Kastamonu University
Journal of Engineering and Sciences
e-ISSN 2667-8209
http://dergipark.gov.tr/kastamonujes

Determination of Comfort Areas According to the Wind Chill Index of the Central Anatolia Region

Mesut Doğan[a], Ercan Vural*[, b], Tuğrul Avcı [c]

[a] *Department of Geography, Faculty Literature, Istanbul University, Istanbul, Turkey*
e-mail: esutan@istanbul.edu.tr
ORCID ID: 0000-0002-4926-5769
[b] *Department of Geography, Faculty of Science and Letters, Harran University, Sanliurfa, Turkey*
e-mail: ercanvural@harran.edu.tr
ORCID ID: 0000-0002-7310-413X
[c] *Department of Geography, Social Sciences Institute, Kahramanmaras Sutcu Imam University, Kahramanmaras, Turkey*
e-mail: fakioglu@gmail.com
ORCID ID: 0000-0003-2395-8134

ARTICLE INFO

RESEARCH ARTICLE
Received: November: 11.2020
Reviewed: December: 3. 2020
Accepted: December: 10. 2020

Keywords:
Central Anatolia Region,
Wind Chill,
Bioclimatic Comfort,
Temperature,
Wind.

Corresponding Author:
E-mail: ercanvural@harran.edu.tr

ABSTRACT

Environmental and atmospheric conditions are very important for human life. The importance of climatic conditions is undeniably high for people to perform their daily activities comfortably. Among the climatic elements, temperature, wind, precipitation, and humidity are the main factors affecting comfort status. Climate-based indexes have been developed to determine the comfort zones of people. In this study, by using the wind chill index, one of these indices, the comfort condition of the Central Anatolia Region throughout the year was determined. For this purpose, the temperature and wind speed values of the Central Anatolia Region were used for the Windchill index. In July and August, the wind speed increased in places in Salt Lake and its surroundings and the east of the region. It is seen that the temperature values in the region fall below 0°C in winter. Apart from this, temperature values in the region are above 0°C in summer, spring, and autumn seasons. Depending on the temperature and wind speed values, in April, May, June, September, and October in the Central Anatolia Region, areas in the "no risk" and "zero" category have been identified in the entire region according to the Windchill index. Especially in the whole winter season (December, January, February, and in the first month of spring in March), especially in the south and east of the region, some areas fall into the "low risk" and "medium risk" category. and they must wear thick clothing, otherwise, hypothermia and subsequent frostbite deaths may occur.

Anahtar Kelimeler:
İç Anadolu Bölgesi,
Wind Chill,
Biyoklimatik Konfor,
Sıcaklık,
Rüzgar.

ÖZ

Çevresel ve atmosferik şartlar insan yaşamı için oldukça önemlidir. İnsanların günlük yaşamdaki aktivitelerini konforlu gerçekleştirebilmeleri için iklim şartlarının önemi yadsınamaz derecede fazladır. İklim elemanlarından sıcaklık, rüzgâr, yağış ve nem konfor durumunu etkileyen başlıca etmenlerdendir. İnsanların konfor alanlarının belirlenebilmesi için iklim eksenli indeksler geliştirilmiştir. Bu çalışmada da bu indekslerden rüzgâr üşüme sıcaklığı indeksi (Wind chill) kullanılarak İç Anadolu Bölgesi'nin yıl boyunca konfor durumu tespit edilmiştir. Bu amaçla Wind chill indeksi için İç Anadolu Bölgesi'nin sıcaklık ve rüzgâr hızı değerleri kullanılmıştır. Temmuz ve Ağustos aylarında Tuz Gölü ve çevresi ile bölgenin doğusunda yer yer rüzgâr hızı artmıştır. Bölgedeki sıcaklık değerleri ise kış mevsiminde 0 °C'nin altına düştüğü görülmektedir. Bunun dışında da bölgede yaz, ilkbahar ve sonbahar mevsimlerinde sıcaklık değerleri 0 °C'nin üzerinde seyretmektedir. Sıcaklık ve rüzgâr hızı değerlerine bağlı olarak İç Anadolu Bölgesi'nde Nisan, Mayıs, Haziran, Eylül ve Ekim aylarında Wind chill indeksine göre bölgenin tümünde "risk yok" ve "sıfır" kategorisine giren alanlar tespit edilmiştir. Özellikle kış mevsiminin tamamında (Aralık, Ocak, Şubat ve ilkbaharın da ilk ayında (Mart) özellikle bölgenin güneyinde ve doğusunda "düşük risk" ve "orta risk" kategorisine giren alanların varlığı görülmektedir. Bu aylarda belirtilen alanlarda yaşayan insanların çok uzun süre açık alanda kalmamaları ve kalın giysiler kullanmaları gerekmekte aksi takdirde hipotermi ve sonrasında da donmaya bağlı ölümler görülebilmektedir.

