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ORIGINAL PAPER

Defining suitable areas for bioclimatic comfort for landscape planning and landscape management in Hatay, Turkey

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Abstract

This study is based on an area in Hatay, Turkey, and involves examining all weather and climate-related data that can be used to determine its suitability for the bioclimatic comfort. It attempts to explain bioclimatic comfort and describes in detail all the variables that make this contemporary concept and why it is important from a landscape architecture planning point of view. According to Köppen climate classification, the general climate character of the study area is classified as medium-altitude, warm summer, and climate type with mild or winters with Csa-Csb letters. As the area is very large in terms of total area, the findings were different across the whole area; which means that some parts were bioclimatic-comfort-friendly and other parts were not to varying degrees. June is the month in which suitable areas cover the province's largest area. Because temperatures have reached a suitable level in terms of climatic comfort, humidity and wind speed have increased. In climatic map result, it shows that Hatay is the highest region area with high altitudes of regions in the center. The examination for thermal comfort took place for months. Hatay's results show that it serves as a helper in future planning of landscape: planning that brings the comfort of bioclimatic to the level of highest and that helps determine new region settlement in Hatay. The study finally proposes that it paves the way for future researches and studies to ultimately standardize bioclimatic comfort in landscape architecture and urban planning that allows achieving the optimal planning objectives in all aspects.

Keywords Bioclimatic region · Climatic elements · Geographic Information Systems (GIS) · Landscape principles · Sustainable cities · Urban design and management

Highlights • Determining the bioclimatic characteristics of an urban area through GIS analysis
• Providing environmental sensitivity in the analysis
• Ensuring continuity in the protection of urban balance
• Learning to develop appropriate means to ensure the value of urban activities and a balance between protection and use of resources

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1 Introduction

Global researches indicate that people are most comfortable in places with a clean atmospheric environment that falls within a certain temperature and humidity range. Turkey, as is the case with most of the world, has encountered a rapid growth in urbanization in recent years. The fast growth results in the deterioration of the ecological balance in urban areas. Planned urbanization is one of the prime markers of the development of socioeconomic and physical. In planned urbanization, one of the important parameters to determine the suitability of a region for humans is the effect of the region on human health (physical and psychological). Bioclimatic comfort is defined as the conditions under which a person can consume the least amount of energy to adjust to the environment (Nowak et al. 2005; Cetin et al. 2018a, 2019; Cetin 2015a, b, c, 2017, 2019). The creation of the healthiest and most dynamic environments is centered on ensuring bioclimatic comfort, with special emphasis on the importance of landscape architecture. This affects bioclimatic comfort as well. Therefore, bioclimatic

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comfort should be considered in the drawings and plans that are oriented toward comfort in all aspects for the ecosystem in a given area (Altunkasa 1990; Kaya et al. 2019a, b; Olgyay 2015; Kaya et al. 2018a, b; Kaya and Yücedağ 2017; Attia and Herde 2009; Sevik et al. 2017; Cetin et al. 2010; Milne 2013; Cetin 2015a, b, c; Bozdogan Sert et al. 2019; Cetin et al. 2018a, b, c; Cetin 2016a, b, c; Cetin and Zeren 2016; Cakir et al. 2016; Navazi et al. 2017; Salehi and Zabardast 2016; Ghanghermeh et al. 2017; Molanezhad 2017).

One of the most commonly used methods for determining bioclimatic comfort zone is the "Bioclimatic Comfort Chart" developed by Olgyay. According to Cetin et al. (2010), the bioclimatic comfort zone falls under the following values: An outdoor area between 30% and 65% (as relative humidity), 21.0–27.5°C (as temperature range) and wind speeds up to 5 m/s. Recent studies show that the comfort of bioclimatic in Turkey is in the middle latitudes in which the humidity temperature and wind substituted were detected from 17.0 to 24.9 °C and is regarded as the sensed temperature value (Yucedag and Kaya 2016, Yucedag and Kaya 2017a, Yucedag and Kaya 2017b; Kocman 1991; Cetin 2015a, b, c; Topay and Parladir 2015; Cetin et al. 2018a; Cetin et al. 2018b; Dereli et al. 2013; Yucedag et al. 2018; Aricak 2015; Yucedag et al. 2017; Sen and Genc 2017; Cetin 2016a, b, c; Sen and Gungor 2018; Yucedag et al. 2019; Cetin et al. 2019; Cetin 2019). The present study considers how the bioclimatic comfort status of a place might be determined, with special reference to Hatay, Turkey.

