

doi: 10.52370/TISC26204CA

FROM METADATA TO POLICY: USING PHOTO-SHARING PLATFORMS TO UNDERSTAND TOURISM DYNAMICS

Cvetko Andreeski¹; Iva Nikoloska²

Abstract

Social networking platforms and websites designed for photo sharing provide access to images of various locations. Several of these services additionally include geo-tagged metadata, indicating the precise geographical coordinates where the photographs were taken. When aggregated in substantial quantities, such data can serve as a proxy for identifying visitor interests, revealing which sites attract tourist attention and how these locations are perceived by other users. Consequently, the analysis of metadata derived from photographs posted on diverse online platforms enables the examination of tourist preferences, their movement patterns within a destination, and the evaluations expressed by other users regarding the shared images. This study undertakes an analysis of a statistically significant dataset of photographs uploaded by contributors to Google Local Guides, a component of the Google Maps platform. The city of Ohrid, is employed as the case study. The findings of this research are expected to provide valuable insights both for prospective visitors and for policymakers.

Key Words: *Metadata, geo-tags, tourism, photos*

JEL classification: /

Introduction

Metadata can provide insights into user activities across various aspects of their lives. Digital imaging devices embed information into each photographic file, including the type of device used to capture the image, the device settings at the time of capture, geolocation data, image

¹ Cvetko Andreeski, Ph.D, professor, University St. Kliment Ohridski – Bitola, cvetko.andreeski@uklo.edu.mk, tel. +38976355501

² Iva Nikoloska, doctoral studies, Municipality – Ohrid, iva.nikoloska@ohrid.gov.mk

resolution, and other technical details. Numerous digital services enable users to share photographs publicly or to upload images accessible to a wider audience. Social networking platforms such as Facebook, Instagram, Flickr, and Pinterest are examples of such services. However, most of these platforms remove metadata from image files upon publication, thereby preventing the use of such data for subsequent analysis.

Furthermore, regulatory frameworks require digital services to delete metadata in order to safeguard authors, prevent location tracking, and mitigate risks of data misuse. Legislation such as the European General Data Protection Regulation (GDPR) exemplifies these protective measures.

Nevertheless, for scientific purposes, cumulative access to metadata-such as the number of photographs taken at a specific location-may be granted. Such data can reveal the level of user interest in photographing particular sites or landscapes.

Recent studies have increasingly employed photographic metadata, particularly geotags, as a basis for analyzing tourist behavior. For instance, Chen et al. (2019) propose a preprocessing method for predicting tourist movements in Beijing, while Afshardoost, M., & Eshaghi, M. S. (2020) review multiple studies examining the relationship between the availability of destination-specific photographs and tourist behavior.

Multiple studies show that photo volumes at locations correlate with visitation and tourism demand, allowing geotagged photos to act as proxies for tourist numbers at city, park, and national scales (Önder et al., 2016; Walden-Schreiner et al., 2018). (Kádár 2014) found strong correlation between city-level bed nights and numbers of geotagged photos in 16 European cities, and used spatial patterns to distinguish tourist activities.

Crowd-sourced photos in Sri Lankan attractions, clustered with DBSCAN and linked by Markov chains, identified dominant travel routes and regional tourism hubs, with cultural heritage dominating visits and coastal/highland areas forming key flows (Senarathne, et al., 2022). At urban scales, density mapping of over a million Flickr images in Barcelona delineated high-pressure tourism zones for sustainable urban

management, providing basis for spatially regulation (Valls, F., & Roca, J. (2021).

Photo-sharing data in six Italian cultural cities were mined with machine-learning to map behavior, annual photographic trends, and to support predictive models and marketing strategies (Giglio et al., 2019). Panoramio/Flickr images across eight European metropolises were used to identify tourist hotspots and compare spatial concentration versus dispersion between cities (García-Palomares et al., 2015).

In Indonesian beach destinations, nearest-neighbor and kernel density analysis of geotagged photos, combined with image content coding, showed that natural beauty and cultural activities drive beach popularity, and informed differentiated development strategies for highly photographed beaches (Wicaksono et al., 2023). In Denizli (Türkiye), Flickr photos were mapped to model cultural ecosystem services, revealing concentration around UNESCO-listed Pamukkale, cultural hubs, and under-recognized hotspots for integrating natural and cultural values into landscape and tourism planning (Örücü et al., 2024). For Chitwan National Park in Nepal, comparison of tourists' Flickr images with official promotional images highlighted mismatches between projected and perceived destination image (Bhatt et al., 2022).

