Evaluating tourist profiles and nature-based experiences in Biosphere Reserves using Flickr: matches and mismatches between online social surveys and photo content analysis

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Abstract

Monitoring visitor dynamics and their nature-based experiences is an important dimension in the conservation management of protected areas. In the current digital age, the content analysis of social media information is being increasingly used in such a context. However, research testing whether social media content analysis provides similar information to that obtained from stated preference methods is lacking. We aimed to identify differences in the classification of tourist profiles and nature-based experiences, both from online social surveys and photo content analysis. Our approach targeted Flickr's social media users visiting two Biosphere Reserves in Southern Europe: Doñana and Sierra Nevada. We manually classified the main content of Flickr photos considering different categories of tourist profiles and nature-based experiences. Concurrently, we distributed online surveys to Flickr users responsible for those photos and gathered their self-stated classification of tourist profiles and experiences. Finally, we compared the classification results from both content analysis and online surveys using multiple congruence metrics and tests. Overall, we found both matches and mismatches between the results from content analysis and online surveys depending on the categories of tourist profiles and their experiences. "Landscape and species" was the only category with consistent matches between content analysis and online surveys for both tourist profiles and nature-based experiences. We suggest that conclusions based on content analysis or online surveys alone can lead to incomplete information. Instead, the adoption of both content analysis and online surveys should provide complementary perspectives for the monitoring of nature's cultural capital.

Keywords

Crowd-sourced photos; Cultural ecosystem services; Doñana; Decision making; Protected areas; Sierra Nevada

1. Introduction

In the current epoch of the Anthropocene, characterised by dynamic human and environmental changes, conservation mechanisms need to integrate a wider social-ecological perspective (Palomo et al. 2014). Biodiversity conservation mechanisms, such as the establishment of protected areas, have been increasingly re-defined to integrate both biophysical and social aspects of ecosystems (Daily et al. 2000). This is because in many regions worldwide, local communities co-exist with protected area and play an important role in the management of ecosystems and their resources (Venter et al. 2014). The "Biosphere Reserve" status has been created by the UNESCO to deal with the interactions between social and ecological systems in protected areas. The rapid development of a global network of Biosphere Reserves reveals many opportunities to reach conservation goals alongside the sustainable use of natural resources (Van Cuong et al. 2017). Therefore, Biosphere Reserves provide a wide perspective on the territory, focused on the co-existence of nature, human culture and sustainable development.

Ecotourism and other nature-based experiences are an important dimension of Biosphere Reserves (UNESCO 2002), providing recreation revenues, shaping human identity and traditions and supporting nature conservation (Di Minin et al. 2015). Neglecting the role of nature-based experiences can result in losses of e.g. cultural identity and heritage, environmental education, and nature enjoyment (De Groot et al. 2005). Nevertheless, ecotourism may also have opposite effects, promoting human pressure and undesirable impacts on biodiversity (Buckley et al. 2016). Therefore, understanding how people interact with nature is essential to inform conservation policy and management.

Nature-based experiences have been traditional estimated from stated preference methods (e.g. questionnaires), which are often costly and limited in geographic space (Bragagnolo et al. 2016). With the emergence of digital conservation (Van der Wal and Arts 2015), social media "big data" has been seen as an alternative way to infer on nature-human interactions, such as visitors' monitoring (Tenkanen et al. 2017; Walden-Schreiner et al. 2018) or nature-based recreation (Jepson and Ladle 2015). Analysing photos posted and shared in social media platforms, such as Flickr, has been receiving particular attention (Di Minin et al. 2015; Ladle et al. 2016; Thiagarajah et al. 2015). This is because social media content analysis allows scientists to evaluate and map nature-human interactions, at multiple scales and resolutions and in a cost-effective and forthright manner (Richards and Friess 2015).

Several approaches focused on the content analysis of social media have been developed to assess human activities and people's preferences for nature-based activities (Allendorf and Yang 2013). However, social media photo content analysis can be biased due to many factors, such as sociodemographic characteristics or differences in landscape perception by social media users (Ghermandi and Sinclair 2019). Given that perceptions and sentimental reactions change between different user profiles (Komossa et al. 2018), inferring about which nature elements are being valued in a photo (and by whom) is still a major challenge in content analysis (Heikinheimo et al. 2017).

Considering the increasing scientific interest in social media content analysis, investigating the added-value of social media data in relation to other methods to monitor nature-based activities is needed (Di Minin et al. 2015). However, few studies have explicitly evaluated the usefulness of social media data in this regard (Hausmann et al. 2018; Heikinheimo et al. 2017). Despite similarities in the information obtained from social media and on-the-ground surveys, e.g. in protected areas from South Africa (Hausmann et al. 2018) and in

Finland (Heikinheimo et al. 2017), evidence from other social-ecological contexts and assessment methods (e.g. online surveys) which target the same populations are lacking. Here we aimed to identify differences in the classification of tourist profiles and nature-based experiences, as obtained from online surveys to Flickr users and from our content analysis of the photos posted by those same users. Specifically, we aim to understand whether the content analysis of those photos would reflect the tourist profiles ("the who") and their nature-based experiences ("the what") as stated by the Flickr users through online questionnaires. To do so, we asked the following questions: (1) What categories of tourist profiles and nature-based experiences (table1) are most identified in the content analysis of Flickr´s photos and in the users' replies to online surveys? (2) Do results from content analysis and online surveys generally match in the identification of tourist profiles and nature-based experiences? and, (3) Which types of tourist profiles and nature-based experiences seem to agree the most between in the classifications obtained from content analysis and from online surveys? Our approach is independently tested in two UNESCO Biosphere Reserves from Southern Spain: Doñana and Sierra Nevada.