The suitable bioclimatic comfort in Hatay as possible maps for the plan that is determined for taking to the climate parameters according to the values of comfort. Thus, maps with the managing of plans to be created for the city, obtaining data will have a guiding quality.

In approaching traditional management and plan, bioclimatic comfort is ignored because climate data is used only as mere inputs. However, in this study, maps were produced within the context that determine the local bioclimatic comfort based on the characteristics of the climate of Hatay and can be used as a basis for the physical planning processes of the basin.

2 Materials and methods

The study location consists of Hatay and its surroundings. Hatay is located in the South of Turkey in the Mediterranean region of Turkey. The center of Hatay province lies at coordinates 36° 14' 40" N and 36° 12' 3" E as shown in Fig. 1. In regional and national terms, Hatay is considered important because of the value of its cultural, recreational resources, and natural. A Mediterranean climate prevails in the region. The monthly average temperature is 17–18°C. North winds in the region make it relatively cool compared to the rest of the Mediterranean region. The monthly rainfall average is 580–1000 mm (Meteorology 2019; Municipality 2019).

The work was conducted in Hatay, and data were collected from field observations, measurements, photoshoots, and meteorological stations. These data were collected from 1960 to 2019; then by using computer programs with natural and cultural data, Geographic Information Systems (GIS), meteorological data, were made with processing into the environment of digital. Then the transformations of data were realized, and the suitable maps of thematic were created in the environment of GIS. Numerical elevation model, slope, view, etc. were obtained by using temperature, humidity, and wind values, and the inventories were evaluated. Finally, bioclimatic zones were defined.

Raster monthly data were analyzed using the ArcGIS program and assessed using the cell statistics function. This function calculates changes between two or more related calls within the raster data according to trends and using ESRI ArcGIS. Formula 1 in RayMan 1.2 software (Thom 1959; Matzarakis et al. 2010; Toroglu et al. 2015) was used as follows:

$$DI = T - (0,55 - 0,0055RH)(T - 14,5) \quad (1)$$

where DI is the discomfort index, T is the temperature (°C), and RH is the relative humidity.

The cell-based statistics function was obtained using the map of monthly sensed temperature as shown in Fig. 2 which is wind chill temperature maps. The cell value of the map was located on the newly formed floating-point value between 0.1 and 1. Values between 0.1 and 1 month on the perceived temperature map were subjected to classification processing and divided into equal intervals.

According to Köppen's climate classification, the general climate character of the study area is classified as medium altitude, warm summer climate type with mild or winters with Csa-Csb letters (Ozturk et al. 2017). According to the drought index, the area is in the semi-humid class (Aydin et al. 2019).

The bioclimatic comfort zones in Hatay were thus identified: a field on the map with a value of 0 has the lowest comfort areas, and whereas value 1 for the highest comfort areas. During the study, classified residential areas were examined in regions where reduced comfort had been shown to provide suitable conditions for increasing comfort in rural areas.

ESRI software with a linear Kriging interpolation universal option was used for ArcView GIS mapping. This allowed the identification of climatic factors and the evaluation of the comfort levels of bioclimatic-friendly areas.

The relative humidity and temperature data for Hatay, measured at 14:00 each day between 1960 and 2019, were obtained from the State Meteorology Affairs General Directorate (SMAGD) (Meteorology 2019). The average monthly

