Modeling Cultural Ecosystem Services Using Social Media Photos: The case of Denizli, Türkiye

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Abstract: Cultural ecosystem services, a complex interplay between humans and landscapes, significantly influence identity, well-being, and social connections. These services, provided through natural and cultural landscapes, can be better understood through spatial data. Using geotagged photos from Flickr, this study delves into user behavior and preferences in Denizli, Türkiye. The aim is to enrich sustainable landscape management by mapping temporal and spatial changes in visitor patterns. The spatial distribution patterns revealed that user activities are predominantly scattered around the city center, historical sites, cultural hubs, and facilities-equipped recreational places. The findings unveiled a concentration in the northwest region in terms of cultural heritage, aesthetic, and recreational values. The period when visitors shared the most photos was between July and October. The study's originality lies in its unique approach to mapping visitor-preferred hotspots and landscape values at the provincial scale, identifying previously unmentioned locations such as Maymun Mountain and the Dodurgalar district. The research underscores the importance of integrating natural and cultural landscape values into urban management and ensuring coordinated efforts to maintain the uniqueness of cities. The practical implications of this study are significant, as they provide valuable insights for urban planners and policymakers interested in sustainable landscape management. Despite the methodological constraints of geotagged social media data, it remains a more time and cost-effective tool. It provides abundant and up-to-date information on user preferences and movements, enabling analysis of spatial and temporal patterns.

Keywords: Cultural ecosystem services, landscape preferences, visitor patterns, geotagged photos, landscape management

Sosyal Medya Fotoğrafları Kullanılarak Kültürel Ekosistem Hizmetlerinin Modellenmesi: Denizli, Türkiye Örneği

Öz: *Kültürel ekosistem hizmetleri kavramı, insanlar ve peyzajlar arasında kimlik, refah ve sosyal bağlantıları etkileyen karmaşık etkileşimleri içerir. Kültürel ekosistem hizmetleri doğal ve kültürel peyzajlar aracılığıyla sağlanır ve mekânsal veriler insanların bu ortamları nasıl algıladıklarını ve kullandıklarını anlamaya yardımcı olur. Bu çalışmada, Denizli'deki kullanıcı davranışlarını ve tercihlerini analiz etmek için Flickr platformu üzerinden temin edilen coğrafi etiketli fotoğraflar kullanılarak, ziyaretçi örüntülerindeki zamansal ve mekânsal değişiklikler haritalandırılmış ve sürdürülebilir peyzaj yönetiminin desteklenmesi amaçlanmıştır. Mekânsal dağılım örüntüleri, kullanıcı faaliyetlerinin öncelikle şehir merkezi, tarihi alanlar, kültürel merkezler ve rekreasyon alanları etrafında dağıldığını göstermiştir. Bulgular, kültürel miras, estetik ve rekreasyonel değerler açısından Denizli'nin kuzeybatı bölgesinde bir yoğunlaşma olduğunu ortaya koymuştur. Ziyaretçilerin en çok fotoğraf paylaştığı dönem Temmuz ve Ekim ayları arası olmuştur. Bu çalışmanın özgünlüğü, Maymun Dağı ve Dodurgalar bölgesi gibi daha önceki çalışmalarda bahsedilmemiş yerlerin tespit edilerek ziyaretçilerin tercih ettiği noktaları ve peyzaj değerlerini il ölçeğinde haritalandırmasında yatmaktadır. Araştırma, doğal ve kültürel peyzaj değerlerinin kent yönetimine entegre edilmesinin ve kentlerin kimlik değerlerini korumak için meslekler ve kurumlar arası eşgüdümlü çabaların sağlanmasının önemini vurgulamaktadır. Coğrafi etiketli sosyal medya verilerinin kullanımı bazı metodolojik kısıtlamalara sahip olsa da daha fazla zaman ve maliyet etkinliğinin yanı sıra, sosyal peyzaj değeri olan mekânlar hakkında bol miktarda ve güncel bilgi sunmaktadır.*

Anahtar Kelimeler: *Kültürel ekosistem hizmetleri, peyzaj tercihleri, ziyaretçi örüntüleri, coğrafi etiketli fotoğraflar, peyzaj yönetimi*

INTRODUCTION

Cultural ecosystems are dynamic systems characterized by complex interactions between humans and the landscape (Berkes et al., 1998). The landscape transcends aesthetic value within these systems, profoundly influencing individuals' sense of identity, well-being, and social connections. The social value of a landscape is determined by the non-material benefits that arise from the significant connections people make with it (Daniel, 2001). Tuan (1997) and Zube (1987) emphasize that the social value of a landscape is a subjective assessment that is inherently place-related, contextual, and spatially variable (Fagerholm & Käyhkö, 2009).

