Environmental Science and Policy 112 (2020) 254–263

Contents lists available at ScienceDirect

Environmental Science and Policy

journal homepage: www.elsevier.com/locate/envsci

Hidden drivers of social injustice: uncovering unequal cultural ecosystem services behind green gentrification

Ana Terra Amorim Maia[a,b,*], Fulvia Calcagni[a,b], James John Timothy Connolly[a,b,c], Isabelle Anguelovski[a,b,c,d], Johannes Langemeyer[a,b,c]

[a] Institute of Environmental Science and Technology (ICTA), Universitat Autònoma de Barcelona (UAB), Edifici Z (ICTA-ICP), Carrer de les Columnes s/n, Campus de la UAB, 08193 Cerdanyola del Vallès, Spain
[b] Barcelona Lab for Urban Environmental Justice and Sustainability (BCNUEJ), Carrer Doctor Aiguader 88, 08003 Barcelona, Spain
[c] Hospital del Mar Medical Research Institute (IMIM), Carrer Doctor Aiguader 88, 08003 Barcelona, Spain
[d] Institució Catalana de Recerca i Estudis Avançats (ICREA), Passeig de Lluís Companys, 23, 08010 Barcelona, Spain

ARTICLE INFO

Keywords:
Environmental justice
Environmental gentrification
Non-material
Social-ecological systems
Crowdsourced data
Urban green infrastructure

ABSTRACT

The extent to which new greening initiatives contribute to gentrification processes in urban areas is of rising interest to researchers and policymakers, but the precise (and often intangible) aspects of green spaces that embed them within gentrification processes are not well understood. The Cultural Ecosystem Services (CES) literature offers new ways of measuring these aspects. In this study, we use geo-located social media data to assess the value attributed to CES in 18 urban parks in Barcelona, of which 9 were shown to have experienced green gentrification in previous studies. We performed descriptive analysis and statistical independence tests on 703 photos downloaded from the social media platform Flickr. Of the 703 photos analyzed, 85% were taken in parks associated with green gentrification; nevertheless, around 80% of all photos depicted built infrastructures rather than ecological features – indicating that green gentrification is not strictly about greenness and how visitors value it. Statistical results show that parks that experienced green gentrification were significantly associated with "aesthetics" and "recreational activities", whilst parks that did not experience green gentrification were significantly associated with "cultural identity" and "social activities". These results suggest that justice outcomes following from the relationship between urban greening and gentrification are dependent on the social-cultural associations with green spaces that the ecosystem services framework formulates, making it a potentially powerful tool for understanding how to generate more just greening policies in cities.

1. Introduction

In densely populated urban areas, new green and blue infrastructure (GBI) can increase livability, health and resilience (Gatzweiler et al., 2018; Triguero-Mas et al., 2015, 2017), but also spark processes of gentrification and displacement (i.e., Pearsall and Anguelovski, 2016; Wolch et al., 2014). In this context, it is challenging to identify the 'net social justice effect' of GBI, because the benefits that determine this effect are varied across space and time (Langemeyer and Connolly, 2020) and materialize in tangible (e.g. climate and flood regulation, habitat provision) and intangible (e.g. opportunities for recreation, cultural expression, socialization) ways (Curran and Hamilton, 2017; Meerow and Newell, 2017). Intangible benefits can be difficult to parse out because of methodological and data considerations, even though they play a core role in shaping how urban environments are valued by residents (Andersson et al., 2019; Langemeyer et al., 2018a), and thus are essential to our understanding of the justice implications of GBI (Jennings et al., 2012; O'Brien et al., 2017). In the face of what has been called 'ecological gentrification' (Dooling, 2009; Gould and Lewis, 2016), we hypothesize that the existence of unequal intangible benefits obtainable from urban green spaces can be potential core drivers of social injustice in cities.

One applicable framework that conceptualizes and develops methods for measuring the intangible benefits derived from nature is Cultural Ecosystem Services (CES) (Chan et al., 2012a, 2016; Chan et al., 2012b). Although Łaszkiewicz et al. (2019) first relate revealed preferences for proximity to urban parks with socio-economic factors like housing price, to the best of our knowledge these methods have not

* Corresponding author.
E-mail addresses: anaterra.maia@uab.cat (A.T. Amorim Maia), fulvia.calcagni@uab.cat (F. Calcagni), jamesjohntimothy.connolly@uab.cat (J.J.T. Connolly), isabelle.anguelovski@uab.cat (I. Anguelovski), johannes.langemeyer@uab.cat (J. Langemeyer).

https://doi.org/10.1016/j.envsci.2020.05.021
Received 13 September 2019; Received in revised form 23 May 2020; Accepted 25 May 2020

been used to link revealed CES assessments with evidence of green (or ecological) gentrification. Therefore, in this study, we bring together these two bodies of literature, CES and green gentrification, in order to examine the social change and justice implications of deploying GBI in cities.

