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Research Paper

Expanding the toolbox: Assessing methods for local outdoor recreation planning

Franziska Komossa [a,*], Flurina M. Wartmann [b,c], Peter H. Verburg [a,c]

[a] Environmental Geography, Institute for Environmental Studies, VU University Amsterdam, De Boelelaan 1085, 1081 HV Amsterdam, the Netherlands
[b] Geography & Environment, School of Geosciences, University of Aberdeen, Aberdeen AB23 3UF, United Kingdom
[c] Swiss Federal Research Institute for Forest, Snow and Landscape WSL, Zürcherstrasse 111, CH-8903 Birmensdorf, Switzerland

HIGHLIGHTS

- We compare methods for collecting data on current and potential recreational use.
- Local planners indicated best results for free listing and participatory mapping.
- Methods that require few resources have highest potential for adoption in planning.
- Technical skills required for social media data analysis currently prohibits use.
- Better communication of scientific methods and insights towards planners needed.

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ABSTRACT

Growing demand for outdoor recreation puts pressure on highly-frequented peri-urban areas. In the Netherlands, a more equal distribution of recreationists has been proposed by the Dutch government to relieve pressure on overcrowded recreation hotspots. Devising landscape planning strategies that redirect recreation flows requires reliable data on areas that people currently use and what areas would also be suitable for recreation. Such data may not be available for local planners. The objective of this study was therefore to analyse how different data gathering methods can support local recreation planning.

For an empirical case study in the Netherlands, we compare data on *current* and *potential* use of landscapes for outdoor recreation through participatory mapping, free listing, quantitative photo ranking, and analysis of social media data. Based on maps produced from these different data we interviewed local planners to assess how applicable and relevant the different methods are for planning practice. Local planners indicated they had limited knowledge of and access to scientific methods and insights. Their assessment of different methods suggests that some methods are not yet applied for local planning, such as free listing or participatory mapping. These methods have potential to be used for evidence-based planning, because they require few resources to be implemented. Planners also indicated that using social media data would be interesting, but that the skills required to collect and analyse data are typically not currently in place. Our results show the potential and challenges for research methods to be integrated into local planning practice to distribute recreation flows more effectively.

1. Introduction

Increasing urbanization and rapid population growth pose major challenges to landscape planning and policy aimed at maintaining and improving landscape quality and providing high-quality recreation opportunities for residents (Cecchini et al., 2018; Colléony et al., 2017). This is of particular relevance in peri-urban landscapes that fulfil multiple landscape functions such as agricultural production, urban development, infrastructure, and outdoor recreation (Janssen, 2009; De Vries et al., 2013; Kienast & Degenhardt, 2012). The focus of this study is on outdoor recreation, an important landscape function or cultural ecosystem service that contributes to people's sense of well-being and appreciation of their home environment (Buchecker, 2009; Plieninger et al., 2015; Haines-Young & Potschin, 2012). However, the growing

* Corresponding author.
E-mail address: f.komossa@vu.nl (F. Komossa).

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demand for outdoor recreation in peri-urban areas puts considerable pressure on the landscape and threatens the effective provisioning of specific landscape qualities such as tranquillity or biodiversity (Almeida et al., 2016; Žlender and Ward Thompson, 2017). Therefore, creating suitable and enjoyable green spaces for outdoor recreation in peri-urban areas that integrate outdoor recreation with other landscape functions has become an important policy and planning objective (Termorshuizen & Opdam, 2009; Pröbstl et al., 2010). Landscape planning and policy for outdoor recreation requires reliable data on outdoor recreationists, their landscape preferences, and particularly their spatial distribution across the landscape (Weyland and Laterra, 2014; Daniel et al., 2012; Rota et al., 2019; Kim et al., 2020). A variety of methods are available to collect data on outdoor recreationists (Kloek et al., 2013; Wolf et al., 2018; Tenerelli et al., 2017; Komossa et al., 2020). Some methods rely on collecting data through direct engagement with outdoor recreationists, such as participatory mapping or landscape photograph ratings (see e.g. Wolf et al., 2018; Van Berkel et al., 2018; Komossa et al., 2020). Other methods allow collecting data that outdoor recreationists have produced, for instance by sharing their experiences on social media platforms (see e.g. Tenerelli et al., 2017; van Zanten et al., 2016; Sonter et al., 2016; Tenkanen et al., 2017). Comparative research showed that there are differences in the information these data are able to capture. For instance, a comparison of free listing interview data and social media content indicated that direct engagement with outdoor recreationists elicited more information on the intangible cultural ecosystem service of sense of place than the social media content (Wartmann et al. 2018). A study by Komossa et al. (2020) found that for gathering data on landscape preferences, free listing and social media user tags captured attributes related to the social and cultural appreciation of landscapes, including sense of place and also sensory qualities of a landscape. However, there is still a lack of research on the degree to which such methods are adopted in local landscape planning and decision-making, and how the choice of method potentially influences spatial planning decisions.

The objective of this study is thus to analyse how different data gathering methods support local planning and decision-making on outdoor recreation. Specifically, our aims were twofold.

1. To apply a methodology that supports local planners in choosing a method that gathers the information needed for formulating specific management strategies.
2. To investigate how the applied methods can address the information needs of local planners for information regarding current and potential recreational use.

To address these aims, we conducted a case study on outdoor recreation in a peri-urban area in the Netherlands, where the pressure for recreation is particularly high due to high levels of urbanisation (Almeida et al., 2016; Žlender and Ward Thompson, 2017). The Dutch government has advocated for a more equal distribution of recreationists across the landscape as a necessary measure to relieve the pressure on overcrowded recreation hotspots, with the declared goal of sustaining or increasing the quality of recreational landscapes (EZK, 2019; LNV, 2019; Rijkswaterstaat, 2019). As a case study, we chose the Kromme Rijn area, a peri-urban landscape to the south-east of Utrecht, where outdoor recreation is an important landscape function (Tieskens et al., 2018), but where continued expected population growth and intensifying recreational usage is proving a challenge to landscape planning and management.