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Cities are integral components of cultural ecosystems and offer various ecosystem services stemming from their natural and cultural attributes. Parks and gardens, for instance, serve as spaces for relaxation and socialization, while historical and cultural sites contribute to a sense of identity and belonging. The urban ecosystem approach extends this perspective, considering cities as ecosystems wherein all services are produced through built, natural, or hybrid systems (Grimm et al., 2015).

Spatial data regarding cultural ecosystems provide insights into how people operate and perceive the environment (Fagerholm & Käyhkö, 2009). These data are instrumental in assessing the social value of landscapes. In planning studies that neglect social value, the crucial aspect of human utilization, which significantly impacts landscape dynamics, is overlooked, leading to deficiencies in site management strategies (Aksu, 2014). Therefore, monitoring the temporal-spatial visitation patterns and user experiences becomes imperative for effective site management and marketing. Also, user data is essential for identifying patterns, assigning resources, and creating efficient management strategies.

In participatory planning studies, traditional methods like semi-structured interviews (Gunderson &Watson, 2007; Strickland-Munro et al., 2015; Tekin Cüre, 2021), surveys (Baylan, 2012; Arslan et al., 2021), or crowdsourced data obtained from social media can be used for data collection, yet they are often time-consuming and costly. Alternatively, social media data, particularly geotagged photos, offer a promising avenue for studying human behavior and preferences related to cultural ecosystem services (Kaymaz et al., 2021; Arslan & Örücü, 2021; Uslu, 2021; Zhang et al., 2022). These datasets have been successfully employed to estimate visits to tourist and recreational areas and determine decision-making processes.

While social media platforms such as Facebook, Flickr, and Instagram provide rich user-generated content related to cultural ecosystem services (Arslan & Örücü, 2020), it is essential to acknowledge their limitations. Platforms like Facebook and Instagram, famous for photo and video sharing, restrict data sharing due to privacy policies implemented since 2019. In contrast, Flickr offers free access to photos for non-commercial purposes (Flickr API, 2021). Hence, in this research, the Flickr platform was selected as the data source for obtaining metadata, given its extensive collection of photos and past use in similar studies.

This study uses social media data to spatially represent cultural ecosystem services in Denizli, Türkiye. By allowing exploration and analysis of user perceptions and preferences related to cultural ecosystems, the study provides valuable insights for sustainable landscape management practice. With its significant potential in cultural and health tourism, Denizli province is an ideal study area due to its rich historical heritage, cultural diversity, and underground resources. The research focuses on modeling temporal and spatial changes in touristic and recreational activities within Denizli province using geotagged photos from Flickr, culminating in analyzing user behavior through trend graphs and density maps derived from geotagged photo data. The practical implications of this research are vast, offering a roadmap for effective site management and marketing strategies.

MATERIAL and METHOD

Study Area

The study area, Denizli province, is a significant location for this research. Situated between 37º 12' and 38º 12' north latitudes and 28º 30' and 29º 30' east longitudes, it covers an area of 11,868 km2. Located in the southwest of the Anatolian peninsula, east of the Aegean Region, Denizli serves as a crossroads between the Aegean-Central Anatolia and Mediterranean Regions (T.C. Denizli Governorship, 2020). This study considers the administrative boundary of Denizli as the study area (Figure 1). Denizli is in the Lycos Valley, boasting fertile soils and rich historical, archaeological, and natural resources. The province is a famous Turkish tourist destination for its textile, trade, manufacturing, agriculture, and renowned cultural and tourist destinations like Pamukkale. With a population of 1,059,082 (TÜİK, 2023), Denizli offers a diverse and dynamic landscape for cultural ecosystem services.

