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Monthly Change of Some Climate Parameters and Biocomfort Status in Ordu Province

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Abstract

Biocomfort, which is shaped depending on the suitability of climate parameters, is an important criterion that affects people's comfort, peace, happiness and performance, as well as their health. Therefore, determining suitable areas in terms of biocomfort and using them as a base in the planning of residential areas is of great importance in terms of both human health and happiness and energy efficiency. In this study, suitable areas in terms of wind, temperature, relative humidity and biocomfort, which shape the biocomfort situation in Ordu, which is one of the largest cities in Turkey and whose population is constantly increasing, were determined on a monthly basis. As a result of the study, it has been determined that the wind speed, temperature and relative humidity parameters that are the subject of the study prevent the formation of biocomfort areas to a large extent. While the wind speed causes the formation of uncomfortable areas in January, February, March, April, October, November and December, there are areas where the temperature is below 15 °C in many months, and high humidity causes the formation of uncomfortable areas every month. Suitable areas in terms of biocomfort account for 0.4% of the surface area of Ordu in May, 1.36% in June, 1.45% in July, 1.77% in August, and 8.06% in September. In January, February, March, April, November and December, the entire province is within the scope of uncomfortable areas.

Keywords: Army; climate; biocomfort

1. Introduction

"Climate", which affects and shapes almost the whole life of people, is briefly defined as "average weather conditions in a large region, which remains the same over a long period of time" (Zeren Çetin and Şevik, 2020). Climate affects human life directly or indirectly in many different ways (Doğan et al., 2022). Because humans are warm-blooded creatures and they have to keep their body temperature within a certain range regardless of the ambient temperature (Dündar, 2015). The human body, which is a homeothermic creature, needs to be kept at an almost constant temperature in order to maintain its vital functions. This balance is mostly provided by clothes and buildings and air conditioning systems that minimize the effects of the external environment (Aker, 2016).

The suitability of the climatic conditions in the environment is called biocomfort or bioclimatic comfort in short (Adıgüzel et al., 2020). Biocomfort is also defined as the conditions in which a person can adapt to his environment by spending the least amount of energy, that is, the most appropriate value ranges in terms of body temperature (Çetin et al., 2010; Tağıl and Ersayın, 2015; Cantürk and Kulaç, 2021; Koç, 2022a; Koç, 2022b; Değerli and Çetin 2022a; Değerli and Çetin 2022b; Çevik Değerli and Çetin, 2023). Providing thermal comfort conditions in which people can feel comfortable, first of all, people can work efficiently, peace of mind and comfort with health (Kılıçoğlu et al., 2021; Zeren Çetin et al., 2023a; Zeren Çetin et al., 2023b).

Biocomfort also has a great impact and importance on energy consumption. While the building sector constitutes one third of the total energy consumption, a large part of this consumption is consumed by the heating, cooling and ventilation systems in the building (Aker, 2016). Therefore, climatic conditions have a great impact on energy consumption. It is estimated that worldwide energy consumption will increase by approximately 60% by 2030. This situation will cause the pressure on limited natural resources to increase even more (Bulut, 2018; Elhadar, 2020).

The increase in energy demand increases the use of natural resources and fossil fuels, and the increased use of fossil fuels brings with it many problems such as the increase in greenhouse effect, global climate change, and increase in air pollution (Şevik et al., 2019; Yayla et al., 2022; Kuzmina et al., 2023). Studies show that the highest level of air pollution in urban centers is reached during the winter months when the need for heating is at its highest (Elsunousi et al., 2021).

As a result, biocomfort is of great importance both in terms of people's comfort, peace, comfort and health, and in terms of energy efficiency, and therefore, urban settlements should be established in areas suitable for biocomfort. In this study, suitable areas in terms of biocomfort in Ordu, which is one of the biggest cities of Turkey and whose population is constantly increasing, were determined on a monthly basis.

2. Methodology

The study was carried out in Ordu, one of the largest cities in Turkey. Ordu province is located in the Eastern Black Sea Region in Turkey. To the north is the Black Sea. According to Greenwich, the city center is located between the 37° and 38° east meridians and the 41° north parallel. (URL-1, 2022).

Within the scope of the study, it is aimed to determine and compare some climatic parameters and bioclimatic comfort areas in Ordu province based on monthly and annual average data. For this purpose, wind speed, humidity and temperature data obtained from the meteorology station were processed on Arc GIS 10.5 software. Then, using the "Inverse Distance Weighted (IDW)" command in Arc map 10.5 software, climate maps were created with the Interpolation method.