1. Introduction

With the increase in the welfare of people, their desire for a comfortable life has also increased. The comfort conditions that affect the quality of life in almost every activity, from daily life to business life, are very important today. The fact that people who live in the physical environment has caused environmental characteristics to have profound effects on all human activities [1-13]. The suitability of the climatic conditions of a region is an important factor that is considered today. Space where people can live comfortably is called the comfort zone. To determine the comfort zone correctly, conditions such as temperature, relative humidity, radiation, and wind must first be determined and determined [14-20]. In determining the comfort zones, Olgyay used combinations depending on these values in his study conducted in 1973 by evaluating the temperature from 21.0ºC to 27.5ºC, relative humidity as 30-65%, and wind speed as 5m/s [21-27]. Temperature and relative humidity are used in most climatic indices and bioclimatic comfort studies, and sometimes only the wind parameter is used [22-32]. Thermal comfort indices play an important role in bioclimatic studies. These indexes are based on the measurement of people's reactions to meteorological parameters. Nowadays, several thermal comfort indexes have been developed using various meteorological parameters [28-33]. The basis of these indexes is human body temperature and meteorological parameters. The internal temperature of the human body is 36.5-37ºC. If the body loses more of the heat produced, the internal body temperature will drop. With the falling internal temperature, the body shows a shivering reflex as a reaction. Although the body temperature continues to decrease, the body goes into hypothermia. In addition to the decrease in temperature, wind also has a great effect on the decrease of body internal temperature. The wind chill index was developed to determine the comfort conditions of people with combinations between temperature and wind. In 1945, the Windchill index was developed by Siple and Passel to examine the effect of the temperature in the shade and the cooling power of the wind. Therefore, they started experiments in Antarctica [34,35]. As a result of experiments, they developed formulas that calculate the cooling power of the atmosphere [36]. The foundations of the wind chill index were laid in this way. It is known that wind speed is very important in addition to low temperatures in high cooling rates, and in extreme conditions such as -25ºC temperature and 49 km/h wind speed, the cooling power reaches a minimum of 19-20 cal/cm^2 [36]. In this respect, the relationship between temperature and wind, as well as the relationship between temperature and humidity, appears to be an effective combination in determining human comfort zones. Air, which is the subject of our study, is an important factor that directly affects human health [40].

In this study, the determination of comfort zones according to the Windchill index developed based on the low temperature and wind conditions that people are exposed to in the Central Anatolia Region are discussed. The formula of the wind chill index is the most common formula used by many foreign researchers and different disciplines [37-39]. The wind chill index formula is widely used by foreign researchers and the wind chill index in the scarcity of studies related to the selection index in Turkey has been an important factor. The high altitude and the low-temperature values and the suitable wind conditions have been important factors in the selection of the area. However, this index can be used frequently in the Eastern Anatolia Region as well as in the Central Anatolia Region and can contribute to the management and determination of human activities.

2. Material and Method

The wind chill is defined as the temperature value calculated by taking the average of the effect of outdoor temperature on the human body and the wind speed [36]. The feeling of coldness, which is felt more on windy days in winter, negatively affects climate comfort. Figure 1 shows the Relation of Wind Chill Index, Temperature, and Wind Speed. Central Anatolia Region selected as the study area is located between 41°04”91", 36°9’03” Northern latitudes and 29°71'21", 38°43'32" East longitudes (Figure 2). After the Central Anatolia Region with 163 057 km², Eastern Anatolia in Turkey to have the largest surface area is Zone 2. On the other hand, with its population of 12,705,812, it is the Region with the highest population after the Marmara Region. The average temperature and wind speed data of the region were obtained from the site https://www.worldclim.org/. Wordclim is a database that shares high spatial resolution satellite images and climate data obtained from terrestrial stations on a global scale. Providing data used in mapping and modeling climate data, the platform provides a base for many climate studies. The data in the cellular data format with a spatial resolution of approximately 1 km^2 provides monthly temperature, precipitation, wind speed, and solar radiation data from 1970 to the present. The wind speed and temperature data obtained for our study area were calculated using the cellular data calculation module in ArcGIS Pro software and the Wind Chill Index and the results obtained were mapped. The wind chill Index is below:

$$WCI = 0.323\left(18.9\ 7\sqrt{V} - V + 37.62\right)(33 - T)$$

In equality;
WCI: Wind Chill Index (W/m^2)
V: Wind Speed (km/h)
T: Air Temperature (°C)
It has been formulated. Wind Chill Index value is calculated in relation to air temperature and wind speed. The values obtained as a result of the calculations are categorized according to the risk level for the human body (Table 1). The risk level scale specified in the table was mapped according to the wind chill index results and visualized.

Table 1. Wind chill Index Classification

Wind Chill Index	**Risk Level**	**General Feel Condition**
Between 0 to -9°C	**Low Risk**	Feeling uncomfortable. Feeling cold.
Between -10 to -27°C	**Medium Risk**	Risk of hypothermia and freezing if left outside for long periods without uncomfortable cold and adequate protection.
Between -28 to -39°C	High risk (Skin exposed to cold can freeze within 10-30 minutes)	High risk of frostbite and numbness of the face and limbs and cold bites. High risk of hypothermia if outside for long periods without adequate clothing or cold protection.
Between -40 to -47°C	Very High Risk (Skin exposed to cold can freeze within 5 to 10 minutes)	Very high frost risk. High risk of frostbite and high risk of hypothermia if outside for long periods without adequate clothing or cold protection.
Between -48 to -54°C	**Severe Risk** **(Skin exposed to cold can freeze within 2 to 5 minutes)**	Serious frostbite risk. The freezing time of the face and limbs is too short. Risk of severe frostbite and severe hypothermia if outside for long periods without adequate clothing or cold protection
Between -55 and cooler	**Extreme Risk (Skin exposed to cold can freeze in less than 2 minutes)**	Outdoor conditions are dangerous for human life.

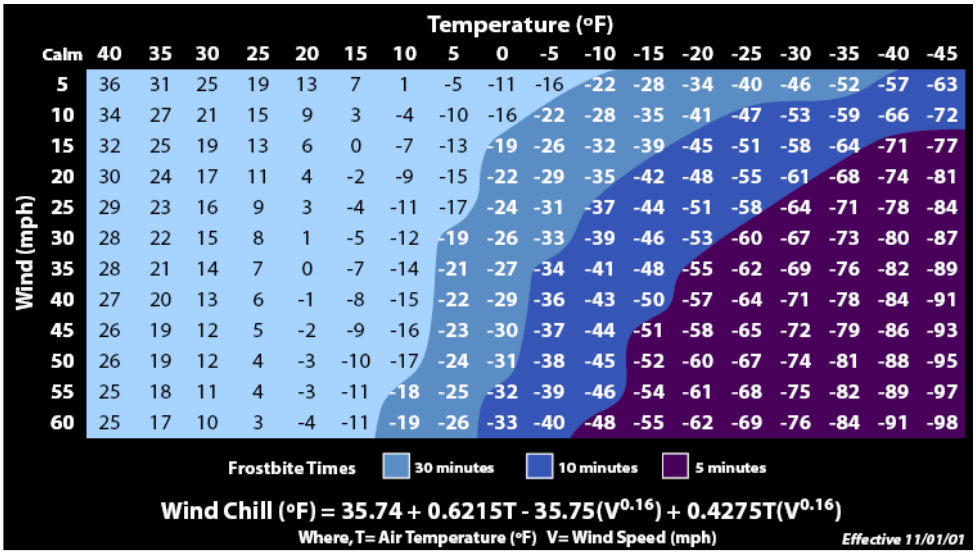

Figure 1. Relation of Wind Chill Index, Temperature and Wind Speed
Source: https://www.sciencebase.com/science-blog/what-is-wind-chill-index.html