2. Methods

2.1. Test areas

Our test areas included two UNESCO Biosphere Reserves in southern Spain: Doñana and Sierra Nevada (Figure 1).

Figure 1. Location of the test areas at the European and Spanish contexts (a), with detailed overview on Doñana and Sierra Nevada biosphere reserves (b).

Doñana (2687 km^2) includes one of the largest wetlands in Western Europe (García and Marín, 2005), marshlands (270 km^2), phreatic lagoons, coastal dune ecosystems (25 km-long coastline) and emblematic Mediterranean plant communities (100 km^2). Doñana shows a high bird diversity, being an important overwintering site for water birds. Doñana includes a Ramsar Site, a Natural World Heritage Site and it is a long term monitoring site in the ALTERNet being integrated in the Natura 2000 network (with both National and Natural Parks). Doñana spreads over the Spanish provinces of Huelva, Seville and Cádiz, including 14 municipalities with more than 163000 inhabitants. Relevant socio-economic activities include agriculture, fishing, cattle raising, timber, beekeeping, nature tourism, and beach recreation (García and Marín, 2005).

Sierra Nevada (1722 km^2) is a mountainous region, with altitude ranging from 860 m to 3482 m.a.s.l. (the highest peak of the summit). Sierra Nevada is among the most important

biodiversity hotspots in the Mediterranean region with a total of more than 2,300 taxa of vascular flora, representing 33.2 % of the Spanish flora. The reserve comprises 27 habitats types from the Habitats Directive, with 31 animal and 20 plant species listed in Annex I and II of the Habitats and Birds directives. Besides being a biosphere reserve, Sierra Nevada also includes Special Protection Areas and Sites of Community Importance (Natura 2000 network) as well as National and Natural Parks. Sierra Nevada spreads over Granada and Almería provinces, with 61 municipalities and more than 90 000 inhabitants. The most relevant socio-economic activity is mostly related to tourism (Zamora et al. 2016).

2.2. Analytical framework

Our general approach is illustrated in Figure 2. Firstly, we collected photographic data from the online social media platform Flickr, considering a stratified sampling procedure for each Biosphere Reserve: Doñana (number of photos, n = 11441) and Sierra Nevada (n = 21048; see section “Sampling strategy and data processing”). Secondly, we classified the photos from each biosphere reserve according to the tourist profiles and the prevailing nature-based experience by means of content analysis (see “Content analysis” section). Thirdly, we distributed online surveys to the Flickr users responsible for each photo, in order to gather their stated information on the tourist profile they are and prevailing nature-based experience they carried out in the BR (see “Online surveys” section). Finally, we compared the classification results from the photo content analysis with those from online surveys, using multiple evaluation metrics (see “Data analysis” section).

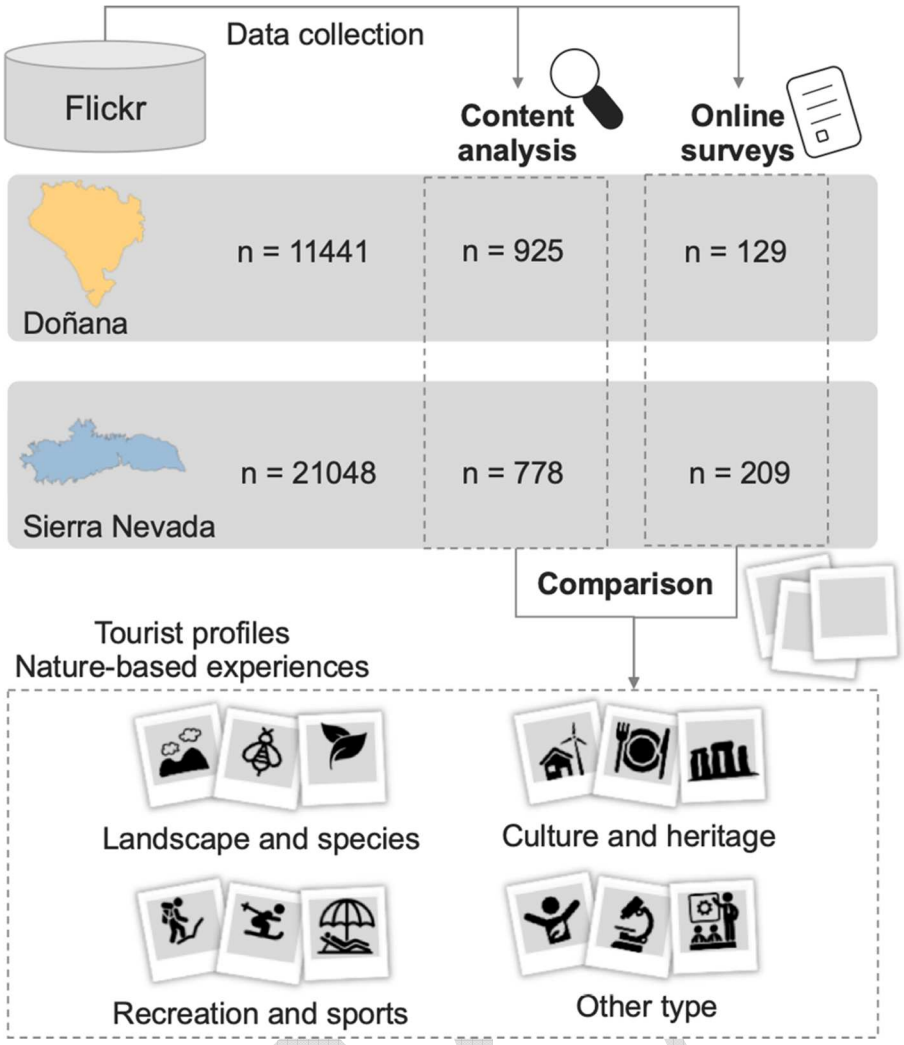

Figure 2. The analytical framework considered to compare the information on tourist profiles and nature-based experiences based on content analysis of Flickr photos and user-stated preferences from online surveys for Doñana and Sierra Nevada.

