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Settlement Suitability Analysis: The Case of Bursa City

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Abstract: Recently, the existing built-up area texture in cities has started to shift towards areas that are not suitable for settlement. In this sense, settlement suitability analyses play a critical role in the realisation of sustainable development goals. Detailed analyses are required to formulate an effective settlement strategy in regions with large and diverse natural features such as Bursa. In this study, in order to determine the areas suitable for settlement in the study area, which covers the borders of Osmangazi, Nilüfer and Yıldırım districts, which are the central districts of Bursa city, a settlement suitability analysis was carried out with the Analytical Hierarchy Process (AHP) method using 9 parameters consisting of slope, elevation, lithology, land use, precipitation, temperature, distance to stream, distance to fault and erosion. The main underlying data used in the study are 10m resolution Digital Elevation Model (DEM), lithology, land use, erosion, 30m resolution precipitation, and temperature (WorldClim) data of Bursa city. As a result of the analysis, it was determined that 9% of the city is very suitable, 44% is moderate suitable and 47% is unsuitable. The area where the city was established is in very suitable and moderate suitable class. It is observed that the settlements established in the study area, especially in the areas close to the fault line and the main river branch, are in the moderate suitable and unsuitable class. In addition, it has been determined that the erosion risk is in the low class, and the settlements far from the main river branch and fault line are in the very favourable class. While it is observed that Bursa city is located at appropriate values in terms of topography, it is seen that especially the southern part of the city is not sufficiently suitable in terms of distance to fault lines. The results obtained aim to contribute to sustainable settlement planning and to provide a guide for the methods and processes to be used in settlement suitability analysis.

Keywords: Analytical Hierarchy Process (AHP), Bursa City, Settlement Suitability Analysis.

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1. INTRODUCTION

Recent rapid population growth worldwide has led to the unplanned expansion of residential areas, resulting in numerous issues related to the natural environment. Over time, as residential areas in cities have become inadequate, areas unsuitable for settlement, such as steep slopes, valley floors, fault lines, agricultural lands, forest areas, and wetlands, have also been subjected to settlement pressures. This situation has caused a shift of settlements toward unsuitable areas (Degerliyurt et al., 2014; Tekeş and Cürebal, 2019).

Unplanned urbanization, misuse of natural resources, natural disasters, changing land use, and increasing population are leading to the expansion of existing settlement areas into disaster-prone regions. Unplanned growth, incompatible with the natural environment, has led to major environmental problems such as the destruction of nature and man-made hazards (Karaoglu, 2013; Tekin et al., 2018). These problems have caused loss of life and great economic losses. Especially, the destruction caused by hazards such as floods, landslides, and earthquakes has made the effects of poor settlement decisions even more apparent (Cui et al., 2021). Therefore, the expansion of urban areas towards disaster areas has increased the importance of appropriate site selection. This situation encourages urban planners and decision-makers to be more careful and meticulous in creating sustainable and livable cities, taking into account environmental, social, and economic factors for the efficient and sustainable use of natural resources.

The widespread awareness of urban and environmental wastefulness is of great importance for local governments, especially in terms of sustainable urbanization. This situation has added a new one to the existing environmental debates on urban development and growth dynamics since the 1970s. In order to resolve the emerging controversies, it is necessary to carry out appropriate site selection studies that take into account the components of the natural environment in the settlement areas (Bayar, 2005). In this direction, the analysis of suitability for settlement enables the identification of areas that are compatible with the components of the natural environment.

Settlement suitability analysis is the process of evaluating and ranking certain settlement areas in terms of their suitability for defined uses (Jeong et al., 2013). It is also one of the basic steps for the planning and development of settlement areas (Mert and Acarer, 2018; Ozkan et al., 2019; Süel et al., 2021). The planning of a new settlement area often depends on various environmental, social, economic and political factors. Geographical Information Systems (GIS), which allows to bring together and evaluate many data, is an important tool used for this purpose (Chen et al., 2010; Özdemir, 2024). In the studies on the suitability of settlement areas, methods consisting of Analytical Hierarchy Process (AHP), Entropy Weight Method, Ecological Footprint, Fuzzy comprehensive evaluation were generally used and reliable results were obtained (Wang et al., 2017; Tang et al., 2017).

Many researches have been carried out on appropriate site selection and land planning in urban areas to find solutions to unplanned settlement problems (Erinc, 1980; Gupta, 2006; Nidumolu et al., 2006; Dai et al., 2001; Ekinci and Sonmez, 2007; Uy and Nakagoshi 2008; Özşahin and Kaymaz, 2015). The common aim of these studies is to assess how suitable a particular area is for settlement in line with various parameters. As a result of these analyses, sustainable and safe settlement areas are determined by taking into consideration factors such as natural disaster risks, environmental factors, infrastructure facilities, social and economic needs. In this way, it is aimed to prevent unplanned and irregular urbanization and to use resources effectively and efficiently.