In this case study setting, we compare data to assess both the current use and the potential use of landscapes for outdoor recreation. Current use relates to landscapes that are already used by outdoor recreationists. Potential use refers to landscapes that might be used by outdoor recreationists in the future based on the landscape preferences of outdoor recreationists, but are not necessarily currently used, e.g. due to lack of access or recreational infrastructure. Identifying additional potential outdoor recreation landscapes, characterized by features that match the general landscape preferences of the recreationist population, can contribute to divert visitor flows from highly used recreational hotspots. We use landscape preferences as a proxy for suitability of landscapes as potential outflow areas, given that potential use or visitation of a landscape is linked to landscape preference and therefore landscape aesthetics (De Vries et al., 2013; Othman et al., 2015). We understand landscape preferences as encompassing bio-physical elements (e.g. flora and fauna), cultural elements (e.g. cultural heritage) as well as perceptual elements (e.g. colour and sounds) that recreationists find aesthetically pleasing during their recreational activities. Areas showing a high degree of preference could for instance be turned into more intensively used areas by adapting infrastructure for recreational use. Shrestha et al. (2007) argue that public land managers can add infrastructure and improve visitor access in order to increase recreation visits of specific sites. Cortinovis et al. (2018) state that planners can promote nature-based recreation through a multifunctional green infrastructure. Attracting visitors to currently underutilized areas to relax overused recreational sites is also a planning option for heavily used peri-urban areas such as our study area of the Kromme Rijn.

2. Materials and methods

In this study we applied methods to collect data on the current and potential use of the landscape for outdoor recreation. To assess current use, we on the one hand conducted a paper-based participatory mapping exercise and on the other hand analysed digital traces of visitors using georeferenced social media data. To assess potential use, we applied free listing, paper-based participatory mapping of landscape services and a quantitative photo ranking. For the direct engagement methods (participatory mapping, free listing and photo ranking) we conducted face-to-face surveys among local recreational users. As a second step, we conducted interviews with local planners, discussing local planning needs and presenting the results from the different data-gathering methods to assess how applicable and relevant the different methods and their results are for local planning practice. Methods will be outlined in more detail in the following sections.

2.1. Study area

The Kromme Rijn area is located in central Netherlands and can be characterized as a peri-urban cultural landscape. The landscape of the area is very attractive for outdoor recreation - an integrated part of landscape management – as it harbours many sites of cultural-historical interest such as old estates, windmills and fortresses. The landscape of this area is characterized by the 28 km long river Kromme Rijn ('Crooked Rijn') - meandering through the area. The river's fluvial deposits have strongly influenced current land use as they form fertile soil for fruit cultivation, focussing mainly on cherries, apples and pears (AVP, 2007; LOS stadomland, 2016). In the Kromme Rijn area, the municipalities Bunnik, Houten, and Wijk bij Duurstede drafted a vision document at the local planning level which aims to provide a planning instrument that meets the needs for a development of recreational activities and functions in the area. In line with the regional plans formulated by Utrecht province, the objective is to both make more effective use of the existing recreational areas and to identify attractive surrounding landscapes that can function as "outflow areas" able to absorb the visitation overspill in the priority areas (LOS stadomland, 2017). This focus of local planning, together with the Kromme Rijn area as a heavily used recreational peri-urban landscape makes this an ideal study site to exemplify challenges and potential ways to address these challenges that are also relevant for other peri-urban landscapes.

2.2. Survey-based data collection and mapping of recreation

We collected data through a survey in our case study area held in

Dutch on various strategically selected locations at different recreation sites in the Kromme Rijn area. As we expected higher numbers of recreationists in late spring to late autumn, when issues of overcrowding would also be most relevant, we focused our sampling effort on those months. The sampling campaigns took place in two phases, one between October and November 2016 (n = 200, ∅ age 55) and one between May and June 2018 (n = 201, ∅ age 55) to gather information on different seasons. During the sampling campaign, surveys were conducted during day time with varying weather conditions during any day of the week. We used a theoretical sampling approach to select interview locations at various recreation sites, so that they reflect the diversity of the study area and its visitors. 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). From this, we retrieved a convenience sample (Strauss, Corbin & Niewiarra, 1996), aiming for a balanced representation across age groups, gender and different recreational user groups (see Table1).

The survey included an assessment of both current use of the landscape through participatory mapping, as well as potential recreational use through participatory mapping, free listing and quantitative photo ranking, which we explain in more detail in the following.

2.2.1. Participatory mapping

Participatory mapping has proven to be an effective method for collecting spatially explicit data applicable for landscape management purposes (Garcia-Martin et al., 2017; Brown et al., 2018). Often, participatory mapping is included in more general survey-based methods (Brown & Kyttä, 2014). Participatory mapping is able to capture current use of the landscape (Wolf et al., 2018), for instance, by asking participants to indicate on a map the places they have visited or will visit (Pietilä & Kangas, 2015), as well as potential use of the landscape, through assessing landscape preferences of recreationists (Korpilo et al., 2018). For example, respondents map areas they find particularly beautiful (Ridding et al., 2018). In this study, we used a paper-based participatory mapping exercise to assess both actual and potential recreational use. We created a paper map of the study area that included simplified landmarks (e.g. location of estates) for orientation (Supplementary Material Appendix A). Participants were asked to indicate the locations of their recreation activities for that day, both those already undertaken and those planned, to account for the current use of the landscape. On the same map, we asked participants to use a differently coloured marker pen to draw the areas as polygons that they valued highest in terms of the landscape's aesthetic appearance to account for the potential use of the landscape. We then digitised all drawn polygons in ArcGIS and calculated the number of overlapping polygons once for current use and once for potential use to produce maps of current and potential use based on participatory mapping with respondents.

