Relation of the Green Structure and the Appropriation of Public Spaces in Large-Scale Residential Areas

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Abstract. More than a half of residents in some capital cities of the former Socialist block live in large-scale residential areas that had been built from the 1950s to the 1980s. The public space satisfaction in the areas is low, the residents rarely appropriate the yards and streets of the housing complexes. The aim of the paper is to provide a framework for the understanding of residents’ assessment of public space and its relation to the appropriation; the framework can be used for the development of building or landscape architecture projects focused at reconstruction of the public space. Public Space Quality Model is generated in the paper. The model includes three spatial categories that are defined by metrical values, configuration components and dominant spatial elements – elements that determine size, category, and the structure of a space. Using the observation method in the residential areas of the former East Berlin, the research concludes that the model demonstrates the highest precision of predictability of the appropriation intensity of the public space when the green structure is used as the dominant spatial element. A method accompanying the model is presented in the paper that permits to use specific types of trees or shrubs in particular distancing and concrete arrangements to create spaces of high, medium, or low appropriation level in large-scale residential areas.

1. Introduction
Contemporary cities are complex and multifunctional organisms where human well-being and the quality of the environment play an important role. Therefore, meeting the needs of urban population is one of the priorities of planners. The city is viable only through the residents, their activities, their interests, their desire to socialise, visit cultural events, parks, do sports. Urban environment has an effect on the daily lives of residents, both physically and mentally, either by showing barriers or by providing opportunities, inspiration and safety. The quality of the urban life environment can be assessed most directly through public spaces, whose planning principles and traditions vary from country to country and represent different historical stages. The public space is an object of transformation: it is a mirror that reflects the needs and attitudes of society as well as political, social and economic circumstances [1,2]. Large-scale residential areas emerged in Europe in the middle of the past century, and still retain their own spatial structure with specific characteristics of the public space. In some cases, despite the initial concept to provide vast public space for leisure, it can be
observed that territories planned for the inhabitants’ recreation have decreased after the break-down of the Soviet rule due to many factors: housing and parking lots were created on the land in the yards that was bought or denationalised during privatisation time, increased transport load contributed to the widening of streets, reducing the size of green areas. The impact of all these processes has influenced both physical parameters and perception of the public space of the large-scale residential areas, reducing rights of the residents to the qualitative urban life environment, diminishing both social interaction of residents and accessibility [3,4,5].

In the context of public space perception researchers of urban environment analyse subjective (individual's perception patterns) and objective factors (materiality, physical reality factors). The later ones are determined by the structural parameters of the space measurable in metric units and easily defined graphically — shape, silhouette, colour, texture, scale, rhythm. The former ones, on the other hand, are related to the individual's perception patterns as well as to education, professional experience, culture, stereotypes, traditions, etc. The interaction of these factors of public space perception (including materiality) needs to be studied [6,7,8]. Public space quality and its criteria are to be discussed in this paper. Outdoor appropriation habits (transit, temporary or long-term maintenance, entry and stay) and inhabitants‘ likability of space are in the focus of our current work. Jane Jacobs, in her studies, draws attention to the quality of the public space. She attempts to provide solutions for people-friendly, physically, and psychologically accessible public spaces. Jakobs describes public space as a close synergy between the urban environment and its population – as a common product that interacts continuously. Each formative element of the public outdoor space – both an architectural element or living being – plays a role in physical and mental life of inhabitants. There are no objects that have purely decorative or mechanical function in public space. One of the key qualities of public space development is the provision of the social integration and multifunctionality in any part of the city. Large-scale residential areas are monofunctional territories, they often are described as the opposite to what Jakobs calls “human-scale”. Importance of a scale and spatial structure in perception of large-scale residential areas has a direct effect on human well-being [9,10]. These problematics are being studied in Latvia – the home to the authors of this paper – by both building architects as well as landscape architects, and both subjective and objective environmental factors are analysed. Latvian researchers are noting a series of problems related to both the outdoor spatial structure and the structure of greenery, environmental accessibility, the aesthetic and physical quality of the outdoor space, and the overall quality of the population's life environment in large-scale residential areas [11,12,13].