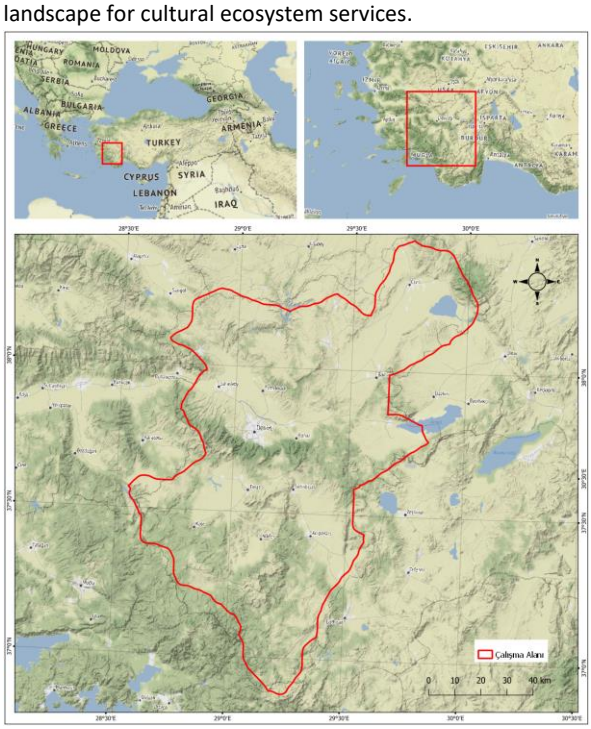


Figure 1. Study area

The history of Denizli is extensive, with settlements dating back to the Chalcolithic Period. (DİKTM, 2017). Civilizations

like the Hittites, Phrygians, Romans, and Byzantines left their mark on the region, contributing to the nearly 1,000 registered cultural assets (DİKTM, 2017). This impressive collection encompasses 19 ancient cities, archaeological and natural sites, and diverse examples of civil architecture, offering a glimpse into the area.

Denizli is a popular destination for religious tourism, with Christian churches and Muslim tombs scattered throughout the city (DİKTM, 2017). However, Pamukkale remains the most popular destination for many. This UNESCO World Heritage Site features unique natural formations, including the famed travertine terraces, alongside the captivating ancient city of Hierapolis. Pamukkale's popularity has increased, attracting over 2.5 million users annually, solidifying Denizli's position as a major center for cultural, religious, and health tourism (DİKTM, 2017). Figure 2 displays Denizli's significant cultural areas.

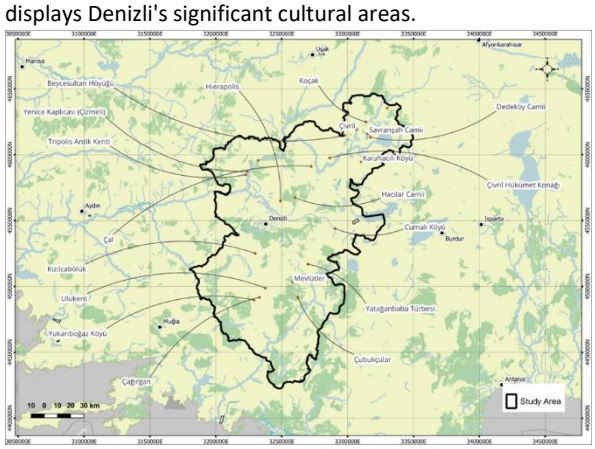


Figure 2. Cultural points of interest in Denizli

Denizli, renowned for its natural resources, is home to a variety of natural attractions including Honaz Mountain National Park, Beyağaç Kartal Lake Natural Reserve, Akdağ Nature Park, Işıklı Gökgöl and Acıgöl, Buldan Yayla Lake Wetland, Akdağ and Beylerli wildlife development areas, hunting grounds, plateaus like Yatağan Kefe and Topuklu Plateau, and caves such as Kaklık and Doğurgalar Keloğlan (Figure 3).

Also, adventurers can enjoy paragliding in Honaz Mountain, Çökelez Mountain, Bozdağ, Çameli Yaylacık Mountain, and Pamukkale Ruins; cycling tours in Honaz Mountain National Park, Beyağaç Eagle Lake, Güney Waterfall, Çal Ağlayan Kaya Waterfall; canoeing and rafting in Dalaman Stream and Büyük Menderes's big canyons in Bekilli and Çal districts; water sports in Işıklı and Gökpınar Lakes and Adıgüzel Dam; trekking and horse riding in areas such as Honaz Mountain, Beyağaç Kartal Lake Natural Reserve, Karcıdağı, Babadağ, and Bozdağ. Bozdağ Ski Centre also offers winter tourism opportunities at an altitude of 2419 meters.