Table 1
Socio-demographic information of outdoor recreationists.

*Education**	% Total sample
None	0.5
Basic education	0.5
High school	9.3
Middle-level applied education	17.5
Higher professional education	40.9
Academic education	31.3
*Income***	
Beneath 0.5× average	8.6
Between 0.5× average and average	14.0
About average	26.2
Between average and 2× average	24.4
More than 2× average	9.6
I'd rather not say.	17.1
Gender	
Male	46.1
Female	53.6
Other	0.2
*Age****	
18–24	2.5
25–34	10.0
35–44	8.0
45–54	20.3
55–64	32.6
65^{+}	26.6

* Basic education here refers to 'basisschool', the lowest level of education in the Dutch system which is comparable to elementary school. Middle-level applied education refers to 'middelbaar beroepsonderwijs' in the Dutch system which is oriented towards vocational training and is the equivalent of junior college education.
** The average income in the Netherlands was 31 000 euro in 2016 and 32 300 euro in 2019 (source: CBS).
*** The average age in the Netherlands was 41,5 for 2015 and 41,8 for 2018 (source: CBS).

2.2.2. Landscape photograph ratings

Landscape photographs are used in recreation research to obtain a respondent's landscape preferences (Van Berkel & Verburg, 2014). To assess the importance of individual elements in explaining preferences for certain landscapes (Häfner et al., 2018; Sahraoui et al., 2016), we present photographs of landscape elements as a ranking exercise (c.f. Arriaza et al., 2004). We used photographs of a number of landscape elements that we identified as typical for this study site through consultation of academic experts working in the field of landscape ecology, landscape dynamics, and land use systems from the Netherlands. These include: cultural heritage sights, villages, fruit orchards, agricultural lands, meadows, marshes, rivers and water, tree lines and hedgerows, forests, wild animals and farm animals (Fig. 1). To ensure that the quality of individual photographs did not affect the assessment, each landscape element (e.g. forest) was represented by three different photographs, that were collected by the authors during a photo excursion in the study area in the summer of 2016. Based on recommendations from previous photograph ranking studies, we also pre-processed photographs so that they displayed similar weather conditions (Soliva et al., 2010), brightness and height of horizon (Barroso et al., 2012; Al-Kodmany, 1999). The ranking exercise was integrated into the survey and required respondents to select and then rank the top-three landscape elements they value most during their recreational activities. We analysed the quantitative photo ranking data by calculating the sample mean value as the mean of preferences among recreationists from low (0) to high (3) per landscape element. We then translated the top five identified preferences for specific landscape elements elicited through the photograph ranking tasks into maps by mapping the presence/absence of the landscape elements in spatial data (Supplementary Material Appendix B). All spatial data was obtained from the website of the province Utrecht (2019), except the spatial data on cultural heritage sites, which was obtained from the Rijksdienst voor het Cultureel Erfgoed (2019). For rivers and water, cultural heritage and marshes, we calculated buffers around the features to account for the landscape around those features instead of the features themselves based on the literature. The justification of buffer sizes used is detailed in (Komossa et al., 2020). Using a 10x10m grid cell resolution size we created layers that indicated presence/absence of the chosen landscape elements and calculated a weighted sum of selected landscape attributes using QGIS taking into account relative preferences indicated by recreationists by using the standardized sample mean value of the quantitative photo ranking, resulting in a map of potential use.

2.2.3. Free listing

Free listing is a method originally developed in cognitive psychology whereby participants are asked to list all the terms that come to mind in response to a certain question (Battig & Montague, 1969). The method has been successfully used in landscape research (Mark et al., 1999;

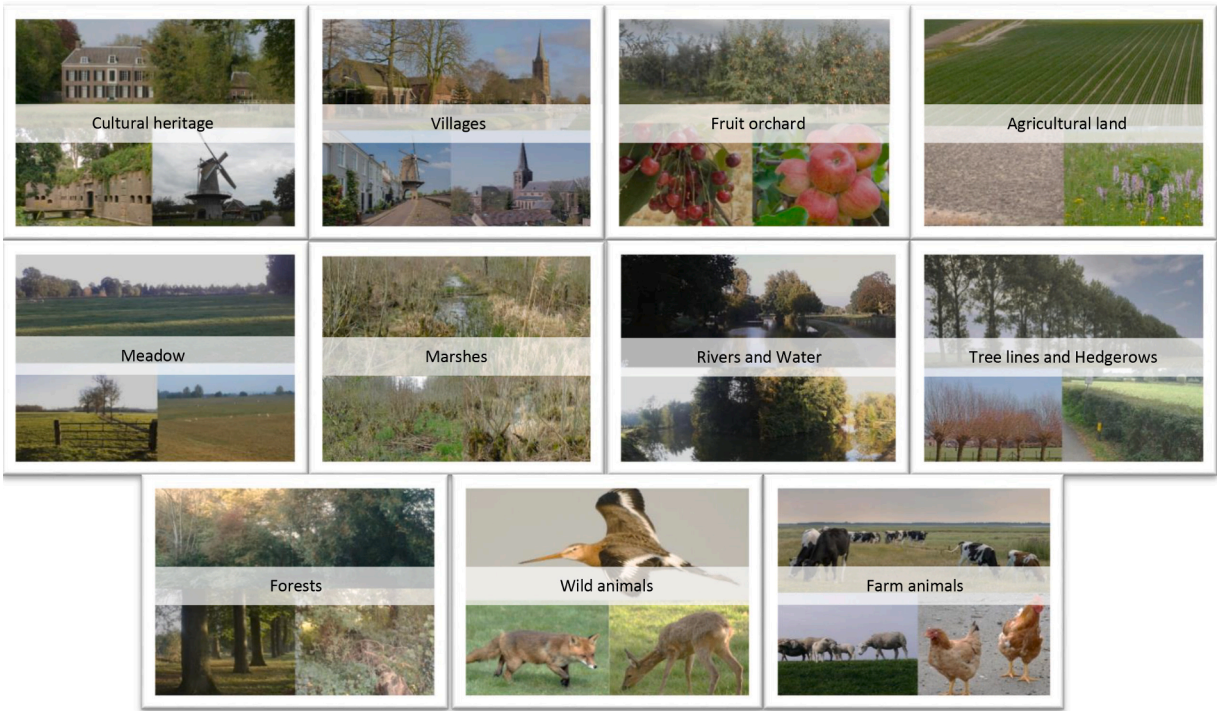

Fig. 1. Photographs of landscape elements as presented in the survey with respondents to elicit preferences for specific landscape elements in the Kromme Rijn area.

