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Conformation Factors of Building Bioclimatic Microclimate

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Abstract This article examines microclimate formation in low-rise urban dwellings and courtyard spaces, focusing on bioclimatic building design in southern Kazakhstan. The article considers various factors, including climate, natural conditions, social and economic considerations, and energy and environmental factors. The use of local resources and "folk architecture" principles are also explored, drawing on experiences from other world regions. The article recognizes the impact of climatic characteristics on building design. It proposes an architectural and planning structure for bioclimatic residential buildings based on factors such as building height, degree of openness, and green space placement. Bioclimatic buildings are designed based on the climatic features of the region and are classified into "northern," "southern," and "moderate types." In southern Kazakhstan, which has a sharply continental climate, "moderate types" of bioclimatic buildings are used. These buildings have a mixed bio-environment to protect against high and low summer temperatures in winter. Both overheating and cooling of the building are given equal attention. Carefully planning yard areas and facade orientation can achieve optimal microclimates in mixed-structure dwellings. This can be achieved through kinetic openings, rotating modules, energy-efficient materials, and renewable energy sources such as solar systems, heat pumps, and wind turbines. The building envelope can respond to external climatic changes, regulate the indoor microclimate, and offer opportunities for the transportability of ceilings, facades, and buildings. It is recommended to install different building operation modes depending on changing settings, such as open, half-open, and closed.

Keywords Bioclimatic Architecture, Bioclimatic Buildings, Building Bioenvironment Structure

1. Introduction

The quality of human life depends on the surrounding living space, a potential resource to form a comfortable artificial habitat in the natural environment. Recognition for the local ecosystem, following the principles of sustainable development, maximizing the use of climatic resources, and improving the environmental situation by conserving natural resources, restoring disturbed areas, replenishing lost green spaces, recycling household waste, and other requirements highlight a new direction in architecture - bioclimatic.

Research on the influence of climatic parameters and the development of techniques and requirements for urban planning and design solutions is one of the essential tasks of an architect.

Considering the climate-forming factors of the area, which create natural and climatic conditions in different climatic regions, creates the need for protection measures from low negative temperatures, wind protection, sun protection, and others.

The formation of architectural and planning solutions for bioclimatic buildings is influenced by natural climatic conditions and social, economic, environmental, energy, and urban factors.

The criteria for the optimality of the design and planning solution of urban development and its climate are:

- Comfortable bioclimatic conditions for a person to stay in an urban and residential environment, which are provided by appropriate buildings and land improvement facilities.
- Expansion of positive influences, weather conditions, and limitation of negative impacts on a person staying outside the building.
- Reduce the cost of optimizing the temperature regime of buildings. The aeration regime of development affects a person's life and environment, affecting all the primary levels of the planning structure of the city (district, micro district-quarter, residential building group, home ownership). Landscaping is a system of components included in this environment with independent functions for each level of the planning structure. The stages of the aeration regime in the development of urban planning documentation and the urban planning structure correspond to the levels of the urban planning structure [1].

The bioclimatic design concept assumes knowledge of human physiology, climatology, and constructional physics, which provides favorable microclimatic conditions for a person in the architectural design process. Next, improving indoor air quality is accompanied by reduced operating costs and an increase in the competitiveness of the building [2,3].

This study considered the following points:

(a) Annual variation of climatic elements.
(b) Evaluation of the wind regime of the area.
(c) Assessment of the sides of the horizon.
(d) Architectural and technical means of microclimate regulation in buildings and the external environment.

2. Methodology

Bioclimatic concepts in vernacular architecture have been developed and used by many worldwide civilizations over the centuries.

Architects have used many different architectural approaches and a range of techniques to mitigate the effects of the climate.

These approaches have the potential to be further developed and can be adapted to meet current needs.

This study examined and proposed methods and tools for various regions of the world.

