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Urban sozology assumption in the planning of housing areas

Sozologia urbanistyczna w planowaniu obszarów mieszkaniowych

Abstract

Sozology is a newly discovered direction in urban planning stem from the growing threats to the natural environment. A contemporary man pursues close and positive relations with the environment and focuses on the premises of human ecology that directly impact the process of planning and composing urban spaces. The article presents the influence of climatic conditions on the shaping of housing areas. The problem was presented on the basis of an analysis of a specific example. The assessment included the shading of the buildings by neighbouring buildings, the shading of the common spaces and the issue of ventilation. These phenomena connected with the structure of the buildings, their scale and intensity have a significant impact on the conditions of the residence. Other factors also affect the housing environment. Their rational use with the help of teams of experts from complementary fields can contribute to raising the standards of the housing environment even at the planning stage, and later to optimising land use by the community of its inhabitants.

Keywords: ecology, sozology, urban planning, climatic conditions

Streszczenie

Sozologia urbanistyczna z uwagi na narastające zagrożenia środowiska przyrodniczego to na nowo odkrywany kierunek w planistyce. Współczesny człowiek, podążając za kształtowaniem bliskich i pozytywnych relacji ze środowiskiem, coraz większą uwagę skupia na przesłankach ekologicznych, mających bezpośredni wpływ na proces planowania i komponowania przestrzeni miejskich. Środowisko naturalne w różnym stopniu było i nadal jest przekształcane przez człowieka. Dziś zawiera ono jedynie naturalne elementy, a w całości należy je nazywać środowiskiem antropogenicznym bądź przyrodniczym. W artykule poddany został rozważaniom wpływ uwarunkowań klimatycznych na kształtowanie obszarów mieszkaniowych. Problem przedstawiono na podstawie analizy konkretnego przykładu. Przy jego ocenie wzięto pod uwagę zacienienie budynków przez sąsiadujące obiekty oraz zacienienie przestrzeni wspólnej towarzyszącej zabudowie, a także problem przewietrzania. Są to zjawiska, których wpływ na warunki zamieszkania uzależniony jest od skali oraz intensywności zabudowań. Czynników oddziałujących na środowisko mieszkaniowe jest o wiele więcej. Ich racjonalne wykorzystanie przy wsparciu zespołów ekspertów z komplementarnych dziedzin przyczynić się może do podniesienia standardów tego środowiska już na etapie planowania, a następnie do optymalizacji użytkowania terenu przez wspólnotę jego mieszkańców.

Słowa kluczowe: ekologia, sozologia, urbanistyka, uwarunkowania klimatyczne

1. Introduction

1.1. The essence of sozology

The development connected with modern times brings not only positive effects. The negative phenomena are primarily associated with the destruction of the environment. The irreversible changes in its structure make it necessary to take actions aimed at stopping the process of further degradation. It is an overarching goal of the sozology, often mistakenly called "ecology", mainly dealing with the relationship between living organisms and the environment. Sozology allows the development of specific methods to prevent or minimise the effects of adverse environmental changes. In urban planning, planning sozology is defined as planning of residential areas, taking care not only about the environment with its natural elements and living conditions but also about human health. By analyzing available research methods and tools, it is used for the protection of nature and contributes to the sustainability of its resources [1].

Sozology (Greek *sōzō* = protect, *lōgos* = science) as an interdisciplinary science, occurred in 1965 on the initiative of W. Goetl – an outstanding Polish geologist and an international precursor of sustainable development, recognised by the UN as a global priority in 2016.

It should be added that prof. W. Goetl initiated open seminars on nature conservation and securing the durability of its resources. He also created the Technician and Humanist Club[1]. The priority of his scientific activities that aimed to improve the quality of the natural environment was the need to undertake comprehensive research from the borderline of many fields of science, including architecture, urban planning, sozology and sozotechnics [3].