Williams et al., 2012) and in research on landscape perception and outdoor recreation (Bieling et al., 2014; Wartmann & Purves, 2018). Through cognitive association, free listing has proven effective for eliciting terms that go beyond physical landscape features and include terms related to sense of place (Wartmann & Purves, 2018). Free listing thus generates a wider semantic spectrum than other methods, which usually only address landscape features that recreationist have directly engaged with. During the free listing exercise, we asked the respondents to list anything that came to mind in reaction to the question: 'What does the landscape of the Kromme Rijn area offer you as a recreationist?' (In Dutch: 'Wat biedt het landschap in het Kromme Rijngebied u als recreant?'). Their responses were noted down verbatim by the interviewer. For the analysis of free listing data, we transcribed the free lists and calculated Sutrop's index (S) (Sutrop, 2001) as a measure of cognitive saliency that combines mean rank and term frequency into a single measure that assesses which landscape elements and associations are cognitively salient for respondents, indicating their importance for recreational experience (Wartmann & Purves, 2018). Terms mentioned by many participants and always at the beginning of a list approach a maximum salience value of 1 (Wartmann & Purves, 2018). Similar to the quantitative photo ranking approach, we selected the top five landscape elements listed as highly cognitively salient and translated these into spatial indicators (Supplementary Material Appendix B and Table 2). We then calculated a weighted sum of all five landscape element indicators using the Sutrop index values as relative weights to create a spatially explicit map of potential use of the landscape.

Table 2
Respondents' preferences for specific landscape elements indicated through the quantitative photo ranking.

Landscape element	Sample mean value
rivers and water	1.93
forests	0.81
cultural heritage	0.80
wild animals	0.60
marshes	0.45
fruit orchards	0.33
tree lines & hedgerows	0.32
villages	0.31
meadow	0.26
farm animals	0.16
agricultural lands	0.03

2.3. Mapping recreational use based on geotagged social media photographs

We used georeferenced social media data from Flickr (www.flickr.com), a social media platform used for the posting and sharing of images to assess current recreational use. We chose the Flickr platform as a data source, because Flickr users often post landscape images, and Flickr has been successfully used as a data source for different recreational studies (Wood et al., 2013; Orsi & Geneletti, 2013; Walden-Schreiner et al., 2018). Furthermore, at the time of writing, the data was freely available for research. We downloaded all georeferenced images originating from the study area, including the metadata (user names, tags, date of image, coordinates) using the Flickr Application Programming Interface (API). We then filtered for bulk uploads and only include one unique user upload per square kilometre (Tieskens et al. 2018). In the next step, we manually filtered the photos based on two criteria: (a) user-generated tags had to be present (automatically created tags were excluded), and (b) the photos had to be related to the landscape, to landscape elements, or to outdoor recreation in the broader sense (e.g., a photograph showing a canoe or bike). We applied a manual filtering approach to our data based on the photographic content and randomly selected a processable sample size from our study area, retaining 671 photographs related to outdoor recreation from 200 different users. The exact number of 671 has been chosen in order to make the sample size comparable with a sample of another study site not included in this paper (Komossa et al., 2020). In order to exclude 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), we snapped all photographs within a distance of 250 m to the most recent Open Street Map roads map (OpenStreetMap Contributors, 2018). This might lead to an underestimation of visitation values in less accessible areas. We then calculated the density of georeferenced Flickr photos using a 10x10m

grid cell resolution. For each cell we calculated the total number of unique user uploads within the overall sample using a 250x250m grid cell resolution (Tieskens et al., 2018).

2.4. Assessing usability of methods together with local planners

To gauge how applicable and transferable the different methods and their results are for local planning, we conducted seven semi-structured interviews with stakeholders (6 male and one female) from regional government (Province Utrecht) and local governments as well as environmental organizations engaged in local planning. The interviews took place between June and September 2019. Each interview was conducted at the office of the respondent and lasted between 45 min to 1,5 h. For the interviews we used the 'Streamline' methodology that combines surveys, semi-structured, and unstructured interviews into one format, and which has been successfully used in earlier research to elicit stakeholders' views on various topics such as land use or ecosystem service trade-offs (see e.g. Metzger et al., 2017; Burton et al, 2019). The method is based on a series of colourful, laminated A3 canvasses that allow for discussion and answering questions posed to the respondent. In this study we used two canvasses (Fig. 2) that focus on planning questions and data gathering methods.

On the first canvas, we collected the stakeholders' views on current landscape planning and management questions and (future) issues they are faced with in relation to outdoor recreation. We asked stakeholders how they currently gather the information they need to answer those questions and they had to give a reasoning for their choice of data collection method. On the second canvas we asked stakeholders to indicate the maps they think, from their point of view as experts, best indicate areas with a) high current use and b) high level of aesthetic quality/potential use. We also asked about the reasons why they prefer certain maps over others, and finally explained which methods were used to produce these maps. We then discussed to what extend and under which conditions these methods would be useful for local planners. The planners' thoughts were recorded on the canvas, and discussions were transcribed on the spot. The results and transcriptions were then amassed into a single document and analysed using open and structured coding (Crang & Cook, 2007) to identify recurring trends and insights as well as notable similarities of opinion regarding the (potential) choice of data gathering methods.