The principles of bioclimatic building construction are given:

- **Sustainability:** waste disposal is not to harm the environment, limiting non-renewable energy sources, using recyclable and reusable materials, and preference for local materials [4].
- **Adaptation:** Orientation choice of plasticity of the façade, shape, and building plan, depending on the area's relief, the wind rises, and other natural resources. Optimal energy source selection, considering regional characteristics (climate, landscape, energy supply, and others).
- **Conservation and replenishment:** The total area of green spaces in the construction area should be greater than the lost green area during construction: a winter garden, green atriums, green balconies and loggias, exploited roofs, etc. [5,6].
- **Interconnection:** The building is connected with the urban infrastructure and impacts the environment, smoothly transferring the street or courtyard into the building: the building is part of the environment in which it is located [7].
- **Energy independence:** Minimum centralized external energy systems and maximum devices based on alternative energy sources: selection of the energy system based on local natural conditions and the availability of central energy systems and gas supply.
- **Autonomy:** Independence from external networks of electricity and heat supply, water supply, and treatment facilities, compact forms with a vast body that retains heat.
- **Organicity:** The house operates according to the same cycles and rules as the natural environment (bio-similarity), and waste recycling processes are implemented in a closed cycle [8,9].

The authors examined the evolution of the forms of people's housing in different countries, demonstrating their stability and connection with nature. Historical prototypes of bioclimatic buildings are considered (examples of the architecture of Le Corbusier, Wright, Niemeyer, and other architects), adherents of "green architecture" [10,11]. The proposed "Architectural Evaluation System", based on the data from the "Mini Metrological Station" [3,12], can be adapted to different regions.

A bioclimatic approach in urban architecture can improve the urban thermal comfort of pedestrians during hot and dry periods by integrating urban elements, vegetation, materials, orientations, etc. Moreover, it can help in forming a new quality of a comfortable urban environment, combining engineering infrastructure, and both elements of the Smart City concept, including environmental parameters and microclimate indicators of individual urban development areas [13-19], [20-24]. Integration contributes to the activation of air movement in urban space and lowers the temperature, regulating humidity and solar radiation. Outdoor comfort means that a fresh microclimate and a comfortable ambient temperature directly affect the energy consumption of buildings. For dry regions, it is desirable to increase the movement of fresh air by increasing green spaces in and around urban areas.

The study results show that passive solar technologies can provide a comfortable indoor thermal environment, regardless of external climatic conditions [25-29]. This showed not only the importance of the thermal inertia of the building in reducing indoor temperature fluctuations but also the role of the courtyard in significantly reducing the air temperature outside the building. It is possible to use exploited roofs, which should exceed the lost landscaping areas in urban areas. The impact on the environment must be minimized, and all measures for operating dwellings, ensuring comfort, and sorting and recycling waste must be considered. For the southern regions, the task is to limit the use of non-renewable sources, where the energy carrier is a hydrocarbon fuel, and use all the light and heat resources of the climate and weather to make the most of autonomous systems and technical devices based on alternative energy sources that provide buildings with heat and electricity. Recyclable and reusable materials must be used. When choosing a material, preference should be given to local materials.

The structural details of the building should provide easy disposal and sorting of waste materials at the end of the building's life so that they can be reused. Municipal solid waste must be disposed of. The erected building impacts the environment, as there are changes in the speed and direction of air flows and shading of other buildings and the site. Based on a detailed consideration of bioclimatic buildings in different climatic zones, their corresponding classification models were developed according to climatic characteristics.

(a) A closed volumetric-spatial structure characterizes the "northern type" of the bioclimatic building. The biosystem in the building is closed, that is, in the form of landscaped internal atrium spaces and winter gardens from the environment.
(b) The "southern type" of the bioclimatic building has an open biosystem. Plants located on the facade of the building serve as a natural screen for protection from the sun and hot air currents.
(c) A composite structure of the bioenvironment of the building characterizes the "moderate type" of a bioclimatic building. The building is exposed to low temperatures in winter and high temperatures in summer, so equal attention is paid to protection against cooling and overheating.

The urban area is divided into high temperatures associated with anthropogenic technogenic influence, known as the "urban heat island", and affects the deterioration of the aeration regime [30].