2.3. Sampling strategy and data processing

We collected publicly available information on the photos published by Flickr users for each biosphere reserve. We used the Application Programming Interface (API) from Flickr, indicating a time window (between the start of Flickr in 2004 and 2017) and a spatial bounding box around the boundaries of each test area. For each photo, we retrieved their date taken, their spatial location (latitude and longitude), the responsible Flickr user, and the corresponding photo gallery and URL. The content of each photo was analysed for a

subset of photos, obtained through a stratified sampling strategy. The sampling was established in order to capture the diversity of prevailing nature protection regimes and land uses in both reserves. This resulted in final subsets of 925 photos (from 663 users) in Doñana and 889 photos (from 708 users) in Sierra Nevada. Details on the sampling procedure and strata description can be found in Supplementary Material.

2.3.1. Content analysis

We performed a content analysis expressed by the manual and visual classification of Flickr photos collected for each Biosphere Reserve. The classification of Flickr photos was based on general categories associated to nature tourism and recreation, following our previous experience (Fernández-Méndez et al. 2019; Vaz et al. 2018) and other related studies (Martínez Pastur et al. 2016; Oteros-Rozas et al. 2018). We used the same categories to classify the photos based on the tourist profile and nature-based experience. Although the classification of nature-based experiences was done considering only the content of each individual photo, tourist profiles were classified considering also the content of the whole photo gallery from the Flickr user. Table 1 shows the description of the categories considered in the content analysis. Unidentifiable photos (e.g. due to poor quality) or photos capturing indoor places or non-natural features (e.g. pamphlets, advertisements) were not considered, resulting in a final dataset of 925 photos for Doñana and 889 for Sierra Nevada. Details on the content analysis and photo classification can be found in Supplementary Material (see table S1).

Table 1. Categories considered in the classification of tourist profiles and nature-based experiences interpreted from photo content analysis and asked in the online questionnaires, with description.

Category	Description
Landscape and species	The tourist (photo-user) or the activity carried out is mainly focused on enjoyment of landscapes, wild and natural areas, or particular species of fauna and flora
Recreation and sport	The tourist (photo-user) or the activity carried out is mainly focused on human activities in the wild, related to recreation and sports
Culture and heritage	The tourist (photo-user) or the activity carried out is mainly focused on cultural, religious or gastronomic elements in the wild
Other type	The tourist (photo-user) or the activity carried out is focused on other elements not previously stated, including business or scientific aims

2.3.2. Online surveys

We distributed an online questionnaire to the Flickr users responsible for the same photos considered in the content analysis, in order to get their stated-classification on the tourist profiles and nature-based experiences. We used Google Forms (https://docs.google.com/forms) to develop the online surveys (in English and Spanish). Questionnaires focused on what the users recalled from their trip/visit to the biosphere reserves, given particular (set of) pictures taken at that given time to explicitly ask the user about: (1) the "who" - which tourist profile he/she would consider to be the most (given the set of options presented in Table 1); and (2) the "what" - which type of nature-based experience were they being enjoyed by the user while taking the photo (again, considering Table 1's options). Questionnaires were disseminated through Flickr Mail between March and September of 2018 to a total of 1437 users (669 Flickr users in Doñana and 768 users in Sierra Nevada). Dissemination of questionnaires targeted first the users from the most recent pictures; however, due to the low number of feedbacks, questionnaires were sent to the remaining users. The invitations sent to the users included a brief description of the research and a weblink to access the questionnaires. We obtained a total of 338 responses (129 for Doñana and 209 for Sierra Nevada), from which 75% pertained to Flickr photos taken

during the last five years, and less than 8% pertained to photos taken during the first five years of the study timeframe (2004-2009). Information from the participants was kept anonymised through the whole study (see Supplementary Material for details).

2.4. Data analysis

The results from the classification of photos obtained from the content analysis and online surveys were evaluated individually for each biosphere reserve. We first conducted a descriptive analysis, based on the relative proportion of photos attributed to each content analysis and online surveys category. In order to compare the congruence between content analysis and online surveys classifications on tourist profiles and nature-based experiences, we used multiple evaluation metrics based on confusion matrices. The overall congruence between both classifications was evaluated by computing the global agreement (%) and accuracy metrics, supported by the Pearson chi-square test for independence and the Cohen's kappa coefficient. We further calculated the Precision, Recall and the F1 scores for each individual category of tourist profiles and nature-based experiences based on the results from content analysis and online surveys. Details are shown in following sections and in Supplementary material.

2.4.1. Overall congruence between content analysis and online surveys classifications

In order to evaluate the overall congruence between content analysis and online surveys, we used the “global agreement” and “global accuracy” metrics. The global agreement indicates the percentage of photos matching the same categories in both content analysis and online surveys, weighted by the total number of photos under evaluation (eq. 1). The global accuracy between classifications indicates the proportion of photos matching or not the same category, weighted by the total number of photos (eq. 2).

Eq. 1: Global agreement = (A / *n*) * 100

Eq. 2: Global accuracy = ((A + D) / *n*) * 100

In equations 1 and 2: *A* stands for the number of records for which a given category of tourist profiles or nature-based experiences was indicated in both content analysis and online surveys; *D* refers to the number of records for which a given category of tourist profiles or nature-based experiences was not indicated in both content analysis and online surveys; *n* is the total number of photos.