3. Results

3.1. Current recreational use

The map of current use produced from social media photo location data (Fig. 3A) shows a distinct pattern of high utilization around popular recreation areas close to urban or residential centres such as Utrecht and Wijk bij Duurstede. These areas offer a number of facilities and attractions, including old estates, museums, small-scale farms, riverside meadows suitable for sun-bathing and picnicking, as well as eateries and sporting facilities. Additionally, museums and monuments in the central part of the study area, mostly castles, fortresses, and windmills, also show frequent visitation. The map produced from participatory mapping data (Fig. 3B) highlights trails and routes. The map shows distinct patterns of high landscape utilization in the south-west of the study area. This area comprises a popular described hiking route that features a number of cultural heritage sites – mainly historic defence works – and continues along the Lek river in the south of the study area towards the small town of Culemborg. Another popular hiking and biking trail identified on the map runs through the centre of the area through a scenic landscape with a variety of cultural landscape elements. Both methods identify high levels of current use in the area of the Amelisweerd Estate in the north-west of the area (Fig. 3A and 3B), visited for its cultural heritage and diverse landscape, and the scenic landscape known as "Coulissenlandschap" in the centre of the region along the Langbroeker Dijk towards the village of Langbroek.

3.2. Potential use for outdoor recreation

The results of the quantitative photo ranking exercise (Table 2) show that respondents most prefer the landscape elements rivers and water, followed by forests and cultural heritage elements. Among the least preferred were farm elements and agricultural lands. The results of the free listing exercise (Table 3) show that the most cognitively salient terms contained terms such as *rust* (tranquillity), *water* (water) or *bos* (forest) but also *natuur* (nature*) or groen* (green).

The map for potential recreational use created with free listing data (Fig. 4C) shows high visual landscape attractiveness along the road Langbroeker Dijk and the surrounding area Langbroeker Wetering in the central part of the area with its various monuments such as castle Beverweerd as well as the village of Langbroek. The map produced with the data of the quantitative photo ranking (Fig. 4D) shows patterns of high perceived landscape attractiveness along the river Lek in the south of the study area. The map based on participatory mapping data (Fig. 4E) displays high levels of potential use around the Amelisweerd Estate in the west, the area Langbroeker Wetering and along the western part of the Lek river in the south of the study area.

For some regions, specific methods show overlapping patterns of high potential use (Fig. 5). The most dominant is the concurrence of patterns stemming from free listing and participatory mapping data along a popular hiking and biking trail in the heart of the area, but also

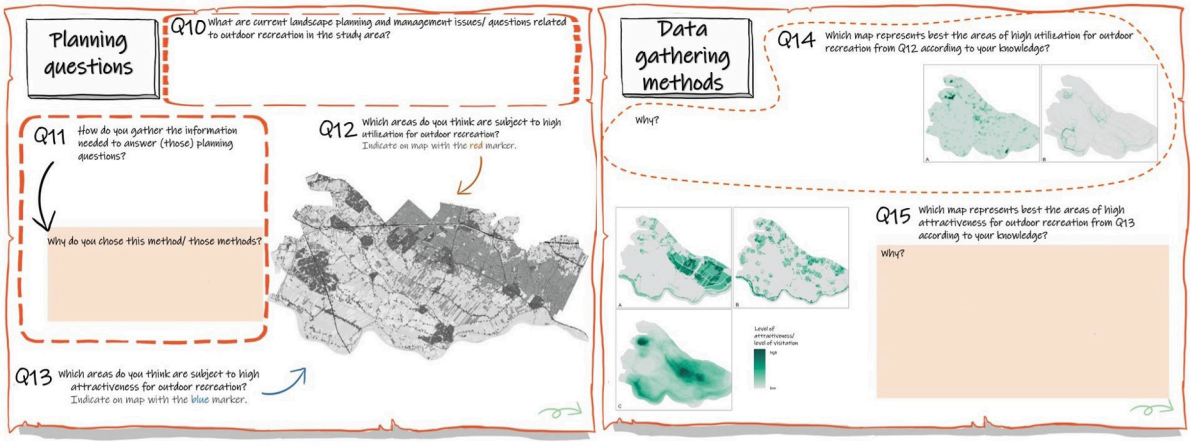

Fig. 2. Streamline canvasses used with local planners in the Kromme Rijn area to discuss landscape planning questions (left) and data gathering methods (right).

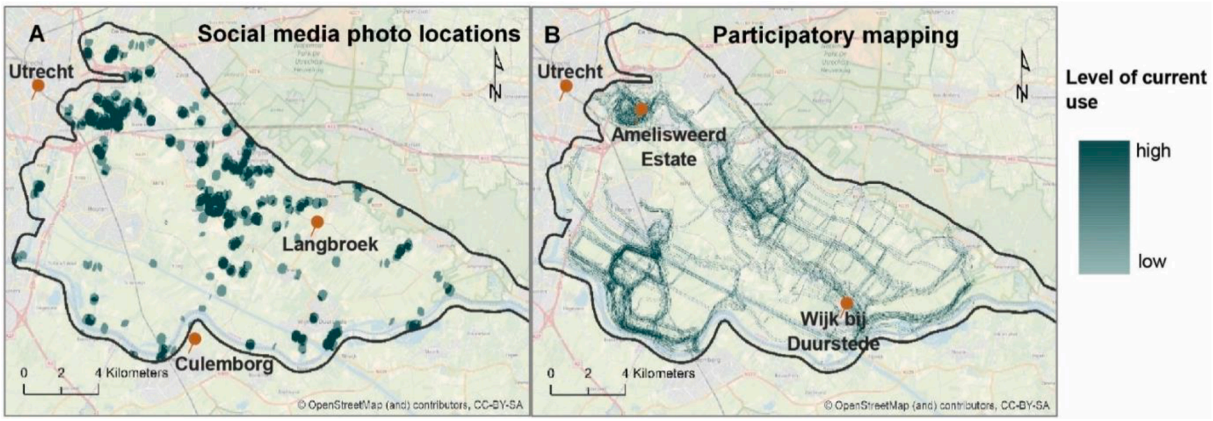

Fig. 3. Level of current use of the landscape in the study area (outlined in black) by outdoor recreationists revealed through: A social media photo locations, B participatory mapping of recreation locations. Maps were simplified for visualization purposes by making cells within the two lowest standard deviations of the data transparent.