In Hong Kong, Flickr photos were used to automatically identify temple POIs via P-DBSCAN, then analyze visiting patterns by tourists from different countries and repeated visitors (Leung et al., 2017). A Hong Kong study used 58,392 Flickr photos and computer vision to map destination images and behavioral trajectories separately for residents and tourists (Zhang et al., 2020).

Motivations for photo sharing and the “shared gaze” further contextualize behavior: qualitative work identifies internal and external motives (self-expression, social connection, co-marketing) that shape what is photographed and shared, reinforcing certain place images and possibly biasing datasets (Lee et al., 2023). A broad systematic review of user-generated photos in tourism and hospitality underscores that motivations, destination image perceptions, spatiotemporal behavior, and impacts of photos are interlinked (Li, H., et al., 2023).

In the present study, photographs generated through the Google Local Guides platform are utilized. Metadata from these images are analyzed to

determine the number of photographs taken at particular locations and to assess how these photographs were rated.

Analysis of metadata uploaded to the platform

Google Local Guides represents a global, crowdsourced initiative aimed at enhancing both the geospatial precision and qualitative richness of Google Maps. Conceptually, it operates as a volunteer-driven data ecosystem in which participants contribute User-Generated Content (UGC) to augment the platform's effectiveness as a tool for navigation and spatial discovery.

The program is grounded in the principle of *Volunteered Geographic Information (VGI)*, whereby participants function as distributed sensors, supplying real-time updates that automated systems-such as satellite imagery or algorithmic web scraping-may fail to capture. Contributions typically encompass: Qualitative Assessments: Narrative reviews and subjective ratings of places and services, Visual Documentation: Photo and video materials enriched with metadata, Database Maintenance: Corrections to meta data, including operational hours, contact details, and categorical classifications and Topological Updates: Identification and mapping of previously unrecorded points of interest (POIs).

To facilitate the empirical component of this study, a custom Python script was developed and executed within the Google Colab environment. The primary objective of this script was to extract and structure metadata associated with photographs uploaded to the Google Local Guides platform, specifically focusing on the eastern shoreline of Lake Ohrid. The script was designed to generate tabular datasets that capture multiple dimensions of the photographic contributions. Beyond simply enumerating the number of locations where photographs were uploaded, the dataset integrates several key variables presented in Table 1.

This methodological approach ensures that the dataset not only reflects the spatial distribution of photographic activity but also provides indicators of user engagement and visibility. By combining geospatial and behavioral metadata, the analysis enables a more nuanced understanding of how specific sites along Lake Ohrid's eastern shore attract attention.

The resulting dataset was organized into tabular form, allowing for systematic comparison across locations. Table 1 presents the outputs

generated by the Python script, offering a consolidated view of the metadata variables and their distribution across the study area. On the platform, a total of 94 distinct locations were identified along the eastern shore of the Lake of Ohrid where photographs had been uploaded.

Table 1 presents only those locations that contain at least 100 reviews. The titles of the locations are retained as defined by the users themselves. Under identical titles, the corresponding sites can also be visualized through OpenStreetMap provided in the subsequent section.