We ask: Are the differentiated, intangible values that visitors attribute to parks associated with the social injustice processes of green gentrification experienced at the neighborhood level? To address this question, we first assess CES values in a set of urban parks in Barcelona, Spain through coding crowdsourced photographs that reveal people's perception of aesthetic, recreational, social and cultural qualities of green spaces. Then, in order to examine to what extent these values correlate with processes of gentrification, we run cross tabulation and descriptive statistical analyses. Finally, we correlate these findings with park size, greenness and topological features to understand how physical aspects in and around urban parks influence processes of social change. Our original contribution is thus to relate the measurement of CES through social media data to the measurement of green gentrification and bring to light the justice implications of CES provision across multiple dimensions.

1.1. Understanding and measuring green gentrification

Gentrification is traditionally defined as transformations in a neighborhood's built, retail and social environments combined with changes in demographic composition, whereby higher socio-economic or ethnic status residents move in and re- or dis-place more socially or economically vulnerable residents (Smith, 1986, 2008; Lees et al., 2015). Beginning in the 1980s, research on processes of urban gentrification has examined a number of foundational (e.g. global financial flows) and proximate (e.g. an influx of young artists) drivers of gentrification (Lees, 2000; Smith, 1986; Zukin, 1987).

Lately, a new body of research started to examine how urban sustainability planning and processes of city re-naturing through public-private redevelopment strategies intensify or contribute to gentrification (Dale and Newman, 2009; Pearsall, 2010; Solecki and Welch, 1995). This process, where new urban green amenities serve as a catalyst for gentrification is called green, ecological or environmental gentrification and involves the application of an environmental planning agenda associated with public green spaces that generates the displacement or segregation of the most economically vulnerable population from access to the localized benefits of ecosystem services (Dooling, 2009). Studies show that greening strategies have been implemented as market-driven elements of urban renewal targeting higher income groups, frequently generating social and physical exclusion of less privileged residents (Anguelovski et al., 2019; Haase et al., 2017; Kabisch and Haase, 2014).

Neighborhood-scale studies have shown that the greater the amount, size and quality of urban green amenities in transitioning areas, the more attractive and desirable they become, thus contributing to the displacement of minority groups toward unwanted (and likely less green) areas (Checker, 2011; Dooling, 2009; Goodling et al., 2015; Pearsall, 2009). Therefore, the establishment of urban GBI has paradoxical implications for environmental justice: while the creation of new green amenities can make neighborhoods healthier and more aesthetically attractive, it can also lead to gentrification and the displacement of the very residents that the green space strategies were designed to benefit (Anguelovski, 2016; Wolch et al., 2014). Green gentrification is thus a fundamental concern for any urban sustainability model that aims at promoting environmental justice (Anguelovski et al., 2019; Connolly, 2019; Garcia-Lamarca et al., 2019).

Yet, so far, the available literature on green gentrification does not present empirical evidence of which specific characteristics of urban green spaces trigger the interest of residents in such a way as to spark or reinforce green gentrification processes, nor is their specific understanding of the value gentrifiers assign to green spaces. Rather, the focus has been on characterizing broad trends in the relationship between new green infrastructure and a posteriori socio-demographic change in the area (Anguelovski et al., 2018; Pearsall, 2010; Wolch et al., 2014). In response in this study we apply a cultural ecosystem services (CES) framework to understand the extent and ways in which people value ecosystem services provided by urban green spaces (Chan et al., 2012a) and how this relates to processes of green gentrification (Kabisch, 2019; Łaszkiewicz et al., 2019). CES can indeed reveal the elements of attractiveness provided by urban green space (La Rosa et al., 2016; Voigt et al., 2014) and people's motivation to use urban parks (Langemeyer et al., 2015) that might trigger green gentrification and enlighten the relationship between green spaces, neighborhood change, and users' perceptions.