In the study of the renovation project of the living area, the authors proposed considering a bioclimatic indicator - the environmental heat load index (THC-index)- measured using a black ball thermometer [31,32].

To increase air humidity, decorative pools and fountains are placed on the airflow paths, which increases humidity by 6-12% and reduces air temperature by 3-5 degrees. Continuous water curtains in the form of fountains and waterfalls reduce air temperature by 8 degrees and increase humidity by 40% [33,34]. Ventilation issues are essential.

Natural ventilation: The aim is to promote air circulation within the building to increase well-being and thermal comfort, which is helpful in cooling overnight in hot climates. At the same time, there is no security reduction as intruders are prevented from gaining access [35,36].

Calculations of radiation temperatures and field studies show that the surface-ground provides the main "contribution" to the resulting radiation temperature from the surrounding surfaces (42÷46%), regardless of the height of the yard building [37,38].

The surfaces of water increase the humidity of the air. Such zones are good in hot dry climates, while in humid climates, they can be a source of problems. In hot climates, their cooling effect must be maximized through a strategic design. This does not allow the cooled air to dissipate. It is directed toward the living areas. In addition to landscape architecture, water can be widely represented in the city as fountains, pools, cascades, ponds, and cooling towers. Plants are sites where winds cause humidity through evaporation, which cools the space. They also provide moisture through natural evaporation (cooling mechanisms through evaporation in the wind), thus creating internal and external comfort and lowering the air temperature of the outdoor space and the surrounding building [39,40].

To generate information about the existing planning structure of the development areas, which affects the characteristics of the improvement components, the information system with consideration to:

- Administrative-territorial levels of urban planning.

Types of territories to be developed (home ownership, development group, block).

- Indicators of the aeration regime:
  (a) Total stagnant zone.
  (b) Total comfort zone.
  (c) Weighted average wind speed.
  (d) Total discomfort zone.

To organize the urban planning process, the following formal planning actions of a specialist urban planner are proposed, combined into nine consecutive blocks:

Urban planning decisions consider the following:

Meteorological indicators of the cold and warm seasons of the construction area are illustrated in (Table 1), showing:

- Wind data (wind speed and the most recurring wind directions by season in open space at 10 m (Tables 3,4,5) regarding the relief of the surrounding area.
- Geometric parameters of the building (number of floors, width of roads and streets, boundaries of residential development, and areas within these boundaries).
- Data for the wind zoning (cumulative stagnant, uncomfortable, and comfortable zones for summer and winter).

Table 1. Climatic parameters of Almaty

Air temperature ºC										
	Cold season						**Warm period of the year**			
	Absolute minimum	The temperature of the coldest day confidence		The temperature of the coldest five-day period		Confidence 0.94	Average maximum of the warmest month of the year (July)	Absolute Maximum	Average monthly relative air humidity at 15:00 in the warmest month (July), %	Average amount (sum) of precipitation in April -October, mm
		0,98	0,92	0,98	0,92					
Almaty	-37.7	-26.9	-23.4	-23.3	-20.1	-8.1	30.0	43.4	36	429

According to the analysis of the wind impact on urban areas, at the intersection of seasonal aggregate stagnant and uncomfortable zones, the designer must offer significant compensation measures with landscaping elements (recreation areas, sports and playgrounds, landscaping, and small architectural forms).

In the long term, it is necessary to encourage the sustainable development of the built environment, which helps to solve the problems associated with the depletion of energy resources and environmental degradation [41].

All objects of the urban area affect the microlevel (up to 3 m) of the environment and thus form different levels of the aeration regime while experiencing the opposite effect in the form of wind load at these levels [42].

