, it was not until late 19th century that the actual green roofs, accessed or not, appeared in the country; the conventional term ‘hanging gardens’ applied to any rooftop greenspace and survived to this day. However, time is nigh to make an orderly classification of the diversity of green roof and terrace types, classes, and techniques.

Over the past twenty five years, private and public buildings have been acquiring green roofs all over Russia: not only in warmer regions such as Sochi, Rostov-on-Don, or Krasnodar, but also in Central Russia (Moscow, St. Petersburg, Nizhny Novgorod, Samara, Perm) and even in Siberia (Yekaterinburg, Novosibirsk, and Krasnoyarsk [3]). A few trends contributed to the green boom: an emerging market for luxury housing, greater public space near shopping malls, new construction technologies, and focus on environmental challenges facing cities [4, 5].

Green roof design and construction is a task for Landscape Architecture specialists; however, lack of textbooks and scientific literature on the topic that could be used in the LA curricula hinders any attempt
to promote green roofs in Russia, which also jeopardizes cities’ environmental potential. At the same time, we have to deal with a variety of papers that cover some isolated issues of green roof creation, construction, itemization, and use; systematizing this chaotic knowledge base is long overdue. As of today, there is no clear-cut classification of accessed green roofs that could lay the scientific foundation for design and construction, would structure, define, and classify green roofs; this problem is imperative to solve.

Russian [6] and international [7] researchers as well as regulations [8] contain a variety of definitions and classifications applicable to green roofs and hanging gardens; each such definition or classification is based on its authors’ interests and competencies: botanists and gardeners consider green roofs a constituent of greenspace [9]; designers rely on an ‘activity-based’ approach [8]; architects and landscapers focus on the functionality of public roofs, whether primary or secondary [10,11]. Russian literature usually applied the term ‘hanging gardens’ to any rooftop greenspace, whether historical [6,12,13,14] or newly constructed [15].

Guidelines for Rooftop Greenspace and Improvement [8], the core regulatory document to date, has a classification of green roof architectures and landscapes in its Section 1. General Provisions; however, the list is limited to “rooftop gardens, ground-level gardens, green roofs, architectures and landscapes on accessed green roofs.”

The newly drafted Russian GOST [9] contains no classification; it briefly summarizes the essential features of green roofs in Terms and Definitions [9, p. 12], while the clause Typology of Accessed Green Roofs only gives two basic classifications: intensive, extensive, and semi-intensive greenspace; and living roofs for pedestrian vs vehicle traffic [9, p. 14-19]. This is not enough to bring together the actual theories and hands-on experience accumulated thus far.

This research thus seeks to organize and systematize the existing knowledge to create a consolidated Green Roof Classification that will cover every issue pertaining to the design, construction, and use of green roofs in the context of their expanded typology.

2. Green Roof Classification
Classification is a method for describing multilevel branching systems of elements and their interrelations. In this case, there are three core elements: the roof, the man, and the greenspace; their relations and applications are what the Classification is based on, see Figure 1.

![Figure 1. Green Roof Classification by generic features](image)

Whether a human person can be present on the roof and use it for their own purposes is the first generic features that divides roofs into accessed and non-accessed roofs. Accessed roofs open up ample opportunities for recreation, recovery, and wellness. If a roof is fully green, its only visitor is a gardener, and the only purpose of staying on the roof is to maintain it, this is a non-accessed roof.

Flat roofs are suitable for creating recreation zones, sports venues, greenspaces, or even parking lots and access roads. This leads to another aspect of classification, which is based on the intended use [15], see Figure 2, *Intended use*, Points 1 to 4:
1. Accessed roofs, not car or firetruck-accessible.
2. Accessed roofs, car or firetruck-accessible.
3. Partly classifiable as accessed roofs.
4. Non-accessed roofs.