1.2. Revealing cultural ecosystem services (CES) embedded in urban green spaces

CES are produced locally by either blue or green infrastructure and their value can be particularly significant in urbanized landscapes, where the spaces that support recreational activities and social cohesion are of paramount importance for a livable and fair city (Andersson et al., 2015; Kohn, 2004; Mitchell, 2003). Chan et al. (2011) define CES as "ecosystems' contribution to the nonmaterial benefits that people derive from human-ecological relations" (p. 9), including e.g., knowledge systems, social relations, and aesthetic values (Millennium Ecosystem Assessment, 2005, p. 40).

The benefits derived from CES are often directly experienced by the public, influencing their way of living, including environmental stewardship, and relation to the urban environment (Daniel et al., 2012; Langemeyer et al., 2018b). Consequently, they have been increasingly quantified and included in urban planning and landscape design (Alkemade et al., 2014; Breuste et al., 2013a; Burkhard et al., 2014; Crossman et al., 2013). Recent studies show that the most important provision of CES comes through traditional public parks (Breuste et al., 2013b; Tratalos et al., 2007). Therefore, to ensure a fair delivery of urban CES, recent studies consider that parks and other green infrastructure ought to be heterogeneous, multifunctional and accessible throughout the city (Gómez-Baggethun et al., 2013; Haase et al., 2017). In short, urban CES offer an important window into the ways in which city residents experience the intangible benefits of green infrastructure and the distribution of CES has serious implications for urban quality of life.

The values assigned to CES are frequently intuitive and depend on individual and cultural assessments of their contribution to wellbeing (Anthony et al., 2009; Kenter et al., 2011). They are generally expressed through indirect manifestations such as increased social activities and events in green space and/or by sharing photos of such spaces and related activities on social networks (Calcagni et al., 2019; Eicken et al., 2009; Scullion et al., 2011).

Approaches to operationalize CES include interviews, questionnaires and hedonic pricing models (Burkhard et al., 2014; Milcu et al., 2013), but standardized and quantitative assessment approaches, especially in spatially explicit form, remain underdeveloped and present a number of shortcomings (Hernández-Morcillo et al., 2013; Milcu et al., 2013; Satz et al., 2013; Pleasant et al., 2014; Thiagarajah et al., 2015). These shortcomings include biases triggered by the interviewer (Pastur et al., 2016), top-down research approaches that privilege policy directives over non-expert landscape knowledge and perception (Derungs and Purves, 2016), and time-intensive data collection (see Riechers et al., 2016). While surveys and interviews can provide deep insights into CES provided by urban green spaces (e.g. Camps-Calvet et al., 2016) they remain often limited in sample sizes and in the provision of spatial information. In contrast, participatory mapping approaches can compensate for this limitation, although they tend to be very resource intensive (Canedoli et al., 2017; Samuelsson et al., 2018). Given these limitations, alternative approaches to the assessment of

CES based on crowdsourced data from social media can provide important context to our understanding of CES, a strength that we leverage in this study.

1.3. Assessing CES based on crowdsourced social media data

Social media data offers possibilities for advancing our understanding of the fine-scale and site-specific relationship of CES and thus potential drivers of green gentrification. Crowdsourced and geographically located data available from social media platforms such as Flickr, Instagram, Twitter, etc., have proved to be a cost- and time-effective means to better understand people's revealed values, perceptions and activities at a finer resolution and a higher magnitude and spatial scale than has thus far been possible (see Ilieva and McPhearson, 2018; Lenormand et al., 2018; Richards and Friess, 2015; van Zanten et al., 2016). In addition, because social media data are passively produced and 'non-authoritative' geographic information (Heikinheimo et al., 2017) resulting from non-deliberate and collective valuation processes (cf. Calcagni et al., 2019), research based on this data is less intrusive and less dependent on institution- and expert-driven settings and biases. These qualities of social media data possibly result in a different perspective on people's perceptions and activities in space than that which can be deduced from active data collection approaches (Heikinheimo et al., 2017).