Elements of dense urban development increase turbulence and reduce the speed of air flows by an average of 5–25%. All groups of components of land improvement are significant for residential development. When assessing the impact of landscaping (elements of the active surface) and other urban planning factors on a person's comfortable thermal well-being, it is essential to determine the lowest voltage of the thermoregulatory apparatus, corresponding to thermal comfort. The components of the improvement system are divided according to the time of stay into those that residents quickly pass through or do not stay there for a long time and those for which assessment of the aeration regime is necessary. The short-term places of human stay are footpaths and driveways. The list of assessed components of the landscaping system included a quiet recreation area, a playground, a sports ground, a dog walking area, a household area (for cleaning carpets and a garbage bin), a micro-district garden (a territory of green spaces), a vehicle storage area, a separate pedestrian path, a pedestrian path associated with a road, and a stopping point for public transport. The statistics of a person's stay in the territory [43] were divided into the following components: the duration of a person's stay, the physical activity of a person, and the age groups of the population.

The energy and environmental design standards are improving daily, flexible enough, and continuously changing. The designers are the first to introduce the inputs into the system to improve it. The overall city should be planned as a socio-natural hybrid system. The LEED program has been developed in the USA since 1998. It has been adopted in almost forty countries, and the public widely uses it. The LEED standards are based on reducing overall impact rather than on a specific issue or topic, trying to be as green as possible. Reliance on outside sources (programs and standards) is also vital to expand the area of expertise and the variety of topics. The green city should be well planned and well documented from the early design stage, reducing costs, and synchronizing the work of different systems within the building. The LEED standards involve the environmental, economic, and social impact; regardless, at this point, the standards are socially neutral. The city planned according to LEED standards is a socio-neutral hybrid [44].

In the future, measures are needed to compensate for the lack of climate information and the creation of additional meteorological centers (as a Mini-meteorological station for the "Architectural Assessment System" [10]. Detailed data are needed to be obtained due to monitoring weather data in different parts of the city and at different heights (minimum: at height - 3m, 6m, 10m. The development of this study of architectural design will be possible with additional energy and environmental factors. Bioclimatic architecture is still fascinating to all of us. The lack of energy that the world is facing today is forcing architects and engineers to implement smart solutions that benefit the maximum from nature itself without considering the primary sources of energy that the world is using. Bioclimatic design has roots in history despite little attention being paid to it throughout history. It is essential to understand how natural systems operate, creating closed or semi-closed systems that mirror the ecological systems on Earth [45].

Regulation of the microclimate that makes it closer to comfortable conditions for human heat sensations is possible only in the seasonal consideration of the initial data using building density, types of enclosing surfaces of buildings and structures, types of road surfaces and sites, and landscaping. The impact of the improvement components on the microclimate of the territory and sanitary and hygienic conditions is different. Three groups are distinguished: constructions of small architectural forms. Covering driveways and pedestrian connections produces intense thermal radiation, which harms humans and the soil, affects the temperature in summer, and creates a feeling of emptiness in a person. The components of the second group improve the microclimate by changing the radiation regime of the territory. This occurs due to the absorption and use of solar radiation for biological processes in plants, with the evaporation of moisture and a decrease in air temperature (on average by 3–4 ℃) and on the surface (by 8–12 ℃) [2,46-50].

The objectives of the study when considering the aeration of a residential area are to the comfort of the living environment of the adjacent territory, which is part of the socially guaranteed quality of development and improvement, including the development of an information system for generating data by monitoring the state of the aeration regime in the existing territories.

The system for collecting and processing information about the aeration regime of residential development in the current situation and the design one serves as the basis for monitoring, effectively complementing existing systems, and providing a full-fledged urban planning process. Detailed information is needed to justify the content of projects at each level of urban development planning.

Like the draft Russian Bioclimatic Standard, it is possible to develop an evaluation table for bioclimatic buildings for Kazakhstan and sustainable architecture (Table 2) [2].

Table 2. Evaluation criteria for bioclimatic buildings and sustainable architecture

Not classified	Bronze Certificate	Silver Certificate	Gold Certificate
Less than 25 points	25-52 points	52-72 points	72 or more points

These studies provide the influence of the climatic characteristics of the construction area, which is conducted according to existing statistical complex and factor-by-factor analytical methods, and calculation and graphic research methods are used. Materials for construction areas are taken from regulatory documents containing statistically processed and averaged data on climatic indicators for more than 25 years.