The independency between the classifications from the content analysis and online surveys was evaluated by means of the Pearson chi-square analysis of independency, tested against the hypothesis that the classifications from content analysis and online surveys are statistically independent (i.e. showing no evidence of association or relationship). The interrater agreement between classifications was computed by means of the Cohen's kappa coefficient. A statistically significant value for Cohen's kappa suggests that the amount of agreement between content analysis and online surveys is higher than an agreement expected to occur by chance (Allouche et al. 2006).

2.4.1. Congruence between content analysis and online surveys classifications for individual categories

For each individual category of tourist profiles and nature-based experiences, we further calculated the Precision, Recall and the F1 scores between the classifications of the content analysis and online surveys (Powers 2011). Results were organised in a confusion matrix (Table 2) constructed for each individual category of tourist profiles and nature-based experiences (cf. Table 1). The matrix considered the amount of photos matching a given category "i" in both content analysis and online surveys (A, in Table 2); the number

of photos mismatching a given category “i” in both content analysis and online surveys (B and C, in Table 2) and the number of photos not attributed to the category “i” in both content analysis and online surveys (D, in Table 2) .

Table 2. Example of a confusion matrix used to compare the classification of photos from the content analysis and online surveys considering each individual category of tourist profiles and nature-based experiences.

		Online surveys	
		Category “i”	Other category but “i”
Content analysis	Category “i”	$A_{(category\ i)}$ [match]	$B_{(category\ i)}$ [mismatch]
	Other category but “i”	$C_{(category\ i)}$ [mismatch]	$D_{(category\ i)}$ [match]

From the construction of this confusion matrix, a series of metrics (Sokolova and Lapalme, 2009) to analyse matches and mismatches for each category: Precision referred to the number of photos which match the same category in both content analysis and online surveys classifications, weighted by the number of photos assigned to that category in the content analysis classification (eq. 5); Recall (or sensitivity) expressed the number of photos matching the same category in content analysis and online surveys, weighted by the number of photos assigned to that category in the online surveys classification (eq. 6); F1 score indicated the weighted average of Precision and Recall (eq. 7), taking into consideration the non-matching cases between both content analysis and online surveys classifications. Details on these metrics, including on their calculations, interpretation and relation with our research hypothesis are shown in Supplementary Material (Table S2).

Eq. 5: $\text{Precision}_{(\text{category i})} = A_{(\text{category i})} / A_{(\text{category i})} + B_{(\text{category i})}$

Eq. 6: $\text{Recall}_{(\text{category i})} = A_{(\text{category i})} / A_{(\text{category i})} + C_{(\text{category i})}$

Eq. 7: F1 score = 2*(Recall * Precision) / (Recall + Precision)

Results from content analysis and online surveys classifications are shown throughout the manuscript as bar plots. Statistical computations were implemented in R software (R Core Team 2019).

3. Results

3.1. Prevailing tourist profiles and nature-based experiences across test areas

The classifications obtained from the content analysis and online surveys showed different distributions in the number of photos assigned to each category of tourist profiles and nature-based experiences (Figure 3). Examples of photos assigned to the “landscape and species” category in the content analysis included close-ups of animals and plants or wide views of natural landscapes. “Culture and heritage” included photos dominated by traditional infra-structures (e.g. monuments) or cultural activities (e.g. gastronomic features). “Recreation and sports” photos focused on sports (e.g. ski equipment or people riding a bike) or recreational activities (e.g. beach leisure or barbecuing).