Green roofs can be at different elevations: directly on the ground, on an overpass, on a terrace, or on the rooftop of a building, whether low-rise or high-rise. This leads to a classification based on the position in relation to the ground level [15], see Figure 2, Position with respect to the ground level, Points 1 to 4:
1. Green roofs on the rooftops of residential buildings, public or production facilities
2. Green terraces on the rooftops of terraced buildings
3. Green roofs on the rooftops of ground floors (basements and stylobates); can have multiple levels
4. Hanging gardens on different levels (one above the other) of a building; hanging gardens are supported by special platforms, bridges, or overpasses (note that none of the four Points applies to underground buildings).

The term ‘hanging gardens’ refers not as much to the design as to the nature of the system; it is referred to as a garden because it is rich in trees, shrubs, and flowers; which means that the definition appeals to the impression the structure makes rather than to the way it is designed. However, there are different features that make a green roof green, be it trees or lawns; hence a classification based on greenspace intensity, see Figure 2, Greenspace Intensity, Points 1 to 9. The term ‘hanging gardens’ conveys three different meanings:
– a historical reference to gardens placed on the rooftops and terraces of palaces and temples, from the Hanging Gardens of Babylon (6th century BC) to those of the Kremlin (16th century) or the Small Hermitage in St. Petersburg. The definition applies to any such garden created up to the 1980s, see Point 1, Figure 3;
– full-fledged gardens with trees and shrubberies on special structures: platforms, bridges, and overpasses, e.g. Gardens of Villas by Le Corbusier, 1925 [16], High Line by Diller Scofidio + Renfro, landscaping by Pete Udolph, New York, 2009;
– finally, a ‘hanging garden’ can refer to any green rooftop in layman’s vocabulary, e.g. ‘the hanging gardens of Zaryadye’. This classification does not apply to such usage.

Rooftop gardens are designed as recreation areas and are structurally similar to mini parks [6]; they provide public space in the vicinity of various social and cultural infrastructures. Such gardens can be placed on rooftops and stylobates, and contain pathways, playgrounds, sports venues, various recreation facilities, and artistic installations. The very term ‘garden’ implies a vast and diverse greenspace; correct use of the term indicates the author’s independent approach to assessing the condition and status of a place, see Point 2 Greenspace Intensity in Figure 4.

Ground-level gardens are located on the ground or directly on the rooftop of an underground structure, be it a railway terminal, a store, a subway station, etc. Trees and shrubs, grass and flowers create extensive greenspace that unfolds across the spatial continuum and gives an impression of a garden, see Point 3 in the figure to the right. Zaryadye Park is a ground-level garden by this definition, as 75% of its territory is on the rooftops of embedded buildings [17], see Point 3 in the figure to the left. Stanislavsky Garden, a quite and romantic place in downtown Moscow, is a good example of a ground-level garden, as it is built upon the rooftop of an underground parking lot, see Figure 5.

Figure 6 shows a facility on an accessed roof located at a street level, i.e. ‘ground-level’ greenspace with lawns and flower beds, intended mainly for pedestrian traffic. This does not give an impression of a ‘garden’. Hence it is referred to as ‘ground-level accessed green roof’ or a green living roof on an artificial foundation.
Accessed green roofs can be owned by different parties: municipalities, housing cooperatives, or natural persons. This defines whether this is a common-access or restricted-access territory, which leads to another classification that is based on affiliation: public or private green roof or terrace, see Figure 2.

**Public accessed green roofs** are found in condominium backyards, public areas in front of buildings such as restaurants and cafes, service facilities, cultural and entertainment venues, or educational institutions, office buildings, banks, or parking lots, as the roof of a parking lot, whether above-ground or
underground, can be a green living roof, see Figure 6. A roof like that may contain a variety of objects: smaller architectural improvements and decorations, playgrounds for children, sporting gear (Figure 7), as well as the necessary engineering infrastructures (ventilation shafts, TS structures, etc.); it features a variety of covers, while the green decorations are limited to special containers, pots, landscape maps, see Figure 2, Point 4 Greenspace Intensity.