3. Results

Analysis and assessment of external climatic conditions for the architectural design are performed according to the Litskevich method [20]. Bioclimatic buildings of low-rise buildings, cottages, and villages within the boundaries of the metropolis can be in green or residential areas (such as quarters "Valley of Roses", "Khan Tengri", etc. in the Almaty region), etc.

Natural and climatic conditions (primary data)

Construction area - Almaty city, Almaty region.

The climate is sharply continental, and winters are cold, with high winds and frosts, whereas summer is hot and dry, with low air humidity and low pressure.

The influence of mountain-valley circulation distinguishes the climate of Almaty. It is considered continental, especially in the northern part of the city, located in the transition zone of mountain slopes to the plain. The average temperature in the city is on average 10 ℃. One of the cold months (January) is -10 ℃, and one of the warm months (July) is 30 ℃.

Basically, on October 14, frosts begin, and on April 18, they end.

From December 19 to February 23, more regular frosts last for about 70 days. There is an average of 36 days per year with temperatures above 30 ℃. In the center of Almaty, like most megacities, there is a "heat island" - the temperature contrast between the southern and northern districts of the city is 3.8% and 0.8 ℃ on one of the coldest days, as well as 2.2% and 2. 6 ℃ on the hottest. Based on this, frosts in the center of Almaty start seven days later and end three days earlier than in the northern regions.

In the conditions of southern Kazakhstan, where the climate is sharply continental, "moderate types" of bioclimatic building are characteristic. The structure of the bio-environment of the building is mixed since the building is exposed to high temperatures in summer and low temperatures in winter. Therefore, equal attention is paid to protection against overheating and cooling of the building.

According to the results of the study of climatic data in the following paragraphs: a, b, c, d, we present graphs of changes in temperature, humidity, and solar radiation (Table 3, Figure 1) in the direction and speed of the wind (Tables 4,5, Figures 2,3), a general assessment of weather conditions (Table 6), an assessment of the sides of the horizon (Figure 4) and recommendations for planning architectural solutions and regulatory measures are given in (Table 7), showing the annual variation of climatic elements.

Table 3. Climate data of Almaty by months

Parameters	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Average air temperature (^{0}C)	-6,5	-5,1	1,8	10,5	16,2	20,6	23,3	22,3	16,9	9,5	0,8	-4,8
Relative humidity (%)	74	74	72	59	56	50	45	44	46	56	71	73
Solar radiation (W/m ^{2})	176	239	354	484	632	678	729	647	497	321	197	136

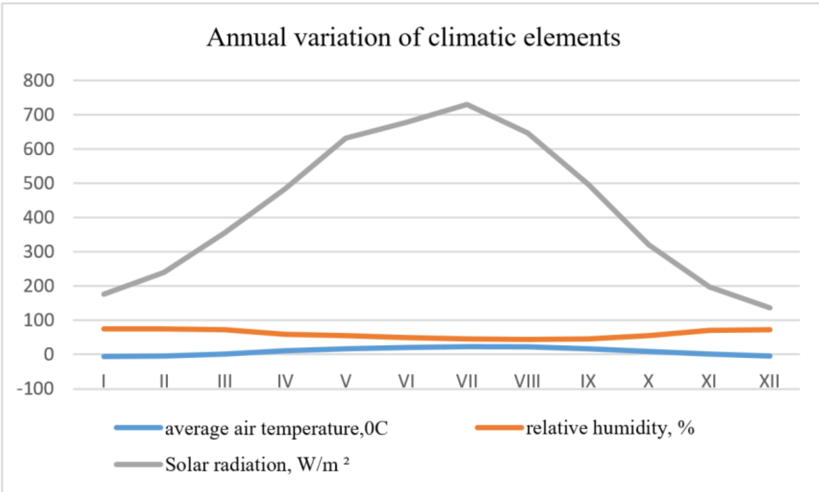

Figure 1. Annual variation of climatic elements

Table 4. Wind frequency and speed indicators for January

	N	NE	E	SE	S	SW	W	NW
Wind frequency %	9	12	7	23	16	20	7	6
Speed m/s	1,4	1,5	1,4	1,8	1,8	1,9	1,7	1,3