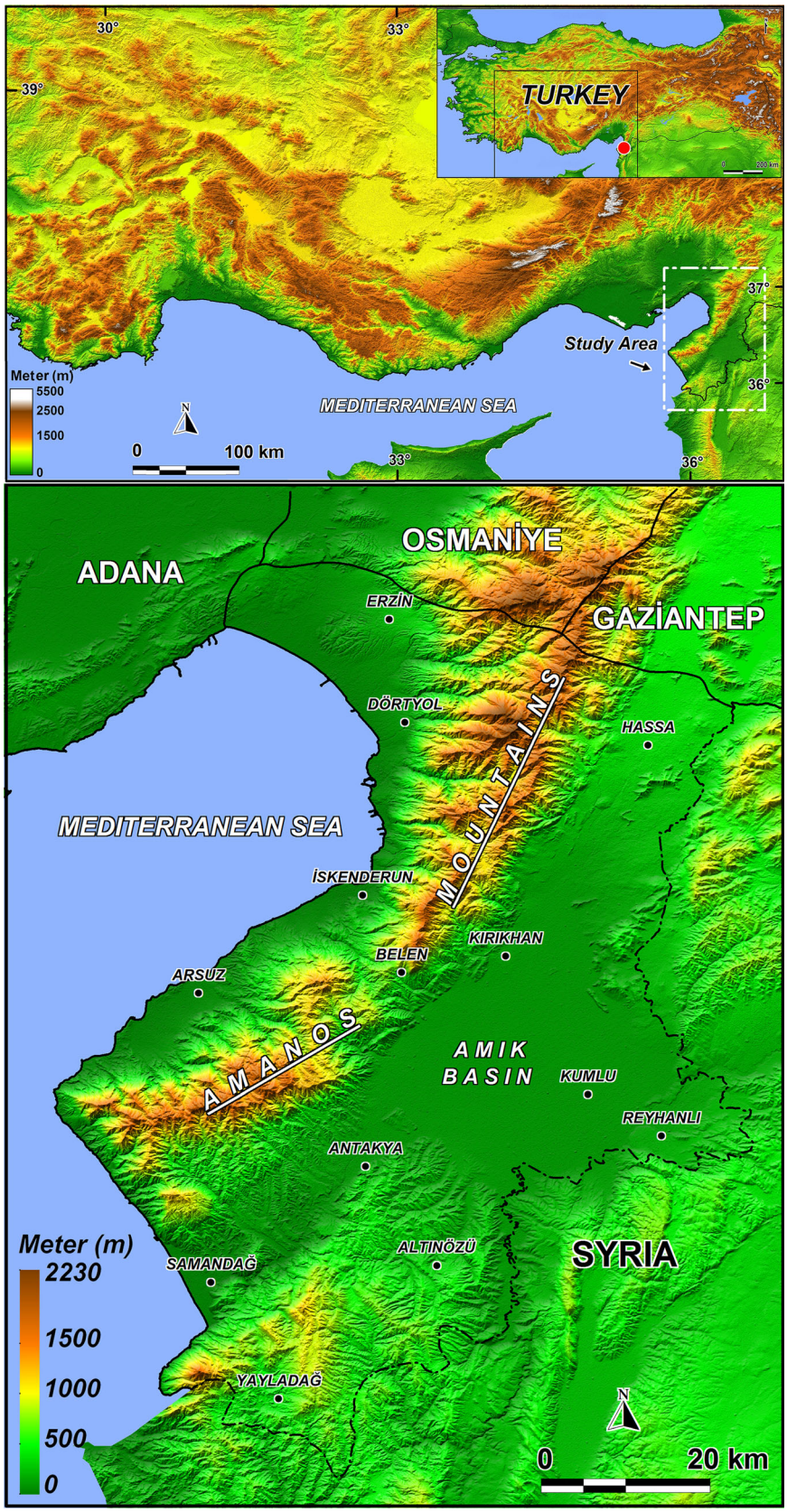

Fig. 1 Location of study area

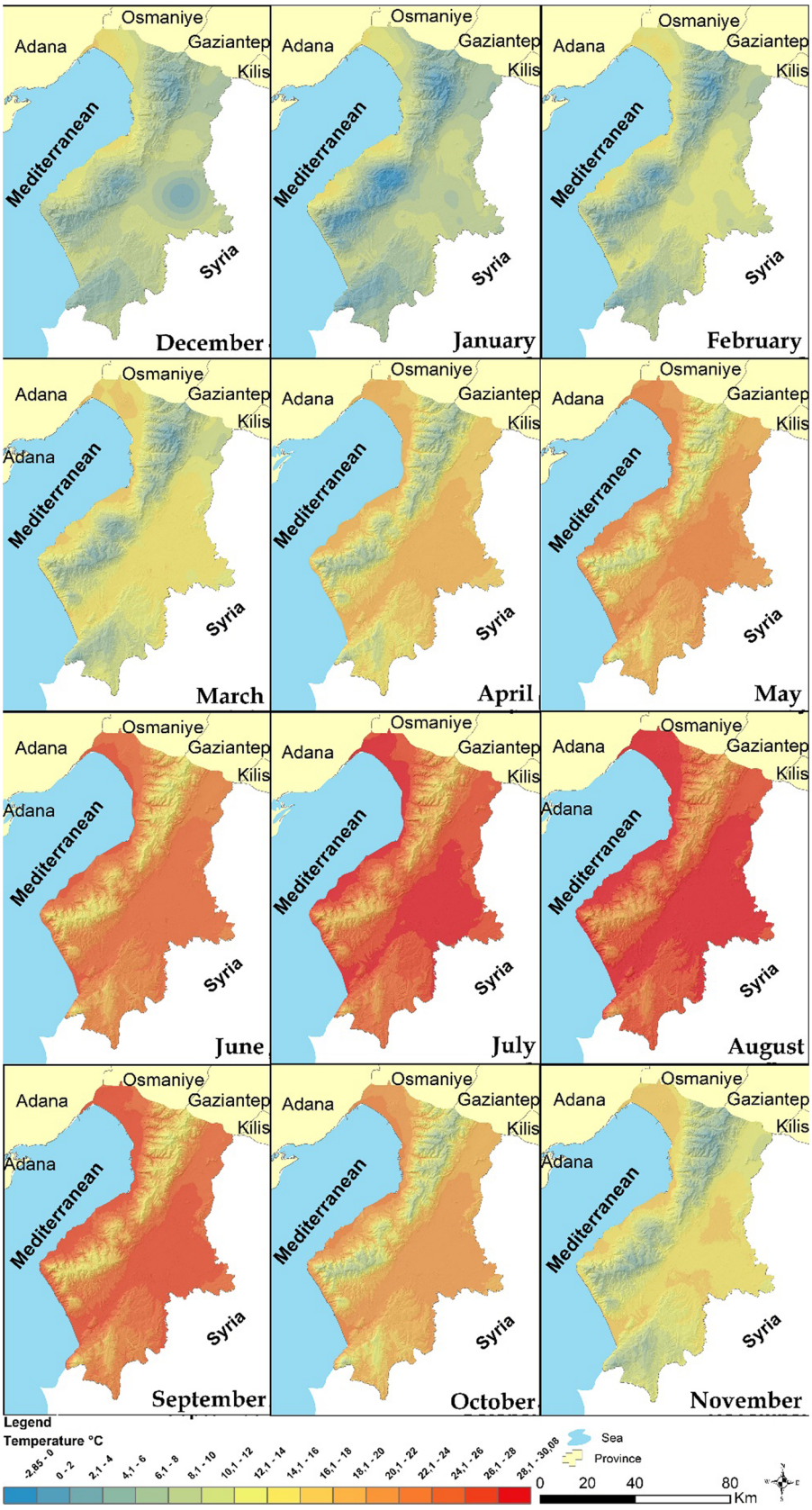

Fig. 2 Average monthly temperature (from 1960 to 2019)

temperature values were processed and evaluated using GIS, and a map was created as shown in Fig. 2 (temperature maps).

For the ArcView software of the maps, climate and Kriging interpolation methods were used to create the appropriate fields. For the evaluation of the data, the universal linear extension system was used, as it obtains the straightest climate data fragmentation in the area. The monthly average temperature was evaluated for Hatay and found to range between 16 and 19 °C for the center; temperatures with the same value as the study area were found primarily in the southern and northern regions.

3 Results

The optimal relative humidity range in terms of bioclimatic comfort in Hatay was determined to be 52%–57%. The average monthly relative humidity is shown in Fig. 3. The values of humidity in the northern section of the research area were found increasing. The monthly average wind data for the region are demonstrated in Fig. 4. The optimal wind speed in terms of bioclimatic comfort was determined to be in the range of 1.5–2.2 m/s. The average monthly wind speed value for the research area in the central and northern regions was 2.02 m/s, and these regions, therefore, have the highest values in terms of bioclimatic comfort.