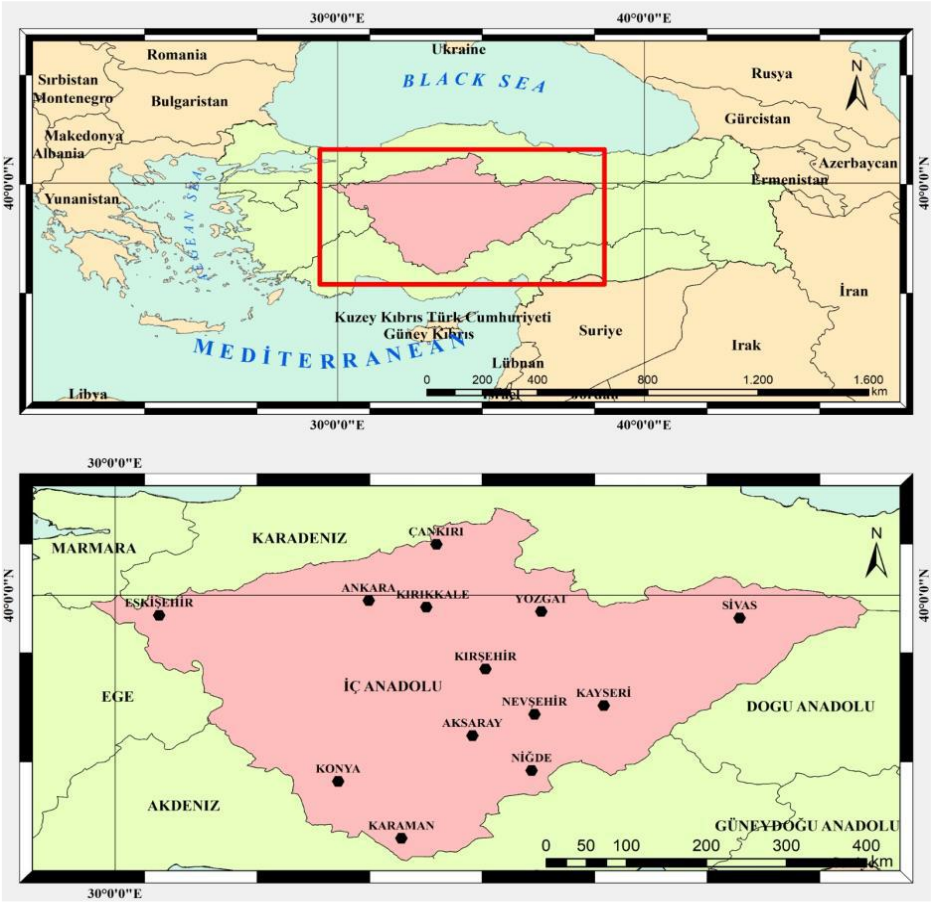

Figure 2. The location of Study Area

3. Results

The western and inner parts of the region have a flat appearance in terms of topography, especially around Konya Plain and Salt lake. Mountainous and rugged areas in the region are seen in the south and west. Erciyes and Hasan Mountains in the south, Tahtalı, Binboğa, Tecer Mountains and Uzunyayla plateau in the west have an elevated and rugged structure. (Figure 3) In the Central Anatolia Region, which has a flat structure with its inner parts surrounded by mountains due to its general morphological structure, the typical continental climate is dominant, where there is a high-temperature difference between summer and winter, and precipitation is generally seen in winter. The decrease in temperature during the winter season, the increase in wind speed, and the decrease in the type of precipitation in the form of snow made it necessary to carry out wind chill analysis in the region.