Table 5. Indicators of frequency and wind speed for July

	N	NE	E	SE	S	SW	W	NW
Wind frequency, %	5	11	6	45	17	8	4	4
Speed, m/s	1,9	2	1,6	2,8	2,8	1,4	2,2	1,9

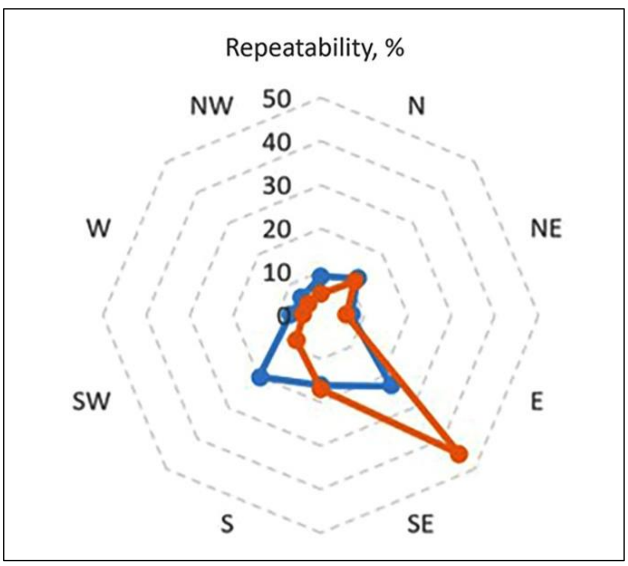

Figure 2. The wind rose chart by frequency for January and July

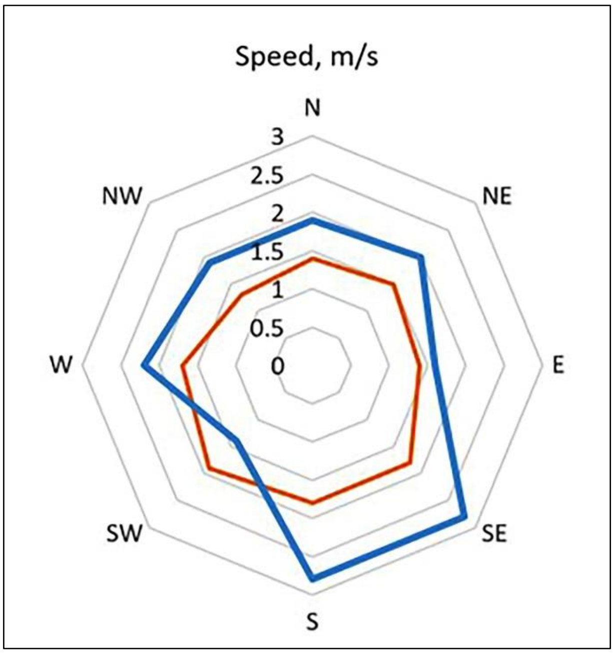

Figure 3. The graph of the wind rose by speed for January and July

The highest solar radiation value is in July; this month has the highest temperature and the lowest relative humidity value. These combinations of climate data exacerbate the discomfort, as did the combinations in January. It should be noted that, in this case, average statistical values were used. However, in individual years, these combinations can give a temperature of +38, relative humidity of 30%, and a value of solar radiation - 900 W/m^2 in summer or winter - temperature minus 380 C, 100% humidity, and 100 W/m^2 solar radiation. The physical well-being of people will be significantly reduced during these periods of the year, and planning, architectural, engineering, and technical, regulatory measures are needed, which will be discussed further.

(a) Assessment of the wind regime of the area:

The comfortable aeration mode provides ventilation of the territories necessary to remove pollutants from its airspace. Ventilating buildings involves considering the wind regime of the area, which includes analyzing the speed and frequency of wind in different directions.