The analysis and evaluation of the data on maps in terms of suitability and unsuitability have led to the designation of certain zones and the exclusions of others. The temperature of the bioclimatic map in Hatay was then analyzed. The relative humidity and the most suitable areas for wind speed are demonstrated in Fig. 4. As a conclusion, the most suitable bioclimatic comfort area in Hatay is shown in Fig. 5. As a result of the applied index in winter (December, January, and February), the work area generally corresponds to uncomfortable areas, except the narrow coastal plains facing the Mediterranean Sea. High-humidity, low-temperature, and low-wind conditions prevail in this season. Especially the slow wind speed increases the effect of humidity. In spring, suitable areas increase due to decreasing humidity, increasing temperature, and increasing wind speeds. At the beginning of the season, only plains are suitable, while toward the end of the season, only mountainous areas remain inappropriate. This is related to the high humidity and low temperature of the mountainous areas at the end of spring season. At the beginning of summer season, June is the month in which suitable areas cover the largest area throughout the province. Because temperatures have reached a suitable level in terms of climatic comfort, humidity and wind speed have increased. However, the rapid increase in temperatures toward the end of summer only makes the mountainous areas suitable, and majority of the province is uncomfortable. The Amanos Mountains comes as comfortable living islands during these months, while the entire Amik and coastal plain forms uncomfortable areas. The autumn season is the most suitable in terms of climatic comfort. Although the wind speed decreases, the decrease in temperatures and low humidity cause low areas to be suitable throughout autumn. However, decreasing temperatures toward the end of the season cause the appropriate area to shrink. The most comfortable month in the study area is September (autumn), and this situation shows a negative change toward November.

4 Discussion

The average monthly relative humidity is shown in Fig. 3. The optimal relative humidity range in terms of bioclimatic comfort in Hatay was determined to be 52%–57%. The values of humidity in the northern section of the research area were found increasing. The monthly average wind data for the region are demonstrated in Fig. 4. The optimal wind speed in terms of bioclimatic comfort was determined to be in the range of 1.5–2.2 m/s. The monthly wind speed values for the work area in the central and northern regions showed an average of 2.02 m/s, and these regions, therefore, have the highest values in terms of bioclimatic comfort.

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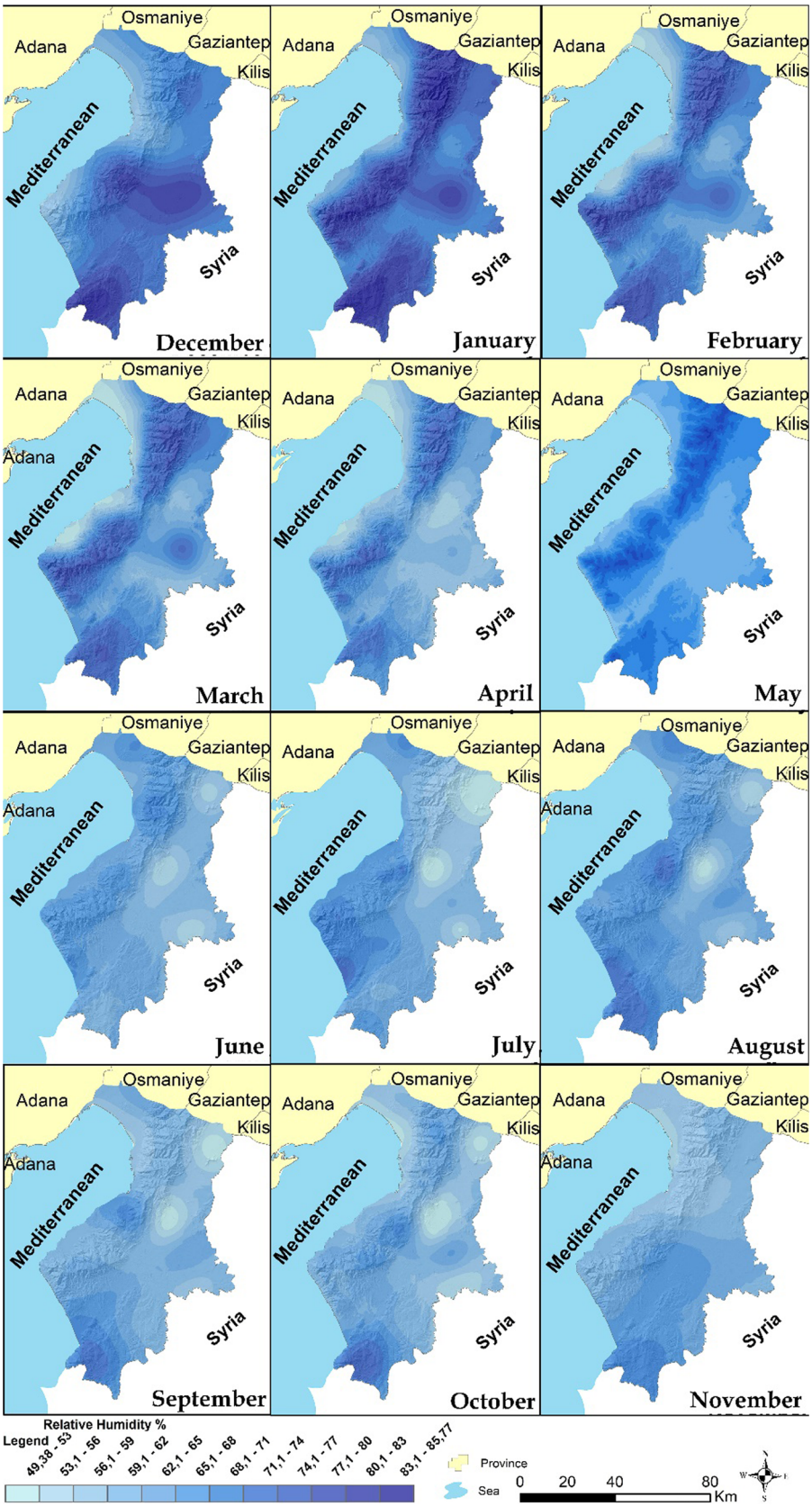