The focus of our previous work was related to the analysis of the influence of landscape elements (blue-green structure, small elevations of the earth surface, public space furniture, roads, etc.) on the perception and likability of the public space [14]. We argued that the green structure – trees and shrubs – plays an important part in how people perceive and like a scene. It was suggested that the role of the trees with low-growing branches was particularly salient [15]. The aim of the current article is to discuss the impact of the green structure on the appropriation of public spaces in large-scale residential areas. Data on relation of the green structure and its appropriation are converted into the category based Public Space Quality Model that has been developed in its previous stage in the foregoing publication [16]. The basis of the model is the notion that human assessment of spatial aesthetics is related to the form and size of public space as shaped by the green structure or other elements, such as buildings.

The model is based on the concept of four spatial categories with different likability that according to S. Kaplan cover all the possible spaces in nature. [17]. It has been suggested that the spatial categories receive the same assessment in urban settings as well. [18]. Open-undefined spaces are disliked, they are too large for a human to judge as to where are the boarders of the space. Enclosed spaces are not preferred either, they provoke the feeling of being entrapped. Blocked views are held in disfavour, as they retain any information on potential actions in the space. Spacious, well-structured spaces are liked, they offer enough possibilities to hide (refuge) and see (prospect) into the space. Furthermore, the research proposes that the presence of the components of mystery and legibility is
related to increased likability [19]. Mystery is a configuration component; it is defined as a specific kind of prospect – a possibility to see into the landscape – which offers a potentiality of new information not accessible from the current vantage point. Configuration component legibility, in its turn, is a kind of a refuge that provides a potential concealment in the distance of the current vantage point at the same time providing a better overview of the part of the space the observer is situated in at the moment. The components of mystery and legibility can increase the likability of open-undefined and enclosed spaces, changing the assessment of a space from disliked to tolerated [15]. Current paper discusses the relation between liked, tolerated, and disliked spaces and the intensity level of their appropriation. It tests the hypothesis that liked spaces attract more visitors and vice versa as proposed by the Attention Restoration Theory. [21] The Public Space Quality Model is used as a framework for analysing the correlations. The size versus components progression principle is utilized in the analysis: spaces larger in size can be tolerated if they possess a larger number of components of mystery or legibility.

2. Materials and Methods
The Public Space Quality Model was developed in the previous research and served as a starting point for the semi-structured interviews regarding the greenery as an element that determines the border of the space and likability of public spaces in the Soviet Era large-scale residential areas of Riga, Latvia. [15] The results of the interview analysis indicated that the size margin of every category described in the model is larger than initially presumed. [15] The analysis of the interview results also demonstrated that likability regarding each category was largely retained. The information is assembled in the table 1. Semi-structured interviews were also carried out to obtain similar data regarding architectural elements as well as outdoor furniture. As seen in the table 1, the interview material provides indications in terms of size, ratio, per cental coverage of the yard or street by the greenery and number of components of mystery and legibility in relation to the assessment: liked, tolerated, disliked.

The aim of this paper is to inspect if the level of likability relates to the intensity of the appropriation. The current research examines the interview results shown in the table 1 extracted from the previous research with the method of observation of participants. Observation permits to control and refine the results that are retrieved from the interviews. [20] The benefit of the observation is the absence of any interpersonal contact. Thus, the maximum of the objectivity provided by a qualitative method is achieved.

Observation of participants was carried out in the Soviet Era large-scale residential areas of Berlin. Berlin was chosen because its city planning history is similar to Riga in the second half of the 20th century. The development of the residential areas at the beginning of the 21st century in the capital of Germany shows some differences to the counterparts in the capital of Latvia. Mostly due to the availability of higher financial resources the public spaces of residential areas of Berlin demonstrate diversified landscape solutions and cultivated greenery – miscellaneous material to prove the role of the green structure in the process of appropriation.

The observation was carried out in Berlin in the autumn of 2020. Approximately 120 public spaces – yards and streets – were observed. The total duration of the observation – 480 hours. The observation took place at different times of the day, under any weather conditions, both, during weekdays and on holidays. During the observation, the level and the kind of the appropriation of one of 120 public spaces was noted and the kind and the structure of the greenery was documented in minute for every space. The intensity of the appropriation was measured as follows: if a yard or a street was used / occupied by at least 70% of users during the observation period, it was ranked as having a high appropriation intensity. If a public space was used / occupied by 30 – 69% of users, it was ranked as having a medium appropriation intensity. Lesser percentage of users of public space
was ranked as a low appropriation intensity. The total amount of the users was derived from the number of inhabitants living around the yard or stretch of the street under the observation.