Figure 3. Natural places in Denizli

Data collection and analysis

This study utilized social media data from the photo-sharing platform Flickr to explore user perceptions and behaviors related to cultural ecosystems in Denizli province based on the assumption that crowd-sourced information can serve as a reliable proxy for visitor behavior and preferences (Wood et al., 2013). Established in 2004, Flickr allows users to upload and share images and videos (Gede, 2018; Flickr, 2021). To collect geotagged photos within the defined study area of Denizli province, a Python script was employed to interact with the Flickr Application Programming Interface (API) (Python, 2021). The Flickr API offers functionalities for searching photos based on their geographical coordinates (Flickr API, 2021). We leveraged this functionality by defining a geospatial bounding box encompassing the study area. This approach facilitated the retrieval of metadata associated with geotagged photos captured within the designated boundaries. The retrieved metadata included user ID, photo ID, capture time, latitude-longitude information, and photo URL. All retrieved data was obtained in JSON format through the Python script. Finally, the data was transformed into a single, comma-separated values (CSV) file for easier management and subsequent analysis.

The dataset for this study covers the period from January 1, 2010, to December 31, 2020. Due to the limited number of geotagged photos shared in Denizli before 2010, attributed to the less widespread use of smartphones and mobile internet during that period, data from 2005-2010 were not included. The Python code was executed using the Anaconda-Jupyter program in the bounding box with corner coordinates of 28.512,37.000 and 30.056,38.419. Within these boundaries, 14,859 geotagged photos were found and downloaded in JSON format. The data was then converted to .csv format in the QGIS program, resulting in vector point data representing the photos. This point data intersected with the polygon data of the study area, resulting in 11,771 geotagged points within the boundaries of Denizli being used for the study.

The next step was downloading 11,771 geotagged photographs using the Tab Save Chrome browser plugin,

enabling rapid and effective multiple file downloads via URL. The authors separated the images into two groups according to their content of prevailing landscape character (cultural, n=3076, and natural, n=3865). Photos with personal, indoor, advertising, or similar content (4830) that fell outside the scope of the study were excluded and not considered for evaluation. The photos selected for evaluation consisted of 470 cultural and 344 natural value photos. The total number of users who uploaded photos was 564.

To evaluate the distribution of cultural and natural landscape points of interest, heat maps were produced using Kernel density estimation in QGIS 3.21. The Millennium Ecosystem Assessment (MA) framework on CES (MA, 2005) was used to determine the service values of landscapes based on site observations. The framework has classified cultural services into ten groups, as shown in Table 1.

Table 1. Cultural services in Synthesis report of MA (2005)

Service	Scope
Cultural diversity	The diversity of ecosystems is one factor influencing the diversity of cultures
Spiritual and religious values	Many religions attach spiritual and religious values to ecosystems or their components.
Traditional and formal knowledge systems	Ecosystems influence the types of knowledge systems developed by different cultures.
Educational values	Ecosystems and their components and processes provide the basis for both formal and informal education in many societies.
Inspiration	Ecosystems provide a rich source of inspiration for art, folklore, national symbols, architecture, and advertising.
Aesthetic values	Many people find beauty or aesthetic value in various aspects of ecosystems, as reflected in the support for parks, scenic drives, and the selection of housing locations.
Social relations	Ecosystems influence the types of social relations that are established in cultures.
Sense of place	Many people value the “sense of place” associated with recognized features of their environment, including aspects of the ecosystem.
Cultural heritage values	Many societies value the maintenance of historically important landscapes (“cultural landscapes”) or culturally significant species.
Recreation and ecotourism	People often choose where to spend their leisure time based partly on the characteristics of a particular area's natural or cultivated landscapes.

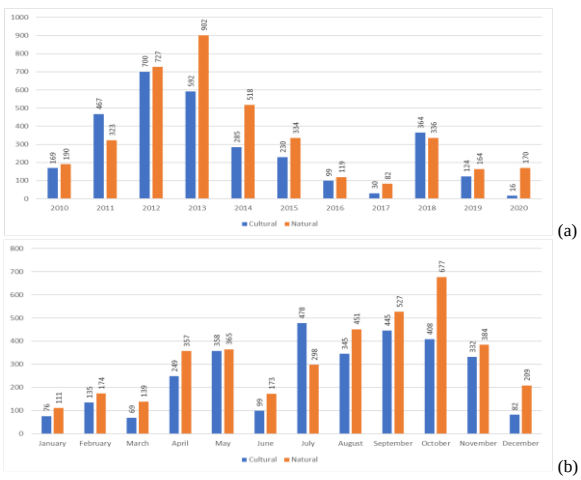
RESULTS and DISCUSSION

To further understand the temporal trends of visits, images taken within the study area were examined according to the time they were taken, analyzing yearly, monthly, daily, and hourly patterns.