It is difficult to present a sufficient amount of literature on sozology in urban planning. In the current state of research, however, publications of such authors as W. Michajłow [1], W. Goetel [4], Z. Kłos [5], J. Dołęga [6], A. Więckowski, J. Kobylarczyk have become permanent. Mikhailov describes sozology as a science that can have positive effects in reduction of problems that arise in the human life environment; W. Goetl describes the problem of sozology in the context of the natural environment; Similarly, subsequent authors of the studies describe the impact of sozology on a specific area. Also, the co-author of this study describes sozology in one of her works as a science that can be used in urban design; she analyzes selected housing areas examining them in terms of compliance with the rules of sozology [7] and explains precisely how the issues related to ecology differ from the issues related to sozology. In this context, issues in the field of sustainable development and design are also important. They prioritize not only care for resources and the current state of the environment but also its future and the future of generations. The approach of W. Goetel has been continued by Prof. J.W. Dobrowolski, whose scientific activity [8–11] is based primarily on conducting interdisciplinary research based on the idea of sustainable development oriented towards the integration of eco-innovation. In his work, Prof. Dobrowolski uses laser biotechnology, of which he is a precursor [2].

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1 Information on this subject was presented by The Institute of Quality of the Jagiellonian Center of Innovation based on the interview with J.W. Dobrowolski [2].

In addition, Prof. Dobrowolski developed a model of training regarding interdisciplinary cooperation between scientific workers and representatives of Student Scientific Circles that aims to solve systematic problems of sustainable development. Together with his colleagues, Prof. Dobrowolski has perfected this model for 50 years, developing cooperation between the experts and a knowledge-based society from various regions of Poland and over a dozen countries from Brazil to China [12, 13].

The aim of the article is to present the application of sozology also in architecture and urban planning, contributing to the rational use of the existing natural conditions in the planning of housing areas. Care for the endangered state of the natural environment is an obligation and requires the promotion of pro-environmental activities consistent with the principles of sozology.

1.2. Architecture in harmony with the natural environment

The use of appropriate technologies and building materials ensuring low energy demand and minimising the negative impact on the natural environment is important in architecture. Created buildings undergo a broadly understood sozoeconomic assessment, including economic and environmental benefits in the process of investment planning, the operation of the building, its demolition and the entire process of production and processing of building materials, as well as waste treatment of the materials [14] which are not always subjected to self-decomposition. The environmental benefits that can be obtained boil down to the rational management of the natural resources, the adaptation to local, but also to changing climate conditions, the use of renewable energy sources and the use of building materials with low energy consumption (so-called embodied energy). It is directly related to the exploitation of raw materials and their renewal. Today, the need to produce ecological and low energy materials (such as smart and composite materials) is triggered due to the exhaustibility of raw materials applicable in the construction industry. Nanotechnology and dynamic development of nanomaterials [15] may bring promising results in the near future.

1.3. Sozology in spatial planning

The article proves that sozology also includes urban conditions. It allows conducting rational land management with respect for nature and its resources. This approach also embraces the problem of increasing compactness of the buildings within urban interiors. Too high intensity displaces green areas, which not only negatively affects the microclimate, but also the well-being of people and living standards. In order to raise them, it is important to adapt the building structures to the existing climatic conditions whose scope of influence depends, among other things, on the location and size of the area under consideration, as well as the number of its users. When planning residential areas, the selection of the right values that are related to the distance between the facilities, service zones and industry is not without significance. It is vital to decide on the scale of development and the size of the biologically active area.

When undertaking the efforts to improve the quality of the housing environment one must be aware of conflicts occurring at the level of the importance of the needs, preferences and priority choices, as well as the activities in the environment [16, pp. 10–14]. They increasingly trigger the sense of improvement of the living conditions, which is becoming and will be the overarching goal of urban sozology in the future. This problem has also become an important subject of the study. It should be noted that due to the dynamic development, it is difficult to unequivocally assess the interventions that will be needed in the future as well as the possibilities of their implementation. However, the need to look into the future with concern for the natural environment and its deteriorating conditions is clear and obvious.