Therefore, social media data, particularly photographs, have increasingly been used for assessing and mapping site- and time-specific values ascribed to CES. This increased reliance on social media analysis allows landscape planning to proceed from an otherwise unavailable knowledgebase premised on what people portray and share, and thus on what they express to their community as things they value across a wide set of contexts (Oteros-Rozas et al., 2018). In other words, the relevance of social media data to ongoing efforts to understand CES relies on the capacity of photographs to communicate through visual representations the perceived and material dimensions of landscapes and the multiple values that they provide (Stephenson, 2008). In particular, the photo-sharing community of Flickr has received attention in the context of CES analysis, due its open API and its wide range of contributing user groups (Dunkel, 2015). Some studies have further explored the potential of this data by performing a comparative assessment with traditional data sources. For instance, using publicly run statistics or surveys, some found evidence of a correlation between the visitation rate and the number of social media posts in a specific area (see Donahue et al., 2018; Heikinheimo et al., 2017; Wood et al., 2013). In addition, other studies used surveys or interviews to reveal the potential of social media data in predicting the explanatory factors for park visitation, such as the presence of water bodies, amenities, trails, etc. (see Donahue et al., 2018; Kothencz et al., 2017; Thiagarajah et al., 2015).

So far, social media data has primarily been used to assess scenic beauty and the aesthetic value of landscapes (Casalegno et al., 2013; Pastur et al., 2016; Guerrero et al., 2016; Richards and Friess, 2015; Tenerelli et al., 2016) as well as nature-based tourism and recreation (Cord et al., 2015; Sonter et al., 2016; Willemen et al., 2015; Wood et al., 2013). Yet, more recent studies have also shown capacity to assess other CES, such as cultural heritage (Gliozzo et al., 2016; Sherren et al., 2017) or social and spiritual values (Oteros-Rozas et al., 2018; Thiagarajah et al., 2015).

Moreover, given the high percentage of urban dwellers within social media users (Guerrero et al., 2016), scholars have highlighted the importance of leveraging this data in urban studies. Some recent studies have, thus, begun to use social media data to examine urban green space perception and its contribution to wellbeing (Donahue et al., 2018; Dunkel, 2015; Kothencz et al., 2017), as well as to assess park visitation and equitable park access (Hamstead et al., 2018), demonstrating that the analysis of crowdsourced data may contribute to a more balanced assessment of the perceived landscape, by providing a foundation for better integrating public values into planning processes.

Based on findings from these studies, we work with the assumption that people visit specific parks and upload photos of the most attractive amenities that they are inspired to share with others (Girardin et al., 2008; Kisilevich et al., 2010; Gliozzo et al., 2016). We further assume that from the pictures we are able to differentiate types of CES, and thereby identify potential drivers of gentrification. A careful disaggregation of crowdsourced and geotagged photos taken within individual parks provides significant evidence for understanding how people value and use the various amenities portrayed in the parks. In all, social media data add a solid and quantifiable empirical base to efforts to understand how the intangible qualities of urban green spaces affect processes of social change, particularly green gentrification.

2. Methodology

In this study, we selected Barcelona as a unique case study of city-wide assessed green gentrification trends (Anguelovski et al., 2018), and for which we analyzed the intangible qualities of gentrified vs. non gentrified parks, as valued by visitors. Our primary data source was the full set of (4320) crowd-sourced images uploaded to the online photo-sharing platform Flickr between January 2004 and December 2017 that were geographically tagged within the boundaries of the 18 urban parks and gardens that the recent Barcelona study analyzed. In addition to coding each photo as taken on gentrified and non-gentrified parks (according to the previous study), we assessed and classified the photos into 4 main categories of CES, and further into 22 sub-categories to reveal how CES values, people's perceptions of the environment, and their relationship to landscape features varied between the two types of parks. Appendix A.1 (in Supplementary material) shows the information downloaded from Flickr Metadata.

2.1. Green gentrification analysis

The present study builds on the prior work of Anguelovski et al. (2018), which assessed through a spatial and quantitative analysis the green gentrification trends of 18 new parks built in Barcelona, Spain, over a 15-year period, examining the distributional outcomes of the city's greening strategy during the 1990s and early 2000s, most of which targeted historically underserved neighborhoods. The results indicated clear green gentrification trends in several areas of Barcelona but not all, revealing a circumstance where the impacts of creating parks in socially vulnerable and green space-underserved neighborhoods were not monolithic or uniform. Rather, they were assumed to depend on the context of creation (i.e. part of a broader neighborhood redevelopment effort), setting in the city (i.e. in closer proximity to the sea), and overall built environment (i.e. in areas with industrial or early 1900s older building stock). Nine parks were found to be associated with green gentrification and nine were not. Table 1 shows the list of parks and their association to green gentrification. A map with the

Table 1
Parks associated with green gentrification and parks not associated with green gentrification.
Source: Anguelovski et al. (2018).