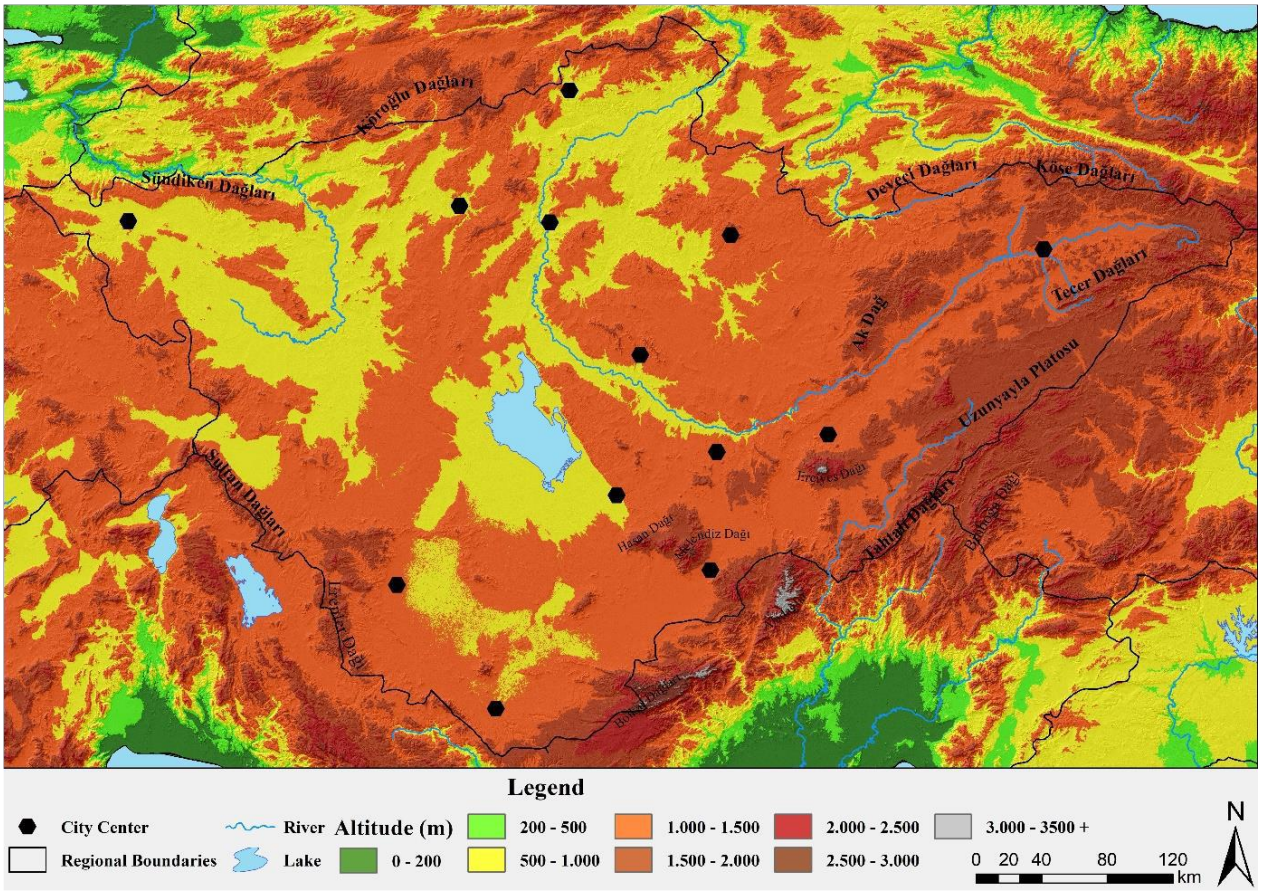

Figure 3. Elevation Map of the Study Area and its Surroundings

When the monthly average wind speed is evaluated, it has been determined that the wind speed varies within the region according to the months. In the region where the wind speed varies between 1 m / sec - 5 m / sec per hour, it has been determined that the fastest flowing values are around Salt Lake in the inner parts of the region, in Uzunyayla Plateau, around Erciyes Mountain, Akdağ and Elmadağ in July and August. It is October, November, December, and January when the wind speed is the lowest. However, in these months, in the high parts of the Erciyes, Hasan, and Melendiz Mountains, the passing speed reaches 5 m / sec per hour. In general, it has been determined that the areas with the highest wind speed in the region are high, while the areas with the lowest wind speed are low areas along the Kızılırmak valley (Figure 4).