2. Climatic factors including ventilation and sun exposure in the design of the residential areas

2.1. General remarks

The basic problem that appears when analyzing sozology and its application in urban design, is the lack of respect for existing natural conditions, including climate in design practice. Therefore, spatial planning that would take into account climatic factors considered on a macro scale seems vital. They allow characterizing in general terms the conditions prevailing in a given region. It is much more difficult to adjust to climatic factors, which vary in the time understood as the time of the day and the changing seasons. The climate is also changing due to environmental pollution and phenomena such as the urban heat island [17]. This phenomenon is related to the local air circulation and arises as a result of impeded warm exchange, so-called "used" air in built-up areas and cold air coming from open areas, i.e. free of building.

The negative effect of the formation of heat islands, apart from air pollution, is the overheating of urban spaces. Therefore an important solution of the problem is an appropriate choice of materials, both vertical divisions and horizontal divisions, surfaces of the floor, whose task is to keep the balance between the absorbed solar energy and the reflected radiation. The city geometry itself, shaped by the street routes, can limit the excessive air circulation, and the growing hazards associated with its pollution. One of the most important reasons is also the increasingly limited size of the natural surfaces, which maintain the same temperature as the air as in the extra-urban areas. Some surfaces, such as the walls, can be much warmer. Hence, the solution to the problem should be connected with the keeping of the right proportions between built-up and building-free areas. The scale – height – of buildings and the way roofs are shaped are also important. It should be noted that the surfaces of the roofs or vertical surfaces maintain higher temperature as they not only absorb the sun's rays but also effectively limit the wind speed by creating the so-called canyon effect. Inside it, there is a dynamic increase in air temperature with a limited flow [18, 19].

The construction process responsible for the emission of greenhouse gases and triggers the need for using fossil fuels energy has a very large impact on climate change. Research conducted by the American Institute of Architects has shown that buildings consume 48% of energy, and also cause greenhouse gas emissions – commercial architecture 17%, residential architecture – 21%, transport – 27%, industry – 35% annually.

These studies do not take into account all stages of the life of objects, that is the values associated with the production of building materials, the process of building objects and the final phase of their demolition and the utilisation of their components. Nevertheless, the results clearly indicate the necessity to undertake actions allowing to avoid irreversible climate changes and determining the effects of the interaction between the natural and built environment. The use of positive effects of these impacts may contribute to raising the quality standards of the living environment – shaping the appropriate spatial conditions accompanying architectural objects, taking into account climatic factors affecting the planning process of buildings of appropriate scale and form. These conditions can be considered in relation to various scales, including – the macro scale referring to the country or the smaller region, the mesoscale – the city, the local scale – the district, housing estate, micro-neighbourhood [20].

2.2. The analysis of the problem on microscale – the neighbourhood

On the scale of the neighbourhood, factors such as the location of buildings shaping building quarters with accompanying spaces of social and public importance, selection of building materials and equipment, which depending on the climate require cooling or reheating are important. In this context, the ability to determine the intensity of solar radiation becomes crucial. Calculated on the basis of Davis's formula, it indicates more than three times the total radiation during the summer in Poland than in the winter in its southern part. The daily sum of the radiation energy in the south of Poland on the June solstice is almost seven times higher than during the December solstice [21]. The insolation is limited in the periods of cloudiness that prevent the free flow of solar radiation, which reaches the Earth in a dispersed form.

The problem associated with excessive heating of built-up spaces can be eliminated by using appropriate surfaces. The degree of the reflection of solar radiation is determined by the albedo. Generally, its value depends, among other things, on the colour of the surface, its roughness and humidity. The darker, rougher and wetter the surface, the smaller the albedo. It can be concluded that the size of the albedo is influenced by the type of land development – the intensity of the buildings, the scale of vegetation, its variability, and terrain configuration. All these elements contribute to the degree of reflection of solar radiation. The albedo value in the built-up areas is 10÷27% (less by 10÷20% than in the undeveloped areas).