Inverse Distance Weighted (IDW) technique is one of the most preferred techniques among interpolation and map generation methods. It is an interpolation technique used to determine the cell values of unsampled points with the help of the values of known sample points. The cell value is calculated by considering various points moving away from the relevant cell and depending on the increase in the distance. The predicted values are a function of the distance and size of the neighboring points, and as the distance increases, the importance and effect on the cell to be estimated decreases. The formula used in the calculations is given in Eq. (1) (Taylan and Damçayırı, 2016; Çetin et al., 2018; Çetin et al., 2023a; Çetin et al., 2023b).

$$z(x_0) = \frac{\sum_{i=1}^{n} z\,(x_i)\, d_{i0}^{-r}}{\sum_{i=1}^{n} d_{i0}^{-r}} \tag{1}$$

The location X_0 from which the estimations are made is a function of neighbor measurements n ($z(X_{0i})$ and i=1, 2, …, n); r is the exponent determining the assigned range of each of the observations, and d is the distance separating the observation location X_i from the prediction location X_0. The larger the exponent, the smaller the assigned weight of observations far from the forecast location. Increasing the exponent indicates that the estimates are very similar to the closest observations. The mathematical formulas were as described above, and the maps were produced in the ArcGIS environment, which is a GIS software. This method has been used in different studies before (Setianto et al., 2013; Qu et al., 2019; Golla et al., 2019).

Then, the climate maps were reclassified by using the Reclassify command in Arc map 10.5 software of the obtained climate maps for the production of the biocore map. Comfortable areas were determined by using the index formula on the classified climate maps obtained. As a biocomfort index, Çetin et al. (2020) is based on the index used. According to this index, a region is considered comfortable if the temperature is between 15-27 °C, the relative humidity is between 30-70% and the wind speed is below 5 m/s (Çetin et al., 2020).

Within the scope of the study, firstly topographic maps were created for Ordu and the land elevation classes map, aspect map and slope map of the province were created. These maps are intended to be used when interpreting climate data and biocomfort maps. Then, the wind speed map, humidity map, temperature map and precipitation map were created for the province in general and the appropriate areas in terms of biocomfort were determined using climate data and interpreted by transferring them to maps.

3. Results

Within the scope of the study, some climate data for Ordu and the biocomfort status depending on these data were evaluated on a monthly basis, and some topographic features were also determined in order to contribute to the interpretation of the change in climate data and biocomfort status. In this context, the land elevation classes map for Ordu is given in Figure 1.