**Table 1.** The Public Space Quality Model. The role of the Green Structure in the Public Space.

| Category/class | Medium width m | Medium height m | Height to width ratio | Number of components of mystery | Number of components of legibility | Assessment | Notes |
|----------------|----------------|-----------------|-----------------------|---------------------------------|-----------------------------------|------------|-------|
| Spacious, well-structured yard | 5 – 110 | 7 – 22 | 0.20 – 0.24 | 4 | 5 | Liked | Legibility – 40 m from the vantage point. Groups of trees, some – low-growing branches |
| 1st class. Open-undefined yard | 100 – 135 | 6 – 23 | 0.11 – 0.19 | 2 | ≤ 2 | Tolerated | Legibility – 40 m from the vantage point. Greenery – 45% of space. Groups of trees, some – low-growing branches |
| 2nd class. Open-undefined yard | < 135 | 6 – 23 | 0.11 – 0.19 | Not relevant | Not relevant | Disliked | The position of the components does not influence the likability |
| 1st class. Enclosed yard | 25 – 45 | 7 – 23 | 0.39 – 0.72 | 5 – 10 | 3 – 9 | Tolerated | Mystery and legibility formed by shrubs mainly. Legibility and mystery in 20 m distance. |
| 2nd class. Enclosed yard | 25 – 45 | 7 – 23 | 0.39 – 0.72 | >5 | 3 – 7 | Disliked | The position of the components does not influence the likability |
| Spacious, well-structured street | 18 – 22 | 16 – 20 | 0.60 – 0.80 | 0 – 2 | 0 – 10 | Liked | Rows of trees, alleys of trees |
| Open-undefined street | 45 – 60 | 7 – 20 | 0.28 – 0.44 | 1 – 8 | 12 – 17 | Tolerated | Legibility in 5 m distance. Greenery covers 60% of the space. |
| Enclosed street | 20 – 23 | 1 – 22 | 0.94 – 1.20 | 0 – 5 | 0 – 6 | Disliked | The position or the number of the components does not influence the likability |

The collected material was contrasted with the data retrieved from the interviews done in previous research. On remaining within the framework of the Public Space Quality Model and thus within the system of categories, the green structure and the intensity of the appropriation was analysed. The spaces of the yards and streets that are appropriated with highly, medium, or low intensity were measured: the green structure was taken as the element that defined the width and the height of the space. Green structure was also evaluated regarding the presence of components of mystery and legibility formed by it. The results were ranked according to the size and ratio. The ranking of spaces was further investigated as to the presence of spatial categories and ordered accordingly. The number of cases matching every category was noted. Rankings of other elements such as an architecture were created in the same mode.

**3. Results and discussions**

Table 2 represents the finding which were carried out by using observation tools were done in Berlin. They correlate to the great extend and refine the findings done in Riga by the tools of interviewing (Table 1).
The findings also show that the structure and size of the greenery is the most precise way to predict the intensity of the appropriation within the framework of the model. The results on the greenery compared, for example, to the results on architecture show more matching cases per category. The size of the space formed by the greenery or architectural elements differs according to the upgraded version of the category-based model, yet the height and width ratio is consistent with the previous studies and is independent on the element that dominates the space. The ratios for spacious, well-structured yard is between 0.2 and 0.24, for open-undefined yard it is smaller than 0.19, for enclosed yards it is larger than 0.40. The ratios for spacious, well-structured street is between 0.60 – 0.90, for open-undefined street smaller than 0.58, for enclosed Street larger than 1.00.

### Table 2. The Public Space Quality Model. The Role of the Green Structure in the Public Space. Predicted appropriation intensity.

