Potential of Bioclimatic Architecture in the Formation of Regional Spatial Environment

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ABSTRACT. Bioclimatic architecture is a world-known trend in building architecture design, but in Latvia this term is scarcely used. While studying the theory of architecture and analysing practical examples, the author of this Paper has endeavoured to outline the role of bioclimatic factors in the formation of features of regional architecture. This Paper renders a historical outset of incoming of sustainable development ideas into architecture. With a glance to the urgency of energy-efficient building in Latvia the Paper also affords a look at the differences between bioclimatic architecture and energy-efficient building.

KEYWORDS: bioclimatic architecture, sustainable architecture.

In architecture, the end of the 20th century and the beginning of the 21st century have been marked by an increased interest in ecological issues. Increasingly more information about designing of energy efficient buildings, especially passive houses, is available in Latvia. This is related to the importance of energy saving on a global scale in all sectors. Yet regarding the variety of concepts available for the rest of ecologically-oriented buildings, the information is fragmented. As a result, either a one-sided approach to the practical solution of ecological issues is applied or different conceptual tendencies are mixed, sometimes using the concepts inconsistently and often interpreting them imprecisely. Today, one of the topical tendencies in the architecture of environmentally-friendly buildings in the world is the so-called bioclimatic architecture, which is less known in Latvia. The present study looks at the link between bioclimatic architecture and features of regional architecture as well as its architectural and spatial forms of expression. The Paper contains a brief review of introduction of ideas of sustainable development into architecture. Based on the analysis of theory and practice, the most important differences between bioclimatic architecture and concepts of energy effective buildings are outlined.

I. HISTORICAL DEVELOPMENT FROM REGIONAL IDENTITY TO GLOBAL ARCHITECTURE

The nature of interaction between the architecture and climate has undergone much change over the different historical periods. In the first man-made homes, local natural and climatic factors played a decisive role and determined their structural and spatial design. Over the centuries, in a long process of trial and error, methods were improved to find the most rational way how to achieve comfortable conditions in a home, while respecting local climate. These methods were best reflected in vernacular building traditions; therefore, bioclimatic architecture is nowadays often inspired by the historical building methods and examples of vernacular architecture.

Although in the examples of the historical regional architecture it was important to consider the elements of the surrounding

Fig. 1. A dwelling house from Vidzeme region. Open-air Museum, Riga, Latvia. A wooden log structure, compact in form with a low ceiling for heat retention. [Photo by the author]

Fig. 2. A dwelling house. Negri Sembalan, Malaysia. The steep roof and the raised roof ends facilitate outflow of heated air from the rooms. [2]

Fig. 3. A group of dwelling houses. Kano, Nigeria. The houses are built of earth, next to the place of excavation of the “building material”. [2]
environment when choosing the location for the house and configuration of the settlement [1], the knowledge of that time was based on the empirical experience, that was handed on from generation to generation. Therefore, not only climatic and natural conditions played an important role, but also local traditions accounting for the distinctive architecture of the different regions and at the same time retaining spatial solution principles characteristic of the particular region (Figure 1 to 3). These principles were preserved in the vernacular building traditions alongside with the development of architectural styles.

Yet this process was interrupted by the industrialisation and technological innovations in the mid-19th century and early 20th century and the character of interaction between the architecture and natural environment was changed significantly. Changes could be observed both at the regional level in the vernacular building traditions and globally in the architectural trends. At a regional level, traditional building materials were replaced by industrially produced ones; new tools appeared, threshing barns were replaced by grain sheds, dwelling houses acquired glass verandas [1]. At a global level, the changes were much more serious. As heating, mechanic ventilation and air-conditioning equipment developed, simultaneously with new construction techniques, architects had a possibility to ignore the role of climatic conditions in the process of architectural designing. For centuries, the structural and spatial solutions of buildings had had the decisive role in ensuring the indoor microclimate; however, with the introduction of technical innovations, the indoor microclimate in buildings came to depend on engineering systems. This enabled to form the shape of the building regardless of the local natural and climatic conditions, as Le Corbusier’s idea of “international style”, namely, “(...) one single building for all nations and climates” spread throughout the world [3]. As a result, architecture became similar in different cities of the world and in different climatic regions; it was not necessary to observe the building’s aspect or direction of prevailing winds in the designing process any more. This architectural practice prevailed in the world throughout the entire 20th century, which is why the same type of architectural expression can be observed both in early 20th century buildings in the USA (Figure 4), in structures built in the second half of the 20th century in Riga (Figure 5), as well as in the buildings constructed over the different periods in the regions with completely different climatic conditions. This similarity was made more conspicuous by the use of standardised construction techniques and similar materials. Centralized production of materials and the possibility of transporting them to large distances allowed the use of the same materials (glass systems in public buildings, slabs in residential buildings etc.) in any region.
II. IMPLEMENTATION OF SUSTAINABILITY IDEAS IN ARCHITECTURE