Figure 4a illustrates the distribution of geotagged photos containing natural and cultural values over the years. It is observed that the year with the highest capture and sharing of photos containing natural values is 2013, while in 2012, photos identified as cultural values were more abundant compared to other years. This outcome is believed to have less to do with the landscape's natural values and more with Flickr being a more popular photo-sharing network throughout the relevant period.

Upon examining the distribution by months, it is noted that geotagged photos containing natural values were more frequently shared in September and October, followed by July and September for photos containing cultural values (Figure 4b). Accordingly, users tended to visit cultural assets during summer, while they preferred relatively cooler autumn months for visiting natural areas.

It is also evident that visitation frequencies were significantly lower during the winter. According to these results, landscape values in Denizli are under more pressure in terms of visitor density in the summer and fall months. This data could be helpful and informative for landscape management strategies of Denizli's natural and cultural landscape features, further discussed below.



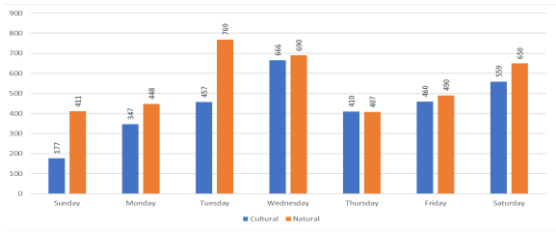
(a)

(b)

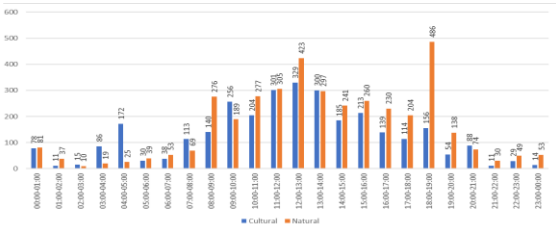
Figure 4. Distribution of cultural and natural values in Denizli according to the years (a) and months (b) when the photographs were taken

According to Figure 5a, photos containing cultural values were mainly taken and uploaded on Wednesdays, while natural values were captured more frequently on Tuesdays, Wednesdays, and Saturdays. Notably, user activity peaks on Wednesdays, so the usual weekend rush anticipated during tourist trips tends to be less observed in Denizli.

Regarding the busiest hours for photography, the photos containing natural content were predominantly captured between 18:00-19:00, while those with cultural content were more prevalent between 12:00-13:00 (Figure 5b).



(a)



(b)

Figure 5. Distribution of cultural and natural values in Denizli according to the days (a) and hours (b) when the photographs were taken

Following the non-spatial data analysis, density maps were generated for the spatial analysis of cultural ecosystem services within the study area. Accordingly, a density map based on kernel density estimation of geotagged photos containing cultural values shared between January 1, 2010, and December 31, 2020, is illustrated in Figure 6.

The areas highlighted in dark red on the map represent high activity, human density, and social media usage. According to the map, the areas with the highest cultural intensity include the city center of Buldan, Kale, the ancient cities of Laodikeia, Tripolis, and Hierapolis, as well as Denizli city center with the surroundings of the chairlift and panoramic terrace.

The hotspots for cultural landscape values present a higher value regarding cultural heritage, sense of place, and inspirational values (Table 2). Particularly, archaeological sites stand out for their spiritual and religious values for Christianity. Therefore, they provide further cultural services for non-local visitors.

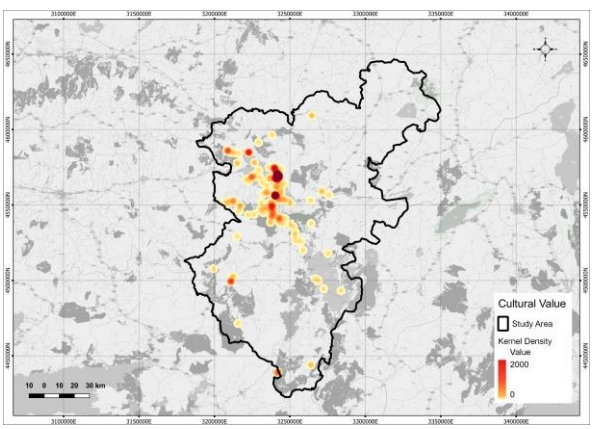


Figure 6. Kernel density estimation map of cultural values uploaded to Flickr in Denizli