| Category | Minimum width (m) | Minimum height (m) | Height to width ratio | Number of components of legibility | Number of components of mystery | Intensity of legibility | Intensity of mystery | Notes |
|----------|-------------------|--------------------|-----------------------|------------------------------------|-------------------------------|------------------------|----------------------|-------|
| Spacious, well-structured yard | 70 – 110 | 17 – 22 | 0.20 – 0.24 | 2 – 4 | 2 – 5 | High | The nearest component of legibility in 40 m distance from the vantage point. The number of components increases proportionally to the growth of a size of a scene. The component of mystery: dense group of trees. The component of legibility: tree with low-growth branches. Greenery covers 20 – 30 % of the scene. |
| 1st class. Open-undefined yard | 110 – 130 | 6 – 23 | 0.11 – 0.19 | 3 – 5 | 4 – 7 | Medium | The nearest component of legibility in 40 m distance from the vantage point. The component of mystery: a group of trees, shrubs. The component of legibility: a tree with low-growing branches. Greenery covers 45% of scene. Larger amount of mystery decreases the likability. |
| 2nd class. Open-undefined yard | ≤30 | 6 – 23 | 0.11 – 0.19 | ≥2 | ≥3 | Low | The location and number of components are irrelevant. |
| 1st class. Enclosed street | 30 – 40 | 7 – 23 | 0.42 – 0.72 | 7 – 9 | 2 – 4 | Medium | The components of mystery are placed 20 m distance apart. The component of mystery: groups of shrubs, less frequently trees. The component of legibility: groups of shrubs. Greenery covers 20% of scene. The number of components increases proportionally to the growth of size of a scene. |
| 2nd class. Enclosed street | 30 – 40 | 7 – 23 | 0.42 – 0.72 | >7 | >2 | Low | The location and number of components are irrelevant. |
| Spacious, well-structured street | 6 – 33 | 14 – 22 | 0.60 – 0.90 | 0 – 2 | 0 – 10 | High | The component of legibility: tree with low-growing branches in rows. Greenery covers 10 % of the scene. |
| 1st class. Open-undefined street | 40 – 50 | 17 – 24 | 0.42 – 0.58 | 4 – 6 | 2 – 8 | Medium | Trees, less frequently shrubs arranged in rows, or groups. Greenery covers 30 % of the scene. Smaller or larger amount of mystery correlates negatively with likability. |
| 2nd class. Open-undefined street | <50 | 17 – 24 | 0.42 – 0.58 | >6 | >5 | Low | The location and number of components are irrelevant. |
| Enclosed street | 20 – 35 | 17 – 24 | 1.00 – 1.30 | 4 – 7 | 2 – 12 | Medium | The components of mystery and legibility: formed shrubs in groups, less frequently trees. Greenery covers 7% of the scene. The number of components increases proportionally to the growth of size of a scene. |
Generally, our discoveries propose that liked spaces are appropriated more intensively than the tolerated spaces by most of the people. This result is in the line with the Attention Restoration Theory. [8] Places, which due to their size and presence of components of mystery and legibility permit to restore human cognitive capacities, are visited and used more intensively and vice versa. The positive influence of the greenery on likability of urban spaces is well documented [22,23,24]

The results of our paper reveal that it is reasonable to predict the intensity of the appropriation within more itemized framework of the categories provided by “The Public Space Quality Model. The Role of the Green Structure in the Public Space” in the table 2. First, categories offer a range of the sizes and ratios that are associated with three levels of the appropriation. Thus, a building or a landscape architect is given a tool to adjust the size of spaces dominated by the greenery according to the desired appropriation intensity of the scene. Second, the number of components of mystery and legibility can be customised with a similar intention. As it was discussed in the previous research [15] and confirmed by the current paper trees with the low-growing branches can form the legibility component in the 1st class of open-undefined and spacious, well-structured yards, i.e., in the spaces that have high or medium appropriation level. Whereas a denser group of trees can form a component of mystery. Groups of shrubs are suitable for creating components of legibility and mystery within enclosed spaces of the 1st class. In spacious, well-structured streets the presence of the components is not of a high importance. In the 1st class of open-undefined streets the trees in lines combined with the shrubs can create components of mystery, in the enclosed street spaces – shrubs are associated with both, components of mystery and legibility. A precise range of number of components within a category and class is given in the table 2. As a rule, spacious, well-structured spaces possess balanced number of components, open-undefined spaces of the 1st class have more components of legibility, but enclosed spaces of the 1st class – more components of mystery (Figure 1; 2). Our discoveries can be interpreted within the matrix of categories given by S.Kaplan [17]. The spaces that are enclosed and thus provide clear structured and feeling of entrapment become tolerated if there are components of mystery presented – they create the possibility of potential action from with the enclosed space. The open-undefined spaces that are vast and provide feeling of being seen are tolerated if there are components of legibility present as these components create the possibility of concealment within an open space. If a tree with low-growing branches, group of trees, group of shrubs and trees or hedges count in a particular space as a component of mystery or legibility depends on the positioning of elements. The positioning must correspond with the definition of legibility and mystery given in the introduction of this paper.