A **private accessed roof** is usually located on the rooftop of a detached house/penthouse and is mainly intended for recreation. It is decorated with a variety of plants, the selection of which will depend on the climate, building height, style, and the owner’s desires subject to the design regulations, see Figure 2, Point 6 Greenspace Intensity.

**Accessed green terraces** are found on detached houses and penthouses as well as on public buildings, where the green decorations are limited to special containers and pots; such a terrace usually features everything that is necessary for leisure and recreation.

![Figure 7. An accessed green terrace. Moscow.](image1)
![Figure 8. Intensive greenspace, Airport City, St. Petersburg.](image2)
![Figure 9. Semi-intensive greenspace, Ilya Mochalov & Partners](image3)

**Green roofs** are roofs that feature an all-over lawn or plant cover; these are not intended for human recreation. These are extensive green roofs. They can be both flat and pitched. These are mainly intended for environmental purposes and esthetic appeal, see Figure 2, Point 8 Greenspace Intensity.

### 3. Green Roof Typology

All the accessed green roofs mentioned above fall into three basic types: intensive, extensive, and semi-intensive roofs, each of which has its own intended use, is designed for a specific maximum permissible load, has a specific layering, features a specific assortment of plants, uses specific equipment, and is subject to specific fire safety rules and restrictions on human use. Regulatory documents [18], handbooks and reference books [8], roofing manufacturers’ catalogues [19, 20] discuss the physical properties of each roof type at length; for space considerations, we omit these details and proceed to the fundamental principles, functionality, and distinguishing features of these types.

Intensive green roof is a park, garden, an accessed living roof or terrace, or an improved (landscaped) backyard that has a variety of features, where the greenspace intensity may vary from zone to zone. In the Classification above, this type corresponds to Points 1 to 7 of Greenspace Intensity, Points 1 to 3 of Intended Use, Points 1 to 4 of Position with Respect to the Ground Level. People tend to stay here for long, which is why such space has to be functionally diverse, accessible, safe, and comfortable, see Figure 7. Greenspace might be expansive and is always high-maintenance. Playgrounds and sports venues, smaller recreation areas may complement the design.

Extensive green roof may take various forms; it is not intended for human access except for maintenance; the green cover it features comprises natural floral communities: crassulæ, sedums, or meadow plants capable of sustainable growth and self-sustenance without watering. It is designed with environmental performance, heat insulation, and esthetic function in mind. The type corresponds to Point
8 of Greenspace Intensity and Point 1 of Position with Respect to the Ground Level. A good example is the large crassula ‘carpet’ (two thousand square meters) on the rooftop of stylobate at Airport City, St. Petersburg, see Figure 8.

Semi-Intensive Green Roof. This is a novel type of extensive green roofing that provides restricted access for non-maintenance use [9]. In the classification above, it corresponds to Point 9 of Greenspace Intensity. A roof like that was made in 2009 for the Landscape Architecture Bureau Ilya Mochalov & Partners; 150 square meters is covered with a 9 centimeters thick substrate, upon which meadow plants, perennials, and segums/crassulae grow perfectly without watering or maintenance. This is a popular site for promotion campaigns and recreation [21]. Semi-intensive green roofs show promise, as they are inexpensive and provide an eye-watering recreation area for visitors, which will become a major selling point.

4. Conclusions
This research has produced a well-ordered and systematized Green Roof Classification for Russia. The classification uses four generic features: intended use, position with respect to the ground level, greenspace intensity, and affiliation. Each feature follows into subfeatures or points to branch the classification further. The diagram presented herein is a clear visualization of all the classes and types of green roofs; it is a useful toolkit for design or appraisal. The typology additionally includes semi-intensive green roofs and is tied to the classification. Thus, the developed Green Roof Classification is a singularized structure that will be fundamental to the advancement of ‘green’ architecture and landscaping in Russia.

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