Along with the environmental studies and increasing evidence of human activity as a factor causing global environmental problems, the mid-20th century saw an upsurge of interest in the nature of the relationship between architecture and natural environment. After the formulation of the definition of sustainable development at an official level (the 1987 Brundtland Report at the UN), application of sustainability principles to various spheres began. The initially very general formulation of sustainable development, namely, a development that “meets the needs of the present without compromising the ability of future generations to meet their own needs”, today is more often attributed to narrower fields, e.g. economics, social sphere, even politics. In this context, architecture as a form of art places much importance on aesthetic sustainability of architecture, while ecological sustainability is important in the context of environmental issues. This is why the issue of reflecting ecological ideas in architectural aesthetics became topical. From this point of view, there is a need for an approach to architectural designing that both ensures energy saving and addresses a much wider scope of issues that are essential for people. Concepts of building design that are focusing only on the economic sustainability and energy saving, can be regarded as incomplete in terms of sustainable development, since they only partly cover the whole scope of problems to be addressed by architecture. The definition of sustainable development, in its turn, covers almost unlimited set of issues to be considered. Thus, the concept of sustainable architecture acquires limits that are difficult to define, since architecture as an art of shaping the living environment of people is inseparably linked to both social and economic aspects. Polls show that Central European countries tend to use the term “sustainability” for environmentally-friendly architecture, whereas in the southern part of Europe, the difference between sustainable architecture and bioclimatic architecture is much more emphasised [5]. Bioclimatic architecture is a tentative mean between the concepts of sustainable and energy effective architecture. Different approaches to the design of buildings complying with natural and climatic conditions in modern architecture have been formed and refined over several decades since the mid-20th century. Therefore, bioclimatic architecture is not something completely new in a global context, while in Latvia, it has been less studied yet, in contrast to energy effective buildings.

III. THEORETICAL BASIS OF BIOCLIMATIC ARCHITECTURE

The term bioclimatic was first used in 1918 (“bioclimatic – something that is related to the climate and the interaction of living beings” [6]), but the concept of bioclimatic architecture was first mentioned in 1963 in the book Design with Climate: Bioclimatic Approach to Architectural Regionalism by architect Victor Olgyay [5]. The book, which has been reprinted several times and is considered to be one of the most important theoretical works for shaping the ideas of bioclimatic architecture, includes a bioclimatic chart (Figure 6), which graphically shows the impact of outdoor air temperature and meteorological parameters on the human comfort level.

The book offers methods how to create a microclimate more favourable for humans with a set of architectural and spatial techniques appropriate to the local climate [7]. The wind, air temperature and humidity are listed as the main bioclimatic factors affecting human comfort. Victor Olgyay believes that in the implementation of bioclimatic architecture it is necessary to combine three scientific disciplines:

- biology – to define requirements for comfort depending on human physiological parameters;
- meteorology – to examine in detail the existing climatic conditions;
- engineering sciences – to provide a rational solution.

Accordingly, the designing process of bioclimatic architecture consists of four successive stages [7]:

1. collection and processing of climate data (temperature, relative humidity, solar radiation and wind);
2. biological evaluation or definition of a comfort zone; comfort zones vary in different climates;
3. finding of technical solutions, defining basic principles for location and aspect of the building, shading requirements and principles of massing;
4. synthesis of the data acquired in the first three stages and their use in the architectural solution.