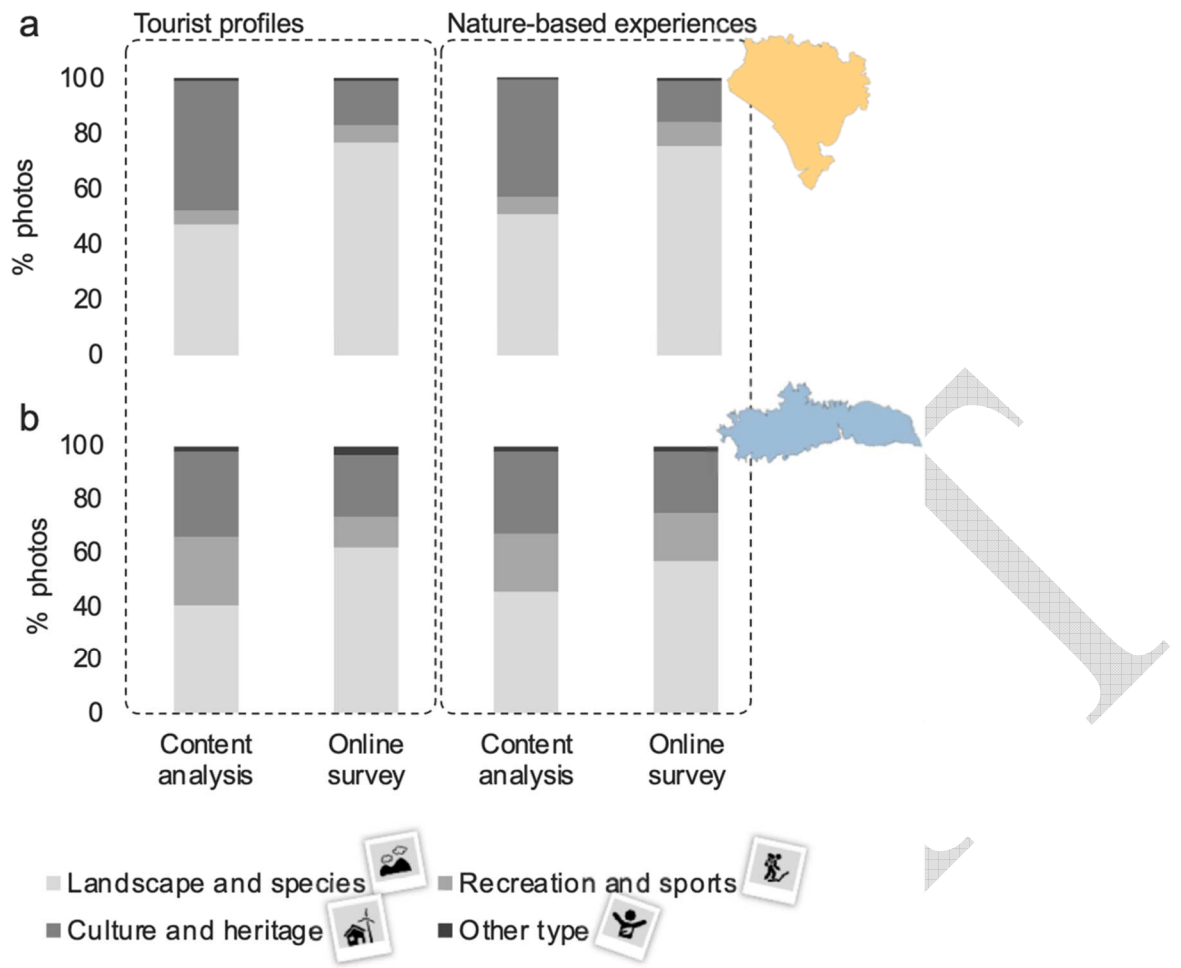

Figure 3. The proportion of photos assigned to each category of tourist profiles and nature-based experiences based on the content analysis and online surveys in Doñana (a) and Sierra Nevada (b).

The content analysis of tourist profiles in Doñana (Figure 3a) revealed the dominance of photos assigned to “landscape and species” and “culture and heritage” categories (48 % of all photos, each), followed by “recreation and sports” (4 %) and “other type” (<1 %). Although the online surveys classification showed a similar trend, the amount of photos assigned to “landscape and species” (77 %) and “recreation and sports” (7 %) by the Flickr users was almost twice of that from content analysis. For Sierra Nevada (Figure 3b), content analysis showed the dominance of “landscape and species” (41 %), followed by “culture and heritage” categories (32 %), “recreation and sports” (25 %) and “other type” (2

%). “Recreation and sports” (11 %) categories were less indicated the content analysis. By contrast, “culture and heritage” (24 %) were more indicated in the context analysis.

The content analysis of nature-based experiences in Doñana (Figure 3a) also showed the prevalence of “landscape and species” (51 %) and “culture and heritage” (43 %) categories, followed by “recreation and sports” (5 %) and “other type” (<1 %). Both “landscape and species” (76 %) and “recreation and sports” (8 %) categories were more indicated in online surveys, whereas “culture and heritage” (16 %) were less indicated by the Flickr users. Contrastingly, for Sierra Nevada (Figure 3b), the online surveys classification indicated less “recreation and sports” (17 %) compared to the results obtained from the content analysis. “Landscape and species” was found to be the dominant category, followed by “culture and heritage” in both content analysis (46 % and 31 %, respectively) and online surveys classifications (58 % and 23 %, respectively).

3.2. Overall congruence between content analysis and online surveys

Different agreement and accuracy levels were found between content analysis and online surveys classifications, depending on the Biosphere Reserve (Figure 4). Results for tourist profiles in Doñana, showed that in 56 out of 100 cases matched the same category in both content analysis and online surveys (i.e. 56 % agreement level). In 78 % of all cases, the content analysis was able to identify and exclude a given category in the same way as in online surveys (i.e. 78 % accuracy level). Despite an apparent higher congruence between content analysis and online surveys for Sierra Nevada compared to Doñana (Figure 3), lower congruence values were found, with only half of all cases matching the same category in both content analysis and online surveys (41 % agreement). The content

analysis identified and excluded a given category in the same way as in online surveys in 67 % of all cases (Figure 4b).

The test of independence (Chi-square = 22.36) and a confusion matrix based agreement measure (Kappa = 0.23) between the content analysis and online surveys classifications resulted in statistically significant values ($p < 0.001$) for Doñana, suggesting a significant association and agreement between content analysis and online surveys classifications on tourist profiles. For Sierra Nevada no significant results were found (Chi-square = 14.97; Kappa = 0.04; $p > 0.05$).

