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Comparing outdoor recreation preferences in peri-urban landscapes using different data gathering methods

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ABSTRACT

The growing demand for a variety of outdoor recreation pursuits in peri-urban areas evokes the need for effective landscape management strategies based on reliable information about recreationists, their preferences and use of the landscape. Although a variety of methods are available for gathering this information, there is a lack of understanding if and how results from these methods are comparable. In this study we apply both *direct engagement* methods in the form of interviews (incl. participatory mapping, free-listing and quantitative photo ranking) and *indirect engagement* methods by analysing social media content (location, tags and photo content). The goal was to gather and compare data on outdoor recreation preferences in two study areas, one in the Netherlands and one in Switzerland. We found similar landscape preferences among study areas through both types of engagement methods. Our results indicate that these methods in general consistently identify similar landscape preferences. However, we also found differences regarding the type of information they manage to capture. For instance, for gathering landscape preferences, we found that free-listing and social media user tags, captured attributes related to the social and cultural appreciation of landscapes, including sensory qualities of a landscape and sense of place. The results highlight the potential of complementary approaches for capturing heterogeneous information needed for outdoor recreation research and, more generally, for landscape monitoring and management. Combining multiple methods enables relatively robust findings to be identified, but also addresses different aspects of landscape appreciation from different user groups.

1. Introduction

Outdoor recreation can be classified as a cultural ecosystem service (CES). CES are defined as "all the non-material, and normally non-consumptive, outputs of ecosystems that affect physical and mental states of people" (Haines-Young & Potschin, 2012, p. 344). CES have a positive effect on attentional, physiological, and emotional stress-recovery (Kaplan & Kaplan, 1989; Korpela & Borodulin, 2014; Thompson et al., 2012). Such beneficial effects are generated through individuals' active engagement with the natural environment and experience of the landscape through among others outdoor recreation activities (Fish et al., 2016; Sandifer, Sutton-Grier, & Ward, 2015). The way individuals engage with the natural environment during outdoor recreation varies on the basis of for instance diverging socio-cultural preferences for ecosystem services (see e.g., García-Nieto et al., 2015; Gosal, Geijzendorffer, Václavík, Poulin, & Ziv, 2019).

The growing demand for outdoor recreation and the increasingly diverse recreational activities (Emborg & Gamborg, 2016; Reis & Higham, 2009), evoke the need for effective landscape management strategies (Kienast & Degenhardt, 2012; Surová & Pinto-Correia, 2016). This is particularly relevant for peri-urban areas that provide important recreational spaces for urban populations. Successful management of public green spaces in peri-urban areas depends on the availability of reliable information about recreationists (e.g., socio-demographic and cultural background), their preferences for landscapes in which to recreate, and their actual (spatial) behaviour in the landscape (Komossa et al., 2018; Pröbstl, Wirth, Elands, & Bell, 2010).

For gathering information about outdoor recreationists, a variety of methods are available, including discrete choice experiments (e.g., Torquati, Tempesta, Vecchiato, Venanzi, & Paffarini, 2017; Barkmann & Zschiegner, 2010) social media analysis (e.g., Wood, Guerry, Silver, & Lacayo, 2013; Sonter, Watson, Wood, & Ricketts, 2016), location tracking via GPS (e.g., Korpilo, Virtanen, & Lehvävirta, 2017), qualitative photo ranking (Heyman, 2012), and language-based methods (e.g., Wartmann & Purves, 2018; Bieling, Plieninger, Pirker, & Vogl, 2014). Existing literature indicates that different data gathering methods vary in both their approach and their capability to capture the heterogeneity of outdoor recreation preferences and behaviour. Importantly, direct engagement methods and indirect engagement methods can be differentiated. In general, methods of indirect engagement, which work with datasets and do not require direct involvement of respondents, are effective in garnering spatial information, but do not capture user group characteristics. For example, Korpilo et al. (2017), used smartphone GPS tracking to gather data on the spatial distribution and density of recreational movement. This method captures spatial information but does not provide user

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characteristics. Tieskens et al. (2017) used geotagged social media data to gather information on recreationists' revealed landscape preferences, providing more than pure spatial insights but lacking demographic information of social media users (Van Zanten et al., 2016).

Conversely, most survey-based direct engagement methods generate socio-demographic profiles of recreationists, but generally falls short of amassing detailed spatial information on the distribution of recreationists across the landscape and its relation to landscape characteristics (e.g., Nekhay & Arriaza, 2016; Tyrväinen, Silvennoinen, & Hallikainen, 2017). Some exceptions are where surveys included targeted questions regarding exact locations of activities, accommodation, and/or transportation (e.g., Kienast & Degenhardt, 2012; Derek, Woźniak, & Kulczyk, 2017). Surveys are also used for studying place attachment in relation to outdoor recreation. For instance, Beery and Jönsson (2017) used both intercept surveys and self-administered questionnaires, and established a positive correlation between outdoor recreation and place attachment in a biosphere reserve in Sweden. Other studies addressing this issue have primarily focused on the place attachment of immigrant groups in western societies (Kloek, Buijs, Boersema, & Schouten, 2013; Peters, Stodolska, & Horolets, 2016), providing information on the landscape preferences of various user groups, but again without supplying spatially explicit data on the distribution of their activities and/or recreational preferences.

A few studies addressed complementarity of different methods. For example, Wartmann, Acheson, and Purves (2018) compared social media tags, interview data, and hiking blogs to gather information about landscape descriptions. However, our understanding is still limited regarding the questions how various data gathering methods for outdoor recreation research perform in comparison to each other and how they can be effectively combined. Such knowledge is crucial both for future research and decision-making in landscape management (see Jenkins & Pigram, 2007). For the latter, decision-makers would be better equipped for planning and managing landscapes (especially multi-functional ones) when they have better insight in which methods – either in isolation or in combination – are most suited for a specific situation, helping them to make an informed decision as to which method(s) to use (Harrison et al., 2018). The added value of combining different methods to streamline landscape management for recreation is illustrated by a case study in Cairngorms (Scotland), where mapping and photo series analysis were combined to gain greater insight in the disparities between accessible nature and actually visited areas (Dunford et al., 2018).