Table 1: *Detected locations of photos, coordinates, reviews and ratings*

	Location	lat	lon	reviews	rating
1.	Saint Naum Monastery	40.9140127	20.7406778	11,266	4.8
2.	Church of Saint Jovan - Kaneo	41.1110753	20.7887506	5,019	4.9
3.	The Bay of Bones Museum	40.9943675	20.7980954	4,600	4.6
4.	Ancient Macedonian Theatre	41.1147561	20.7936668	4,548	4.5
5.	Chinar Tree	41.1160049	20.8002968	3,079	4.6
6.	Church of Hagia Sophia	41.1120722	20.7940373	2,848	4.7
7.	National Park Galicica	40.9672707	20.8400775	2,689	4.7
8.	Old City Park	41.1137451	20.7904726	1,923	4.7
9.	St. Clement of Ohrid City Square	41.1127568	20.7994681	1,579	4.7
10.	Ohrid City Park	41.1121285	20.8002848	1,223	4.7
11.	Church of St. Clement of Ohrid	41.1124229	20.7909423	1,101	4.7
12.	National Park of Drlon	40.8995919	20.7131695	1,092	4.5
13.	Plaoshnik Archaeological park	41.1127678	20.7908025	886	4.6
14.	Bay of Bones Museum - Entrance	40.9940733	20.8001501	820	4.6
15.	Mosque of Ali Pasha	41.1154972	20.8004934	729	4.5
16.	Ohrid Boardwalk	41.1112598	20.7940369	667	4.8
17.	Church - Virgin Mary Peribleptos	41.1142006	20.7954559	516	4.8
18.	Robevci Family House	41.1123564	20.7961384	451	4.6
19.	Workshop For Handmade Paper	41.1124535	20.7953697	447	4.8
20.	Old Swimming Court	41.110359	20.8017003	318	4.7
21.	Biljana's Springs	41.1024912	20.8149813	289	4.5
22.	Paragliding Ohrid	41.1013301	20.8061114	259	5
23.	Upper Gate of the Fortress	41.114997	20.7948963	207	4.6
24.	Paragliding Take-off Galicica	40.9546647	20.8122255	176	4.8
25.	Black Drin River Springs	40.9132615	20.7438555	137	4.9
26.	Labino Vista Point	41.1140814	20.7879326	126	4.8

Source: *Google Local Guides accessed and organized with Google Colab*

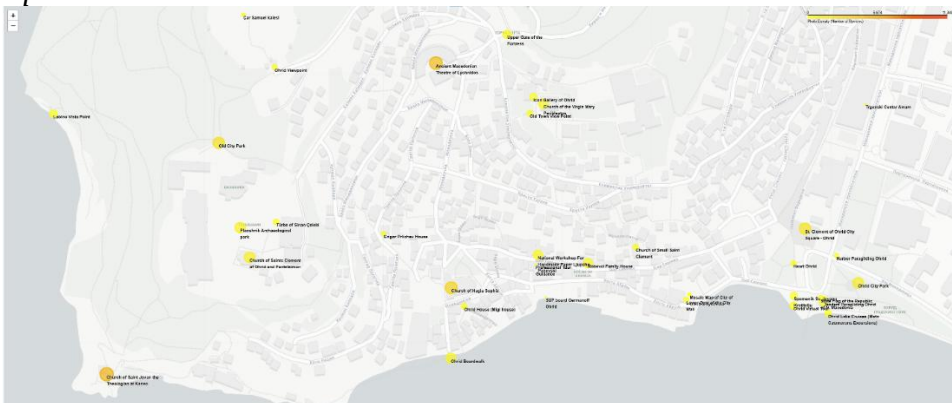
The location with the highest number of reviews is St. Naum, which has accumulated 11,266 reviews and holds an average rating of 4.8. The

second most reviewed site is the iconic St. John Theologian - Kaneo, with 5,019 reviews and an average rating of 4.9. In third place is the Bay of Bones Museum, which has received 4,600 reviews and an average rating of 4.6. These three sites are situated within a radius of approximately 15 kilometers from one another.

From a tourism development perspective, this spatial distribution is particularly advantageous. The fact that the most attractive locations are not concentrated within a short walking distance, but rather require deliberate planning of visits and activities, encourages extended tourist engagement. Visitors are incentivized to allocate more time to exploring the region, which contributes to the diversification of tourism flows.

The highest concentration of locations is found in the old town district (Figure 1). Within this area and the central square, 34 locations have been identified as points of interest for visitors. Beyond the Church of St. John the Theologian at Kaneo, significant numbers of reviews are recorded for the Ancient Theatre (4,548 reviews) and the Church of St. Sophia (2,848).

Figure 1: *Locations of taken photos in the Old town and Ohrid main square*



Source: Own Python code with Google Local Guides and Open Street maps

On the maps, the number of reviews is represented by circles whose radii are calculated using the logarithmic function $\log_{10}$ relative to the number of reviews. This method of visualization ensures that locations with at least ten reviews are assigned a visible marker, while those with thousands of reviews do not appear disproportionately large. In addition,

the circles vary in color depending on the number of reviews, with the color scheme displayed in the upper right corner of the map.