The aim of this study is to conduct a suitability analysis for settlement in the districts of Osmangazi, Nilüfer, and Yıldırım within the city of Bursa using the AHP method, one of the Multi-Criteria Decision Making (MCDM) techniques. In the study, the question of where the research area is suitable for settlement was sought with the help of GIS techniques by using nine parameters: slope, elevation, lithology, land use, precipitation, temperature, distance to the stream, distance to the fault, and erosion. In this respect, the study is of great importance in terms of providing benefits to local administrators, researchers and planners to design the plans of settlement areas.

2. STUDY AREA

Bursa province is located between 39º 35' and 40º 40' east longitudes and 28º 10' and 30º 10' north latitudes in the south of the Marmara Sea in northwest Turkey. The province, which is largely within the borders of the Marmara Region, is surrounded by Kocaeli and Yalova to the north, Eskisehir and Kütahya to the south, Bilecik and Sakarya to the east, and Balıkesir to the west. Bursa, which has a total area of 10.886 km², has 17 districts including Büyükorhan, Gemlik, Gürsu, Harmancık, İnegöl, İznik, Karacabey, Keles, Kestel, Mudanya, Mustafakemalpasa, Orhaneli, Orhangazi, Nilüfer, Osmangazi, Yenisehir and Yıldırım. In this study, the central districts of Osmangazi, Nilüfer and Yıldırım within the borders of Bursa city constitute the study area (Figure 1).

Osmangazi, Nilüfer and Yıldırım districts are important regions of Bursa, reflecting its general structure and diversity. The study area is located in the south of Bursa Plain, on the northwestern foothills of Uludag. Uludag has a peak that rises to 2543 meters, starting from 100 meters above the Bursa Plain and creating flat areas at different elevation levels over a short distance. This city, which shows diversity from a geomorphological perspective, has besides main geomorphological units such as mountains, plateaus, and plains, landforms with very different characteristics, such as alluvial fans.

The geological structure of Bursa city generally consists of metamorphic, ophiolitic, volcanic, plutonic and sedimentary rock types representing the Paleozoic - Quaternary time interval. Bursa, Sogukpinar and Uluabat faults were effective in shaping the city structurally.

The study area has a transitional climate type between the Black Sea and Mediterranean climates. There are significant elevation differences between Bursa Plain and Uludag in a short distance, which leads to the diversification of the climate. The hottest months in the study area are July-September and the coldest months are February-March.

The most significant factor in the development of the current relief features of the city is the rivers. The alluvium brought by the rivers accumulates in areas where the slope decreases, forming intra-mountainous plains, piedmont plains, and alluvial fans. The city, which drains its waters into the Sea of Marmara via the Nilüfer Stream, has numerous seasonal or permanent rivers.

The study area is of great importance in terms of understanding the historical, cultural, economic and social dynamics of the city. However, it also offers important opportunities in terms of its location and ecological structure (Figure 2). Bursa is one of the most populous cities in Turkey in terms of population. The areas where the population (2.083.47) is concentrated in Bursa are Osmangazi, Yıldırım and Nilüfer districts (TÜİK, 2023).