In the discussed aspect, one should also indicate the benefits that are associated with the design of water reservoirs. The horizontal water surface is characterized by a variable albedo value, depending on the solar incidence angle. During winter (when the sun is relatively low over the horizon), it is a highly reflective surface, while in the summer, when the sun rays strike at a higher angle, it becomes a light absorber. This behaviour meets the variable seasonal demand for sunlight and solar heat – it allows, among others, to reduce the amplitude of the external air temperature, and as a result, to improve the quality of the microclimate in the city [22].

As it was previously explained, the height of the buildings and their content is also important. The friendly scale of the objects with limited intensity can facilitate the penetration of the sunlight, illuminating the interiors. In this respect, the size of parameters determining the proportions between the height of buildings and the distance between them H/S is significant – when the objects are of the same height and $(H/S)_p = (h_1+h_2)/2(s_1+s_2)$ when they have different heights or vertical offsets. While: h – height of objects, s – distances of vertical planes covering the walls of buildings from the P point.

Similarly, the difference in the height of objects adjacent to each other (higher building shades the lower object) or the distance between the building and the greenery as well as the height of the greenery itself is of significance for the degree of shading. The shading may also be caused by the loggias, balconies or eaves. When the h_a angular height of the sun (Fig. 1) is greater, the shading from the neighbouring building is smaller but greater from the balconies and eaves. The h_a angular height of the sun depends on the geographical latitude of the point and the time of day. The biggest values are obtained at noon, while during the sunrise and sunset they are equal to zero. The duration of sunlight on the façade during the day also depends on the location of the building relative to the sides of the world [23].

The impact of the climatic factors on the area of residence is largely determined by the building development – its height, the degree of diversification, their layout – loose housing, compact housing, quadrilateral housing, open or closed systems [24] (Fig. 1–7). These systems facilitate or hinder ventilation of the residential areas.

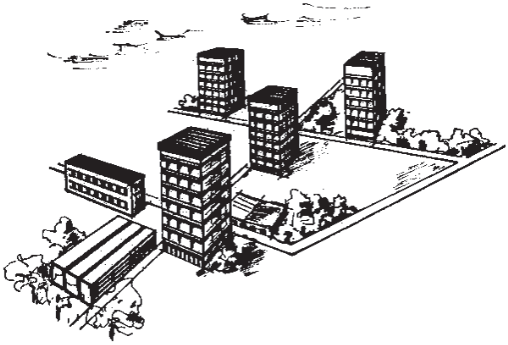

Fig. 1. Loose, high, open housing. It allows free airflow and even actuates it [24, p. 26]

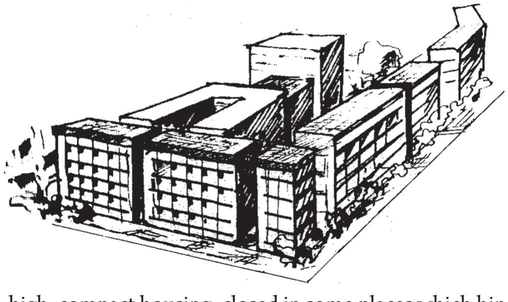

Fig. 2. Medium-high, compact housing, closed in some places which hinder ventilation. Narrow breaks between the buildings actuate the wind leading to “drafts” [24, p. 27]

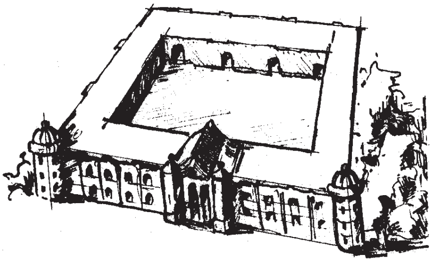

Fig. 3. Medium-high buildings with a closed inner yard that causes air stagnation [24, p. 27]