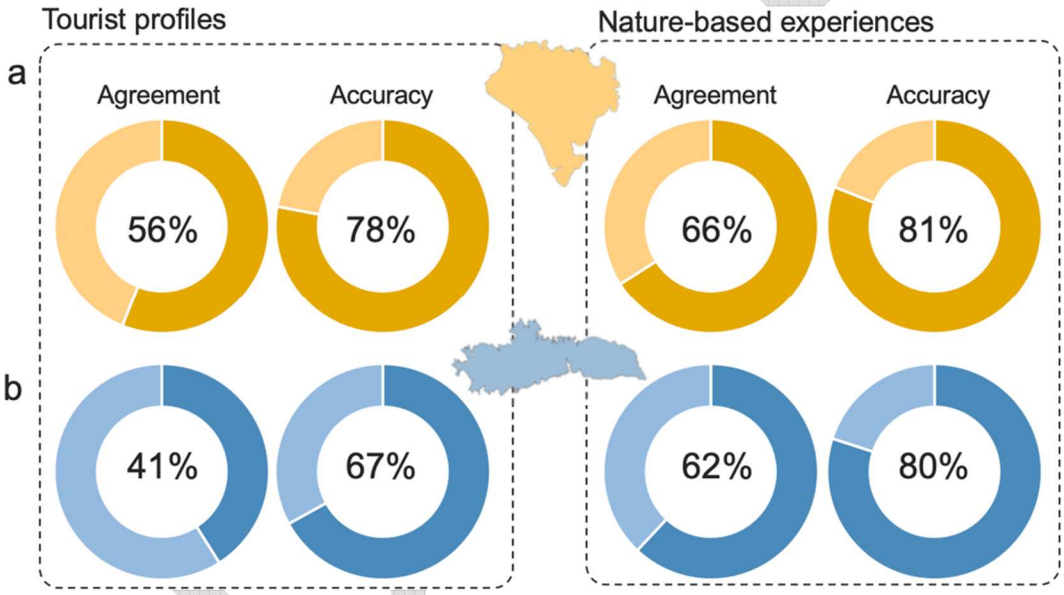

Figure 4. General agreement and accuracy levels between the classification results from content analysis and online surveys on tourist profiles and nature-based experiences in Doñana (a, top of the figure) and Sierra Nevada (b, bottom of the figure).

For nature-based experiences, higher agreement (66 %) and accuracy (81 %) values were found between content analysis and online surveys in Doñana (Figure 4a) and Sierra Nevada (Figure 4b). Additionally, the results of the independence and inter-agreement

tests showed a significant ($p < 0.001$) association and inter-agreement between content analysis and online surveys classifications for Doñana (Chi-square = 22.36; Kappa = 0.30) and Sierra Nevada (Chi-square = 63.11; Kappa = 0.31).

3.3. Tourist profiles and nature-based experiences in content analysis versus online surveys

When analysing the tourist profiles in Doñana by comparing the categorization of content analysis of Flickr photos and the online surveys answers, low congruence levels were observed for each individual category of tourist profiles in Doñana (i.e. < 0.50; Figure 5). An exception was found for the “landscape and species” category, showing a high F1 score (0.69), a very high Recall (0.93), and a moderate Precision (0.55). This suggests that among all photos assigned by the users to the “landscape and species” category in the online surveys, 93 % matched the result from the content analysis conducted by use. However, among all the photos assigned to that category by us through the content analysis, only 55 % matched the classification provided by the Flickr users during the online surveys. Also, the category “culture and heritage” showed a high Precision value (0.90), but low Recall and F1 score. For Sierra Nevada, the highest congruence level was also detected for “landscape and species”, which showed a moderate F1 score (0.57) with a fairly high Precision (0.68).

Similar trends were found when analysing the congruence between content analysis and online surveys classifications for each individual category of nature-based experiences. In Doñana, “landscape and species” showed the highest values for F1 (0.75), Precision (0.94), and Recall (0.62). In fact, these scores were also higher than those previously obtained for tourist profiles. A similar pattern was observed for Sierra Nevada, with the

category “landscape and species” revealing the best congruence between content analysis and online surveys, with high F1 (0.73), Precision (0.88) and Recall (0.63) scores. “Culture and heritage” showed also a moderate congruence (F1: 0.52) with a high Recall value (0.71) in Sierra Nevada (Figure 5).

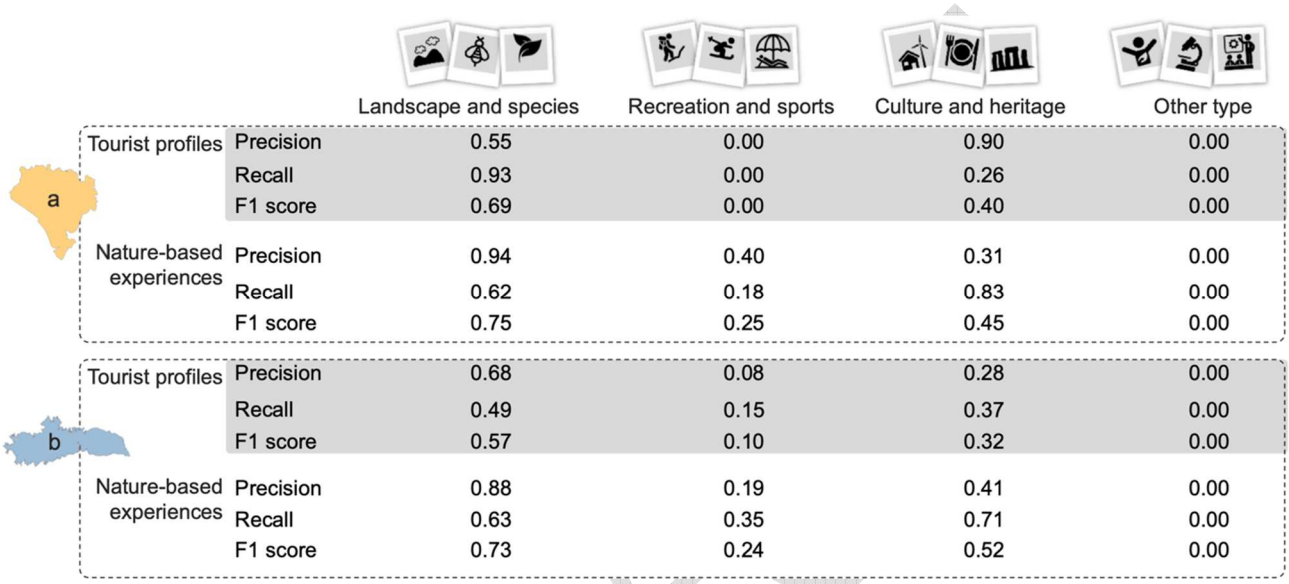

Figure 5. Precision, Recall and F1 scores obtained for the congruence analysis between content analysis and online surveys classifications on tourist profiles and nature-based experiences in Doñana (a) and Sierra Nevada (b).