At the Bay of Bones Museum, only four distinct positions were identified from which photographs were taken (Figure 2). Nevertheless, this site has emerged as one of the most popular destinations, indicating strong tourist interest in visiting the location despite the limited number of photographs. The Bay of Bones is regarded as the most visited archaeological site in the region. Between 2010 and 2024, it attracted a total of 885,639 visitors, a period that also encompassed the challenges of the COVID-19 pandemic and its post-pandemic consequences. The site is perceived as a perfect synthesis of an exceptional natural environment and anthropogenic influence upon it. Underwater research campaigns were periodically conducted between 1997 and 2005, marking the first systematic underwater archaeological investigations in Macedonia. Most recently, in 2025, the Water Museum together with the pile-dwelling settlement were reconstructed, further enhancing the interpretative value of the site.

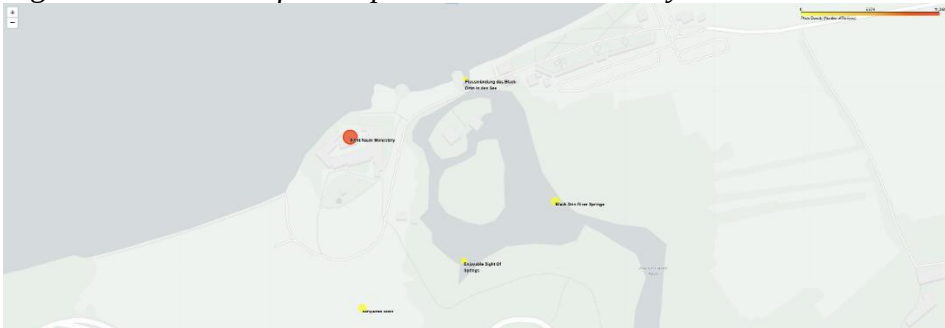
Figure 2: *Locations of taken photos in the Museum Bay of Bones*



Source: Own Python code with Google Local Guides and Open Street maps

The site with the highest number of reviews is the location of the St. Naum Monastery, situated near the border with the Republic of Albania (Fig. 3). Photographs taken at this location have accumulated 11,266 reviews, with an average rating of 4.8, indicating consistently high visitor satisfaction. In addition to the scenic view from the monastery overlooking Ohrid Lake and the city of Ohrid in the distance, the complex also encompasses part of the springs of the Black Drim River. These natural features, combined with the cultural and historical significance of the monastery, attract a substantial number of visitors due to the uniqueness of the landscape.

Figure 3: *Locations of taken photos in the Monastery St. Naum*



Source: Own Python code with Google Local Guides and Open street maps

These findings are not incidental. Since 2013, the Saint Naum Monastery Complex has implemented a series of infrastructural and horticultural interventions. Based on these conceptual works, the Macedonian Orthodox Church – Saint Naum Monastery undertook the actual development, which included the expansion of parking facilities to more than 1,000 spaces for private vehicles and tourist buses, landscaping and horticultural enhancement of the courtyard, and the planting of 420 maples and Japanese cherry trees along the access road. Their seasonal blossoming contributes to a distinctive aesthetic that reinforces the integrity of the site's ambience.

Conclusions

Metadata derived from photographs taken by tourists and visitors constitutes a valuable source of information for assessing levels of interest in specific destinations. While the locations themselves are not unknown, their relative attractiveness can be systematically ranked through the analysis of geospatial metadata and user engagement indicators provided by digital platforms.

Such analytical approaches hold significant potential for local governance and destination management. First, they enable authorities to design targeted promotional strategies that highlight the most attractive tourism assets. Second, they provide an evidence-based foundation for implementing measures aimed at the sustainable development and maintenance of culturally and environmentally significant sites. By quantifying visitor interest, local governments can also forecast potential revenue streams, including concessions for the use of public spaces, the

provision of parking facilities, and the regulation of access to protected areas. This is particularly relevant in the case of Ohrid, which is recognized as a UNESCO World Heritage Site. Effective management of visitor flows is essential to balance economic benefits with heritage conservation.

Moreover, metadata analysis can inform broader policy objectives such as spatial planning, infrastructure development, and environmental protection. Identifying high-interest areas may justify investments in transportation networks, visitor amenities, or conservation initiatives. Conversely, recognizing sites with lower levels of engagement may prompt authorities to reconsider promotional strategies or diversify tourism offerings to distribute visitor flows more evenly across the region.