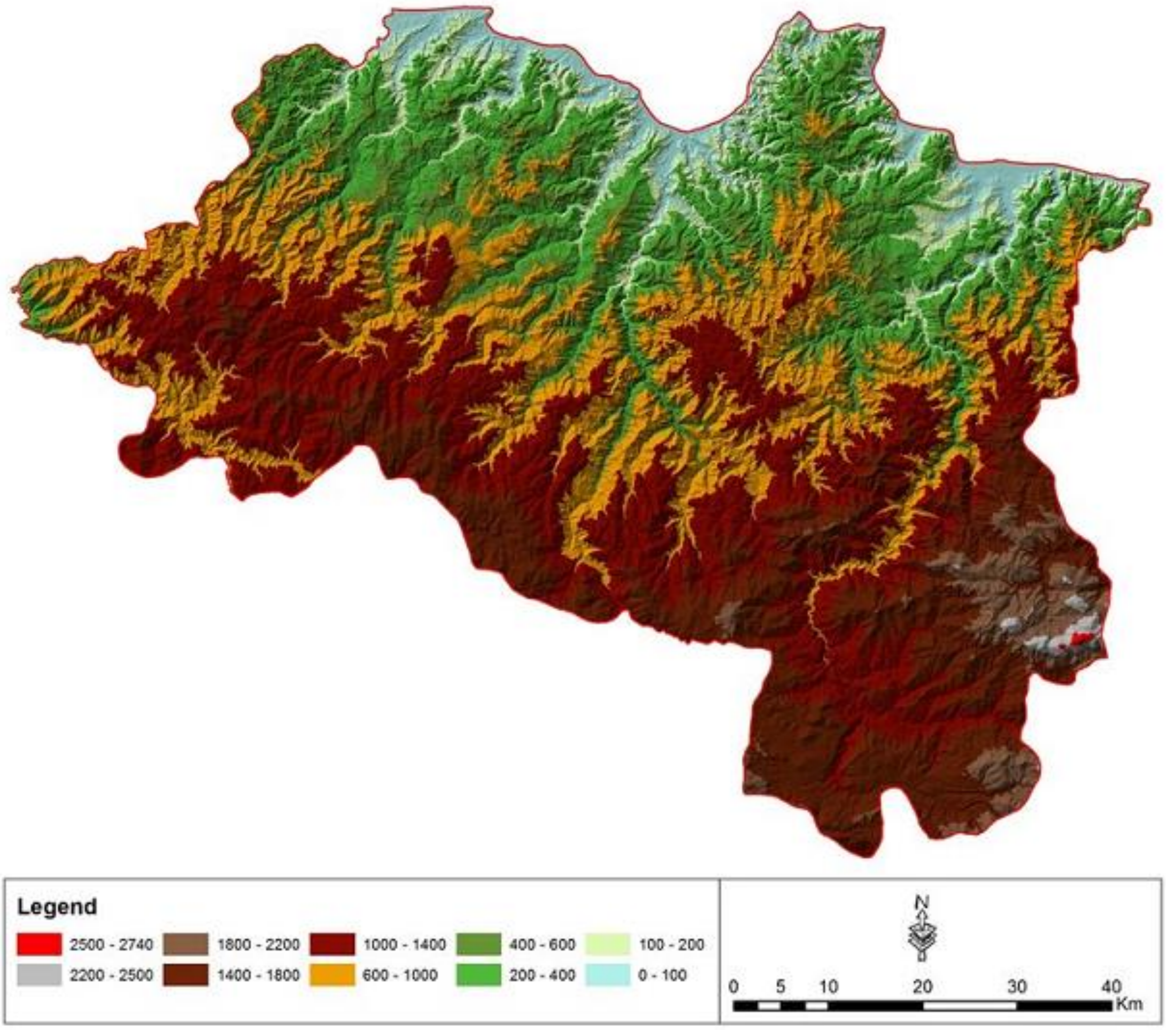

Figure 1. Ordu land elevation classes map

When the Ordu elevation classes map is examined, it is seen that the elevation of the southeastern parts of the province is quite high, and the elevation generally increases from the north to the south of the province. As you move away from the Black Sea in the north of the province, the altitude increases rapidly and reaches 1400 m above sea level, and even over 2500 m in the southeast of the province.

According to the calculations, approximately 4.16% of Ordu province is below 100 m, 5.38% of it has an altitude of 100-200 m, while 3.37% is at 1800-2200 m and 0.45% is at 2200 m. Apart from this, approximately 12,47% of the provincial area is 200-400 m, 11.82% is 400-600 m, 21.98% is 600-1000 m, 24.46% is 1000-1400 m and % 15.91 of them consist of areas with an altitude of 1400-1800 m.

As a result of the evaluations based on long-term meteorological data for Ordu, the wind speed, precipitation, temperature and humidity maps were prepared on a monthly basis and the monthly variation map of the wind speed is given in Figure 2.