Parks associated with green gentrification	Parks not associated with green gentrification
Jardins de Princep de Girona	Jardins de Rosa de Luxemburg
Parc de Auditoris	Parc Central de Nou Barris
Parc de Carles I	Parc de Josep Maria Serra Martí
Parc de Diagonal Mar	Parc de Can Dragó
Parc de la Nova Icària	Parc de la Barceloneta
Parc de les Cascades	Parc de la Maquinista de Sant Andreu
Parc del Poblenou	Parc de la Trinitat
Parc del Port Olímpic	Parc de Sant Martí
Parc Lineal Garcia Faria	Parc de Sant Pau del Camp

location, date of construction and area of the parks can be found on Appendix C, Figure C.1 (in Supplementary material).

In order to develop these classifications of green gentrification by park, Anguelovski et al. (2018) examined changes in income, age, house sale prices, educational attainment, and percent of immigrant population from the Global South and Global North over time near parks relative to changes further away from parks. They used local and global regression techniques to determine whether distance to parks was a causal driver of this change. Taking these results into consideration, and in order to examine the possible underlying drivers of green gentrification in Barcelona, we asked if the nine parks that were associated with green gentrification reveal higher CES values or unique types of CES – as defined by users/visitors – relative to the nine that were not.

2.2. CES analysis

To build empirical evidence of the CES associated with each of the 18 parks examined in the Anguelovski et al. (2018) study, we downloaded the metadata of the photos taken within the entire Barcelona area from the Flickr API and extracted those photos taken within the park boundaries. The script for executing the download was written in ECMAScript 6 on Github[1] and the queries were run in April 2018. The query outcomes were grouped in. csv format files, which were divided per month and imported into ArcMap© v10.5 using a coordinate system suitable to the study area (ETRS89_UTM_zone_31 N). We confirmed through manual checks the location of all photos and removed from the dataset 3617 photos, which were considered invalid. As a rule, for a picture to be considered valid, the elements depicted as the main subject in the photos needed to have an explicit connection to a CES provided by urban parks. We also excluded photos taken by the same user, at around the same location and time to avoid biases (this is common practice in CES assessments through social media data, e.g. Ghermandi and Sinclair, 2019).

Protocol for photo selection and categorization

Table 2

After categorizing the photos from the most recent (December 2017) to the oldest (January 2004), we assigned to each valid photo at least one CES category and one major CES tag, followed by the sub-tags describing the content or the activity pictured. A further category recorded whether the main subject portrayed was green (natural environment) or not green (non-natural / built environment). A full list of activity-related tags can be found in the Appendix A.2 (in Supplementary material).

2.3. Descriptive and statistical analyses

In order to analyze how green gentrification trends in Barcelona relate to the values portrayed on social media, we divided pictures by year and by park and conducted cross tabulation analyses for the parks that experienced green gentrification processes and the ones that did not. We performed descriptive analyses to measure the percentage of photos that depicted each CES, the ratio of photos depicting green and non-green settings, and the proportion of photos taken from outside the parks. Finally, we conducted a master cross tabulation analysis with the aggregated categorization of all years divided for the parks that experienced green gentrification and the ones that did not.

To verify if the attribution of the CES categories was related to whether or not a park experienced green gentrification, we performed a Chi-Square Independence Test using IBM SPSS Statistics 24. The Chi-Square test calculates the Pearson chi-square value, the significance level (p-value) and the strength of the relationship Phi (ϕ), and thus determines if and to what extent there is a statistically significant difference between the expected frequencies and the observed ones for the main categories of CES and the two groups of parks. The equation for the Chi-Square Formula, variables and a description of the full and alternative hypotheses can be found under Appendix B (in Supplementary material).

2.4. Park greenness and features analyses

In order to control for underlying physical conditions that might generate more social media photos, we identified the size and greenness of each park. The total area of parks was calculated using ArcMap 10.5 software and the average Normalized Difference Vegetation Index (NDVI) was calculated using points derived from high resolution imagery taken in 2011 (a midpoint year within our dataset). The imagery is based on photogrammetric flight data (Barcelona City Council, 2014) with resolution of 40 cm. NDVI is a commonly used indicator of the density of green (USGS, 2018), with values varying from −1.0 to 1.0 and is calculated at the center point of each grid cell in the imagery. All center points that fell within the boundaries of the parks were averaged by park.