Fig. 3 Average monthly relative humidity (from 1960 to 2019)

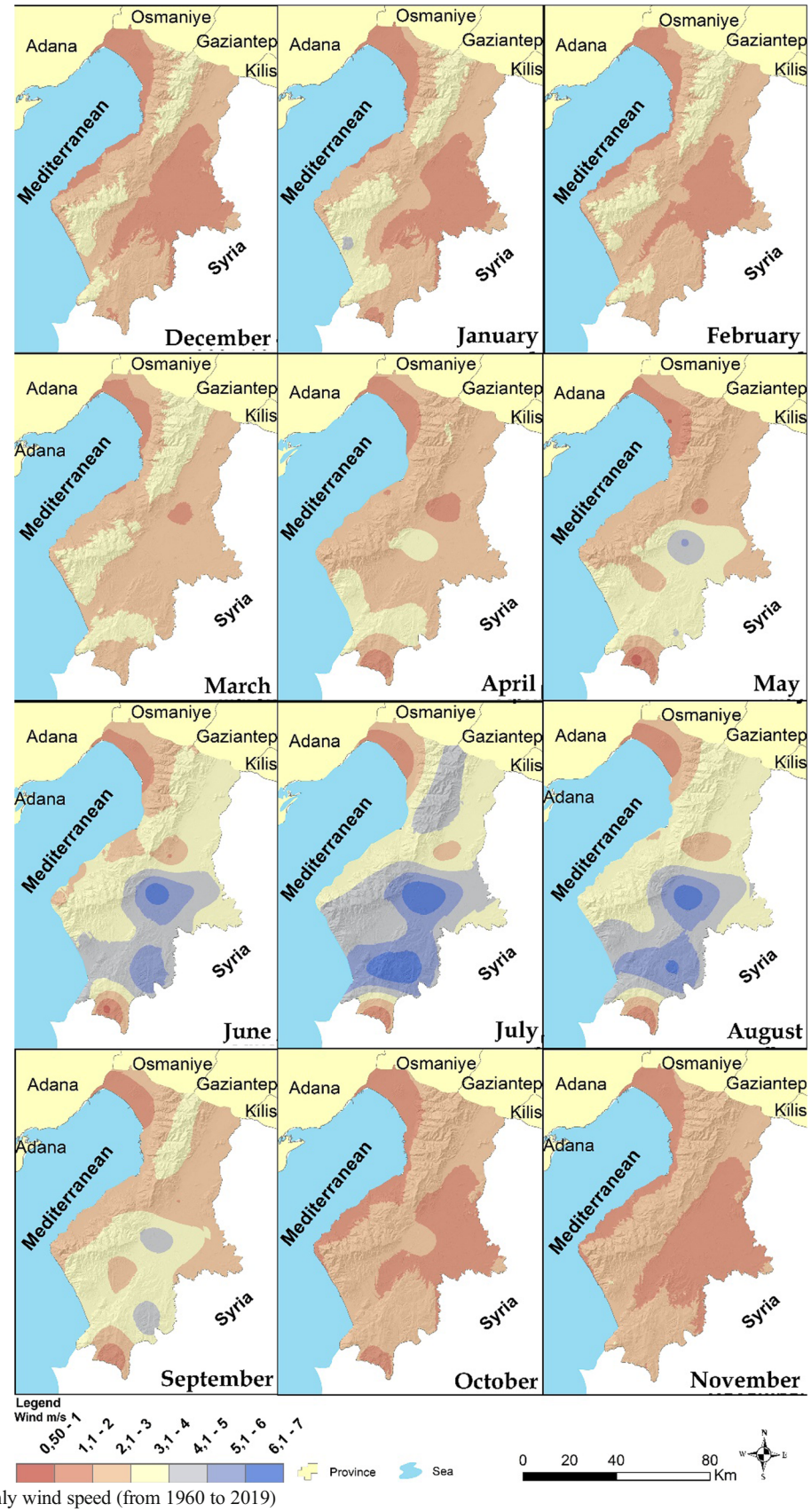

Fig. 4 Average monthly wind speed (from 1960 to 2019)