Table 2. Cultural service potential of cultural hotspots

Location	Landscape character and value	Prevailing cultural service potential
Buldan	Rural settlement famous for exquisite handwoven fabrics and unique architecture	Inspiration and aesthetic values
Kale (Castle)	The rural settlement with archaeological and historical sites: Tabae archaeological site, Cebherpaşa Mosque, local markets	Cultural heritage and sense of place
Laodikeia	Archaeological sites including the Church of Laodicea - one of the seven churches in the Book of Revelation	Cultural heritage, sense of place, and spiritual and religious values
Tripolis	Archaeological site	Cultural heritage and sense of place
Hierapolis	Archaeological sites including the Tomb of St. Philip; are listed as UNESCO World Heritage Sites	Cultural heritage, sense of place, and spiritual and religious values
Denizli city center	Urban	Recreation

Figure 7 shows the analysis map for kernel density estimation for images with natural values. Places with a high concentration of people, activity, and social media use are highlighted in dark green. The map indicates that the most significant natural areas in terms of density are Pamukkale travertines and its neighboring regions, Kaklık Cave, Gökpınar Stream in Çakıroluk, Honaz Mountain National Park, Ucarı Pond, Dodurgalar Neighborhood, Acıgöl, Altındere Valley, Maymun Mountain, and the area around Colossae Ancient City.

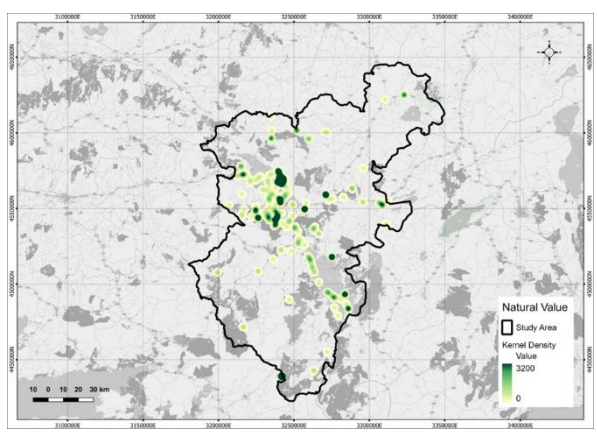


Figure 7. Kernel density estimation map of natural values uploaded to Flickr in Denizli

Highly visited natural values were discovered to be primarily dispersed throughout northwest Denizli, much like cultural hotspots. Together with visual benefits, the natural hotspots provide significant recreational and ecotourism

opportunities (Table 3). The most visited locations are protected areas and distinctive geomorphological structures.

Table 3. Cultural service potential of natural hotspots

Location	**Landscape character and value**	**Prevailing cultural service potential**
Pamukkale Travertines	Travertine formations because of the combination of both geological and hydrological processes; listed in UNESCO World Heritage Sites	Recreation and aesthetic values
Kaklık Cave	Cave conveying geothermal fluids with recreational facilities nearby	Recreation and aesthetic values
Gökpınar Stream	Riparian landscape with recreational opportunities for trekking, picnicking and fishing.	Recreation, ecotourism, and aesthetic values
Honaz Mountain National Park	Mountain and forest landscapes offer nature-based tourism activities such as climbing, hiking, trekking and passive recreational opportunities such as picnicking.	Recreation, ecotourism, and aesthetic values
Ucarı Pond	The former irrigation pond was transformed into a recreation facility	Recreation and aesthetic values
Dodurgalar Neighborhood	Rural landscape; trekking routes and Keloğlan Cave as visitor attractions	Recreation, ecotourism, and aesthetic values
Lake Acıgöl	Tectonic hypersaline lake	Aesthetic value
Altındere Valley	Riparian valley landscape with trekking routes	Recreation, ecotourism, and aesthetic values
Maymun Mountain	Mountain landscape with a rough terrain; mostly preferred for nature walking	Recreation, ecotourism, and aesthetic values
Colossae Ancient City	An ancient city, it is situated on the west foothills of Mount Honaz (Mt. Cadmos) next to the Aksu River.	Recreation, ecotourism, and aesthetic values

When the spatial distribution of user activity was examined, most visited locations included the city center, historical landmarks, cultural centers, and recreational places with facilities. Shared user content showed a particular pattern along various highways connecting Denizli to neighboring cities. On the other hand, not all areas on the road with shared photo content provide recreational facilities. For example, Lake Acıgöl is located on Denizli-Afyonkarahisar, and there are no facilities for recreational use in the immediate vicinity. However, it can attract the attention of passers-by due to the scenic landscape created by the mineral content of the lake and the bird species that reside there.