We obtained a list of park features from the municipal Barcelona database of parks and gardens, which was used to test how physical attributes affected the amount and type of photos. These features include significant historical buildings, emblematic architectural constructions, monuments, sculptures, water structures, landscaping, auditoriums, and sports facilities. Last, we conducted a cross-tabulation relating the photos tagged with specific subcategories of CES to NDVI and the list of features in each park.

3. Results

3.1. CES & green gentrification

From the 4320 photos retrieved from Flickr, 703 were designated as applicable to this study after applying the initial guiding filters. 594 photos (85%) were taken in parks that experienced green gentrification and 109 (15%) in parks that did not. Fig. 1 shows the number of photos per park, indicating that three parks had substantially more photos than all others.

3.2. Proportion of photos and respective CES

First, overall, our analysis reveals that parks that experienced green gentrification show a clear higher proportion of the photos that reflect Aesthetic and Recreational services, while non-gentrified parks had a smaller margin of more photos showing Cultural Identity and Socialization services.

From a CES perspective, Aesthetic Value was the most commonly photographed CES, regardless of whether a park was associated with green gentrification or not. Interestingly, in gentrified parks, only 1% of the photos were related to Cultural Identity and 4% with Socialization, while for non-gentrified parks these rates were 10% and 15% of photos respectively. Fig. 2 shows the attribution of CES categories for each type of park.

The results obtained through the chi square test show that there is a weak but mostly significant association between the categories of CES and the groups of parks. Table 3 shows the test results of Pearson's Chi-Square for park gentrification and the four categories of CES.

The chi square tests largely affirmed a significant interaction between the four categories of CES and the two types of parks. There was an interaction for photos tagged as "Aesthetics" ($X^2(1, N = 703) = 4.06$, $p = 0.04$, $\varphi = 0.08$) and green gentrified parks, showing that the latter were more likely to have "Aesthetics" photos than non-green gentrified parks. In the chi square test of independence for photos tagged as "Recreation", there was a nearly significant

[1] Available on https://github.com/JALB91/queries/blob/9985026257b7f8cfbf86c5d866889b9686bfec61/flickr/index.js.

Table 2
Cultural Ecosystem Services and related categories for visual content analysis.

CES category	Description	CES tags
Recreation and mental and physical health	Nature-based leisure-oriented activities, physical and intellectual activities, as well as activities performed for enjoyment or entertainment.	Athletic activity Pet-walking Children Team sports Sports on wheels (e.g. bicycle, rollerblade, skate) Outdoor meal Relaxation Entertainment (e.g. event, concert)
Aesthetic value	People's perceptions and judgments of natural beauty and appreciation and interaction with the environment.	Nature observation Animal observation Landscape Constructions (e.g. buildings, bridges) Art object (e.g. sculpture, statue) People
Socialization	Social or political activities, aimed to strengthen social bonds or fulfill political motivations.	Social cohesion Political fulfillment (e.g. protests, demonstrations)
Cultural identity, knowledge and heritage	Legacy of physical science artifacts and intangible attributes of a group or society that are inherited from past generations, maintained in the present and bestowed for the benefit of future generations.	Environmental education cultural heritage