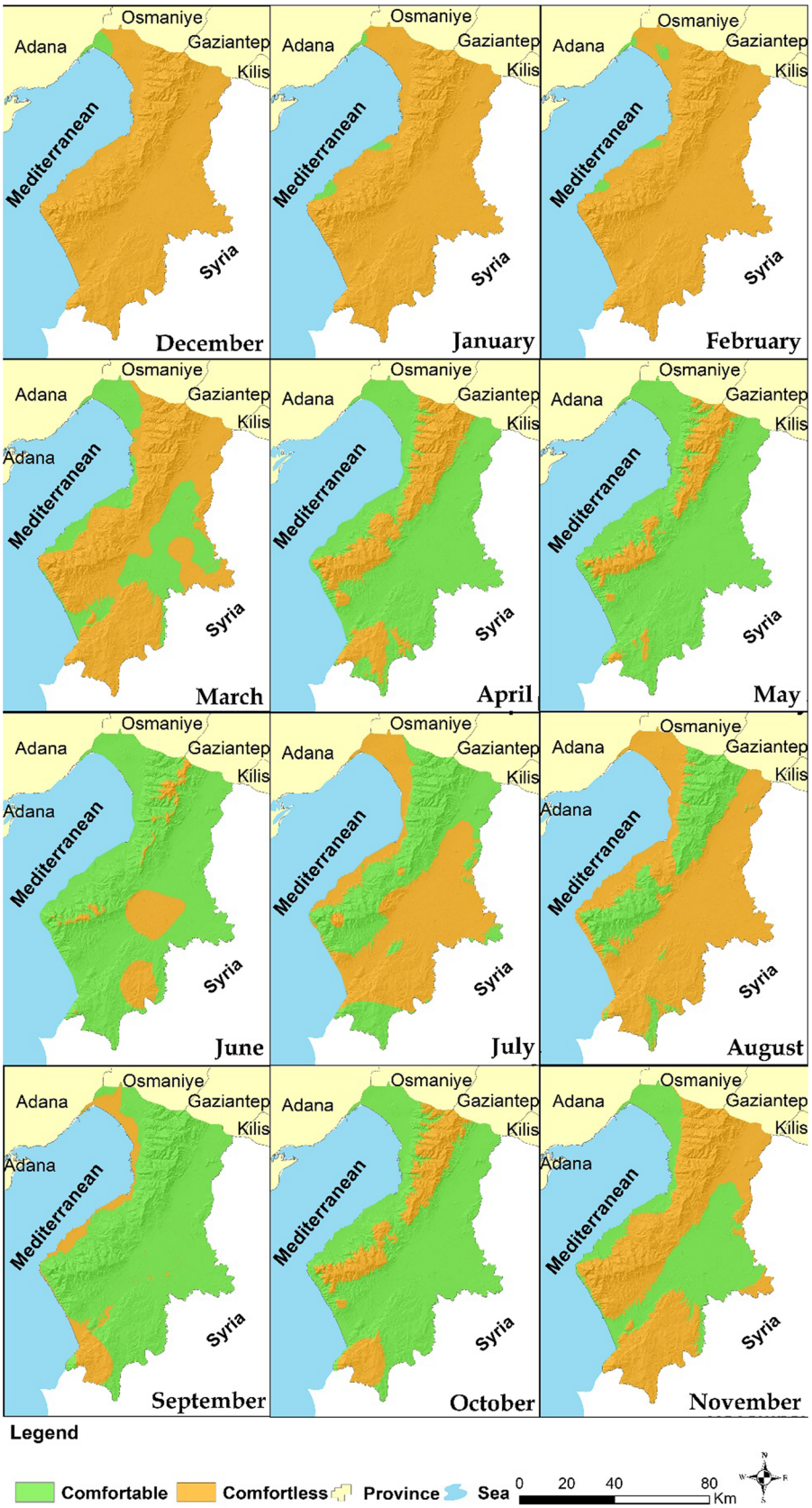

Fig. 5 Bioclimatic comfort areas in Hatay (from 1960 to 2019)

comfort. Although the wind speed decreases, the decrease in temperatures and low humidity cause low areas to be suitable throughout autumn. However, decreasing temperatures toward the end of the season cause the appropriate area to shrink. The most comfortable month in the study area is September (autumn), and this situation shows a negative change toward November.

5 Conclusions

The concluded of the overall results of the bioclimatic suitable comfort maps in Hatay was highest in the Hatay's central regions with the altitudes of high as the results of the Hatay's comforts were evaluated. The examination for thermal comfort took place for months. We also found that the less intense residential settlements are, the better is thermal comfort, as the intense settlements often "rapidly intensify" in developing countries. In other words, rapid urbanization tends to overlook some delicate factors that might be insignificant at the time but might grow in severity afterward. Planned urbanization should take bioclimatic comfort into account and should be implemented in a manner that does not allow for sudden or rapid growth to disrupt that comfort.

In studies on human bioclimatic comfort, it is generally tried to find the distribution of comfort conditions of a region during the year. As a result, it is recommended to perform outdoor activities based on outdoor activities (recreation and tourism) during periods of comfort.

Since outdoor planning and design are primarily the area of interest in the professional discipline of landscape architecture, comfortable periods should be known to know at which seasons the intensity of use of the area will be high in a region. In this way, space usage can be shaped according to comfortable periods. As can be seen from the study, bioclimatic comfort conditions are influenced by too many parameters, depending on the individual's characteristics and not. Therefore, small variations in one of the variable parameters can affect the total result very much. It is impossible to intervene in the direction of external correction of human characteristics. Therefore, external factors that affect bioclimatic comfort conditions can be controlled by various measures and corrections.