![Figure 1](image-url). An example of an open-undefined yard profile with four components of mystery (bended arrows) and five components of legibility (straight arrows).

Attained results also provide the information as to the distance of location from the vantage point of every component. They also present a percental coverage by the greenery in every category and class.
For the utilization of “The Public Space Quality Model. The Role of the Green Structure in the Public Space” for design purposes the Public Space Quality Measurement Method is developed. The first step is to select the public space and to find the vantage point (entrance to the yard, exit from the staircase). The second step of the method is to document the selected public space at the current stage with the help of a camera that is positioned in 150 cm height and depicts the scene at an angle of 180°. Perfect photos of the scene are taken when there is no foliage. The third step is to mark the space. The scene is marked by connecting in a straight line the outer points of the architectural elements forming the courtyard or street in the original plan of the residential area. The fourth step is to measure the area. The average length and width of the yard are measured by calculating the average edge length. Protrusions outside a rectangle or triangle must not exceed 15% of the area. The fifth step is to calculate the height of the outdoor space as formed by the architectural elements. The average height of the floors is multiplied by the height of the floors and the average height of each side is calculated. In cases where more than a half of the side is not formed by buildings, the height of the specific side is divided by two. The total height of the volumes forming the sides of a rectangle or triangle space are divided by the number of corresponding sides. The sixth step is to count the components – legibility and mystery – in the documented photographs. The components of mystery formed by architectural elements may include prospect formed by a curved or broken facade or the gap between two volumes of buildings. The components of legibility formed by architectural elements may include facade protrusions, niches in the facade, elevations. The seventh step is the categorization of the public space as it is formed by architectural elements. A rough categorization is made according to the height and width ratios as follows. The ratios for spacious, well-structured yard are between 0.2 and 0.24, for open-undefined yard smaller than 0.19, for enclosed yards they are larger than 0.40. The ratios for spacious, well-structured street are between 0.60 – 0.90, for open-undefined street smaller than 0.58, for enclosed street larger than 1.00. The method advices to maintain the category created by green elements. The eights step, evaluating the purpose and the appropriation intensity of the redesigned yard or street section design the space based on the parameters, classes and categories of “The Public Space Quality Model. The Role of the Green Structure in the Public Space” (Table 2). Here, mystery components can be formed by dense groups of trees, groups of trees with shrubs or groups of shrubs, but components of legibility can be formed by trees with low-growing branches or groups of trees with benches under them, as well as hedges.

4. Conclusions
It can be concluded that correlation of two data blocks obtained by two qualitative methods in situ and their comparison is successful. The data of two block is similar to large extent. It permits us to assert that the results are reliable.
The data on the greenery forms an essential part of the Public Space Quality Model which is represented in this paper. Greenery is the element that dominates space, i.e., determines size, category, as well the structure of a space. Thus, greenery is the main element in predicting likability and appropriation intensity of public space in large-scale residential areas.

Due to the high predictability potential regarding appropriation intensity Public Space Quality Model serves as a basis for reconstructing the public space in large-scale areas. We believe that inhabitants’ environmental quality assessment, likability and appropriation concepts presented in the model have to create the ground for the reconstruction of public space; the reorganisation of public space can not be led by the private interests of few. The accompanying method that is also represented in this paper is easy to apply in the process of reconstruction of public space by building and landscape architects.

Our findings of the present research ascertain the size, structure and appropriation intensity of a greenery dominated space in large-scale areas of a Soviet Era. A further investigation is needed to examine if attained results / discoveries similar to the above-described ones could either be done in the urban spaces of other periods.