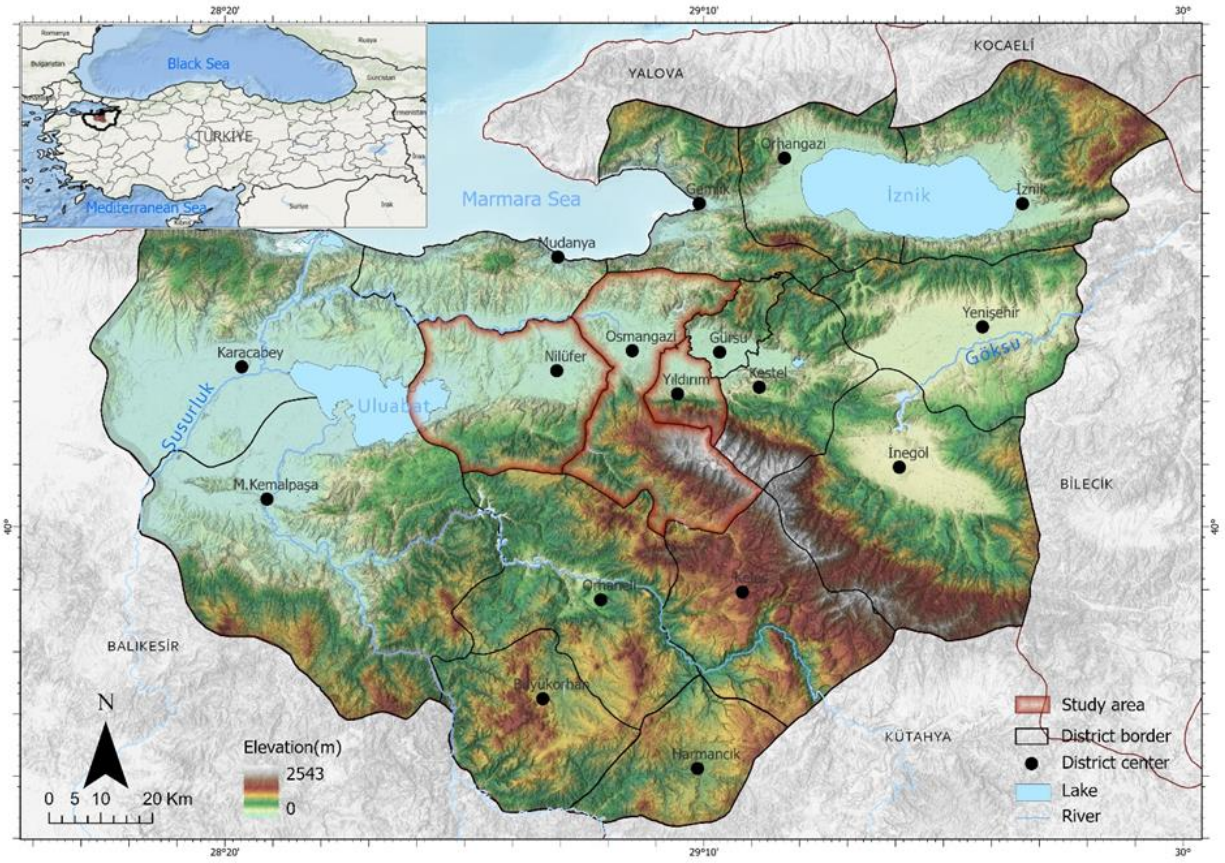

Figure 1. Location map of the study area.

Figure 2. Satellite image of settlement distribution in the study area.

3. MATERIAL AND METHOD

In the study, 10m resolution Digital Elevation Model (DEM), 1/100.000 scale lithology digital data and 30m resolution raster precipitation and temperature (WorldClim) data produced by Fick and Hijmans (2017), 1/25000 scale erosion data prepared by the General Directorate of Rural Services, and Corine land use data, whose applicability has been demonstrated in many national and international studies, constitute the basic base data. In settlement suitability analyses, the determination of suitable areas depends on many factors. In the study, using 9 parameters including slope, elevation, lithology, land use, precipitation, temperature, distance to rivers, distance to faults, and erosion, the suitability of the study area for settlement was investigated using GIS techniques to answer the question of where the most suitable areas for settlement are. In line with the purpose of the study, AHP, which is one of the MCDM methods widely used in the decision-making process of GIS-based applications, was utilized as a method. MCDM is a method that provides the opportunity to evaluate many measurable and unmeasurable parameters at the same time, and in addition, it can include a large number of parameters in the decision-making process (Dagdeviren et al., 2005).

AHP was first introduced by Saaty in 1977. In the AHP method, it is first necessary to determine the importance of each causative parameters suitability for settlement based on a binary evaluation. There are certain numerical values required for this. In this direction, pairwise comparisons and percentage importance distributions of the factors are made using the 1-9 comparison importance scale developed by Saaty, as shown in Table 1 (Yaralioglu, 2001).

Table 1. Analytic hierarchy process evaluation scale (Saaty, 1977).

İmportance value	Value definitions
1	Both factors are of equal importance
3	Factor 1 is more important than factor 2
5	Factor 1 is much more important than factor 2
7	Factor 1 is much stronger important than factor 2
9	Factor 1 is much superiority important than factor 2
2,4,6,8	Intermediate values

AHP helps users to determine the weights of parameters in solving a multi-criteria problem. It provides mathematical measures to determine the consistency of the decision matrix. The consistency index, which measures the consistency of binary comparisons, can be calculated using the following equation.

$$CI = \frac{\lambda max - n}{n-1} \qquad \textit{(Equality 1)}$$

In Equation 1, CI is the consistency index, n is the number of items compared in the matrix, λmax is the largest or principal eigenvalue of the matrix. In Equation 2, CR is the consistency ratio, CI is the consistency index and RI is the random index. A consistency ratio coefficient of less than 0.1 has a positive meaning. (Hanbali et al., 2021). Saaty (1977), suggested that if this ratio exceeds 0.1, the judgments might be too inconsistent to be reliable. A CR ratio of 0 indicates that the decision is completely consistent.

$$CR = \frac{CI}{RI} \qquad \textit{(Equality 2)}$$

Within the scope of the study, the class and percentage importance weights of the parameters whose scale coefficients were determined were obtained in a way to ensure consistency (Table 2). AHP weight values are determined according to the preferences of the decision makers and the weighting of the factors has an important effect on obtaining the result. In this context the validity of consistency was checked by calculating the consistency index and ratio. Subsequently, alternatives were determined considering these criteria, and a hierarchical structure was established.

Table 2. Parameters evaluated in the study and weights.