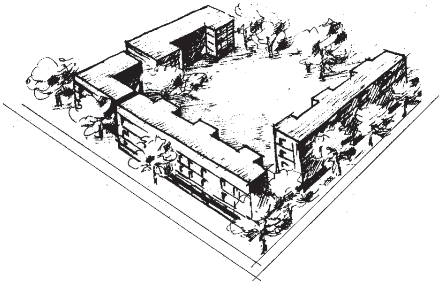

Fig. 4. Mid-high housing with a semi-closed system. The airflow can be hindered by the growth of the greenery [24, p. 27]

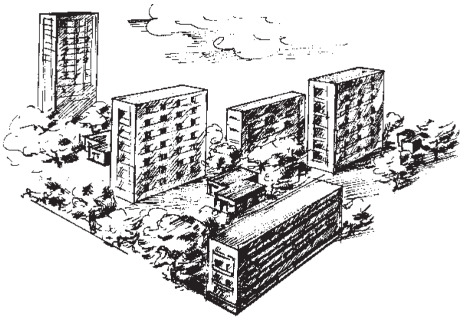

Fig. 5. Mixed housing with a different number of storeys. The most favourable climatic conditions occur with this type of building in green spaces [24, p. 28]

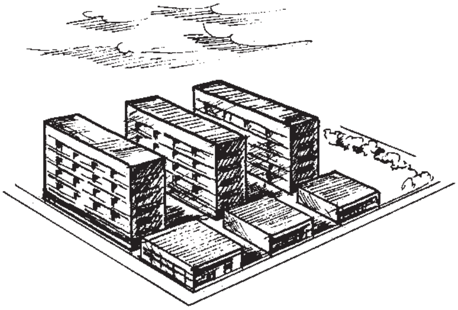

Fig. 6. Diverse, mixed housing development with a loose, open layout and a small amount of greenery. There will be excessive wind speeds when the wind blows along the buildings. In the area with higher and longer buildings, wind speeds will be even higher [24, p. 28]

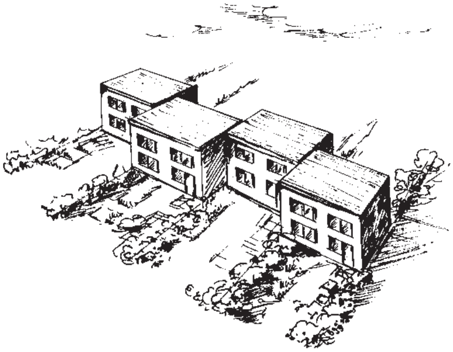

Fig. 7. The type of a low, compact, open housing with a small amount of greenery. This type of building interferes with the prevailing airing conditions to the slightest degree [24, p. 29]

The geometry of the building and its intensity, taking into account the distance between the buildings, regulates the shading and insolation of the area. Moreover, it also affects the strength and direction of the wind (Fig. 8).