Table 3
The top 5 most salient categories from the free listing exercise ranked according to Sutrop's index.

Rank	(S)	Dutch	English gloss
1	0.16	rust	tranquility
2	0.08	water	water
3	0.06	natuur	nature
4	0.06	bos	forest
5	0.05	groen	green

the pattern at the recreational hotspot in the north-west of the area produced by participatory mapping and quantitative photo ranking data.

3.3. Usability and applicability of outdoor recreation research methods for local planning

The interviewed planners almost univocally stated that the map produced by social media data most clearly displays the known hotspots such as the recreation areas adjacent to the city of Utrecht. When discussing the process of developing this map, planners were not familiar with using geotagged social media photographs as a data source and indicated that the currently available resources - especially related to scraping the data from the internet – would not be sufficient and therefore detains them from using this method. By contrast, according to the planners the map produced by participatory mapping is predominantly focused on the hiking network and appears to exclude the more widely known touristic hotspots. Some hiking routes are shown as being more popular than others. One stakeholder mentioned that '*there are much more hiking paths in the area than those identified on the map and we do not know (yet) how frequently these are used*'. Another planner stated that '*there are various hiking paths in the area that are not being displayed in the present map but might be just as popular*'. Thus, the planners questioned the reliability of the output from participatory mapping regarding the current use of hiking trails especially on the scale of the entire study area. However, on a smaller scale, for instance at the level of a single park, this method might be suitable to track recreationists movement patterns and identify potential hotspots.

Regarding the landscapes with high aesthetic attractiveness, the map produced by participatory mapping on aesthetic landscapes is considered suitable by planners, but they point out that the hotspots are less clearly identified than in the free listing-generated map. Local planners thus clearly stated that the map produced by free listing best reflects their own impressions of which areas are perceived highly aesthetic by recreationists. According to one local planner the free listing map as opposed to the other maps is '*capable of showing the typical Dutch scenic landscape*' by highlighting the cultural landscape in the heart of the area. Another local planner said about the same area that '*this area is for Dutch terms rather unique, it is a very well-conserved landscape with a variety of landscape types in close proximity to each other*'. Local stakeholders had no prior knowledge of the free listing method but consider it an easy to learn and easy to apply method for which only few resources would be needed. One stakeholder indicated that gathering data using either free listing or participatory mapping could be outsourced to students within the context of for instance potential external thesis supervision.

4. Discussion & conclusion

In this study we applied methods identifying spatial patterns of the current use of landscape through geotagged social media photographs and participatory mapping with recreationists in the study area. We also investigated the potential use of the landscape for outdoor recreation as approximated through landscape preference using free listing, quantitative photo ranking, and participatory mapping. By comparing these methods and discussing results with local planners we highlight the applicability of complimentary data collection methods to inform recreational planning.

Despite some similar spatial patterns for the current use of the landscape, especially regarding established recreational attractions, we observe considerable differences between maps from social media and participatory mapping. The social media map displays hotspots around urban areas as well as at cultural heritage sites, particularly museums. According to the interviewed local planners, the social media map best represented areas highly attractive for recreationists, which is in line with previous results on showing that crowd-sourced data are a suitable proxy for the more traditional time- and labour-intensive empirical estimates of visitation for highly frequented visitor attractions (Wood et al., 2013). However, using social media data to study outdoor recreation has several limitations. One is that many social media data platforms do not provide demographic information on their users (Tenerelli et al., 2016) and several studies suggest that the data are likely biased towards certain demographic groups (Tufekci, 2014; Heikinheimo et al., 2017). This means that the spatial distribution generated through the social media data might not be a reflection of the entire visitor population as it only captures the movements of social media users. Additionally, the distribution of data among users has been shown to be often uneven, as exceptionally prolific users contribute more to the overall dataset, warranting the need to filter out the data of prolific users (Hollenstein & Purves, 2010; Purves et al., 2011). The availability or use of mobile phones by certain user groups might lead to an undercounting of these groups in social media-based visitation counts compared to