Parameters	Parameter classes	Suitability class	Weight
Slope	0-5	4	0.16
	5-10	3	
	10-15	2	
	15>	1	
Elevation (m)	0-300	4	0.12
	300-600	3	
	600-900	2	
	900>	1	
Lithology	Ophiolitic	1	0.07
	Plutonic	1	
	Volcanic	2	
	Metamorphic	3	
	Sedimentary	4	
Temperature (°C)	2.7-4.7	1	0.09
	4.7-6.7	2	
	6.7-8.7	3	
	8.7>	4	
Precipitation (mm)	531-617	4	0.09
	617-704	3	
	704-791	2	
	791>	1	
Distance to river	0-300 m	1	0.13
	300-1000	2	
	1000-2000	3	
	2000>	4	
Distance to fault	0-45	1	0.10
	45-90	2	
	90-135	3	
	135>	4	
Land use	Wetland	1	0.14
	Forest and natural area	2	
	Agricultural land	3	
	Settlement area	4	
Erosion	Low	4	0.10
	Moderate	3	
	High	2	
	Very high	1	

4.RESULTS and DISCUSSION

4.1. Parameters Used in Settlement Suitability Analysis

In the scope this study, to analyze the settlement suitability of Bursa city, 9 parameters consisting of slope, elevation, lithology, land use, precipitation, temperature, distance to streams, distance to faults, and erosion were applied to the study area (Figure 3). At this stage of the study, the values of parameters other than lithology, land use, and erosion were given as ranges and were not classified.

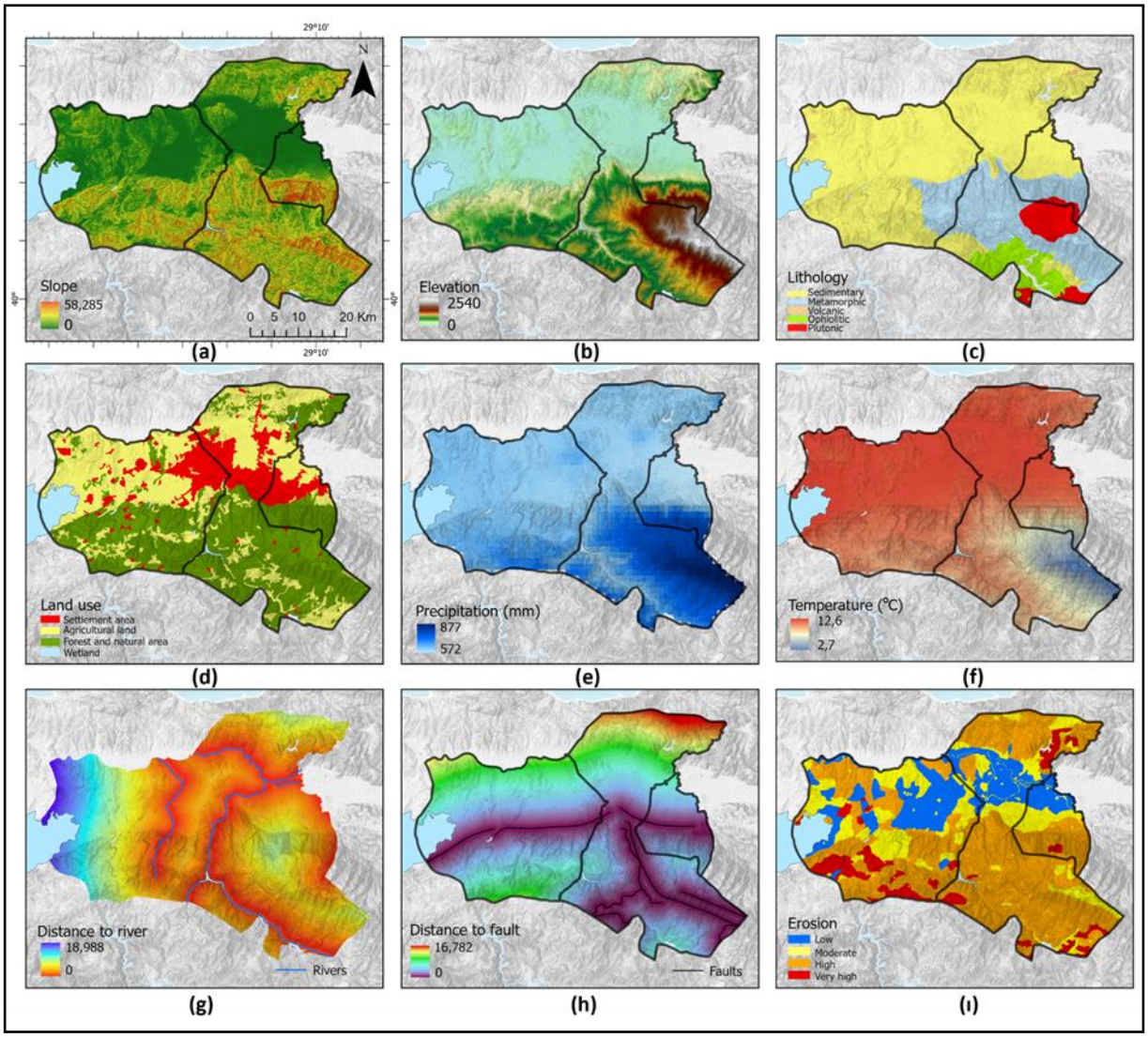

Figure 3. (a) slope, (b) elevation, (c) lithology, (d) land use, (e) precipitation, (f) temperature, (g) distance to river, (h) distance to fault, (ı) erosion (Value distributions of the parameters evaluated for the suitability for settlement analysis).