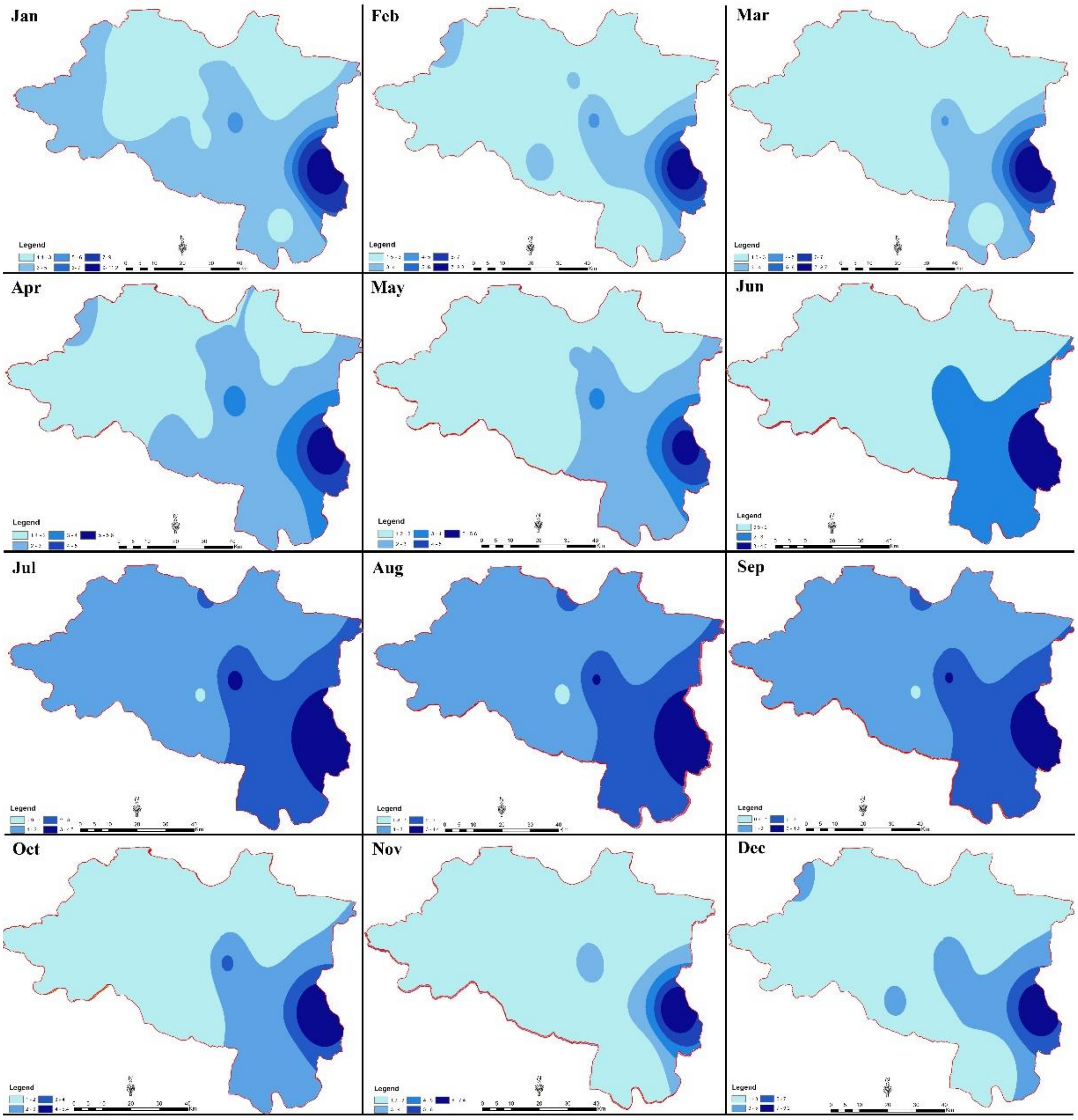

Figure 2. Ordu monthly wind speed map

When the Ordu wind speed map is examined, it is seen that the areas with the highest average wind speed are the southeast part of the province and the wind speed in this section exceeds 5 m/sec especially in winter and creates areas that are not suitable for comfort. The monthly humidity change map across Ordu is given in Figure 3.