The objective of the present study is to compare outdoor recreation preferences in peri-urban areas derived from applying different methods (both direct engagement through interviews and indirect engagement methods including analysis of social media content) for gathering data in two case studies. In doing so, we highlight the potential of combining complementary approaches for capturing heterogeneous information needed for outdoor recreation research and landscape management. By conducting the comparison in two different study regions we broaden the applicability of our findings beyond the specific context of a single case study.

2. Materials and methods

We focus our comparison on methods to gather information about two interrelated topics that are highly relevant for outdoor recreation research: a) landscape preferences of outdoor recreationists and b) spatial preferences for recreation (Fig. 1). The first approach directly addresses recreational preference regarding landscapes including preferences for biological and physical landscape elements, while the second approach is location-based. We understand spatial preferences as relating to where recreationists recreate in a landscape which among others depends on landscape preferences but also other factors such as accessibility or recreational activities (see e.g., Paracchini et al., 2014). Spatial preferences can – depending on the method – be analysed in terms of stated spatial preferences (here: through participatory mapping) or actual preferences (social media point data). The same applies to landscape preferences, which directly address recreational preferences regarding landscapes, including preferences for biological and physical landscape elements. Landscape preferences can be analysed through either stated preferences (e.g., when using the quantitative photograph ranking exercise) or actual landscape preferences (e.g., when analysing social media content). We chose the terms landscape preferences and spatial preferences as we believe this distinction helps to distinguish the methods that we compare. We selected methods that capture data directly, through active engagement with participants (*direct engagement*) and include participatory mapping, free listing, and quantitative photo ranking. Also, we selected methods that capture passively created data (*indirect engagement*) (Fig. 1). Indirect engagement methods do not require respondent participation and derive information from data sets; harvesting and analysing existing user-generated content in the form of images and tags from the social media platform Flickr (www.flickr.com) is an example of indirect engagement.

2.1. Case study areas

The study area in the Netherlands is situated in the province of Utrecht in the central part of the country (Fig. 2) and is referred to as the Kromme Rijn area (219 km^2). The area is named after a 28-km long river, a former affluent of the Rhine, that flows through the heart of the area. It is located close to the city of Utrecht and borders the National Park Utrechtse Heuvelrug. The river's fluvial deposits form fertile soil for fruit cultivation, which is accordingly the area's most important agro-economic sector (AVP, 2007; LOS stadomland, 2016). Grasslands used for dairy farming are likewise characteristic for the landscape's appearance, much more so than other forms of agriculture (cereal and vegetable growing) and forest areas, which overall take up a much smaller area Provincie Utrecht, 2016.

The Swiss study area – the Zurich Weinland (175 km^2) – is located in northern Switzerland in the canton of Zurich. The Zurich Weinland is characterized by its river landscapes of Rhine and Thur including the 'Thurauen', the largest floodplain in Central Switzerland. The area is known for its viticulture and is in fact the largest winegrowing region in the canton (Branchenverband Zürcher Wein, 2019). Alongside tobacco, other produce deemed typical for Switzerland in general and the Weinland in particular include cheese, beer, melons, and asparagus.

Both study areas are characterized by a cultural landscape or river landscape, but they display differences in scale, relief, and openness. Both are peri-urban, multifunctional landscapes, which are widely used for recreation, offering a well-developed touristic infrastructure. The most popular sites used for recreation offer diverse landscapes that combine river vistas with forest patches, cultural heritage, and small-scale agriculture. Also the recreational activities pursued here are diverse and include hiking, biking, angling, swimming, canoeing, sunbathing and more.

We selected these areas for our comparison because of the similarities in the physical landscape settings as well as the uses and functions assigned to these landscapes, while they offer interesting comparative settings due to the different planning contexts of Switzerland and The Netherlands.

2.2. Data collection from indirect engagement approaches

Publicly available user-generated content is a common data source used to gain insights into spatial choices and preferences (Oteros-Rozas et al., 2018; Van Zanten et al., 2016). User-generated content presents an opportunity to capture greater volumes of data with respect to landscape perception as compared to empirical methods such as face-to-face interviews (Wartmann & Purves, 2018). Particularly uploaded images are a useful source of information regarding outdoor recreation and preferences (Tenerelli, Demšar, & Luque, 2016; Wood et al., 2013).

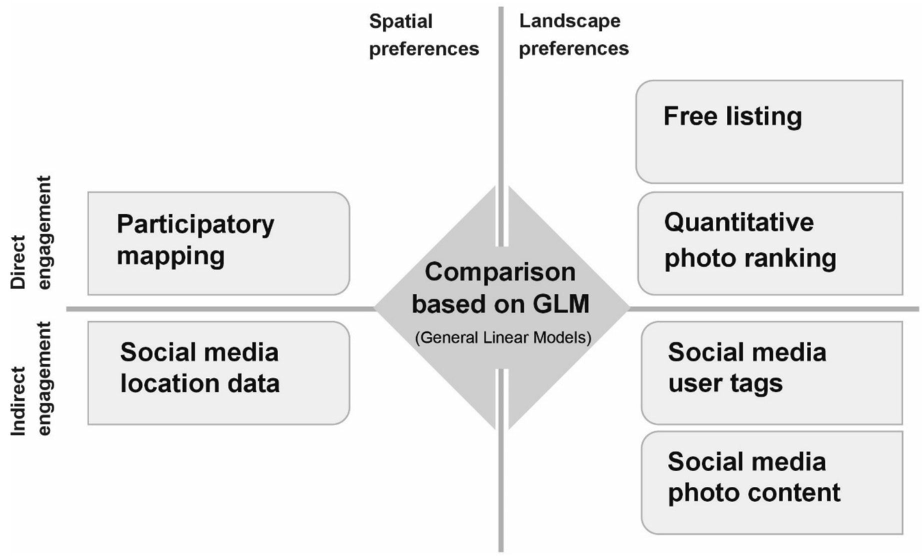


Fig. 1. Overview of the methods used in this study to investigate spatial preferences and landscape preferences of recreationists using direct and indirect engagement methods.