It was observed that natural landscapes that attract visitors' attention were concentrated in more points than cultural landscape points. Similar to previous research (Zhang et al., 2020), the results also demonstrated that waterfronts and natural landforms draw more visitors, thus delivering more cultural ecosystem services. However, as Alessa et al. (2008) point out, these frequently visited locations are also at risk of being negatively impacted by human use due to their popularity. To give an example specific to Denizli, in a study conducted for Pamukkale/Hierapolis (Dağ & Mansuroğlu, 2018), both physical and social carrying capacities were investigated, and it was determined that the number of visitors exceeded the capacity. It is known that the microorganism structure of the travertines is susceptible to severe damage from the walking activity of visitors (Çetinoğlu & Meydan Uygur, 2020). This poses a risk of damage to the natural structure that reveals the unique value of the area. Therefore, it is essential to manage these areas with sustainable planning strategies that balance protecting these valuable resources while still allowing people to enjoy and experience them. It should also be noted that social media has the power to influence destinations via user/visitor-shared content, which can also lead to overcrowding (Çetinoğlu & Meydan Uygur, 2020).

There are no studies on cultural ecosystem services in Denizli in the literature; hence, the findings could not be compared. On this basis, studies on recreation and tourism were examined. However, the research on these topics in Denizli is either specific to a particular district or destination (e.g., Pamukkale, city center, etc.) or related to a specific type of tourism (e.g., thermal tourism, gastronomy tourism, etc.). Therefore, determining the hotspots preferred by visitors within the scope of this study and mapping the landscape values at the provincial scale for tourism in Denizli reveals the originality of this study. Based on our findings, it may be possible to consider cultural ecosystem services more holistically throughout the province. Furthermore, this study found landscape hotspots like Maymun Mountain and the Dodurgalar district that have not been mentioned or given any attention in earlier studies. Understanding the supply, demand, and actual usage of ecosystem services through identifying the natural and cultural landscape values, considering them across all professional disciplines in urban management, and ensuring the coordination of relevant units are essential for sustaining the uniqueness of cities and for developing sound environmental management policies (Zhang et al., 2020; Dağ & Mansuroğlu, 2018).

Nevertheless, the use of social media data raises some methodological issues. Most likely, only a limited percentage of visitors' photos are geotagged and posted to social media

(Figueroa-Alfora & Tang, 2017). Additionally, the lack of representativeness in social media samples due to accessibility issues results in user-generated content reflecting the behaviors and perceptions of certain sociodemographic groups, potentially misleading land management decisions (Oteros-Rozas et al., 2018). However, user data, encompassing users' temporal-spatial behavior patterns and preferences, is valuable for managing tourism and recreational activities and research based on natural and cultural resource sustainability. In cases where obtaining user information is laborious and costly, location-based social media data is an alternative data source to access such information. Social media data, while valuable, comes with challenges that require careful consideration during analysis. The subjective nature of user-generated content often introduces biases, making it essential to handle this data meticulously. Analyzing large datasets typically demands advanced techniques like natural language processing, which requires specialized skills and resources. Ethical concerns are also significant, particularly regarding data privacy and the protection of personal information. Researchers must be cautious of unauthorized data usage and its legal implications, ensuring they address these issues thoroughly. Implementing robust data cleansing and validation processes is crucial to enhance the accuracy and reliability of analysis outcomes.

CONCLUSION

This study explored the usability of geotagged photos obtained from the social media platform Flickr as an alternative data source to determine users' temporal and spatial visit patterns throughout Denizli province regarding cultural ecosystem services supply and flow. As a result, it was concluded that the region's geomorphological formations and archaeological sites have a substantial capacity to attract visitors, thus providing a high flow of cultural ecosystem services. Pamukkale and its surroundings, which are UNESCO World Heritage Sites, are significant landscape values for the province. The data also provided information on hotspots for natural and cultural landscape values, which could assist authorities in developing landscape management strategies, particularly in protected areas.