Bioclimatic comfort conditions can be improved with the criteria and principles applied in planning and design. The main purpose is to distribute the space usage in a balanced way and leave enough light green areas. Shading and moisture-providing effects of plants in adequate and suitable plantation areas prevent heat stress in summer, while deciduous plants in winter can help prevent cold stress in areas by avoiding sun rays. This and many other measures and regulations should be considered in landscape planning and design. In the case of wrong design and planning, bioclimatic comfort conditions can extremely become negative. Areas with low temperature or cold stress under natural conditions may become unsuitable for bioclimatic comfort due to dense construction and destruction of natural vegetation. The lack of sufficient green space in design and planning and intensive use of space are unfavorable in terms of bioclimatic comfort.

As a result, outdoor designs are extremely important in creating areas suitable for bioclimatic comfort. Therefore, every stage of landscape planning and design should be done with great care and without compromising the principles.

Our aim is that this study contributes significantly to land-use decisions in Hatay and that it assesses the natural and cultural values for bioclimatic comfort. We believe that it is possible to achieve the desired results and that similar works can be published, especially in touristic areas that play an active role in the field of usage decisions. Landscape architecture and planning can be improved by the application of bioclimatic comfort principles and design criteria. Planning in the wrong conditions can create extremely negative circumstances as natural vegetation cannot become suitable for bioclimatic comfort in hot- and cold-stressed areas and intense natural conditions. A significant energy loss has been detected in the construction of the new zoning plan in Turkey, and we hope this study may contribute to the energy conservation by rearranging old plans. Perhaps the most important influence of the results of this study is that it will serve as a guide in future landscape planning: a planning that brings bioclimatic comfort to the highest level and that will also help identify new settlement areas in the Hatay.

Compliance with ethical standards

Conflict of interest There is no financial and commercial support.

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