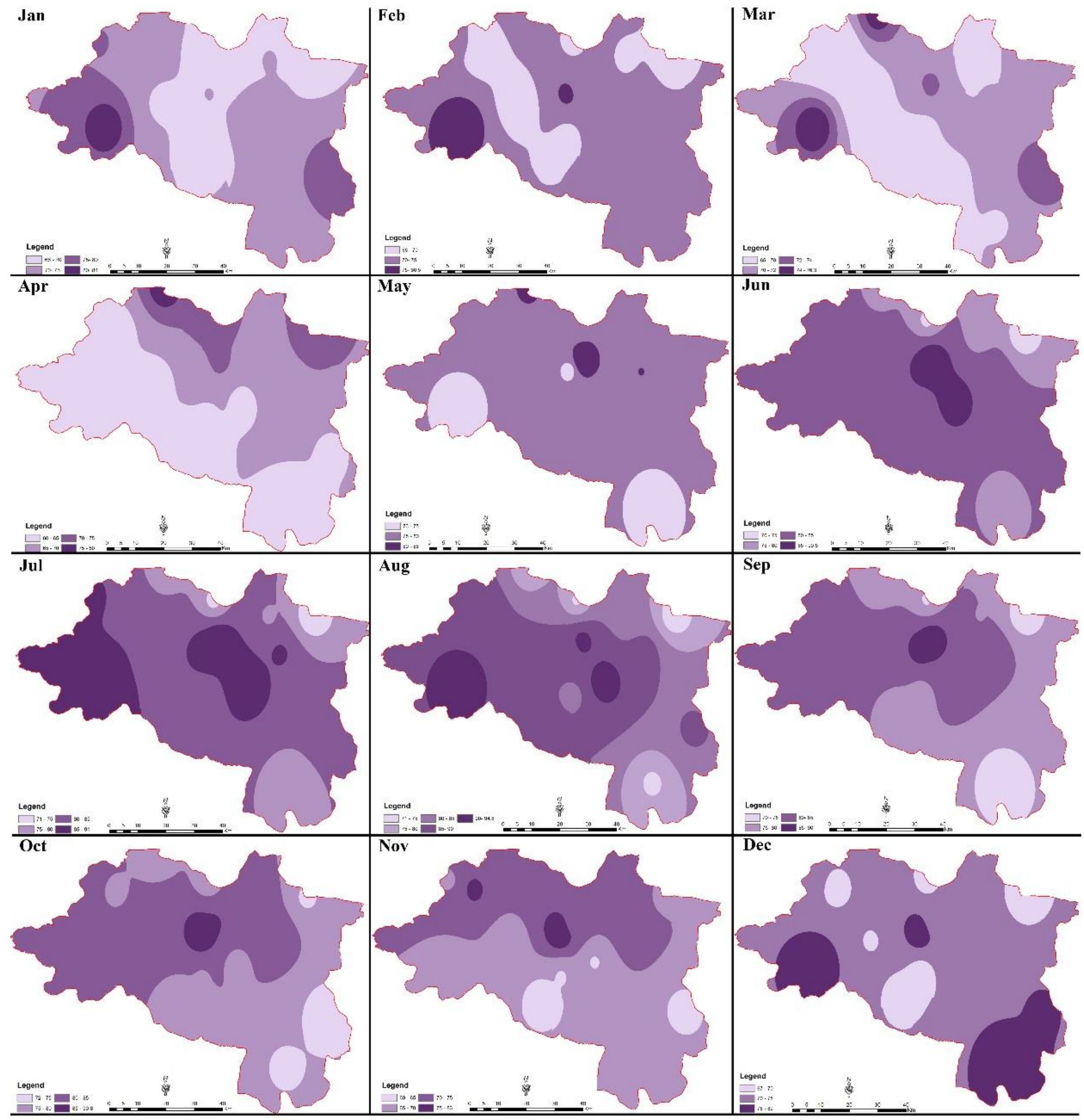

Figure 3. Ordu monthly humidity map

As seen in the monthly humidity change map of Ordu, the humidity rate throughout the province of Ordu is at a level that will cause the formation of uncomfortable areas to a large extent. The humidity rate, which is over 60% throughout most of the year, exceeds 90% in the summer months. Ordu monthly temperature change map is given in Figure 4.