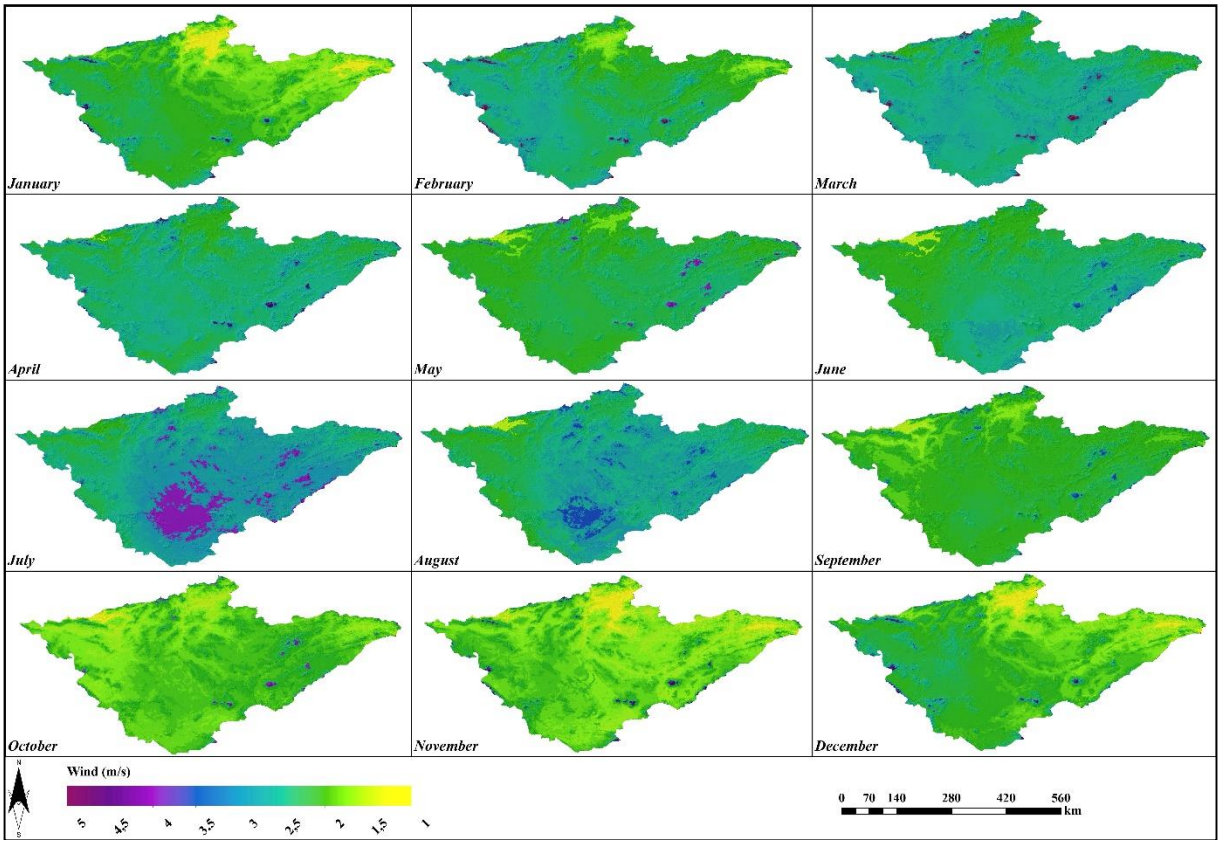

Figure 4: Annual Wind Speed Map of the Study Area

Looking at the temperature conditions; It has been determined that there are important differences between winter and summer in the Central Anatolia Region. The coldest month is January and the hottest month is July. When the annual average temperature in the region is evaluated, it has been found that it is high in Konya, Aksaray, and Eskişehir Plains, whereas it is low in the fields where Erciyes, Ak, and Tecer Mountains are located. When the temperature values of the region are evaluated monthly, it was observed as 0 ºC in the whole region in January. In July and August, it was observed that it was above 16 ºC except for the high peaks of the mountains. Temperatures in February and December were found to be between -2 and 6 oC, showing a great similarity. It was determined that the temperatures were between 0 and 8 ºC in March and between 4 and 14 ºC in April. (Figure 5).

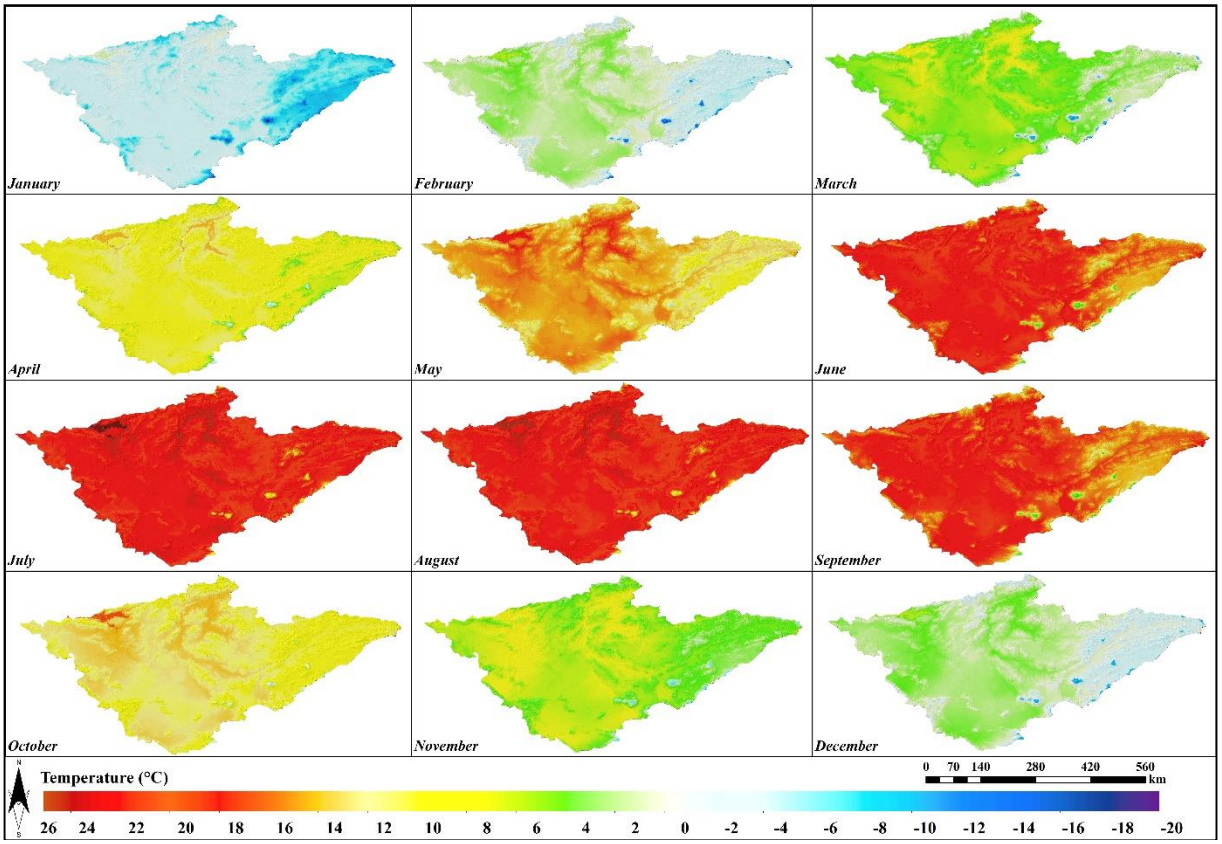

Figure 5. Annual Temperature Map of the Study Area

When the Central Anatolia Region wind chill index is evaluated according to the risk scale, it has been determined that low-grade and medium-risk areas are concentrated in the winter months (Figure 6). In December, January and February, it was determined that there are low and medium-risk areas in the low areas on the west side of the region and all areas except Konya plain. It is seen that Sivas, Kayseri, Niğde, and Çankırı are low and medium risk areas, especially in winter. The main reason for this is the high altitude in these areas. Also, the areas with Erciyes, Hasan, Melendiz, Ak, Tecer Mountains, and Uzunyayla Plateau are classified as medium risk according to the wind chill index comfort status. In this classification, the risk is expressed as hypothermia and freezing if the person is left outside for a long time. Low-grade risk has also been identified around Aksaray and Konya. It was determined that there was uncomfortable weather in these areas in January. Considering the month of February, Ak, Tecer, and Hınzır and the high parts of Erciyes, Hasan, and Melendiz Mountains in the east of the region and a large part of Sivas and Kayseri and certain regions of Niğde are included in the medium-risk classification. Aksaray, Konya plains, and Cihanbeyli and Haymana Plateaus have been identified as the regions where the temperature is 0 ºC. By March, the high parts of the Erciyes, Hasan, Melendiz Mountains are in the middle-risk group, while the high parts of the Ak and Tecer Mountains are in the low-risk category. In this month, Konya, Aksaray and Eskişehir Plains and Kızılırmak Valley were identified as places that do not carry any risk in terms of wind chill. It has been determined that there is no risk in terms of wind chill throughout the Central Anatolia Region from April to November. During this period, it has been determined that there is a low-risk factor at the points close to the summit of Mount Erciyes only in April and November. When it comes to December, it was determined that the risk situation reappeared after 1.500 meters of altitude. Especially, medium-level risk has been detected again starting from 2,500 m altitude of Erciyes, Hınzır, Ak, and Tecer Mountains. The mountainous morphological structure of the region has caused the elevation to be high, so it has been observed that the settlements on the foothills and the settlements around the high areas are in low and medium-risk groups.