Slope: For settlement areas, slope refers to the degree of slope of the land. In the study area, slope values vary between 0 and 58 (Figure 3a). Steep slopes, generally with high gradients, reduce the suitability of land for settlement by introducing various challenges and additional costs, leading to infrastructure and transportation difficulties (Alam et al., 2023). For this reason, gently sloping areas were preferred for settlement in the study.

Elevation: It refers to the height of the settlement area above sea level. The elevation range of the study area varies between 0 and 2540 m (Figure 3b). Elevation is an important parameter in the selection and planning of settlements (Jeong et al., 2013). The reason directly affects climatic conditions, water resources, soil characteristics and infrastructure challenges. High areas are not suitable for settlement due to landslides, landslip and other geological risks. However, settlements established on the riversides or valley floors in low-lying areas are also exposed to flood risk. For this reason, this was prevented by considering the distance to the river parameter in the study.

Lithology: Lithological features help us to recognize the region in terms of topography. It is an important parameter as it greatly influences groundwater and surface water movement and accumulation (Miller, 1990). A distribution of sedimentary, metamorphic, volcanic, ophiolitic and plutonic rock groups is observed in the study area. Places where Plutonic and Ophiolitic rocks are observed are not suitable for settlement as the water will directly flow to the surface during sudden downpours (Figure 3c).

Land use: Land use are one of the important parameters in defining the earth. In settlement suitability analysis, land use should be considered as a basic parameter to prevent unplanned and uncontrolled development in urban areas. This is essential to ensure sustainable and orderly urbanization, conservation of natural resources and efficient delivery of infrastructure services. The study area consists of 4 classes: settlement area, agricultural area, forest and natural areas and finally wetlands (Figure 3d). Forest and natural areas and wetlands are considered as restricted areas for human settlement. Agricultural and settlement areas are

more important areas for settlement development as they are important for human livelihoods (Alam et al., 2023).

Precipitation: Precipitation is a highly influential parameter in the occurrence of disasters of hydrological origin (MGM, 2021). In areas of high rainfall, draining water and protecting infrastructure will be more difficult, making low rainfall areas more suitable for sustainable and safe settlements. When the precipitation data was applied to the study area, it was found that the values varied between 572 and 877 mm (Figure 3e).

Temperature: It directly affects the climate, agricultural productivity and quality of life of the region. Temperature is a determining factor especially for agricultural production. Appropriate temperature values are essential for the growth of plants and the sustainability of agriculture. When the temperature data was applied to the study area, it was found that the values varied between 2.7 and 12.6 (ºC) (Figure 3f). The part of the study area where the Bursa plain is located has high temperatures, while the part where the Uludag massif is located has the lowest temperature.

Distance to river: Although being close to rivers provides various services to people, settlements close to rivers are at high risk. It has also been observed that the vulnerability of settlements decreases as they move away from rivers (Ghosh and Kar, 2018). In this study, areas far from the river were considered suitable for settlement. The distance to the river in the study area varies between 0 and 18,988 (Figure 3g).

Distance to fault: Proximity to fault lines increases the risk of seismicity. Earthquakes cause damage to structures, loss of life and disruption of infrastructure. However, this varies depending on factors such as the intensity of the earthquake, its depth, proximity to the settlement and the durability of the structure. Therefore, areas away from fault lines are considered safer for settlements. In the study area, the distance to the fault varies between 0 and 16,782 (Figure 3h).

Erosion: The erosion parameter plays a critical role in assessing the risks of landslides and surface erosion. It reduces land productivity and threatens the safety of infrastructure. Soil susceptibility is low in erosion-prone areas, jeopardizing the safety of buildings and roads. In terms of suitability for settlement, areas with low erosion risk were given a score of 4, areas with moderate erosion risk were given a score of 3, areas with high erosion risk were given a score of 2 and areas with very high erosion risk were given a score of 1 (Figure 3ı).

4.2. Settlement Suitability Analysis

Most of the cities that are not built-in appropriate areas face various risks. Turkey has a susceptibility to various natural disasters such as earthquakes, floods and landslides due to its geographical location and geological structure (CRED, 2023). The city of Bursa has also been under the influence of these risks from past to present. In order to better understand the impact of these risks and the process of settlement suitability analysis, after analyzing the 9 parameters applied to the study area, the weight values of all parameters were calculated and overlay was performed with the AHP method. After this process, three suitability classes were defined on the settlement suitability map: Very suitable, moderate suitable, unsuitable. The distribution of the area covered by these classes is 9% very suitable, 44% moderate suitable, 47% unsuitable (Figure 4). The AHP consistency index (CI) of the 9 parameters used in this study is 0.05, the consistency ratio (CR) is 0.04. Similarly, Vilasan and Kapse (2022) found the AHP consistency ratio as 0.04 in their study. Hammami et al., (2019) found the CR value to be 0.013 and Kazakis et al., (2015) found it to be 0.08. According to AHP, the CR value should be <0.1 to validate the weight; otherwise, the weights of the comparison matrix need to be recalculated (Swain et al., 2020).