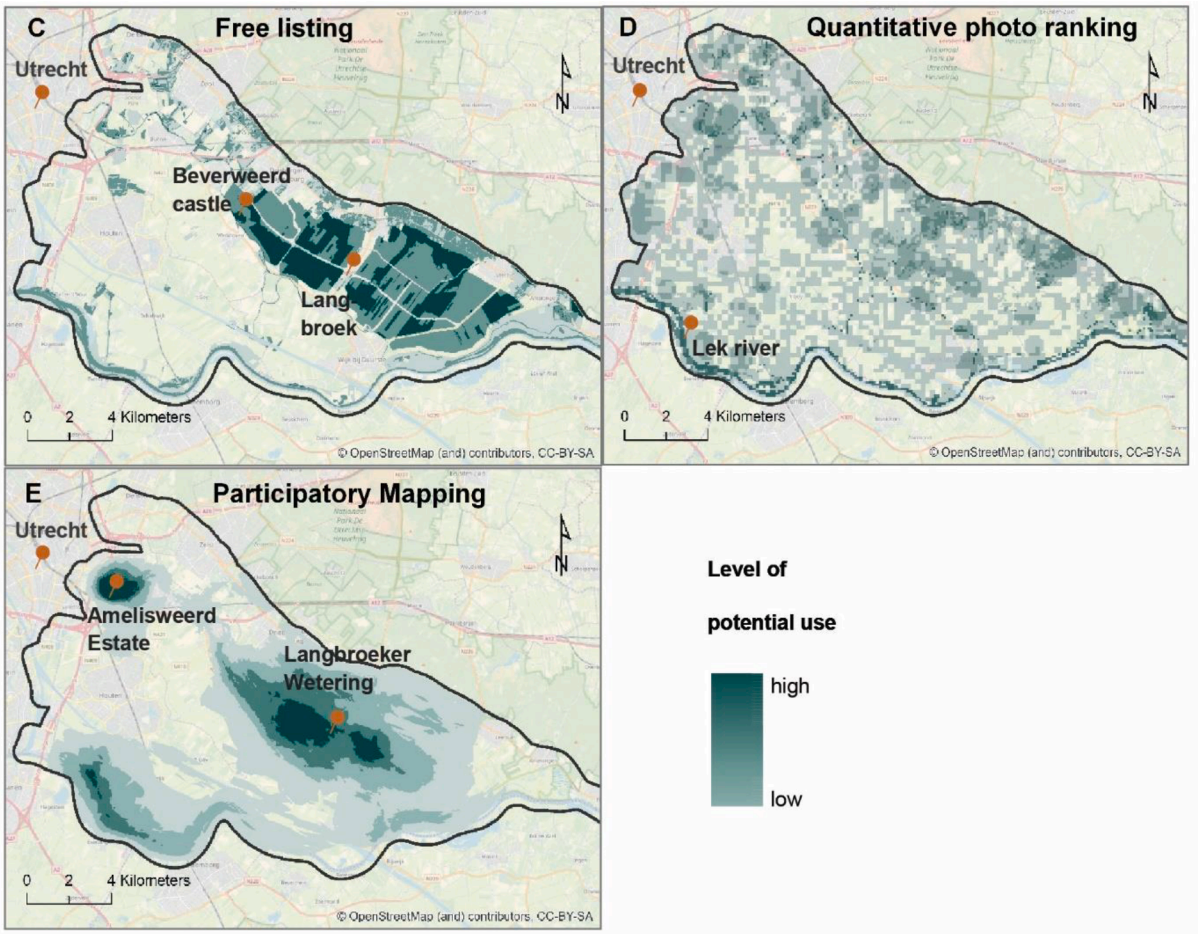

Fig. 4. Level of potential use of the landscape in the study area (outlined in black) as indicated by outdoor recreationists through: C free listing, D quantitative photo ranking and E participatory mapping of aesthetic areas. Maps were simplified for visualization purposes by making cells within the two lowest standard deviations of the data transparent.

traditional field-based survey counts (Hamstead et al., 2018). In our study area, areas that are less well represented in the social media data might still be used by user groups that do not engage in social media. A survey in the Kromme Rijn area (authors, unpublished) revealed that only 12% of the sample engaged in social media for the sharing information and pictures of the study area. The methods used in our study might accordingly provide complimentary information because they reflect the behaviour of different user groups, specifically, in this case, social-media users and non-social-media users.

In contrast to patterns generated from social media data that revealed hot spot locations such as cultural heritage sights, the participatory mapping reflected parts of the area's path network. The nature of the questions we posed to recreationists has in all likelihood affected this, as we specifically asked for the locations of their recreational activities of that day. One distinct pattern is formed along a hiking route in the south-west of the study area. The interviewed local planners questioned whether these maps were reflecting overall trail usage, suggesting the maps did not identify all popular trails. This might be attributed to the locations at which interviews were conducted, as locations of interviews have been shown to affect results (Ecker, 2017; Hanssen, 2012). However, we have tried to minimise this effect by selecting many different interview locations across the study area, and as such, the result may also be reflective of the usage of hiking paths for a certain demographic or user group that is represented in our surveys.

Our results on the mapped potential recreational use areas suggest that different approaches provide comparable results. Generally, local planners valued the map based on free listing data over other methods, as the indicated hot spot areas matched their own perceptions best. Both free listing and quantitative photo ranking resulted in quantifiable preferences that we translated into spatial indicators. Participatory mapping displays areas of preference drawn by participants and thus allows detection of areas respondents considered aesthetically pleasing. As the participatory mapping itself does not allow to identify the underlying reasons for why specific areas are perceived aesthetically pleasing, we supplemented the mapping exercise with additional methods in the form of free listing and quantitative photo ranking. These two methods can – albeit to a different extent – help explain the observed patterns in participatory maps. For example, the areas where all three methods overlap are characterized by a scenic mosaic landscape, including cultural, agricultural, and natural elements. This combination of landscape elements is in line with landscape preference theories that postulate a human preference for such landscapes (Kaplan & Kaplan, 1989; Arnberger & Eder, 2011; Van Zanten et al., 2014). Both free listing and the quantitative photo ranking showed that preferences that contribute to the formation of spatial patterns in this scenic area can be partly attributed to preferences for rivers and water, as well as forests. Free listing revealed the perceived tranquillity of a landscape as an attribute related to sensory qualities to influence landscape preference (Wartmann & Mackaness 2020). One of the challenges using free listing to elicit landscape preferences is that the results may be difficult to operationalize for spatial analysis. For instance, highly salient terms such as 'green' or 'tranquillity' are not self-evidently captured in maps, although methods exist to map such vague concepts using spatial data (Hewlett et al., 2017). However, concerning physical landscape