Frequent repetition is typical for the southeast direction, where the wind speed is less than 3 m/s.

In conditions of low wind speeds, buildings are placed at an angle of 45 °to the direction of a favorable wind since the size of the wind shadow is sharply reduced with such a setting of the building. When the wind is directed along the facades of buildings, the initial wind speed does not decrease, and zones of increased wind speeds are formed near the windward ends. In this case, the wind speed is significantly reduced in some areas in the city center, and special building techniques are required to regulate the aeration regime effectively. In the studied areas, where low-rise buildings are provided, and there are no large shielding buildings, the wind speed does not significantly decrease, and the natural aeration of the building is not disturbed.

Thus, in the city master plan, planning projects, and development projects, environmental factors are considered in two aspects, which are:

(b) Creating comfortable conditions for the life of people in the city.

(c) Regulation of the state, protection, and ecological safety of the environment.

Based on the results obtained for dense and high-rise areas, it can be concluded that there are zones with low wind speeds in which harmful substances and chemically active dust can accumulate. Based on the assessment of the aerodynamic comfort of urban areas, it is possible to conclude the quality of the proposed design solution and, if necessary, take measures to optimize it by designing the appropriate placement of green spaces and/or wind protection structures.

An important grade is the climatic assessment of the sides of the horizon (diagrams in Fig. 2-4) regarding wind regime and solar radiation.

(d) Climate assessment of horizon sides

Assessment of the sides of the horizon by a complex of climatic factors

Assessment of the sides of the horizon: there are no critical climatically unfavorable sides, but for architectural design, it is necessary to highlight the increased solar radiation and the likelihood of overheating from the west and southwest, the undesirability of the northern orientation of the facades due to insufficient insolation and the likelihood of non-compliance with the norms for ensuring insolation in residential premises.

A general assessment of weather conditions (Table 6) will assist you in choosing the main modes of building operation. There is a general assessment of weather conditions and selection of the primary mode of operation of buildings.

Depending on changing weather conditions, it is recommended to vary several modes of operation of buildings: open, semi-open, and closed (Table 7).

(e) Architectural and technical means of microclimate regulation in buildings and the external environment.

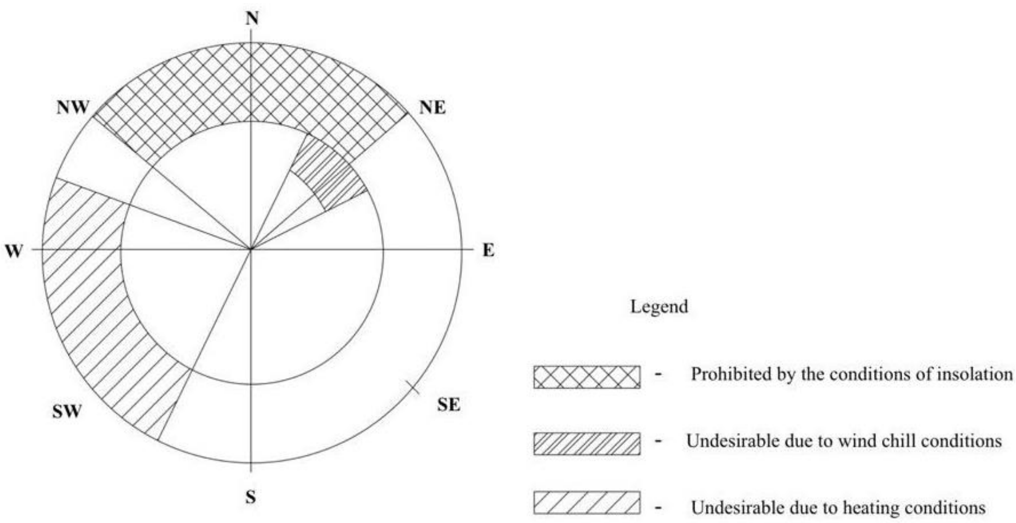

Figure 4. Climate assessment of the sides of the horizon [2]