The data analysed from user-generated content includes associated natural language descriptions in the form of user-created *tags* (see e.g., Oteros-Rozas et al., 2018; Wartmann et al., 2018), the location of uploaded georeferenced photographs (see e.g., Tieskens, Van Zanten, Schulp, & Verburg, 2018; Wartmann, Tieskens, van Zanten, & Verburg, 2019) and the image content (see e.g., Oteros-Rozas et al., 2018).

In this study, we used content from the photo-sharing platform Flickr that was publicly available for research. We used automated API requests with Python to download all georeferenced images for the bounding boxes of our respective study areas dated between 2004 and 2017, including both images and metadata (e.g., coordinates, user names, tags, date image was taken). Following the approach implemented by Tieskens et al. (2018), we then manually inspected all photographs and filtered them using two criteria: (a) to have both an image URL and user-generated tags, and (b) to relate to landscapes, landscape elements or outdoor recreation in general (e.g., race bike parked next to tree). We excluded all automatically created tags and only processed tags given by users. Photographs taken during winter months were excluded as data from the other methods were gathered during spring, summer, and autumn. For the Swiss study area this resulted in 671 photos made by 476 unique users and for the Dutch study area in 1860 photos. From the Dutch images we selected a random sample of 671 photographs (taken by 200 unique users) to match the Swiss sample. We used matched sample sizes to directly compare the frequencies of terms used.

2.2.1. Landscape preferences (indirect engagement)

To obtain information on recreationists' landscape preferences through indirect engagement, we manually analysed the content and the natural language tags of all social media images collected from Flickr. For the manual analysis of these data, we developed a coding scheme applying an iterative process known as 'open coding', where

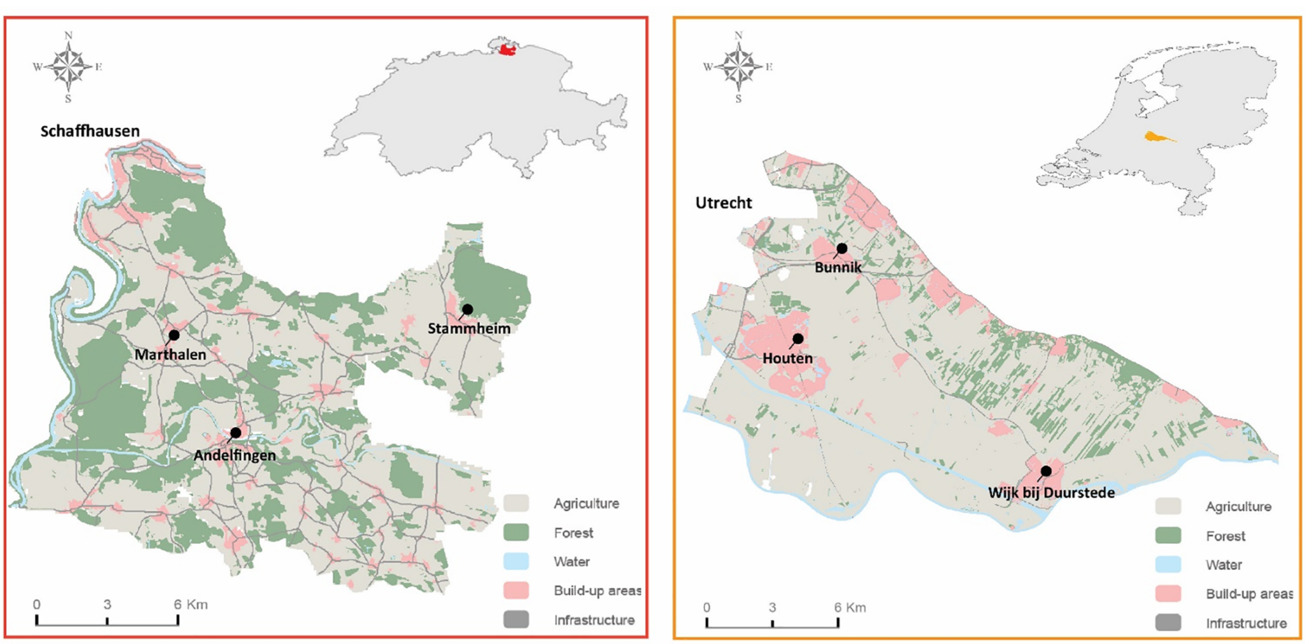


Fig. 2. Location of the Swiss (A) and Dutch (B) case study area. © OpenStreetMap (and) contributors.