In conclusion, geotagged data's spatial and temporal distribution can provide valuable insights into peak visitor periods and visitors' preferred landscapes. This might help implement additional visitor management measures and enhance overall visitor activities. Additionally, location-based social media data could be utilized as a potential data source for tracking users and may offer opportunities for future research.

TEŞEKKÜR

Bu çalışmanın özeti 'Spatial Analysis of Natural and Cultural Landscape Values via Social Media Photos' başlığı ile 2. Uluslararası Mimarlık Bilimleri ve Uygulamaları Sempozyumu bildiriler kitabında yayınlanmıştır.

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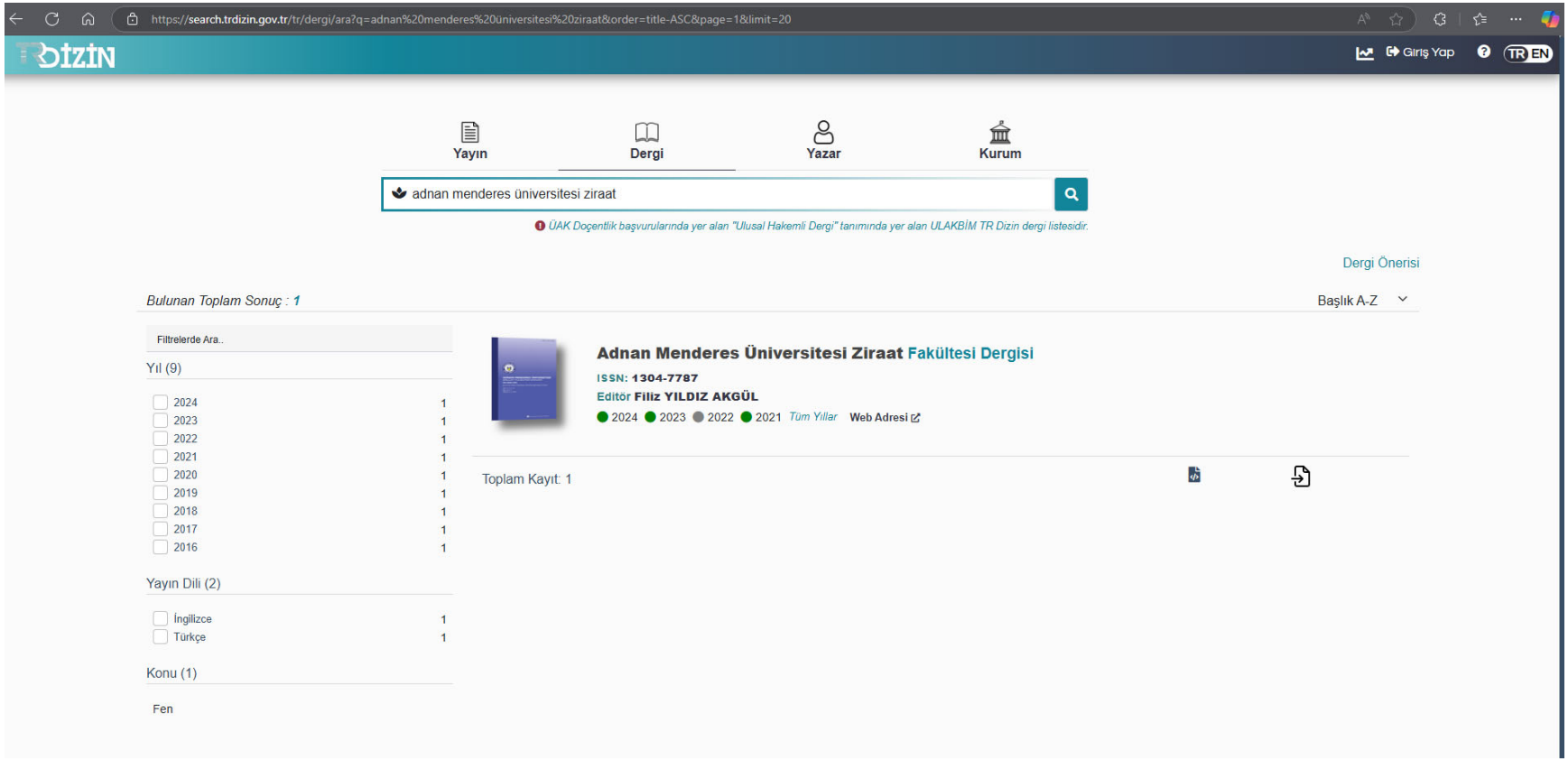
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