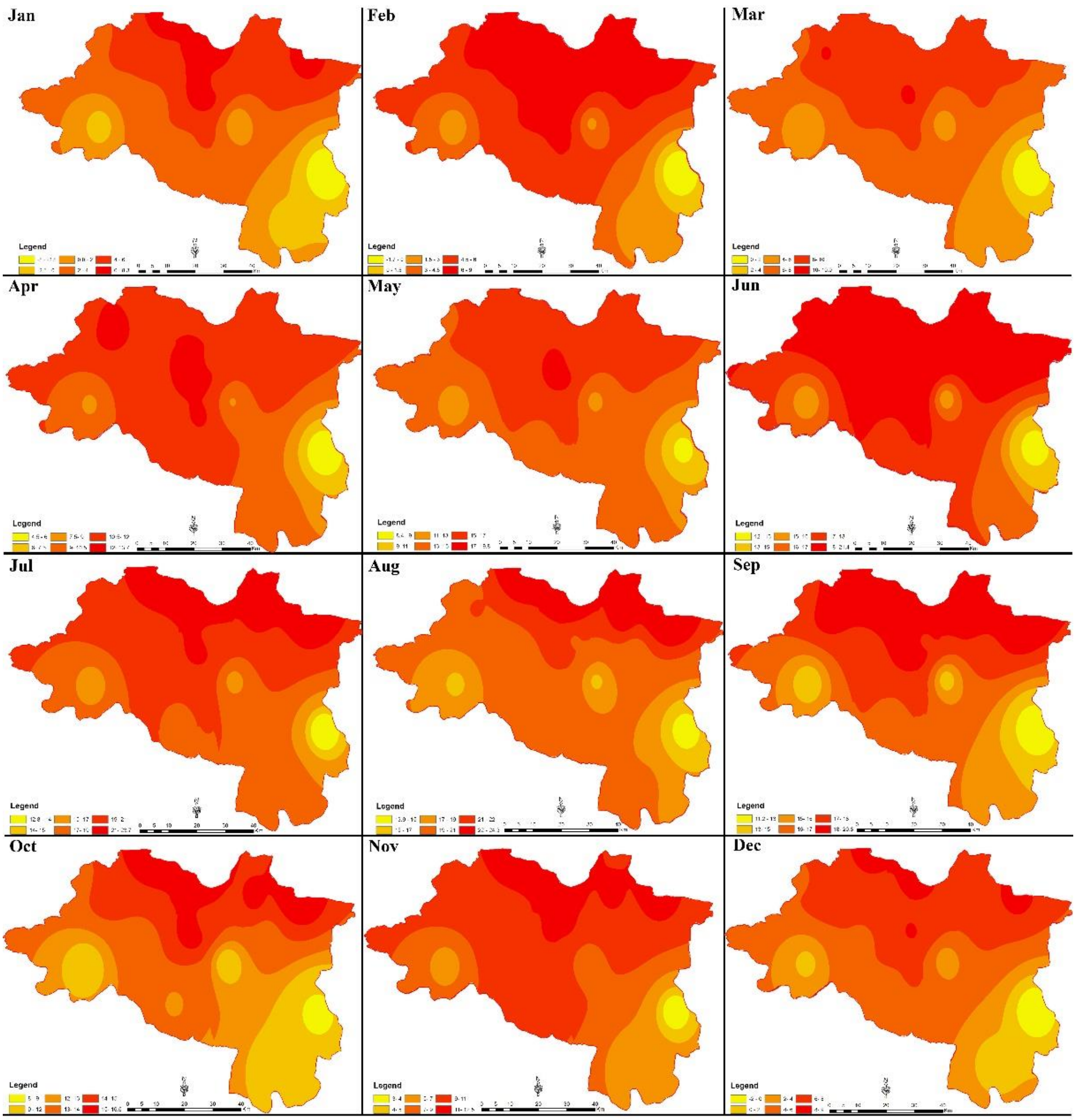

Figure 4. Ordu monthly temperature map

When the map is examined, it is seen that the areas with the highest temperature in Ordu are in the north of the province, and the average temperature values in the southeast and southwest of the province are quite low. The temperature, which goes up to 25 C in summer, drops down to -5 degrees in winter, causing uncomfortable areas to form. Based on the climate data in Ordu, suitable and unsuitable areas in terms of biocomfort were determined and according to the calculations, suitable areas in terms of biocomfort are given in Figure 5 on a monthly basis.