emerging themes are identified based on the data (Crang & Cook, 2007; Wartmann & Purves, 2018). Similar to the method described in Wartmann and Purves (2018) we used open coding to identify recurring themes in our free-listing transcripts. We then repeated the same procedure of open coding for the social media content and compared and merged mentions of different facets among data sources. Following this process, we identified different facets that we labelled with English expressions/terms – informed by academic literature – that we believe best reflect their content. These facets include cultural landscape element, biological and physical landscape elements, sense of place and landscape experience (see coding scheme in Appendix A of the manuscript). Biological and physical landscape elements contain terms that refer to land-use or land cover such as agricultural areas and forests, but also terms referring to flora and fauna. Cultural landscape elements include terms for villages, cultural heritage, touristic infrastructure or anthropogenic objects. Perceptual elements include mentions of sounds, smells, touch/feel, colour, weather, and atmospheric conditions. The fourth aspect – sense of place – is represented in our data by terms referring to meanings, memories, feelings, and terms relating to a sense of attachment, history of a place or landscape, or identity. In our usage, sense of place is understood as an umbrella concept, which includes other concepts such as place attachment and place identity (Wartmann & Purves, 2018). From open coding we derived additional aspects such as accessibility of a landscape and *activities* participants associated with a landscape. Using this final coding scheme (see Appendix A) we applied 'structured coding' (Crang & Cook, 2007), whereby each term is then assigned to a category or facet. For instance, we would assign "castle" to the facet "cultural landscape element". We applied structured coding to the free-listing as well as the Flickr tag data. In annotating the content of social media photographs, we did not apply the categories "landscape composition", "accessibility", "sense of place" and "perception". We did not deem these categories applicable to the coding of image tag data.

2.2.2. Spatial preferences (indirect engagement)

Locational data from social media can be used to analyse the landscape preferences through determining landscape characteristics at frequently visited locations (Tieskens et al., 2018). As an indicator of spatial preference of outdoor recreationists we calculated the density of unique user uploads of geo-referenced Flickr photographs that are publicly available through the Flickr API (Tieskens et al., 2018; Wood et al., 2013). For each grid cell (10 × 10 m), we made a calculation of the total number of unique user uploads in a 250 m radius neighbourhood to account for the unknown directions in which photographs were taken and errors in the location accuracy. The geotag accuracy error of Flickr rarely exceeds 250 m (Tieskens et al., 2018; Zielstra & Hochmair, 2013). We snapped all photographs (within a distance of 250 m) to the most recent Open Street Map roads map (OpenStreetMap Contributors, 2018) to not include parts of the landscape that are relatively inaccessible and therefore are naturally less visited by recreationists than more accessible areas (see Tieskens et al., 2018).

2.3. Data collection from direct engagement approaches

The target population for the direct engagement methods were recreationists within the study areas. We used a convenience sample, focusing on maximizing variety among respondents including all genders, levels of education, and age groups, who engaged in various recreational activities typical for the areas (Strauss, Corbin, Niewiarra, & Legewie, 1996). The semi-structured interviews were held in Dutch or (Swiss-)German respectively, using a questionnaire. We used a theoretical sampling approach to select interview locations at various recreation sites, so that they reflect the diversity of the study areas. With theoretical sampling, the analyst jointly collects, codes and analyses his/her data and decides what data to collect next and where to find it in order to develop his/her theory as it emerges (Glaser and Strauss, 2012). The full questionnaire is provided in Appendix B in the Supplementary material. A total of 402 persons (201 per study site) were interviewed; socio-demographic characteristics of our sample are reported in Appendix C. An average interview lasted between 15 and 20 min. The questionnaires in the Kromme Rijn area were conducted in two phases, one between October and November 2016 and one between May and June 2018. The interviews in the Zurich Weinland were conducted in August 2018. Interviews were conducted during the day time, any day of the week, with varying weather conditions (mostly sunny, dry days).

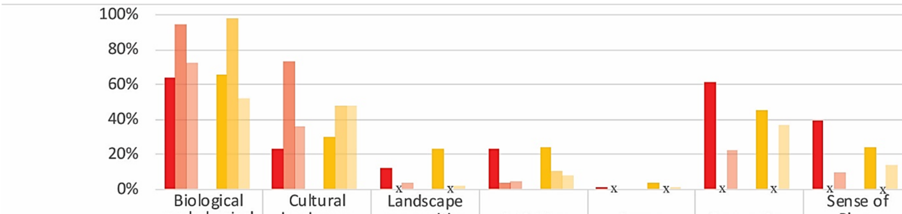
2.3.1. Landscape preferences (direct engagement)

For gathering data on landscape preferences directly we used free-listing and a quantitative photo ranking exercise incorporated in questionnaires conducted with outdoor recreationists. Free-listing is a common method in cognitive psychology and is used to elicit terms for a cognitive domain, which has been previously applied in research on outdoor recreation (Bieling et al., 2014; Wartmann & Purves, 2018) as well as landscape preferences (Mark, Smith, & Tversky, 1999; Williams, Kuhn, & Painho, 2012). Based on a previous study using free-listing for eliciting landscape terms in Switzerland by Wartmann, Egorova, Derungs, Mark, and Purves (2015), we used the following elicitation statement: "what does the landscape in this area offer you as a recreationist", while instructing them to list anything that came to their mind. All terms were transcribed by the interviewer as they were listed by the participants. For analysing free-listing data, we calculated a Sutrop's index as a measure of cognitive saliency that combines mean rank and term frequency (Sutrop, 2001), which has been previously applied to analyse free-listing of landscape terms (Bieling et al., 2014; Wartmann et al., 2015, 2018). We used this index to quantitatively compare our results from the two study areas.

The on-site employment of photographs, which we applied through our quantitative photo ranking exercise, is generally regarded as an adequate method for collecting empirical data about landscape preferences (e.g., Arriaza, Cañas-Ortega, Cañas-Madueño, & Ruiz-Aviles, 2004; Van Berkel & Verburg, 2014). We first consulted academic experts working in the field of landscape ecology, landscape dynamics, and land use systems from the Netherlands and Switzerland to identify different typical landscape elements for both case-study areas. The identified elements were cultural heritage sights, meadows, marshes, agricultural lands, fruit orchards, forests, rivers and water, tree lines and hedgerows, villages, farm animals, and wild animals. For the Swiss study area, we additionally included vineyards. The photographs were collected by the authors during photo excursions in the respective study areas in the summer of 2018 for the Swiss photographs and in the summer of 2016 for the Dutch photographs. Using these photographs, respondents were asked to rank the three landscape elements they valued most during their recreational activities. Each landscape element was captured in three different pictures to ensure that the characteristics of individual photographs had less influence on the respondents' judgments. For comparability, each picture showed corresponding sunny weather conditions (Soliva et al., 2010), and was manually adjusted using Microsoft Word Picture Tools to display similar brightness and height of horizon (Al-Kodmany, 1999; Barroso et al., 2012).