When the settlement suitability analysis result map of Bursa city is examined, it is seen that the areas close to the fault line and main river branch have moderate suitable and unsuitable, while the areas with high elevation, steep slope, high precipitation, low temperature and high and very high erosion risk are unsuitable for settlement. In addition, it was determined that slope, elevation and precipitation parameters showed low values, and settlements far from the main river branch and fault line were in a very suitable class.

Since settlements close to water sources in the study area may face flood hazards, various measures need to be taken. While it is observed that the city of Bursa is located in topographically appropriate values, it is seen that especially the southern part of the city is not built appropriately enough in terms of distance to fault lines. Settlements located close to rivers and fault lines therefore have moderate suitable and unsuitable.

The northern part of the study area is more suitable for settlement than the southern part. The reason for this is that the southern part of the district borders is located in a mountainous area that is unsuitable for settlement. The mountainous area is unsuitable for settlement due to its high elevation, gradually increasing slope, high and very high erosion risk, being located in forest and natural areas in terms of land use, and the lithological units do not show a distribution suitable for settlement.

In this study, a GIS based, medium resolution (10m) settlement suitability analysis was carried out for the city of Bursa. Using the AHP based on expert opinion, settlement suitability analyses and syntheses were carried out as a basis for planning, thus contributing to the identification of potential development directions.

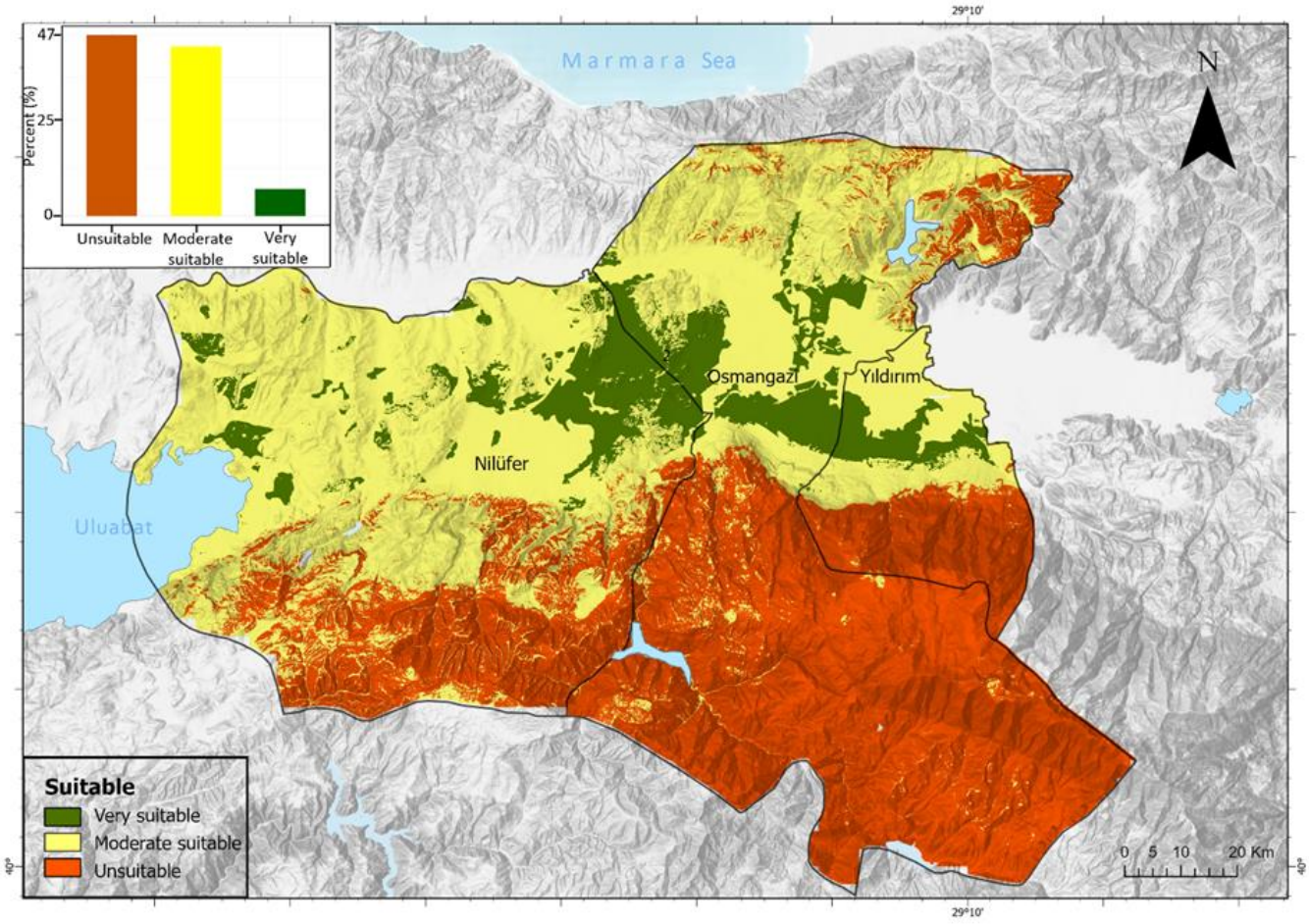

Figure 4. Settlement suitability analysis of Bursa city.