4. Discussion

4.1. Tourist profiles and nature-based experiences between Biosphere Reserves

Our descriptive analysis showed different distributions in the number of photos assigned to each category of tourist profiles and nature-based experiences between the classifications conducted by us in the content analysis and those indicated by Flickr users during the online survey (see section “Prevailing tourist profiles and nature-based experiences across test areas”). In both Biosphere Reserves (Doñana and Sierra Nevada), “landscape and species” and “culture and heritage” were the most represented categories of tourist profiles

and nature-based experiences regardless of the classification method (i.e. content analysis or online surveys; Figure 3).

These results seem to agree with other studies (e.g. Hausmann et al. 2018; Martínez Pastur et al. 2016; Richards and Friess, 2015). For instance, Martínez-Pastur (2016) found that more than 83 % of all photos shared on social media expressed settings with aesthetic and existence values associated to "culture and heritage" in Patagonia. Also, Hausmann (2018) showed the dominance of "biodiversity and landscape" photos shared on Instagram (ca. 61 % of all photos) and Flickr (89 %) platforms for the Kruguer National Park. Finally, Richards and Friess (2015) assigned more than 60 % of all photos to a category expressing “nature appreciation and landscape” in urban mangrove sites from Singapore.

The dominance of “landscape and species” and “culture and heritage” photos is also congruent with the natural and cultural capital of Doñana and Sierra Nevada. Doñana includes natural wetland landscapes (e.g. marshes, lagoons and dune ecosystems) and a diversity of species (e.g. birds and emblematic mammals) which are popular for many visitors. Doñana is also the place of many cultural and religious traditions which have become internationally known (García and Marín, 2005). Similarly, due to its altitudinal range, Sierra Nevada holds remarkable topographic landscapes which are the habitat for a high and peculiar biodiversity (Zamora et al. 2016). Sierra Nevada also includes a cultural legacy with elements of historical human practices, traditions and activities (e.g handcrafted products and archaeological remains) of touristic importance.

Conversely, “recreation and sports” was less represented compared to the remaining categories (Figure 3) in Doñana. This was a rather surprising result, given that Doñana offers many opportunities for recreation activities and sports, namely through beach-oriented activities (García and Marín, 2005). In the case of Sierra Nevada, “recreation and

sports" was found to be particularly pertinent in content analysis classification, in which a diversity of recreation and sport activities, such as hiking and skiing, could be identified (Gómez-Ortiz et al. 2013). However, "recreation and sports" was underrepresented in the results from online surveys (compared to content analysis). This result suggests a plurality of nature contributions to tourists when exploring multi-functional landscapes such as the ones included in Sierra Nevada (Martín-López et al. 2012). For instance, visitors may simultaneously capture cultural elements in their photos, while being involved in "recreational and sports" or while enjoying "landscape and species".

4.2. Matches and mismatches between content analysis and online surveys

When evaluating the overall congruence between the results retrieved from our photo content analysis and from Flickr users' surveys, in general, we found poor to medium agreement and accuracy levels (see section "Overall congruence between content analysis and online surveys"). This suggests that the elements interpreted from the photo content may not always match the stated-preferences expressed in the online surveys. Nevertheless, higher congruence values were observed for nature-based experiences compared to tourist profiles (Figure 4). Differences in the interpretation of human-nature interactions in content analysis versus online surveys have also been shown for other protected areas (Hausmann et al. 2018; Heikinheimo et al. 2017). Our result may suggest that it might be easier to interpret a nature-based experience from a photo (i.e. "the what") than to infer on the social profile of the tourist (i.e. "the who"). In fact, most content analysis studies tend to focus on the classification of nature-based experiences and activities in the wild (e.g. Van Zanten et al. 2016).

Our results seem to change with the social-ecological context, with higher congruence levels between content analysis and online surveys for Doñana compared to Sierra

Nevada (Figure 4). Previous studies have suggested the influence of the social-ecological context in people's preferences for nature benefits (Martín-López et al. 2012). Sierra Nevada includes a complex territory (due to its topographic heterogeneity and land use diversity (Zamora et al. 2016)), potentially supporting a variety of nature-based experiences and making them harder to interpret from a photo content.

Also, our study shows that the agreement level between content analysis and online surveys classifications depends on the category being analysed (Figure 5). In fact, rather matching results, in terms of Precision, Recall and F1 scores, between content analysis and online surveys were only found for the category "landscape and species". This observation not only suggests that most photos classified in the content analysis as "landscape and species" match the online surveys classification (Precision), but also that one can predict a good percentage of photos classified as "landscape and species" by online surveys (Recall). The consistency found for this category may be explained by the fact that "landscape and species" express the most common tourist profile and their nature-based experiences when visiting the Biosphere Reserves. This inevitably makes "landscape and species" as the most-stated category in the online surveys, as well as the most easy-to-recognise category in the content analysis (particularly when the content analysis is performed by ecologists or nature-oriented researchers).