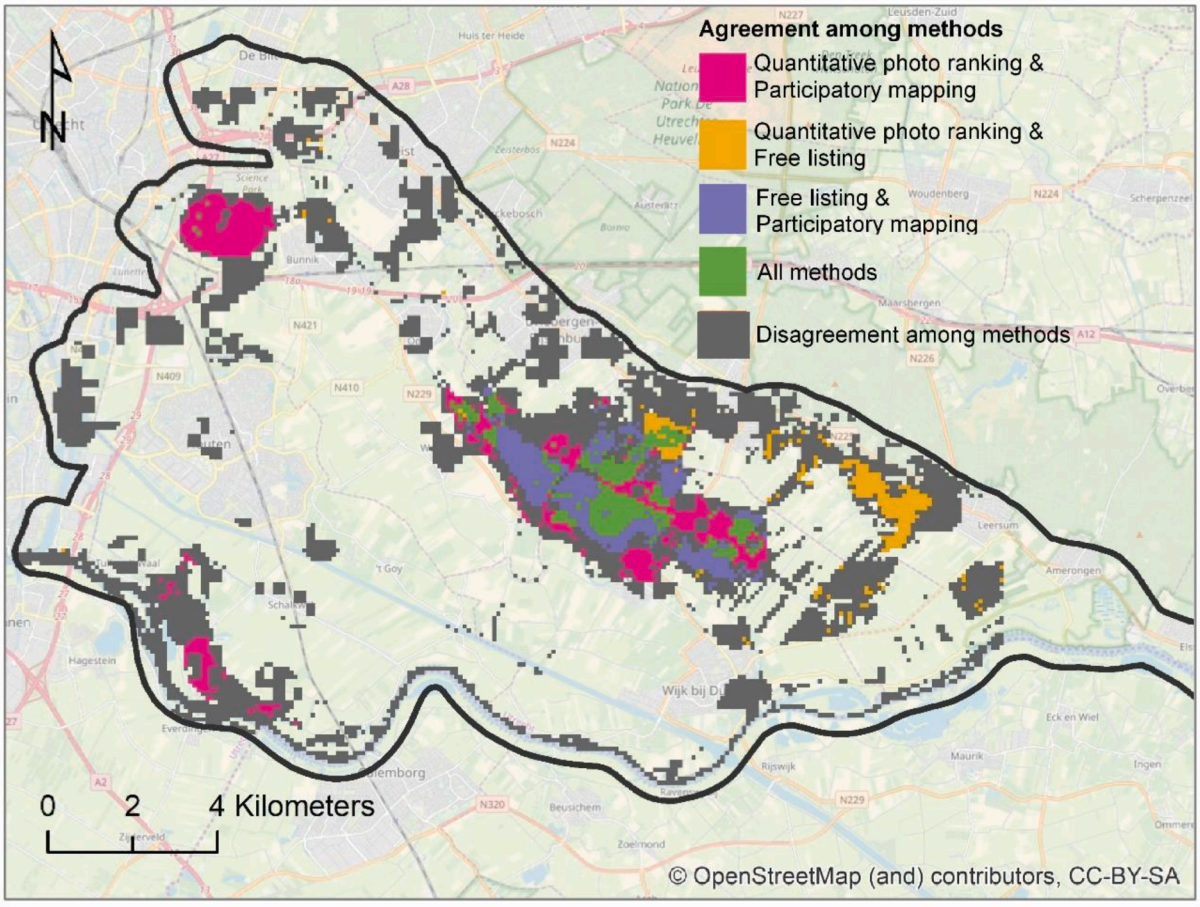

Fig. 5. Agreement among methods for retrieving information on potential use. Map was simplified for visualization purposes using only the highest 2 standard deviations per method.

attributes, free listing provides a promising method for identifying landscape features that people consider relevant for recreation, and our approach is innovative in mapping landscape elements identified through free listing data to spatially express landscape preferences.

Our results indicate areas that are currently highly used and perceived as highly attractive at the same time. High recreational pressure is generally associated with environmental modifications especially concerning vegetation, wildlife, and water resources (Dynowski et al., 2019; Arriaza et al., 2004). Both the photo-ranking and the free listing exercise showed that water elements and forests were highly preferred by recreationists. A degradation of these landscape elements might thus lead to a decrease in perceived attractiveness, which may, however, not necessarily result in decreasing visitor numbers. Our results highlight that currently intensively used areas of the landscape do not align well with perceived landscape attractiveness, indicating that use is not only related to attractiveness, but also other factors, such as proximity to cities (Zasada, 2011), accessibility (Paracchini et al., 2014), land ownership (Emborg & Gamborg, 2016) and presence of recreational facilities (e.g. parking lots, gastronomy, paths) (Paracchini et al., 2014), landscape preferences (Van Zanten et al., 2014) as well as the socio-economic profile of recreationists (Howley et al., 2012). These factors may vary between different user groups – e.g. for most dog walkers accessibility is key, while most hikers desire scenic surroundings – which reveals that visitation of specific landscapes is related to specific outdoor recreation user groups.

In order to formulate landscape policies that effectively decrease the pressure on recreational hotspots, local planners need reliable data. During interviews, local planners indicated that they were largely unaware of the state of the art within scientific research related to landscape management. There is thus still a considerable gap between research and practice, and there is a need for the scientific community to better communicate their methods and results to make them available and useful for stakeholders. For example, using free listing data for creating landscape preference maps was seen by planners as a feasible method that created evidence for decision-making on where to focus efforts to relieve overcrowding in visitor hotspots and redirecting some of the visitors to such areas. In contrast, the social media data method - although understood by planners to provide evidence of hotspots with potential overcrowding - was seen as more technically intensive and planners did not see it as feasible to conduct such data collection or analysis themselves, but would welcome collaboration with researchers on this.

Our study thus revealed that local planners would welcome a closer cooperation with scientists to improve current management strategies by implementing state-of-the-art methods for data collection and analysis. Striving towards bridging the gap between research and planning is of importance in order to maintain or improve the quality of multifunctional peri-urban landscapes that provide essential recreational opportunities for a growing peri-urban population.

CRediT authorship contribution statement

Franziska Komossa: Conceptualization, Methodology, Investigation, Formal analysis, Writing - original draft. **Flurina M. Wartmann:** Conceptualization, Methodology, Investigation, 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.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.landurbplan.2021.104105.

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