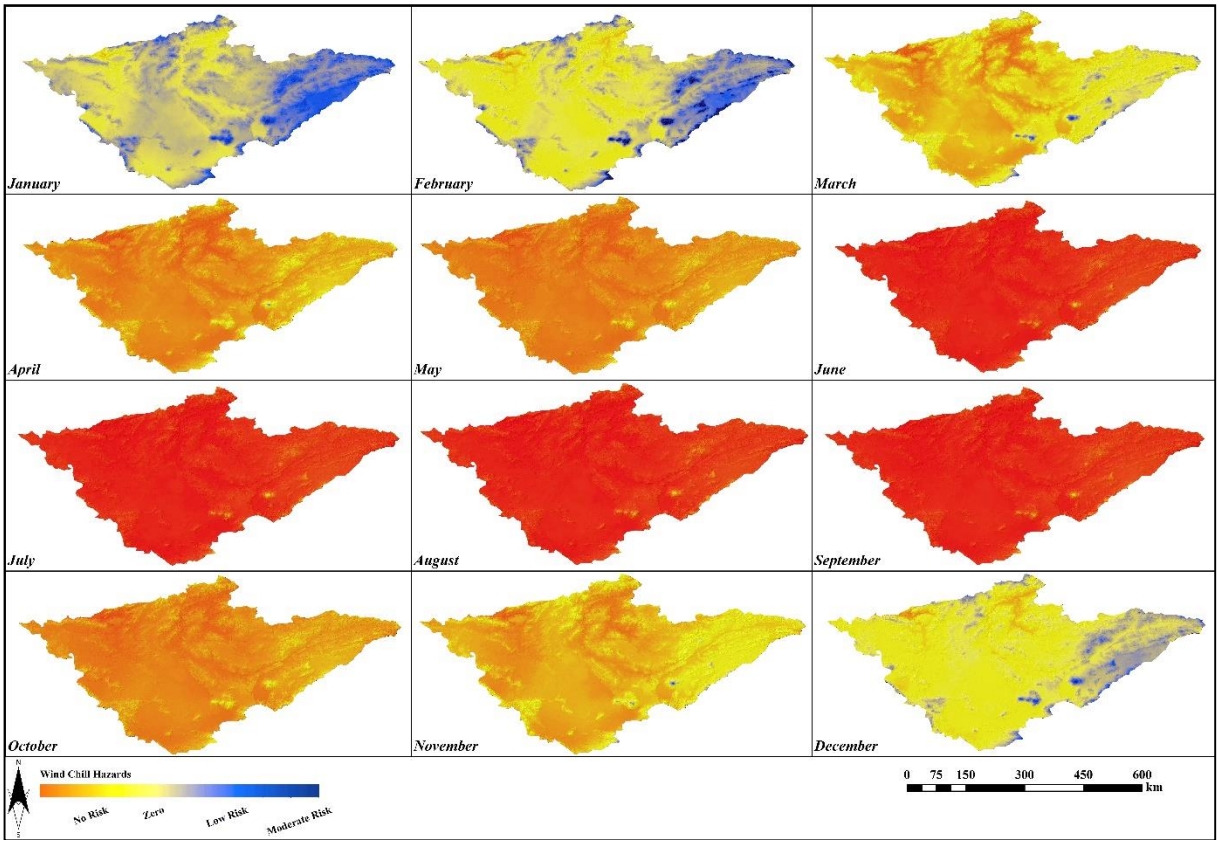

Figure 6:Windchill Index Status of the Study Area

4. Conclusions

The thermal conditions of the Central Anatolia Region, which have different elevations and different climatic conditions, change seasonally. Especially in January, it is seen that the temperature values in the region fell below 0ºC. In December and February, the temperature values in the east of the region are below 0 ºC. The most important reason for this is the high altitude in the east of the region. Apart from that, the wind conditions also vary in the region of 1-2.5 m / s during these months. In March, April, and May, the wind speed in the region increased up to 3.5-4 m / s, and the temperature values varied between 4 ºC and 18 ºC in these months. Temperature values in the region increased considerably in June, July, and August and reached up to 26 ºC. The wind speed has also increased up to 4.5-5 m / sec on the Konya Plain and its surroundings, especially in July and August. In September and October, the temperature values in the region tended to decrease by 10 ºC, from time to time to -6 ºC in November. In the wind values, a speed of 1-1.5 m / sec in the north of the region and 4-4.5 m / sec in places in the east has been observed. Looking at these values, seasonal differences are observed in the comfort zones according to the Windchill index of the Central Anatolia Region. Especially in the winter season, "medium risk" and occasionally "low risk" regions have been identified in the east of the region. Apart from this, "no risk" and "zero risks" groups were determined in the region in other months. The high altitude of the region, low temperature and high wind speed, and the continental climate cause difficult winter conditions. Accordingly, in determining the comfort zones of the region according to the Windchill index, people living in cities and settlements have been affected by this situation at a "medium risk" level. People who stay outside without protection for a long time at the "medium risk" level will be exposed to hypothermia and freezing events. It is vital that people living in "medium risk" regions, which are seen especially during the winter months, do not stay in unprotected areas for a long time. Human life needs to determine the comfort areas according to the wind chill index at the local level in Central Anatolia and Eastern Anatolia, where winter conditions are difficult in our country. It is expected that this study will guide other studies in which comfort zones will be determined according to the wind chill index and contribute to the literature.