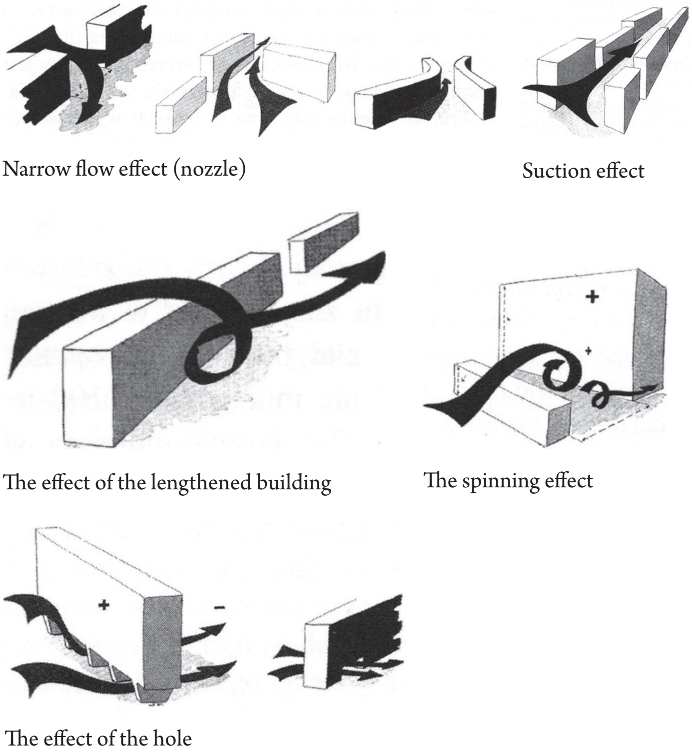

Fig. 8. Wind flow with different building geometry [25], according to A. Flaga [26]

The ventilation intensity is higher when the area is more open. It decreases with increasing building intensity and its height.

3. The case study

3.1. General remarks

The purpose of the undertaken analysis was to indicate the extent the area of residence chosen for the research, that is the estate of Dywizjonów 303 in Cracow implements the assumptions of urban sozology. The adopted research method is based on field studies – a site inspection, which allowed the analysis of functional and spatial conditions of selected areas, and thus the relationship between the natural environment of these locations and the constructed area. Given the fact that the analysis concerned the existing area, it should be perceived as a diagnosis of existing conditions. The elements and phenomena subjected to evaluation concerned: the impact of climatic factors – insolation, ventilation – on built-up areas, traffic noise and the assessment of the intensity of car communication inside the areas selected for testing and their influence on the degree of air pollution.

Sunlight patterns were created in Sketchup computer program. They show not only a spatial picture of the shading of the area during the analysis, but also present the intensity of shading and lighting over the next 10 hours.

The threat of noise in selected settlements has been presented on the basis of the location plan generated by means of a publicly available portal: http://observatorium.um.krakow.pl/ [27]. The colour differentiation signifies the different frequency of road noise expressed in db and thus indicates the areas most at risk of excessive noise.

3.2. The results of the analysis

The subject of the study – the estate of Dywizjonów 303 (Fig. 9), in Cracow – has been inhabited for years, therefore the analysis included the assessment (which was already emphasised) of the existing conditions, not planned. They are shaped by the building structure, and the area free from it, intended for interiors with a social character. The greenery accompanies the neighbourhood and public spaces, taking the form of squares and a park located on the north side. The balance of the greenery expressed by the ratio of built-up areas to the green spaces is very favourable. It has a beneficial effect on the microclimate as a barrier to excessive ventilation of the area and protects it against the road noise and pollution caused the transport. Therefore it contributes to the development of health-promoting conditions.

The structure of the building creates a free, open layout with objects of mixed scale from 4 to 11 storeys. This system determines the free air circulation. Due to the scale of the highest point-spaced objects, the insolation is limited (Fig. 10).

The diagrams show that most sunlit areas are those where the greatest distance between the objects is preserved. In these areas, shading lasts only an hour. Adjacent to them is the area, which shading does not exceed two or three hours.

The shading of the terrain is additionally introduced by the high greenery, the location of objects forming strings and elements co-creating their shape – balconies, roofed entrances to staircases.

Fig. 9. Dywizjon 303 housing estate, source: http://obserwatorium.um.krakow.pl/obserwatorium/ (access: 1.08.2018)