2.3.2. Spatial preferences (direct engagement)

In the second part of the questionnaire we used a participatory mapping exercise for eliciting recreationists' spatial preferences through direct engagement. Participatory mapping is a method used in participatory spatial planning (Eadens et al., 2009; Kahila-Tani et al., 2016) and in mapping cultural ecosystem services (Brown & Fagerholm, 2015; Klain & Chan, 2012) where the inclusion of spatially explicit individuals' values and preferences is needed (Vajjhala, 2005). For this study, we prepared a base map for each study area using OpenStreetMap data with various landmarks (e.g., location of castles, hiking paths) to ease readability (see Appendix D). Participants were then



	Biological and physical landscape elements	Cultural landscape elements	Landscape composition	Activities	Access	Perception	Sense of Place
CH: Free-listing	64.2%	22.9%	12.4%	23.4%	1.5%	61.2%	39.3%
CH: SM photos	94.5%	73.0%	n/a	3.9%	n/a	n/a	n/a
CH: SM user tags	72.6%	36.1%	3.5%	4.5%	0.0%	22.3%	9.3%
NL: Free-listing	65.2%	29.9%	23.4%	23.9%	3.5%	45.3%	23.9%
NL: SM photos	98.1%	47.9%	n/a	10.5%	n/a	n/a	n/a
NL: SM user tags	52.4%	47.9%	1.8%	8.1%	0.1%	36.4%	14.1%

Fig. 3. Comparison of recreationists' preferences coded into the following 7 categories: biological and physical landscape elements, cultural landscape elements, perceptual elements, and sense of place among data sources and study areas. *Note:* Landscape composition, Access, Perception and Sense of Place were not coded for social media photos. X refers to these non-coded categories.

asked to indicate with coloured marking pens (a) the locations where they have recreated and will be recreating on that specific day, and (b) the areas where they consider the landscape to be aesthetically pleasing. All hand-drawn maps were digitized. We then calculated the densities of recreational locations (lines or dots) and locations of aesthetically pleasing landscapes (polygons) as indicators of spatial preference of outdoor recreationists, similar to the density of geo-referenced Flickr photographs. We tested three different neighbourhood radius distances: none, 10 m and 250 m. From visual inspection we found the 10 m neighbourhood setting for the line and point data to reflect recreationists' location preferences best. Moreover, we did not include a neighbourhood radius for each grid cell setting (Tieskens et al., 2018) for the landscape preference polygons as this would interfere with the accuracy of the model results.

2.4. Making landscape preferences and spatial preferences comparable through general Linear models (GLM)

In this study we take into account *landscape preferences* and *spatial preferences* for outdoor recreation and make these comparable in terms of preferences for landscape elements through a formalized approach using General Linear Models (GLM).

In this study we used free-listing, social media photo content, and social media user tags to analyse recreationists' *landscape preferences.* For this, we first calculated frequencies of terms or images contained within the four categories we had defined and compared term/image frequencies in these categories among methods. We analysed the quantitative photo ranking data by calculating the sample mean value as the mean of preferences among recreationists from 0 (low) to high (3) per landscape element.

We used recreationists' location information derived from georeferenced social media data and participatory mapping data to analyse the *spatial preferences* of recreationists (Tieskens et al., 2018). We generated the recreationists' preferences for specific landscape settings using GLM (Kienast & Degenhardt, 2012). We related the spatial occurrence of landscape elements identified as typical for both case study areas (see Section 2.3.1) to the presence/absence of recreationists. To obtain spatially explicit data for the Dutch study area, we used a map depicting landscape conservation areas, which we simplified and aggregated into layers of geographic data for each of the landscape elements mentioned above (Provincie Utrecht, 2016). For the Swiss study area we used the swissTLM3D dataset from the Federal Office of Topography of Switzerland (Swisstopo, 2018). Data on the location of agricultural areas, meadows and villages was retrieved from the Federal Statistical Office of Switzerland using the 'NOLU04 Arealstatistik' spatial statistics dataset (BFS, 2018). To measure the effect of cultural heritage sites on recreationists' spatial preferences we used the location of estates, castles, and churches for both study areas and added the location of forts and mills in the Dutch area (Rijksdienst voor het Cultureel Erfgoed, 2017; Swisstopo, 2018). We calculated spatial layers with the inverse of the distance to these landscape elements with a maximum of 500 m. We then applied a Generalized Linear Negative Binomial Regression with an estimated dispersion factor as described in Tieskens et al. (2018) to predict recreationists' landscape preferences in the two study areas, as approximated by (a) the density of unique user uploads of landscape photographs and (b) the densities of recreational locations (lines or dots) and separately the density of locations of aesthetically pleasing landscapes (polygons) as indicated through participatory mapping using IBM SPSS 25.0. We calculated the variance inflation factor (VIF) of each predictor (see Appendix E) to check for multi-collinearity (Guisan & Zimmermann, 2000). To assess the models' goodness of fit, various measures exist that typically summarize the discrepancy between observed values and the values expected under the models in question (Allison, 2014). In this study we used the Akaike Information Criterion (AIC) for model selection (Akaike, 1973). After the calculation of frequencies of terms and image content according to the different categories we had defined earlier, we compared frequencies in these categories among methods and study areas.