References

[1] J. Gehl, “Life Between Buildings: Using Public Space,” Copenhagen: Arkitektens Forlag, 1996.
[2] A. Burden, [Accessed 20.05.2018] How public spaces make cities work, Ted talks [Online] https://www.ted.com/talks/amanda_burden_how_public_spaces_make_cities_work
[3] S. Kressel, “Privatizing the public realm,” New Democracy Newsletter, July-August 1998.
[4] M., Kohn, “Brave New Neighbourhood: The Privatization of Public Space,” New York: Routledge, 2004.
[5] Rivlin, L.G. 1994. Public spaces and public life in urban areas,” in: S.J. Neary, M.S, Symes, F.E Brown, (Eds.), The Urban Experience: A People-Environment Perspective. London: Taylor & Francis Group, pp. 289–296, 1994.
[6] I. Strautmanis, “Dialogs ar telpu“, Riga: Liesma, 1989.
[7] D. Zigmunde, “Estētiskās kvalitātes kričēri urbanizētas ainavas izpētē,” Urban Landscape Aesthetic Quality Assessment, LLU Rakstī, Nr. 25 (320),1–12 lpp., 2010.
[8] K. Lynch, “The image of the city,” Cambridge: MIT Press, 1960
[9] S. Schmidt, J. Németh, “Space, Place and the City: Emerging Research on Public Space Design and Planning”, Journal of Urban Design, Vol. 15 (4), pp. 453–457, 2010.
[10] J. Jacobs, “The Death and Life of Great American Cities,” New York: Vintage Books, 1961.
[11] U. Īle “Principles for Planning Residential Area Greenery,” Proceedings of Research for Rural Development, Annual 17th International Scientific Conference, vol 2. 182–182 pp., 2011.
[12] A. Ziemeļniece, U. Īle, “Criteria of Architectural Composition Design in Residential Courtyards,” IOP Conference Series: Materials Science and Engineering, vol. 245 (4), 2017.
[13] S.Treija, U. Bratuškins, “Development Problems of Large-Scale Housing Estates in Riga,” Scientific Journal of Riga Technical University, Architecture and Urban Planning, vol. 4, pp.77–83, 2003.
[14] A.S. Kusmane, U. Īle, “Importance of landscape elements in perception of spatial aesthetics in residential areas,” Conference: Research for Rural Development, Jelgava, 2017.
[15] A.S. Kusmane, U. Īle, A. Ziemeļniece, “Importance of Trees with Low-growing Branches and Shrubs in Perception of Urban Spaces,” Proceedings World Multidisciplinary Civil Engineering Architecture – Urban Planning Symposium, Prague, p. 256–264, 2018.
[16] A.S. Kusmane, „How to Measure the Impact of Spatial Aesthetics on the Everyday in Soviet Housing Estates?”, Landscape Architecture and Art, volume 9, number 9, pp. 7 – 20, 2017.
[17] S. Kaplan, “Concerning the Power of Content-identifying Methodologies,” in: T.C. Daniel, E.H. Zube (eds.), Assessing Amenity Resource Values, USDA Forest Service General Technical Report RM-68, Fort Collins: Rocky Mountain Forest and Range Experimental Station, pp. 35 – 42, 1979.

[18] T.R. Herzog, “A Cognitive Analysis of Preference for Urban Spaces,” Journal of Environmental Psychology, vol. 12, pp. 237 – 248, 1992.

[19] J.L. Nasar & E. Cubucku, “Evaluative Appraisals of Environmental Mystery and Surprise,” Environment and Behavior, vol 43, pp. 387 – 414, 2011.

[20] F. Dunstana, N. Weaverb, R. Arayad, T. Bella, Simon Lannonb, G. Lewisd, J. Pattersonb, H. Thomasc, P. Jones, S. Palmer, S. An Observation Tool to Assess the Assessment of Urban Residential Environments. Journal of Environmental Psychology, Vol. 25, p. 293–305, 2005.

[21] S. Kaplan, The restorative benefits of nature: Toward an integrative framework. Journal of Environmental Psychology, Vol. 15, p. 169–182, 1995.

[22] E.V. White, B. Gatersleben, “Greenery on residential buildings: Does it affect preferences and perceptions of beauty?” Journal of Environmental Psychology, vol. 31, pp. 89 – 98, 2011.

[23] M.S. Taylor, B.W. Wheeler, M.P. White, T. Economou, N.J. Osborn, “Research note: Urban street tree density and antidepressant prescription rates—A cross-sectional study in London, UK”, Landscape and Urban Planning, Vol. 136, pp. 174 – 179, 2015.

[24] M. Asgarzadeh, T. Koga, K. Hirate, M. Farvid, A. Lusk. “Investigating oppressiveness and spaciousness in relation to building, trees, sky and ground surface: A study in Tokyo,” Landscape and Urban Planning, Volume 131, Pages 36-41, 2014.