As regards the nature of the acquired data, designing of bioclimatic architecture refers to ensuring the comfort in the building to the same extent as to the improvement of the outdoor microclimate with architectural methods and spatial planning solutions. Today bioclimatic architecture is characterized by a complex approach to the designing, as well as taking into account the features of regional environment and the building materials used. The amount of energy consumed in the operation of a building is not a key factor in bioclimatic architecture, as opposed to the energy-efficient construction or a passive house concept. However, energy consumption of the bioclimatic buildings is usually lower if compared to the buildings of a traditional design. Besides, this is achieved through the use of only architectural and spatial designing methods. Bioclimatic architecture is not a style of architecture. However, it is seen more as an approach of architectural and spatial designing than, for example, the idea of a passive house currently so popular in Latvia, which is rather a type of an engineering solution for a building.

Fig. 6. A bioclimatic chart showing location of comfort zones. 1963, V. Olgyay. [7]
IV. A SYNTHESIS OF AESTHETIC AND CLIMATIC FACTORS IN BIOCLIMATIC ARCHITECTURE

The relation of bioclimatic architecture to nature requires that the principles of bioclimatic architecture are often rooted in the vernacular building traditions, which over the centuries, have been naturally adapted to the local natural and climatic conditions in a long process of trial and error. The use of local building materials is also one of the features of the regional architecture. Formerly, the use of local materials made the building traditions of each region unique, even if they fell within one climatic zone. Differences were also seen in the territory of Latvia, since the availability of forests or prevalence of farming in the region determined the choice of the material for the roofs [1]. The material used, in its turn, determined the shape of the roof, since it was more convenient to cover gable roofs with wood shingles, while in the regions where thatch was used, the roofs had four slopes [1].

Many architects today, especially in the initial development stage of bioclimatic architecture, try to visually demonstrate the relation of the building to the surrounding environment, nature and climate, employing simple and relatively primitive building techniques, which were characteristic for the historical regional architecture (Figure 7).

Potentially, the adaptation of historical climate-sensitive practices to the modern architectural vocabulary could be the most promising approach. Besides, the dwelling houses designed in vernacular traditions are actually the basis of the regional architecture, which in later centuries were used by architects to make the new types of buildings blend into the regional environment more harmoniously, e.g. transposing their visual elements or materials to multi-storey residential buildings. However, such an approach has its limitations, because it is difficult to apply the aesthetics rooted in the vernacular building practices to many types of modern buildings, e.g. office buildings. In the bioclimatic context, such “transposition” is questionable at best. The principles of bioclimatic designing should be understood in substance and reapplied to new types of buildings in new ways using the modern vocabulary of forms, like Malaysian architect Ken Yeang is trying to do. He has developed a concept of a bioclimatic skyscraper, which is implemented mostly in the tropical climate zone (Figure 8). In Australia, bioclimatic principles in designing of residential buildings are widely used by architect Glen Murcutt. Emilio Ambasz, one of the well known representatives of bioclimatic architecture in Europe, is looking for a visual link between architecture and environment in his works, while designs by Mario Cucinella are visually neutral [3].

Interpretation of bioclimatic factors greatly varies in architecture. Some groups of architects are trying to deal with ecological issues by the means of modern technologies (Figure 9), i.e. relying on bioclimatic designing principles, while also actively employing the opportunities offered by modern technologies.

The existing urban environment is one of the problems in the successful application of bioclimatic architecture. If cities were planned with respect to local climatic conditions, then in cold climates the buildings would be arranged in dense groups, in order to protect them from wind and heat loss, in temperate climates, the buildings would be freestanding blending with elements of nature, in dry and hot climates, groups of buildings would be built around shaded inner courtyards, and in wet and hot climates, the buildings would be freestanding and scattered to allow free movement of air between them [7]. The location and configuration of historic settlements made Victor Olgyay come to this conclusion. However, formerly, the main precondition
required for a settlement to grow was its ability to adapt to the local conditions. Modern cities are built following many other considerations: economic, social, political and ideological as well as purely functional, like alleviation of transport problems. Technical facilities of buildings allowed compensating for an inadequate to climatic conditions. Taking into account that the climate is no longer given priority in the urban organization, the main line of research refers to the principles of bioclimatic architecture in Latvia (since 2006). The main features of bioclimatic architecture are the regional context and the relation to a particular place, logical forms and diversity of geometric forms, logical location of buildings within the landscape and precise composition of groups of buildings in the urban environment, as well as a balance between ecological, economic and aesthetic priorities in defining the architectural image of the building.