3. Results and interpretation

We found that biological and physical landscape elements were the most frequent elements in our data in both the Swiss and the Dutch study site for free-listing data, social media images and social media tag data (Fig. 3). This is followed by the category of cultural landscape elements with high frequencies in social media tag data and social media photo content. Another category frequently mentioned is perception of the landscape (e.g., terms relating to sounds, smells, colour). Especially free-listing data and user tags depict high term frequencies in this category. Results of the individual methods can be found in Appendices F and G.

When comparing data sources with each other based on their term/image frequencies, we notice that individual methods differ considerably in the preferences they reveal (Fig. 3). For example, social media photo data depict highest numbers in the category biological and physical landscape elements. Free-listing also shows relatively high frequencies for biological and physical landscape elements, but the highest term frequencies are in the category perceptual elements. In the categories sense of place, landscape composition, and access free-listing had higher content than social media tags. Both social media photo data and free-listing data show higher frequencies for specific biological and physical landscape elements than the other data sources (Fig. 3). Social media photo data exhibits higher frequencies of photographs in the categories rivers and water as well as agricultural lands in both case study areas compared to the other methods. Similarly, social media photographs show higher frequencies for the categories meadows and

Fig. 4. Biological and physical landscape element frequencies in the Swiss (red) and Dutch (orange) case study area presented as the % of the total sample using data stemming from three different methods, namely free-listing, social media photos and social media user tags. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

flora in the Dutch study area, and for photographs related to trees, forests, and tree lines and hedgerows in the Swiss study area. Free-listing data shows high term frequencies for marshes, farm and wild animals in the Swiss study area. For free-listings in the Dutch study area, terms for wild animals were frequently listed.

Our results indicate that there are differences in what recreationists encounter during a visit (e.g., wild animals, smell, sound) and what they are able to capture on camera. It that sense, free-listing provides a broader overview of preferences related to landscape than social media does.

Comparing frequencies of biological and physical landscape elements in more detail (Fig. 4), rivers and water are the most preferred elements throughout the three methods compared to other elements in both study areas. Another element that was highly preferred by recreationists is forests. Especially free-listing and social media photo data captured high frequencies for this element in both study areas. These findings are similar to the results from our photo ranking tasks in the survey (see Appendix F), which also indicated highest preferences for rivers and water, followed by forest.

The results of the generalized negative binomial linear models are presented in Table 1, showing the regression coefficients of all predictor variables calculated by the models for both study areas using social media locational data and participatory mapping data (see column 'participatory mapping location' in Table 1) and aesthetically pleasing areas (see column 'participatory mapping aesthetic areas' in Table 1). As the variance inflation factor of each predictor was lower than 2 and mutual Pearson's correlations were all below 0.5, there was little to no collinearity among the predictors. The estimates were comparable among each other, as they all use inverse distance to features at the same scale.

Comparing the model estimates between data sources, all three models show relatively high positive values for rivers and water as well as cultural heritage in both study areas as compared to other elements. High estimate values indicate that increasing proximity to certain landscape features is associated to higher use density at that location, thus reflecting recreationists' appreciation of the presence of these landscape features. The highest estimate values emerge for rivers and water from participatory mapping location data at both study sites. The coefficient estimates should be interpreted as follows: a value of $0.5\ E^{-2}$ for rivers and water in the Swiss study area implies that for each 10 m closer to the rivers and water features, the natural log of predicted photo density increased by $0.5\ E^{-2}$.

From the model estimates it is also striking that significant estimates for agricultural lands have low or even negative values in both study areas, indicating the low preference of recreationists for this landscape element.

Comparing the GLMs based on their estimate values, it is noteworthy that for some landscape elements, such as marshes, we found diverging results depending on the data source. While the GLM using social media location data results in negative estimate values for

Table 1
Negative Binomial Generalized Linear Model regression estimates (including goodness of fit measures) for the Social Media location data, participatory mapping reported recreation location data and participatory mapping reported aesthetically pleasing area data for both the Swiss and the Dutch case study areas.

Landscape elements	Zurich Weinland (CH)			Kromme Rijn area (NL)		
	Social media recreation location	Participatory mapping location	Participatory mapping aesthetic areas	Social media recreation location	Participatory mapping location	Participatory mapping aesthetic areas
Agricultural lands	$-0.2\ E^{-2**}$	$0.0\ E^{-2}$	$0.0\ E^{-2**}$	$0.0\ E^{-2}$	$-0.2\ E^{-2**}$	$-0.1\ E^{-2**}$
Cultural heritage	$1.1\ E^{-2**}$	$0.3\ E^{-2**}$	$0.1\ E^{-2**}$	$0.1\ E^{-2**}$	$0.1\ E^{-2*}$	$0.1\ E^{-2}$
Meadow	$0.0\ E^{-2}$	$0.0\ E^{-2}$	$0.0\ E^{-2**}$	$0.0\ E^{-2*}$	$0.1\ E^{-2**}$	$0.1\ E^{-2**}$
Marshes	$-0.1\ E^{-2*}$	$0.2\ E^{-2**}$	$0.1\ E^{-2**}$	$-0.1\ E^{-2**}$	$0.1\ E^{-2}$	$0.1\ E^{-2**}$
Fruit orchards	$0.1\ E^{-2**}$	$-0.2\ E^{-2**}$	$-0.1\ E^{-2**}$	$0.1\ E^{-2**}$	$0.2\ E^{-2**}$	$-0.1\ E^{-2**}$
Tree lines & hedgerows	$0.1\ E^{-2*}$	$0.1\ E^{-2}$	$0.0\ E^{-2**}$	$-0.1\ E^{-2**}$	$-0.1\ E^{-2**}$	$0.1\ E^{-2**}$
Forests	$0.0\ E^{-2}$	$0.0\ E^{-2}$	$0.1\ E^{-2**}$	$0.1\ E^{-2**}$	$-0.1\ E^{-2**}$	$0.1\ E^{-2**}$
Rivers and Water	$0.2\ E^{-2**}$	$0.5\ E^{-2**}$	$0.3\ E^{-2**}$	$0.1\ E^{-2**}$	$0.2\ E^{-2**}$	$0.1\ E^{-2**}$
Villages	$0.0\ E^{-2}$	$0.1\ E^{-2**}$	$0.0\ E^{-2**}$	$0.0\ E^{-2*}$	$0.0\ E^{-2}$	$0.0\ E^{-2**}$
Viticulture	$0.0\ E^{-2}$	$0.2\ E^{-2**}$	$0.1\ E^{-2**}$	N/a	N/a	N/a
Akaike's Information Criterion (AIC)	*Value*	*Value*	*Value*	*Value*	*Value*	*Value*
	5542.665	9870.040	37078.636	11921.071	21363.906	70101.507