Competing Interest / Conflict of Interest

The authors declare that they no conflict of interest. The none of the authors have any competing interest in the manuscript

Funding

There is no financial support and commercial support.

Acknowledgements

We declare that all Authors equally contribute.

5. References

[1] Toy, S. and Yılmaz, S. (2009). Peyzaj Tasarımında Biyoklimatik Konfor ve Yaşam Mekanları için Önemi, Atatürk Üniversitesi Ziraat Fakültesi Dergisi, 40 (1), 133-139.

[2] Adiguzel, F., Cetin, M., Kaya, E. Simsek M., Gungor S., Bozdogan Sert E (2020) Defining suitable areas for bioclimatic comfort for landscape planning and landscape management in Hatay, Turkey. Theoretical and Applied Climatology (Theor Appl Climatol) (2020) 139(3): 1493-1503 doi:10.1007/s00704-019-03065-7, https://link.springer.com/article/10.1007/s00704-019-03065-7

[3] Cetin, M. (2020) Climate comfort depending on different altitudes and land use in the urban areas in Kahramanmaras City. Air Qual Atmos Health 13, 991–999 (2020). https://doi.org/10.1007/s11869-020-00858-y; https://link.springer.com/article/10.1007/s11869-020-00858-y

[4] Cetin, M., Sevik, H. & Cobanoglu, O. (2020) Ca, Cu, and Li in washed and unwashed specimens of needles, bark, and branches of the blue spruce (Picea pungens) in the city of Ankara. Environ Sci Pollut Res (2020). DOI: 10.1007/s11356-020-08687-3; https://doi.org/10.1007/s11356-020-08687-3; https://link.springer.com/article/10.1007/s11356-020-08687-3

[5] Bozdogan Sert E, Turkmen M, Cetin M (2019) Heavy metal accumulation in rosemary leaves and stems exposed to traffic-related pollution near Adana-İskenderun Highway (Hatay, Turkey), Environmental Monitoring and Assessment, 191:553, https://doi.org/10.1007/s10661-019-7714-7, https://rd.springer.com/article/10.1007/s10661-019-7714-7

[6] Cetin M., Cobanoglu O. (2019) The Possibilities of Using Blue Spruce (Picea pungens Engelm) as a Biomonitor by Measuring the Recent Accumulation of Mn in Its Leaves. Kastamonu University Journal of Engineering and Science. 5(1): 43-50. https://dergipark.org.tr/download/article-file/745562

[7] Altera A.Z.A., Bayraktar O.Y., Cetin M. (2019) Advanced Road Materials in Highway Infrastructure and Features. Kastamonu University Journal of Engineering and Science. 5(1): 36-42. https://dergipark.org.tr/download/article-file/745527

[8] Cetin Mehmet (2017). Change in Amount of Chlorophyll in Some Interior Ornamental Plants (Bazı İç Mekan Süs Bitkilerinde Klorofil Miktarının Değişimi) Kastamonu University Journal of Engineering and Sciences 3(1):11-19, 2017. http://dergipark.gov.tr/download/issue-file/5600

[9] Sandal, E., & Adiguzel, F. (2014). Spatial development of Tarsus and the changes in land use. Urban and Urbanization, 1, 570-579.

[10] Alkan, A., Adıgüzel, F., & Kaya, E. (2017). Batman Kentinde Kentsel Isınmanın Azaltılmasında Yeşil Alanların Önemi. Coğrafya Dergisi, (34), 62-76.

[11] Sancar, M. C., & Güngör, Ş. (2020). A Review of Bioclimatic Comfort Areas Determined by the New Summer Index in Terms of Tourism in Antalya. Acta Biologica Turcica, 33(1), 53-63.

[12] Cetin M., Zeren I., Sevik H., Cakir C., Akpinar H. (2018). A study on the determination of the natural park's sustainable tourism potential. Environmental Monitoring and Assessment. 190(3): 167.https://doi.org/10.1007/s10661-018-6534-5

[13] Cetin, M.; Sevik H. (2016). Evaluating the recreation potential of Ilgaz Mountain National Park in Turkey. Environmental Monitoring and Assessment, 188(1):52, http://link.springer.com/article/10.1007%2Fs10661-015-5064-7

[14] Kestane, Ö. and Ülgen, K. (2013). İzmir İli İçin Biyoklimatik konfor Bölgelerinin belirlenmesi, Süleyman Demirel Üniversitesi Teknik Bilimler Dergisi, 3 (5), 18-25.

[15] Cetin, M.; Sevik, H. (2016). Assessing Potential Areas of Ecotourism through a Case Study in Ilgaz Mountain National Park, InTech, Chapter 5, Eds:Leszek Butowski, 190, ISBN:978-953-51-2281-4, 81-110, http://www.intechopen.com/books/tourism-from-empirical-research-towards-practical-application/assessing-potential-areas-of-ecotourism-through-a-case-study-in-ilgaz-mountain-national-park

[16] Zeren Cetin I, Ozel HB, Varol T (2020) Integrating of settlement area in urban and forest area of Bartin with climatic condition decision for managements. Air Quality, Atmosphere & Health, 13(8), 1013-1022.. https://do.org/10.1007/s11869-020- 00871-1

[17] Zeren Cetin, I. & Sevik, H. (2020). Investigation of the relationship between bioclimatic comfort and land use by using GIS and RS techniques in Trabzon. *Environmental Monitoring and Assessment*, *192*(2), 71.

[18] Zeren Çetin, İ. (2019). Trabzon ekoturizm potansiyelinin GIS kullanımı ile biyoklimatik konfor açısından değerlendirilmesi. *Yüksek Lisans Tezi. Kastamonu Üniversitesi Fen Bilimleri Ensitüsü*. Kastamonu.