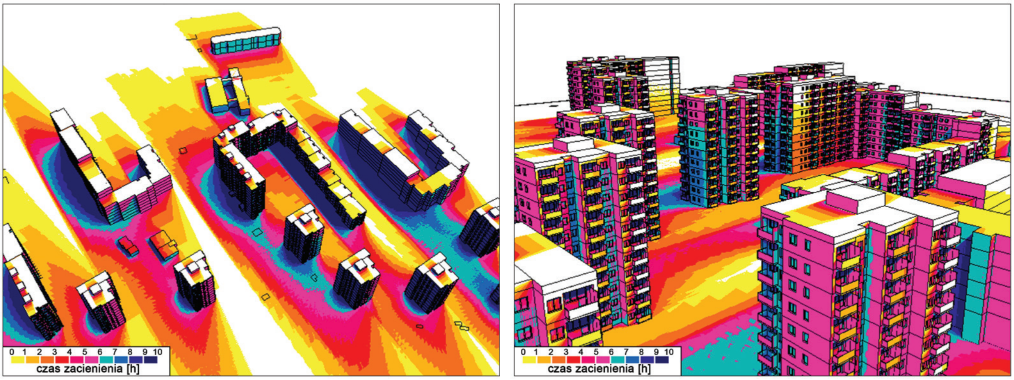

Fig. 10. Diagram of insolation of the Dywizjon 303 estate in Kraków, own study

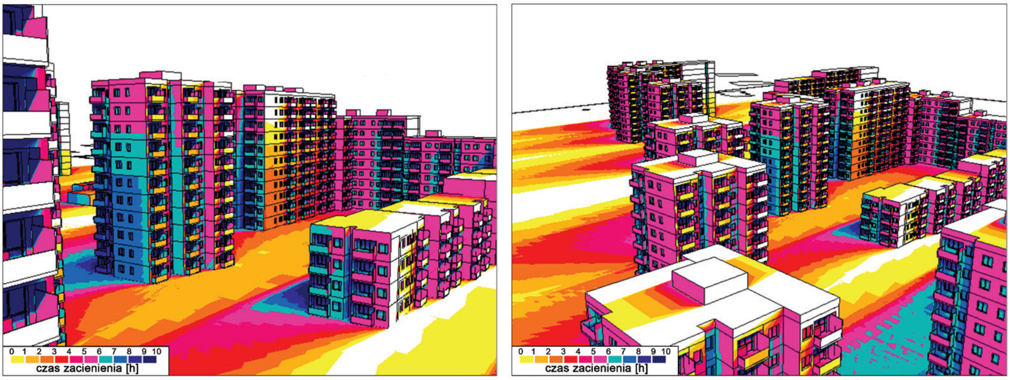

Fig. 11. Shading of the elevation

The façade surfaces from the side of the neighbouring objects are the most exposed to the limited availability of sunlight. The time of shading lasts 6–7 hours. The remaining fragments of the objects – their façades are mostly shaded for 5–6 hours.

The blocks themselves are characterised by a monotony of solutions devoid of individual features, which is typical for multi-family large-panel housing estates from the turn of the 70's and 80's of the 20th century. However, the estate can be assessed positively due to spatial and environmental conditions. The team has large reserves of free areas, which contributes to the formation of pro-health conditions, including maintaining the biodiversity of the space. Also, the harmonious inclusion of housing in the natural environment, and thus adaptation to the existing terrain is important in relation to sozology.

The biggest inconvenience of the housing estate is connected with the intensity of transport traffic (Fig. 12). It forced the application of acoustic insulation such as screens constituting a barrier for noise and vibrations as well as earth embankments. The chaotically arranged communication space inside the housing estate introduces conflicts in its spatial and functional layout. Noise pollution of 65÷70 decibels occurs in the space adjacent to the roads. However, inside the estate, this nuisance does not exist. The highest noise value amounts to 50÷55 decibels.