**$p < 0.001$.
*$p < 0.01$.

marshes at both study sites, the GLM using participatory mapping data result in positive estimate values for marshes in both study areas. In order to assess the models' goodness of fit, we used AIC. The low AIC indicates that the co-variates provide a good explanation/fit of the spatial patterns of the social media data. In other words, the social media data provide a better fit than the direct engagement methods.

4. Discussion and conclusion

This study aimed to improve our understanding of how various methods differ in their capacity to capture data on outdoor recreationists' preferences. We compared empirical data from direct engagement methods such as interviews and participatory mapping, as well as indirect engagement methods using social media data. This approach is novel, as it compares different methods within the same setting, thus improving comparability. Furthermore, by conducting this work in two case study areas in Switzerland and the Netherlands, we offer a comparison of recreational preferences in river landscapes. We took into account both *landscape preferences* and *spatial preferences* for outdoor recreation and compared those using statistical modelling techniques. We found overall similar landscape preferences among all methods employed including high preferences for water elements and cultural landscape elements which corroborates earlier studies on landscape preferences (e.g., Arriaza, Cañas-Ortega, Cañas-Madueño, & Ruiz-Aviles, 2004; De Aranzabal, Schmitz, & Pineda, 2009). This indicates that the applied methods in general produce consistent results regarding landscape preferences. We found e.g. that two of the methods applied to gather information on landscape preferences, namely free-listing and social media user tags, were able to capture attributes related to the social and cultural appreciation of landscapes, including sensory qualities of a landscape and sense of place.

We found that biological and physical landscape elements are the most preferred landscape elements for both study areas and across all methods. A more detailed analysis of the extent to which specific biological and physical landscape elements are appreciated by recreationists revealed consistent and high preferences for rivers and water in both our study areas, which is consistent with previous studies (e.g., Burmil, Daniel, & Hetherington, 1999; Arriaza et al., 2004). For instance, a nationally representative survey in Ireland indicated that the public had the strongest preference for landscapes with water related features, followed by cultural landscapes (Howley, 2011). A study in residential areas in Sweden revealed preferences for water-dominated areas and forests for outdoor recreation (Ezebilo, Boman, Mattsson, Lindhagen, & Mbongo, 2015). In Spanish National Parks, a study on landscape preferences described recreationists' preferences for a peaceful 'prototype landscape' including green mountainside with water (DeLucio & Múgica, 1994). These findings are all in line with theories on landscape preferences, such as the savannah-theory (Orians, 1980, 1986) that postulates a preference for semi-open landscapes with water bodies.

Our results also indicate a high preference for cultural landscape elements including cultural heritage sites and villages. Although cultural landscape elements may entail both built amenities (Dissart & Marcouiller, 2012) and elements of agricultural land use (IEEP, 2007; Schaich, Bieling, & Plieninger, 2010) our results show that it is mainly the built amenities that were highly preferred in both study areas. This corresponds with findings from other studies that relate the appreciation of cultural landscape elements to historical-artistic heritage (De Aranzabal et al., 2009) or traditional buildings (Carneiro, Lima, & Silva, 2015). The low preference for agricultural fields that we found supports earlier findings that especially areas of intensive farming are usually less preferred (Howley, 2011), while the degree of wilderness contributed most to individual's appreciation for rural (agricultural) landscapes (Arriaza et al., 2004; Junge, Schüpbach, Walter, Schmid, & Lindemann-Matthies, 2015). Both case study areas are dominated by intensive agriculture, which could explain the low preferences for agricultural lands we observed.

Generally, our findings suggest that different approaches provide comparable results. On this basis, we argue that where sufficient social media data are available these data can be used as a proxy for traditional direct engagement approaches, especially since its acquisition is less time consuming, relatively cheap and covers a longer timeframe. Thus, it could be used for the analysis of prospective changes in a landscape's outdoor recreation potential over time (Komossa et al., 2018) as a function of conservation management actions (Gosal, Newton, & Gillingham, 2018).

Notwithstanding the converging results, substituting one method for the other risks inadvertently losing detail, as the following example reveals. The GLM using participatory mapping data results in positive estimate values for marshes in both study areas, indicating generally high spatial preferences among recreationists for marshlands. In contrast, the GLM using social media location data results in negative estimate values for marshes. This low preference of social media users towards marshland is supported by previous studies that found heathland and marshes contributed less to predicting social media photo density (Tieskens et al., 2018). These diverging preferences found between social media data and face-to-face interviews might be ascribed to divergent preferences of different age groups captured through the two different data sources. Our empirical data shows that a majority of recreationists were aged 55–65, with high preference for marshlands, often related to the commonly wild and unspoiled nature of such landscapes, which are characterized by a great biodiversity (Keddy, 2010). An advisory report for the English government published in 2016 identified a similar age group, stating that the wildlife found in marshlands attracted visitors typically over 65 years of age who liked to engage in wildlife observation (NaturalEngland, 2016). Furthermore, access to marshlands is often limited, making it easier to state a preference for this landscape type rather than taking a social media picture of this often inaccessible landscape element. As social media data reveal a trace of actual behaviour in a landscape – these data are constrained by accessibility. Recreationists may also appreciate landscapes that are not easily accessible (see e.g., Komossa et al., 2018), such as marshlands, but such preferences are not captured through social media data. We therefore argue that one should use social media data with caution when assessing landscape preferences, because it can only reveal accessible areas. Basing our recreational management decisions solely on social media data may thus lead to biased decision-making. This provides a compelling argument why we should strive for complementarity in our methods. The results of this study are thus of relevance both for landscape management and future research, highlighting the benefits of methodological diversity and complementarity (Jenkins & Pigram, 2007). Having information on what methods are able to capture what type of information can aid decision-makers and landscape planners in identifying the methods that are best suited for their specific management questions.