[19] Cetin, M. (2015). Evaluation of the sustainable tourism potential of a protected area for landscape planning: a case study of the ancient city of Pompeipolis in Kastamonu. International Journal of Sustainable Development & World Ecology, 22(6), 490-495

[20] Cetin, M. (2016). Determination of bioclimatic comfort areas in landscape planning: A case study of Cide Coastline, Turkish Journal of Agriculture-Food Science and Technology 4 (9), 800-804

[21] Toy, S., Yılmaz, S. and Yılmaz, H. (2007). Determination of bioclimatic comfort in three different land uses in the city of Erzurum, Turkey, Building and Environment, 42, 1315-1318.

[22] Cetin, M., Adiguzel, F., Gungor, S., Kaya, E. and Sancar, M. C. (2019). Evaluation of thermal climatic region areas in terms of building density in urban management and planning for Burdur, Turkey. Air Quality, Atmosphere and Health, 12(9): 1103-1112. https://link.springer.com/article/10.1007/s11869-019-00727-3

[23] Çetin, M., Güngör, Ş., & Adıgüzel, F. (2020). Bulanık Mantık Ve Cbs İle Kentsel Dokudaki Bozulma Miktarını Ölçmek İçin Mekânsal Model Geliştirme. Ş. Güngör, & F. Adıgüzel içinde, Kapadokya Araştırmaları İnsan Ve Mekân (s. 55). Nevşehir: Literatürk Academia.

[24] Cetin, M. (2015). Determining the bioclimatic comfort in Kastamonu City. Environmental Monitoring and Assessment, 187(10), 640, http://link.springer.com/article/10.1007%2Fs10661-015-4861-3

[25] Kaya, E., Agca, M., Adiguzel F., Cetin, M. (2019). Spatial data analysis with R programming for environment. Human and Ecological Risk Assessment: An International Journal 25 (6): 1521-1530. https://www.tandfonline.com/doi/full/10.1080/10807039.2018.1470896

[26] Cetin M., Adiguzel F., Kaya O., & Sahap, A. (2018) Mapping of bioclimatic comfort for potential planning using GIS in Aydin. Environment, Development and Sustainability, (2018) 20 (1): 361-375.https://doi.org/10.1007/s10668-016-9885-5

[27] Cetin M, Sevik H, Canturk U, Cakir C (2018) Evaluation of the recreational potential of Kutahya Urban Forest. Fresenius Environmental Bulletin, 27(5):2629-2634.

[28] Güngör, S., Cetin, M. & Adiguzel, F. (2020) Calculation of comfortable thermal conditions for Mersin urban city planning in Turkey. Air Quality, Atmosphere & Health (Air Qual Atmos Health) (2020). DOI: 10.1007/s11869-020-00955-y; https://doi.org/10.1007/s11869-020-00955-y; https://link.springer.com/article/10.1007/s11869-020-00955-y

[29] Güngör, Ş., & Adıgüzel, F. (2019). Kentsel Yeşil Alanlar İçin Mekânsal Yeterlilik Veulaşabilirlik Analizi: Nevşehir Örneği. A. Uysal, & H. İçen içinde, Kapadokya Araştırmaları (s. 90). Nevşehir: Pegem Akademi.

[30] Cetin, M. (2015). Using GIS analysis to assess urban green space in terms of accessibility: case study in Kutahya. International Journal of Sustainable Development & World Ecology, 22(5), 420-424, DOI: 10.1080/13504509.2015.1061066

[31] Deniz, A , Güngör, Ş . (2020). Mapping With Unmanned Aerial Vehicles Systems: A Case Study Of Nevsehir Haci Bektas Veli University Campus . Kastamonu University Journal of Engineering and Sciences , 6 (1) , 27-32

[32] Cetin M (2019). The effect of urban planning on urban formations determining bioclimatic comfort area's effect using satellitia imagines on air quality: a case study of Bursa city. Air Quality, Atmosphere & Health, (Air Qual Atmos Health). 12(10):1237-1249. https://doi.org/10.1007/s11869-019-00742-4 https://rd.springer.com/article/10.1007/s11869-019-00742-4

[33] Sandal, E , Adıgüzel, F , Karademir, N . (2020). Changes In Land Use Between The Years Of 1990-2018 In Mersin Province Based On CORINE (Coordination Of Information On The Environment) System . Kastamonu University Journal of Engineering and Sciences , 6 (1) , 8-18.

[34] Baloğlu, M. (2001). Hissedilen ve üşüme sıcaklıklarının Türkiye üzerindeki dağılımı, İstanbul Teknik Üniversitesi Fen Bilimleri Enstitüsü, basılmamış yüksek lisans tezi, İstanbul.

[35] Osczevski, R. J. (1995). The Basis of windchill, Arctic, 48, 372-382.

[36] Toros, H., Deniz, A., Şaylan, L., Şen, O. and Baloğlu, M. (2003). Marmara bölgesi için üşüme sıcaklığı analizi, III. Atmosfer Bilimleri Sempozyumu, 19-21 Mart, İTÜ, İstanbul.
[37] Keimig, F.T. and Bradley, R. (2002). Recent changes in wind chill temperatures at high latitudes in North America, Geophysical Research Letters, 29 (8).
[38] Shitzer, A. and De Dear, R. (2006). Inconsistencies in the "New" Windchill Chart at low wind speeds, Journal of Applied meteorology and climatology, 45, 787-790.
[39] Acar Deniz, Z. and Uslan, E. (2018). Ekstrem soğuk hava dalgası: Ocak 2017, Gaziantep Universty Journal of Social Sciences, 17(3), 761-773.
[40] Vural E. (2020). Investigation of Experienced Air Pollution on Selected Pollutants Scale in Kırıkkale City (2018-2019), Kastamonu University Journal of Engineering and Sciences, 6(1), 41-50.