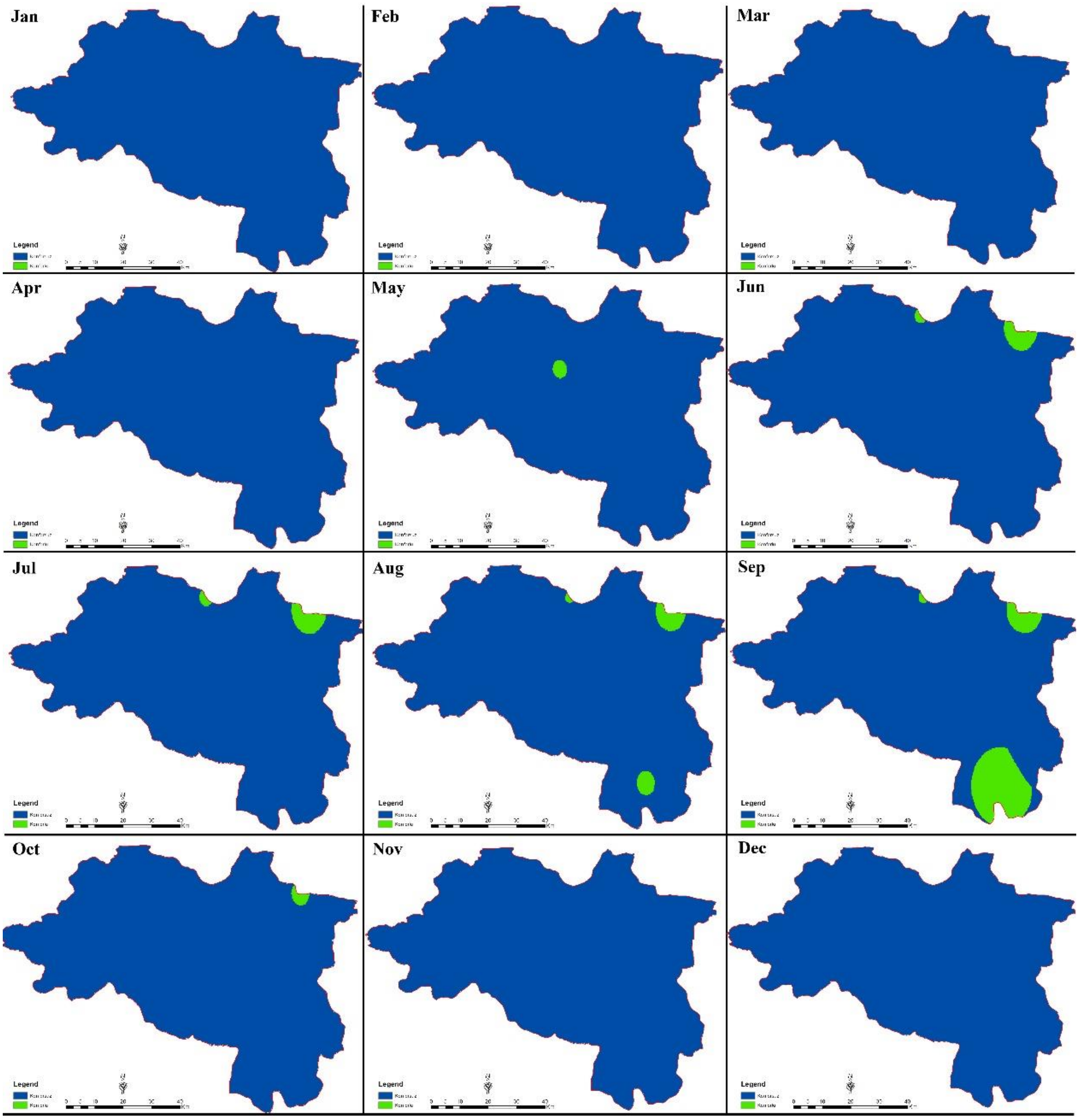

Figure 5. Ordu monthly biocomfort map

When the monthly biocomfort map of Ordu is examined, it is seen that the entire province is within the scope of uncomfortable areas in January, February, March, April, November and December. In other months, areas suitable for comfort cover a very small part of the province. It was determined that the area with the highest percentage of comfort occurred in September, but even in this month, it was calculated that the areas suitable for biocomfort cover only 8.06% of the province's surface area. In terms of biocomfort, suitable areas account for 0.4% of the surface area of Ordu in May, 1.36% in June, 1.45% in July, 1.77% in August, 8.06% in September and 0.37% in October.

4. Discussions

In Ordu, which was evaluated within the scope of the study, it can be said that all three parameters that are the subject of the study prevent the formation of biocomfort areas to a large extent. For example, in January, the wind speed reaches up to 11.2 m/s, the humidity is more than 70% in about 68% of the province, and the temperature rises to a maximum of

8.3 °C. While the wind in Ordu causes uncomfortable areas in January, February, March, April, October, November and December, there are areas where the temperature is below 15 °C in many months, and high humidity causes the formation of uncomfortable areas every month. Especially, high humidity stands out as the factor that most affects the formation of comfort areas, and it was determined that the humidity rate increased up to 94.6% in August.

Biocomfort is one of the issues that has come to the fore especially in recent years and has been studied extensively. One of the main reasons for this is people's desire for more comfort in the modern world. Humans are warm-blooded creatures and therefore they are significantly affected by external environmental conditions. If the outdoor conditions are not within certain ranges, that is, outside the comfort ranges, people feel uncomfortable in that environment and want to leave (Çetin et al., 2018; Yücedağ et al., 2021; Arıcak, 2020).