4.3. Methodological considerations and limitations, future research and perspectives for management

Here we identified differences in the classification of tourist profiles (i.e. "the who") and nature-based experiences (i.e. "the what"), as obtained from online surveys to Flickr users and from our content analysis of the photos posted by those same users, in two Biosphere Reserves: Doñana and Sierra Nevada. We found the lack of a clear congruence between

content analysis and online surveys, but also that this congruence depends on the category of nature-based experience under analyses and their social-ecological context. This suggests that although content analysis and online surveys alone can lead to incomplete information, their combined use can provide a more holistic evaluation of natural and cultural indicators.

We are nevertheless aware that any method tested here, or their combination, cannot be seen as flawless and that other methods were not considered (e.g. in situ survey). Yet, using methodologies based on social media networks, either content analysis or online surveys, can add advantages compared to more traditional state-preference methods. Among others, they facilitate the acquisition of thematic and geographical information through large areas and across time. They can also be cost-effective methods with increasing number of users, allowing replication and to reach large audiences. Therefore, it is recommended that the management of recreation in protected areas combine all these methods in an optimized protocol, adapting them according to their geographical, social and environmental reality. Maybe a way to integrate the information of both sources can be operationalized through the Cultural Salience Index proposed by Vieira et al. (2018), in which a given cultural ecosystem service (or nature-based experience) is evaluated from different user groups based on a ranked list.

Still, some methodological considerations are recognised in social media data. Despite the amount of photos taken in a given area, social media users make decisions on which photos they share in social networks. This does not necessarily mean that the photos shared online express the most preferred and valued elements of the landscape (e.g., selfies over particular species to serve as social testimonies of the user presence in the protected area). As suggested by Malik (2015), different dimensions' influence photo

sharing in social networking, namely, affection, attention seeking, disclosure, habit, information sharing, and social influence, behind sharing digital photos.

Also, we are aware that our research could have represented some bias due differences in time when the photo was taken and questionnaire was administered to the same user. Nevertheless, we are confident that the way we approached the Flickr users in the questionnaire could have contributed to diminish this bias. As noted by Kim (2018), there is a direct and positive relationship between the memorable tourism experiences and the intention to share them with others. Also, Tung and Ritchie (2011), highlighted that recollection (activities as sharing photos) can be amongst the most important dimensions to help memorizing tourism experiences.

Also, there is a broad literature that analyses the biases in social media data and we assume that our sample has the same bias in terms of geographical accuracy or mobile coverage (Heikinheimo et al., 2017), socio-economic factors (i.e: age, gender and income level) (Hausmann et al., 2018; Oteros-Rozas et al., 2018) or the availability to detect less popular activities (Heikinheimo et al., 2017).

Furthermore, stated-preferences for given tourist profiles, either online or face-to-face, can change in time and space, meaning that a given social media user may consider him/herself as a tourist of type *A* in a given time period, but as a tourist of type *B* in another time period. As highlighted by Hausmann et al. (2018), understanding how users' profiles and nature preferences change through time could be important to support continuous monitoring. The choice of which and how many categories are stayed in the questionnaire depends not only on the words, concepts and definitions used in the survey, but also on human psychological and cognitive factors, such as perceptions, judgements and attitudes. The former change in time and were not considered in our analyses. In this sense, methodologies such as the critical incident proposed in e.g. Moreno-Llorca (2019)

could be used to extract non-conditioned expressions of users experiencing or enjoying an activity in nature. This study opens the possibility of future researches. It would be interesting to analyse the reasons which explain the matches and mismatches found between content analysis and online surveys, and also investigate those matches and mismatches form a spatial perspective. In addition, it would be enriching in the future to undertake a triple analysis, including on-ground surveys.

Finally, caution should be made when extrapolating the results from our study to other areas. Several studies have evaluated visitor trends and their experiences in protected areas based on the analysis of photo content shared on social networks (Martínez Pastur et al. 2016; Oteros-Rozas et al. 2018; Richards and Friess 2015). Some of them compare the results of the content analysis with the results obtained in questionnaires carried out by visitors of the study area (Hausmann et al. 2018; Heikinheimo et al. 2017). However, many of these studies differ from ours given their use of distinct categorisations or social media platforms and target populations (Heikinheimo et al. 2017; Oteros-Rozas et al. 2018).

Concluding remarks

Our approach provided preliminary insights on the comparison between information collected through the content analysis of social media photos and the stated preferences of social media users in online surveys. Our results can be particularly important in a time in which the use of data from social media is increasingly rising to monitor human-nature interactions (Di Minin et al. 2015; Ladle et al. 2016; Richards and Friess 2015; Hale et al. 2019), including the assessment of cultural ecosystem services (Martínez Pastur et al. 2016) and the development of machine learning techniques for photo content analysis (Gosal et al. 2019; Lee et al. 2019). The content analysis and online surveys classifications of Flickr's photos resulted in matches and mismatches, suggesting different

yet complementary views from both classification methods. The combined use of content analysis and online surveys should thus be encouraged to obtain more holistic insights on nature-based experiences and preferences, as well as the use of on-the-ground surveys to analyse sampling biases and understand visitor's motivations. These insights would include both the interpretation from the researcher (i.e. the user interpreting the photo) and the information from the nature user (i.e. the person taking the picture). A way to consider such a complementary information can be found in the development of the salience index (Vieira et al. 2018). Further progress in combined assessments should consider multidisciplinary teams of researchers (e.g. from natural and social sciences) as well as managers' participation (Enquist et al. 2017), and include information from wider social media platforms (besides Flickr) and a spatially-explicit component. This would make it easier to better interpret and communicate the information provided by the visitors, either through social media content analysis or stated-methods and indicators. In this context, an exploratory analysis of the users' vocabulary used to tag social media photos could be a promising approach (Qian et al. 2013). Advances in culturomics, namely through text sharing analysis, will also show promising contributions in this regard (Ladle et al. 2016).

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