5. CONCLUSIONS

In order to determine the most suitable area for new development areas in the study area, which covers the borders of Osmangazi, Nilüfer and Yıldırım districts, which are the central districts of Bursa city, a settlement suitability analysis was carried out using GIS. In this respect, a comprehensive urban settlement suitability analysis has been carried out to identify potential and appropriate regional development directions for the city of Bursa and to form the basis for urban planning studies. For this purpose, after analyzing 9 parameters consisting of slope, elevation, lithology, land use, precipitation, temperature, distance to stream, distance to fault and erosion, the weight values of all parameters were calculated and overlay was performed with the AHP method. Determining the impact of the 9 parameters evaluated in the study for settlement suitability analysis, their priority order and weight for the study area is a comprehensive process based on expert opinion within the scope of the AHP method. As a result of the settlement suitability analysis for Bursa city, it was determined that 9% of the city is very suitable, 44% is moderately suitable, and 47% is unsuitable. The area where the city is located found the very suitable and moderate suitable classes. When the settlement suitability analysis result map of Bursa city is examined, it is seen that the areas close to the fault line and main river branch have moderate suitable and unsuitable, while the areas with high elevation, steep slope, high precipitation, low temperature and high and very high erosion risk are unsuitable for settlement. In addition, it was determined that slope, elevation and precipitation parameters showed low values and settlements far from the main river branch and fault line were in a very suitable class. Since settlements close to the river in the study area may face flood hazards, various measures should be taken. While it is observed that the city of Bursa is located in topographically appropriate values, it is seen that especially the southern part of the city is not sufficiently suitable in terms of distance to fault lines. In recent years, the city has been at the forefront with its identity as an industrial city. The increase in industry and urbanization together with the migration from rural to urban areas has led to the destruction of fertile agricultural lands in the city and increased out of purpose. This situation still continues today. Therefore, it is necessary to prepare land use plans and projects in order to reduce the misuse of land and its use in risky areas. For a solution, strategic planning should be made to support the development of regions suitable for settlement, and infrastructure and transport investments should be directed to these areas. In unsuitable areas, the natural structure should be preserved and conservation policies should be developed for these areas. The results will contribute to a sustainable and environmentally susceptibility settlement planning.

Ethics Committee Approval
N/A

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Conflict of Interest
The authors have no conflicts of interest to declare.

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REFERENCES

Alam, N., Saha, S., Gupta, S., Chatterjee, A. (2023). Settlement suitability analysis of a riverine floodplain in the perspective of GIS-based multicriteria decision analysis. Environmental Science and Pollution Research, 30(24), 66002-66020.

Bayar, R. (2005). CBS yardımıyla modern alışveriş merkezleri için uygun yer seçimi: Ankara örneği. Coğrafi Bilimler Dergisi, 3(2), 19-38.

Chen, Y., Yu, J., Khan, S. (2010). Spatial sensitivity analysis of multi-criteria weights in GIS-based land suitability evaluation. Environmental Modelling & Software, 25(12), 1582–1591.

Cui, P., Peng, J., Shi, P., Tang, H., Ouyang, C., Zou, Q., Liu, L., Li, C., Lei, Y. (2021). Scientific challenges of research on natural hazards and disaster risk. Geography and Sustainability, 2(3), 216-223.

CRED, (2023). 2022 Disasters in Numbers. Brussels. This document is available at: https://cred.be/sites/default/files/2022_EMDAT_report.pdf

Dağdeviren, M., Eraslan, E., Kurt, M., Dizdar, E. N. (2005). Tedarikçi seçimi problemine analitik ağ süreci ile alternatif bir yaklaşım. Teknoloji, 8(2), 115-122.

Değerliyurt, M. (2014). İskenderun-Arsuz ilçelerinin (Hatay) CBS tabanlı zemin hareketleri duyarlılık analizi. Electronic Turkish Studies, 9(5), 655-678.

Dai, F. C., Lee, C. F., Zhang, X. H. (2001). GIS-based geo-environmental evalution for urban land-use planning: a case study. Engineering Geology, 61(4), 257-271.

Ekinci, D., Sönmez, E. (2007). İstanbul konürbasyonunun yeni habitat adacığında CBS tabanlı jeoekolojı planlama analizi. Türk Coğrafya Dergisi, (46), 147-167.

Erinç, S. (1980). Jeoekoloji açısından İstanbul yöresi. İstanbul Üniversitesi Coğrafya Enstitüsü Dergisi, 23, 279-290.

Fick, S. E., Hijmans, R. J. (2017). WorldClim 2: new 1-km spatial resolution climate surfaces for global land areas. International Journal of Climatology, 37(12), 4302-4315.

Ghosh, A., Kar, S. K. (2018). Application of analytical hierarchy process (AHP) for flood risk assessment: a case study in Malda district of West Bengal, India. Natural Hazards, 94(1), 349–368.