CONCLUSIONS

In bioclimatic architecture and designing the architectural and spatial techniques are used to improve the microclimate not only inside, but also outside the buildings, as well as in the bioclimatic integration of freestanding buildings into the landscape. It implies a much more complex approach to the formation of architectural and spatial environment than the one oriented only on energy-efficient design practices.

The fact that the principles of bioclimatic architecture are related to many aspects of the vernacular building traditions, makes it possible by the means of bioclimatic architecture to create a spatial environment that is ecologically and aesthetically appropriate to the regional conditions.

The differences of architectural expression in bioclimatic architecture derive from the designing approach. The artistic expression rooted in vernacular and regional architecture is most often used in the architecture of residential buildings along with the theoretical principles of bioclimatic architecture, which are implemented in a modern vocabulary of forms based on estimates and climate data. In the architecture of public buildings, contemporary expressions prevail along with the use of architectural forms that are based on calculations and modern technologies.

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Edgars Suvorovs, Sandra Treija. Bioklimatiskās arhitektūras potenciāls reģionālās telpiskās vides veidošanā


Lūdz ar ilgtspējīgas attīstības ideju aktivizētā starpība saglabājušās saimnīcība arhitektūrā 20. gadsimta sākumā, arhitektūrā no jauna tika pārvērtēta klimata apstākļu vērtēnā prasa, radot pamatu bioklimatiskās arhitektūras koncepcijas izveidei. Šobrīd bioklimatiskās arhitektūras koncepcijas ir vidusceļš starp ilgtspējīgas arhitektūras un ļoti aktīvi definēto energoefektīvas arhitektūras jēdzienu. Ignorējot klimatisko un vietējo apstākļu un vietējo tradicijas ietekmi telpiskās vides veidošanā, arhitektūras formu valoda kļuva līdzās dažādos klimatiskajos reģionos visā pasaulē. 

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Bioklimatiskās arhitektūras potenciāls regionālas
telpiskās vides veidošanā

Edgars Suvorovs, Sandra Treija, Rīgas Tehniskā universitāte
Latvijā tā vēl ir maz pētīta, pretstatā energoefektīvām ēkām. Arhitektūra nav nekas principiāli jauns globālā kontekstā, bet atšķirīgas pieejas dabai un klimatam atbilstošu ēku projektēšanā starp ilgtspējīgas un energoefektīvas arhitektūras jēdzieniem.

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Viens no zināmākajiem bioklimatiskās arhitektūras pārstāvjiem
Europā Emilio Ambasz savos darbos meklē arhitektūras un
apkārtnējās vides vizuālo saikni, kamēr Mario Cucinella savus
darbus veido vizuāli neatkarībā [3]. Bioklimatisko faktoru
interpretācijās arhitektūrā ir ļoti dažādas. Dažas arhitektu
grupas ekologiskā rakstura jautājumus ir cenšies risināt
ar modernāko tehnoloģiju palīdzību (9. att.), bioklimatiskos projektēšanas
principus ķēm pamato, bet arī intensīvi izmantojot moderno
technoloģiju sniegts iespējas.

Viena no problēmām bioklimatiskās arhitektūras veiksmēgā
izrados no cēlošās pilnībā. Ja pilnītas tiktu plānotas
atbilstoši klimata apstākļiem, tad aukstā klimata zonā ēkām būtu
jābūt piektiekami bīsti grupētām, lai pasargātos no vēja un
siltuma ietekmes. Mērenā klimata zonā ēkām būtu jābūt izvietotām
pēc brīvā plānojuma principa, saplūstot ar dabas elementiem,
zudumiem, mērenā klimata zonā ēkām būtu jābūt izvietotām
reģionālajā arhitektūrā balstīta mākslinieciskā izteiksmē, kā arī
arhitektūras piemēri biežāk sastopami no apbūves relatīvā brīvā
vidē un estētiskajām prioritātēm ēkas arhitektisko tēla definēšanā.

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