A commonly cited issue with social media data relates to the potential bias in user contribution (Li, Goodchild, & Xu, 2013). We found that in the Dutch sample, about 1% of all users contributed to over a quarter (25.6%) of all data. In the Swiss sample, 1% of the users took 15.6% of all images. Landscape preferences of proliferous individuals may therefore influence the result if there is also a bias from such individuals towards specific landscape elements. In our study we limited the bias from prolific users by using unique user uploads. Moreover, and contrary to direct engagement methods, there is usually no demographic information available about social media platform users, making inferences between user characteristics and preferences difficult to establish (Tenerelli et al., 2016). Our empirical data stemming from the questionnaires show that a majority of recreationists were aged between 55 and 65, suggesting that a different user group is represented as compared to what is commonly assumed to be the age range of contributors to social media. This is corroborated by that fact that in the Dutch case study area only 13.4% of the interviewees indicated that they used social media to share photographs of the landscape, while in the Swiss area this was only 17.9%, indicating a lower usage of social media in the users that agreed to be interviewed for our study. This observation matches previous findings that interview methods and social media target different user groups and complementary results (Heikinheimo et al., 2017). To investigate the differences between social media users and direct engagement methods in the field, further research is needed into the demographic composition of social media users and a comparison of preferences among different user groups.

Landscape perception and evaluation are determined by a set of environmental attributes, namely the landscape as a whole (unity), its function (use), maintenance, naturalness, spaciousness, development in time, soil and water, as well as sensory qualities (e.g., colour, acoustics) (Coeterier, 1996). These multiple layers of landscape perception are reflected in the different methods we compared. Methods to gather *spatial preferences* for outdoor recreation often reflect the appreciation for the landscape and facilities at a specific place as a whole. Conceptually, we decompose these preferences in preferences for individual biological and physical landscape elements, and cultural landscape elements in our GLMs. Methods to capture information on *landscape preferences* more directly account for biological and physical as well as cultural landscape elements and activities, but may fail to capture the appreciation of the landscape as a whole. Two of the methods applied to gather information on landscape preferences, namely free-listing and social media user tags, were able to capture attributes related to the social and cultural appreciation of landscapes, including sensory qualities of a landscape or sense of place. Our results thus constitute a step towards integrating such cultural ecosystem services (CES) into assessments. This study thus constitutes a step towards addressing the critiques of approaches that generate spatially continuous data and apply traditional GIS analytical techniques for the location and quantification of ecosystem services, which are deemed less well suited to capturing and representing cultural values (De Groot et al., 2010). Previous research showed that cultural values of landscapes can be retrieved using methods based on language that is spatially grounded, meaning language explicitly referring to landscape characteristics that have a spatial component (Wartmann & Purves, 2018). In our study we used free-listing and social media user tag analysis. Characterizing landscape preferences through the lens of language gives us the opportunity to look beyond landscape appreciation related to land cover/land use and reveal the emotive, non-physical elements that individuals appreciate in a landscape. In this study, we used a measure of cognitive saliency based on the free-listing data and found that perceived landscape qualities such as tranquillity were ranked as more cognitively salient than most other biological and physical landscape terms, indicating the importance of this CES to outdoor recreationists (Goossen & Langers, 2000; Goossen, Meeuwesen, Franke, & Kuyper, 2009). Given the increasing pressure on recreation areas through anthropogenic noise from traffic and other disturbance sources (Merchan, Diaz-Balteiro, & Soliño, 2014), it seems particularly relevant to manage outdoor recreation areas with the goal of protecting or enhancing tranquillity. The importance ascribed to tranquillity in outdoor recreation also holds potential for conflict with other – less tranquil – recreation activities, as the aspirations of different recreationists may collide within the same space, thus warranting the need for better landscape management (Boyd and Butler, 1996; Komossa et al., 2019). In this study, we focused on methods that capture preferences of users who have recreated in this landscape (in situ interviews or social media data). Future research should also aim at addressing preferences of non-users, which would also be important for policy-making.

Moreover, our results highlight the complementary value of combining multiple methods, enabling relatively consistent findings to be identified (e.g., preferences for rivers and water), but also addressing different aspects of landscape appreciation (Gosal et al., 2018). Diverging results for some features of the landscape, however, illustrate that different methods address different aspects of outdoor recreation preferences. Accordingly, a pluralistic approach to the selection of methods yields more holistic insights into the distribution of CES than the use of methods in isolation (Cheng, Van Damme, Li, & Uyttenhove, 2019, Scholte et al., 2015). We therefore argue for a combination of different approaches that includes multiple perspectives as well as qualitative and quantitative approaches. Such a multifaceted approach has the potential to benefit both outdoor recreation research and management by integrating multiple perspectives from different user groups.

CRediT authorship contribution statement

Franzika Komossa: Conceptualization, Methodology, Investigation, Formal analysis, Writing - original draft. **Flurina M. Wartmann:** Conceptualization, Methodology, Investigation, Writing - review & editing. **Felix Kienast:** Writing - review & editing. **Peter H. Verburg:** Conceptualization, Methodology, Writing - review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.landurbplan.2020.103796.

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