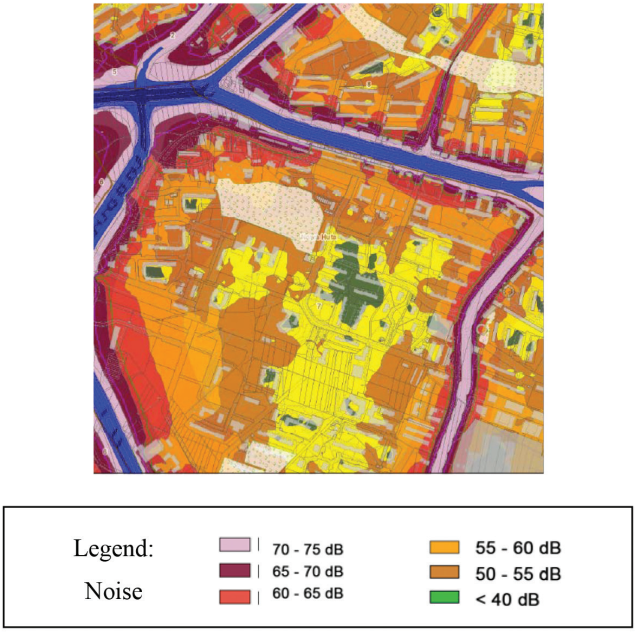

Fig. 12. Noise pollution in the Dywizjon 303 housing estate in Krakow [27]

The analysis offered an insight to the issue of urban sozology dealing with the relationship between the built and the natural environment in order to rationally plan housing areas with the emphasis on the role and importance of the areas constituting the resources of the natural environment. The analysis covered the problem of sun exposure and shading, ventilation and noise pollution. The analysis shows that there are close relationships between the natural environment and architecture, which can be shaped by adjusting to the existing climatic, location, and terrain conditions. The rational use of these dependencies may contribute to shaping appropriate housing conditions with pro--health features, indicating the need to care for the state of the natural environment (which is consistent with the planning sozology).

4. Final conclusions and remarks

The results of the analysis proved an important role of urban sozology in spatial planning, It includes the relationship between the built and the natural environment in order to rationally plan housing areas with the emphasis on the role and importance of the areas constituting the resources of the natural environment. The analysis covered the problem of sun exposure and shading, ventilation and noise pollution. The results show that there are close relationships between the natural environment and architecture, which can be shaped by adjusting to the existing climatic, location, and terrain conditions. The rational use of these dependencies may contribute to shaping appropriate housing conditions with pro-health features, indicating the need to care for the state of the natural environment (which is consistent with the planning sozology).

In recent years, more and more attention has been directed toward the natural environment. Hence, an urgent need to rediscover the principles of sozology, including urban sozology that allows rational planning of housing areas. The development of design assumptions is characterised by dynamic advances in technology and construction as well as in materials. It enables the pursuit of low-energy architecture, the increased use of renewable energy sources and the creation of friendly living conditions also in the field of urban solutions, as demonstrated by the housing estate selected for the research. The estate of Dywizjonu 303 is an example of implementation from the 70's and 80's. Despite the fact that the areas from that period are characterized by the low standards regarding finishing, architectural detail technological or even spatial solutions. These estates may be perceived positively due to their spatial conditions. They provide proximity to extensive green areas, free building systems, often with a friendly scale. The housing teams in question were the places where neighbours formed close relationships, and the social spaces lived their lives.

Although we return to the idea of the past period, it should be remembered that the lifestyle and the needs of contemporary people have changed. New trends in architecture and spatial planning, taking into account the priorities of planning sozology, try to deal with these issues. They should be regarded as recommendations for housing planning. They include pro-environmental activities, expressed in maintaining appropriate proportions between built-up and building-free areas; creating the possibility of access to open green areas and other assumptions that take into account natural elements. It should be noted that both water assumptions and greenery, apart from aesthetic and functional values, are important in maintaining an appropriate microclimate – air humidity and temperature, but most importantly, they contribute to reduction of air pollution. The walls of greenery used on the roads not only isolate against noise but also absorb pollution from traffic. When designing a residential area, it is necessary to take into account the scale of the building and its impact on the ventilation of the area and the microclimate of the interior of the buildings, especially on their top floors. The use of appropriate materials on the floor with appropriate roughness and colours enabling reflection or accumulation of radiation heat is also significant. It can, therefore, be assumed that new trends in architectural design that turn towards low-energy architecture using climatic factors and alternative energy sources such as solar radiation or wind energy.

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