Table 6. Assessment of weather conditions in Almaty

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Weather type	cold	cold	cold	chill	comfortable	comfortable	comfortable	comfortable	comfortable	chill	cold	cold

Table 7. Architectural and technical means of microclimate regulation in buildings and the external environment

Mode of operation and type of weather	Architectural and planning means	Structural means	Engineering means
Open, comfortable	Open spaces, loggias, verandas. Organization of household processes in the air. A pavilion in which the concepts of internal and external spaces were blurred. The house fits in nature, dissolving in the surroundings. The walls here are presented as sliding partitions, the position of which changes depending on weather conditions. Mobile partitions made it possible not only to erase the boundaries between internal and external spaces but also to carry out the necessary natural ventilation of the premises under high humidity conditions.	Fencing transformation	Not used
Semi-open, cool	Orientation of residential premises to the sunny side of the horizon, protection of the territory by a wind protection device from green spaces, use of intermedium.	Single glazing, fence transformation	Low power heating, irregular. Natural ventilation device, exhaust with inflow through valves and vents.
Closed, cold	Compact solutions, heat loss reduction due to warm staircases and vestibules, and orientation of the premises to the sunny side. Protection of the territory from the wind due to nearby buildings, green spaces (mainly coniferous trees)	Fences with the necessary thermal insulation qualities and air permeability	Central heating medium power.

The architectural and planning concept of the facility was chosen to consider the weather conditions (cold and comfortable), collect all the necessary compensation, and neutralize the negative impact of many climatic factors; design, engineering, and technological requirements were applied according to the type of operation mode.

4. Discussion

The research results on the analysis of climatic conditions are relevant and will be in demand for the design of bioclimatic buildings. The features of this analysis of bioclimatic architecture factors are that they can exist not only in the southern region of Kazakhstan but also in the middle zone and the eastern and western regions.

For architectural design, a comprehensive assessment of the sides of the horizon reveals favorable and unfavorable sides and determines the necessary measures to regulate the building microclimate. When applying research data, it is possible to encounter difficulties in differentiating data on meteorological indicators (statistical and experimental or of any other kind) of various parts of urban areas. Currently, there is insufficient climatic data (Tables 1,2,3) for individual climates (center and outskirts) of a large metropolis and small settlements around the city, where bioclimatic architecture is possible on a broader scale. This limits the applicability of the proposed methods.

5. Conclusions

In the considered region, the concept of a bioclimatic building with a mixed bioenvironment structure will be in great demand. As a result of the study, recommendations are given on consideration of environmental factors:

a) Considering the minimum and maximum temperatures, measures are given to isolate buildings from cooling and overheating, which are typical for this region.
b) Considering the frequency and wind speed, plan the development of bioclimatic buildings with an effective aeration regime.
c) Considering the assessment of the sides of the horizon.
d) To regulate the microclimate's state and the environment's ecological safety.

Optimal microclimate conditions in mixed-structure dwellings can be created through optimal planning of yard areas and rational orientation of facades, which can be kinetic /use of kinetic-opening, closing sectors, rotating modules/choice of materials /energy-efficient, natural, environmentally friendly, and recyclable/energy supply of the dwelling /using active and passive solar systems, heat pumps and wind turbines/. For the shell of the building, the principle of a living shell, which can respond to climatic changes in the external environment and regulate the microclimate inside the premises, and the principle of the constructor, which can provide opportunities for the transformability of floors, facades, and individual modules of the building.

Engineering and technological solutions in combination with structural and architectural-spatial solutions to ensure air-thermal comfort of ventilation and humidification: the use of green roofs and facades to reduce the heating of structures and premises, lawns and trees to absorb solar radiation, facade systems, sun blinds, the use landscaped courtyards, atrium spaces for ventilation and cooling of the building, the use of landscaping on balconies, winter gardens to scatter sunlight and humidify the air, will provide bioclimatic comfort.

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