Gupta, J. P. (2006). Land use planning in Indıa. Journal of Hazardous Materials, 130, 300- 306.

Hammami, S., Zouhri, L., Souissi, D., Souei, A., Zghibi, A., Marzougui, A., Dlala, M. (2019). Application of the GIS based multi-criteria decision analysis and analytical hierarchy process (AHP) in the flood susceptibility mapping (Tunisia). Arabian Journal of Geosciences, 12(21), 1-16.

Jeong, J. S., García-Moruno, L., Hernández-Blanco, J. (2013). A site planning approach for rural buildings into a landscape using a spatial multi-criteria decision analysis methodology. Land Use Policy, 32, 108–118.

Karaoglu, G. T. (2013). İstanbul Küçükçekmece ilçesinin mühendislik jeolojisi ve yerleşime uygunluk değerlendirmesi. İstanbul Teknik Üniversitesi, Fen Bilimler Enstitüsü, Jeoloji Mühendisliği Ana Bilim Dalı, Yüksek Lisans Tezi.

Kazakis, N., Kougias, I., Patsialis, T. (2015). Assessment of flood hazard areas at a regional scale using an index-based approach and analytical hierarchy process: application in Rhodope–Evros region, Greece. Science of the Total Environ, 538, 555–563.

MGM, (2021). Yılı Meteorolojik Afetler Değerlendirmesi. T.C. Çevre, Şehircilik ve İklim Değişikliği Bakanlığı, Meteoroloji Genel Müdürlüğü.

Mert, A., Acarer, A. (2018). Wildlife Diversity in Reed Beds Around Beyşehir Lake. Bilge International Journal of Science and Technology Research, 2(1), 110-119.

Miller, A. J. (1990). Flood hydrology and geomorphic effectiveness in the central Appalachians. Earth Surface Processes and Landforms, 15(2), 119-134.

Nidumolu, U. B., De Bie, C. A. J. M., Van Keulen, H., Skidmore, A. K., Harmsen, K. (2006). Review of a land use planning programme through the soft systems methodology. Land Use Policy, 23(2), 187-203.

Özdemir, S. (2024). Testing the Effect of Resolution on Species Distribution Models Using Two Invasive Species. Polish Journal of Environmental Studies, 33(2), 1325-1335.

Özkan, B., Özceylan, E., Sarıçiçek, İ. (2019). GIS-based MCDM modeling for landfill site suitability analysis: a comprehensive review of the literature. Environmental Science and Pollution Research, 26(30), 30711–30730.

Özşahin, E., Kaymaz, Ç. (2015). CBS ve AHS kullanılarak doğal çevre bileşenleri açısından kentsel mekânın yerleşime uygunluk analizine bir örnek: Antakya (Hatay). Doğu Coğrafya Dergisi, 20(33), 111-134.

Saaty, T. L. (1977). A scaling method for priorities in hierarchical structures. Journal of Mathematical Psychology, 15(3), 234-281.

Süel, H., Ünal, Y., Özdemir, S., Koca, A. (2021). Hunting tourism map of Wild goat: antalya district. Bilge International Journal of Science and Technology Research, 3(1), 77-86.

Swain, K. C., Singha, C., Nayak, L. (2020). Flood susceptibility mapping through the GIS-AHP technique using the cloud. International Journal of Geo-Information, 9(12), 1-23.

Tang, L., Ruth, M., He, Q., Mirzae, S. (2017). Comprehensive evaluation of trends in human settlements quality changes and spatial differentiation characteristics of 35 Chinese major cities. Habitat International, 70, 81-90.

Tekeş, A., Cürebal, İ. (2019). Arazi Kullanımı İle Yükselti Ve Eğim Özellikleri Arasındaki İlişkinin Analizi: Şehzadeler (Manisa) İlçesi. Turkish Studies-Social Sciences, 14(4), 1787-1806.

Tekin, S., Yalçınkaya, B., Acarer, A., Mert, A. (2018). A research on usage possibilities of satellite data in wildlife: Modeling habitat suitability of Roe deer (Capreolus capreolus L.) with MaxEnt. Bilge International Journal of Science and Technology Research, 2(2), 147-156.

TÜİK (2023).https://data.tuik.gov.tr/Bulten/Index?p=Adrese-Dayali-Nufus-Kayit-Sistemi-Sonuclari-202349684

Uy, P. D., Nakagoshi, N. (2008). Application of land suitability analysis and landscape ecology to urban greenspace planning in Hanoi, Vietnam. Urban Forestry & Urban Greening, 7(1), 25-40.

Wang, Y., Jin, C., Lu, M., Lu, Y. (2017). Assessing the suitability of regional human settlements environment from a different preferences perspective: A case study of Zhejiang Province, China. Habitat International, 70, 1-12.

Yaralıoğlu, K. (2001). Performans değerlendirmede analitik hiyerarşi proses. Dokuz Eylül Üniversitesi İktisadi İdari Bilimler Fakültesi Dergisi, 16(1), 129-142.