For a more comprehensive and comparative analysis, it would be advantageous to incorporate photographic data from multiple platforms, such as Flickr.

Acknowledgement

This research is financed by the Ministry of education and Science of the Republic of North Macedonia for the project “Applying predictive analytics and artificial intelligence to improve tourism in North Macedonia”

The authors wish to express sincere gratitude to Archimandrite Nektarij, hegumen of the Saint Naum Monastery – Ohrid, for his contributions.

References

1. Afshardoost, M., & Eshaghi, M. S. (2020). Destination image and tourist behavioural intentions: A meta-analysis. *Tourism Management*, 81, 104154.
2. Bhatt, P., & Pickering, C. M. (2022). Destination image of Chitwan National Park, Nepal: Insights from a content analysis of online photographs. *Journal of Outdoor Recreation and Tourism*, 37, 100488.
3. Chen, W., Xu, Z., Zheng, B., & Luo, C. (2019). Geo-Tagged Photo Metadata Processing Method for Beijing Inbound Tourism Flow. *ISPRS International Journal of Geo-Information*, 8(12), 556.

4. García-Palomares, J. C., Gutiérrez, J., & Mínguez, C. (2015). Identification of tourist hot spots based on social networks: A comparative analysis of European metropolises using photo-sharing services and GIS. *Applied Geography*, 63, 408–418.
5. Giglio, S., Bertacchini, F., Bilotta, E., & Pantano, P. (2019). Using social media to identify tourism attractiveness in six Italian cities. *Tourism Management*, 72, 306–312.
6. Kádár, B. (2014). Measuring tourist activities in cities using geotagged photography. *Tourism Geographies*, 16(1), 88–104.
7. Lee, C., Richardson, S., Goh, E., & Presbury, R. (2023). From the tourist gaze to a shared gaze: Exploring motivations for online photo sharing in present day tourism experience. *Tourism Management Perspectives*, 46, 101099.
8. Li, H., Zhang, L., & Hsu, C. H. C. (2023). Research on user-generated photos in tourism and hospitality: A systematic review and way forward. *Tourism Management*, 96, 104714.
9. Önder, I., Koerbitz, W., & Hubmann-Haidvogel, A. (2016). Tracing tourists by their digital footprints: The case of Austria. *Journal of Travel Research*, 55(5), 566–573.
10. Örüçü, Ö. K., Arslan, E. S., Kaymaz, I., Hoşgör, E., & Tekin Cüre, C. (2024). Modeling cultural ecosystem services using social media photos: The case of Denizli, Türkiye. *Adnan Menderes Üniversitesi Ziraat Fakültesi Dergisi*, 21(2), 205–212.
11. Senarathne, M. P., Hewakuruppu, D. T., Perera, P., Silva, R. M., & Wickramaarachchi, D. C. (2024). Exploring tourist flow patterns through geotagged social media data: A case study from Sri Lanka. In *Proceedings of the International Forestry and Environment Symposium*, 28,
12. Valls, F., & Roca, J. (2021). Visualizing digital traces for sustainable urban management: Mapping tourism activity on the virtual public space. *Sustainability*, 13(6), 3159.

13. Walden-Schreiner, C., Rossi, S. D., Barros, A., Pickering, C., & Leung, Y. Fai (2018). Using crowd-sourced photos to assess seasonal patterns of visitor use in mountain-protected areas. *Ambio*, 47, 781–793.
14. Wicaksono, A., Farda, N. M., Khakhim, N., & Wibowo, T. W. (2023). Flickr photos analysis for beach tourism management in Bantul Regency, Indonesia: Popularity and tourist attractions. *Forum Geografi*, 35(1).
15. Leung, R., Quan, H., & Rong, J. (2017). Understanding tourists' photo sharing and visit pattern at non-first tier attractions via geotagged photos. *Information Technology & Tourism*, 17(1), 55–74.
16. Zhang, K., Chen, Y., & Lin, Z. (2020). Mapping destination images and behavioral patterns from user-generated photos: A computer vision approach. *Asia Pacific Journal of Tourism Research*, 25(11), 1199–1214.b