Many of the external factors that affect people's comfort; While factors such as noise, smell, and light are perceived by the five senses, there are also air pollution components such as the amount of CO_2, particulate matter, volatile organic compounds, and heavy metals that cannot be easily perceived by the five senses (Cesur et al., 2021; Sulhan et al., 2022). Some of these factors may pose a threat to human health when they exceed certain limits (Işınkaralar et al., 2022).

However, one of the most important conditions affecting the comfort of people is temperature and humidity. Ensuring the continuity of human life is possible, especially if the temperature is within certain intervals. If the temperature values are outside of human needs, people need clothes, heating or cooling equipment, etc. and temperature values within certain ranges (Kaya et al., 2019; Güngör et al., 2020; Ertuğrul et al., 2021). However, bringing the climatic conditions in the outdoor environment to the appropriate value ranges causes a significant amount of energy consumption. It is stated that around 40% of fossil resources worldwide are used to meet heating, cooling or lighting needs in buildings. Therefore, it is of great importance for people to establish their residential areas in areas with suitable value ranges in terms of comfort, in terms of reducing energy consumption and therefore the pressure on the natural resources of the world (Elahsadi, 2020).

Climate is a factor that affects not only humans but all living things. Survival of living things is possible if various external conditions are in suitable value ranges. The most effective factors in the development and spread of living things on the earth are especially climatic and edaphic factors (Ertuğrul et al., 2019; Kravkaz Kuşçu et al., 2018a; Erdem et al., 2023; Kravkaz Kuşçu et al., 2018b). Climatic factors significantly affect the morphological, anatomical and phenological characters of living things (Şevik et al., 2021; Yiğit et al., 2021).

As a result, the climate; It is a factor that affects people's health, happiness, psychology, life style, in short, their whole life, but also affects almost everything from the habitats of other living creatures to their morphological, anatomical and physiological characteristics (Varol et al., 2022a; Tekin et al., 2022; Özel et al., 2022). Since there are quite different climate types in our country, it is normal for the biocomfort situation to differ in areas where these climate types prevail.

Especially in recent years, climatic conditions have started to be one of the important factors in choosing the region where people will live. Therefore, studies on biocomfort have started to be among the criteria evaluated especially in the planning of residential areas (Kılıçoğlu et al., 2020; Doğan et al., 2022; Zeren Çetin et al., 2023a; Zeren Çetin et al., 2023b).

Another factor affecting the change of climatic parameters is climate change, which is effective on a global scale. While the world population was only around 717 million in the 1750s, it is estimated to exceed 7.7 billion in 2020 and to reach 8.5 billion in 2030 (Elsunousi et al., 2021).

Population growth around the world has brought along many problems. One of the most important of these problems is environmental pollution. The process has caused soil (Çetin et al., 2022a, Çetin et al., 2022b; Zeren Çetin et al., 2023a; Zeren Çetin et al., 2023b), water (Ucun Özel et al., 2020) and air (Key et al., 2022; Çobanoğlu et al., 2023) pollution. Industrial activities carried out in order to meet the demands and needs of the increasing world population have caused significant human-induced destruction in the ecosystem, the release of elements and fossil fuels used as raw materials in the industry from underground and released into the atmosphere, and the concentration of many pollution sources, especially CO_2, in the atmosphere (Varol et al., 2022b; Ghoma et al., 2022).

5. Conclusions

In addition to industrial activities, efforts to meet the shelter and food needs of the increasing world population have put a significant pressure on forest areas. Human activities such as deforestation, the use of fossil fuels, and agricultural activities, especially with the industrial revolution, have caused a significant increase in the emissions of natural greenhouse gases such as methane (CH_4), carbon dioxide (CO_2), nitrous oxide (N_2O). This increase in greenhouse gas emissions in the atmosphere has caused and continues to cause the deterioration of the natural greenhouse effect and warming of the atmosphere. The potential effect of this warming is climate change. It is certain that these changes that may occur in climate parameters as a result of global climate change will significantly change the comfort zones. However, few studies have been conducted on this subject. It is recommended that studies be continued by diversifying and expanding both to determine biocomfort areas and to determine how biocomfort areas will change with the effects of global climate change.

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Author Statement

The authors confirm contribution to the paper as follows: study conception and design: Osama, Mehmet; data collection: Mehmet; analysis and interpretation of results: Osama and Mehmet; draft manuscript preparation: Osama. All authors reviewed the results and approved the final version of the manuscript.

Conflict of Interest

The authors declare no conflict of interest.

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