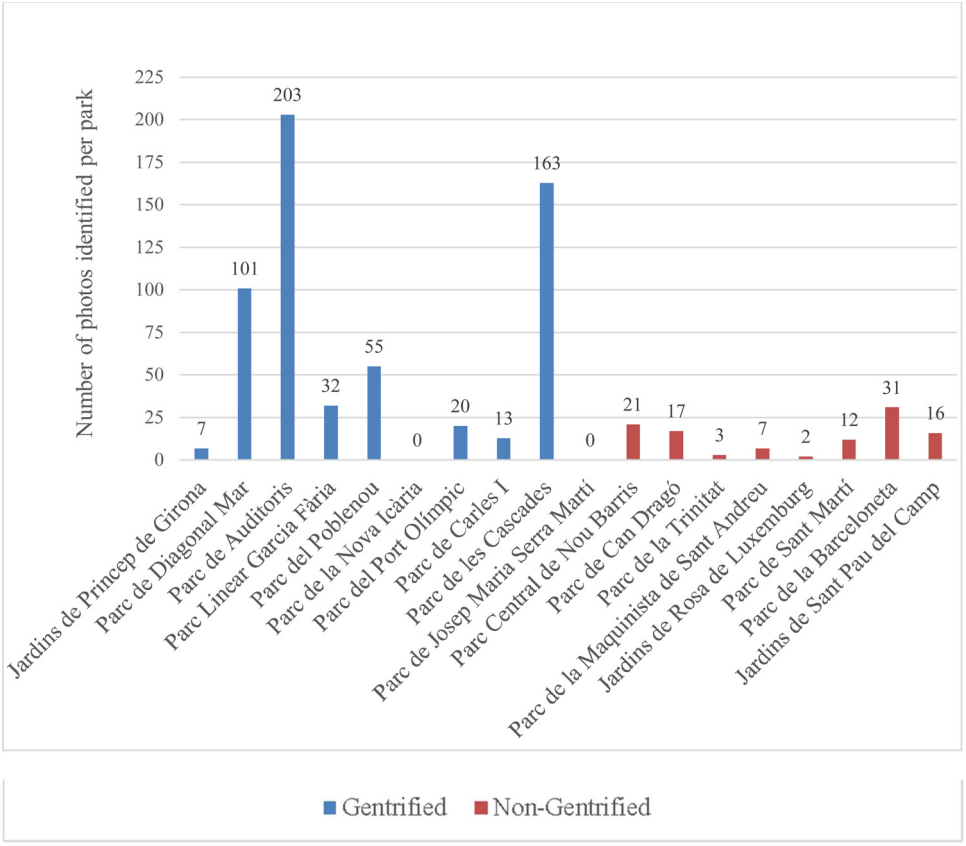

Fig. 1. Number of photos identified (y-axis) per park (x-axis). Blue columns represent parks associated with green gentrification and red columns represent parks not associated with green gentrification.

interaction: $X^2(1, N = 703) = 3.55$, $p = 0.06$, $\varphi = 0.07$. Again, green gentrified parks were more likely to have "Recreation" photos than non-green gentrified parks. Meanwhile, the opposite was found in the chi square test of independence for photos tagged as "Cultural Identity" and "Socialization." We found a significant interaction: $X^2(1, N = 703) = 27.17$, $p = 0.00$, $\varphi = -0.20$ and $X^2(1, N = 703) = 22.81$, $p = 0.00$, $\varphi = -0.18$ respectively, whereby non-green gentrified parks were more likely to have higher counts of "Cultural Identity" and "Socialization" than green gentrified parks.

3.3. Subcategory photo counts

A further analysis was conducted relating the photo counts for the two types of parks with the CES subcategories and tags, providing insights into what aspects within the major CES categories particularly drive the differences in photo counts across park types. As an illustration, in gentrified parks, 43% of the photos were tagged as Construction (i.e. buildings both inside and outside the park) and 30% as Art Object (i.e. sculptures). In parks not associated with green gentrification, 8% of

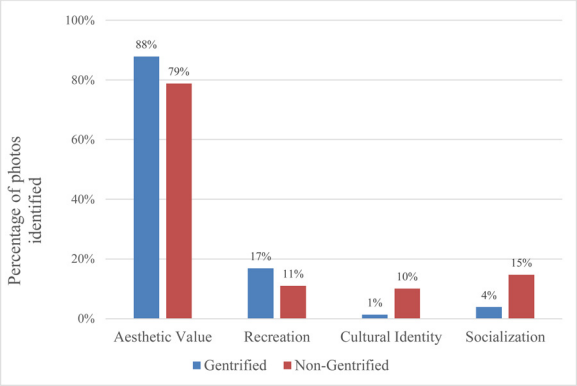

Fig. 2. Percentage of photos identified (y-axis) per CES category (x-axis) in parks associated with green gentrification (blue) and parks not associated with green gentrification (red).

Table 3
Chi-Square Test of Independence Results: Pearson Chi Square Value, p-Value and Phi (ϕ) for Aesthetics, Recreation, Cultural Identity and Socialization in relation to the groups of parks.

	Aesthetics	Recreation	Cultural	Socialization
Pearson Chi-Square	4,063	3,554	27,168	22,812
p-value	0,044	0,059	0,000	0,000
Phi *(ϕ)*	0,076	0,071	−0,197	−0,18

the photos depicted Cultural Heritage (i.e. cultural events) and 12% Social Cohesion (i.e. social relations). Interestingly, Social Cohesion presented significant counts for both gentrified (3%) and non-gentrified parks (12%), thus, a chi square test was run for this subcategory. The results show a weak though significant negative association between a photo being tagged for the subcategory of social cohesion and green gentrification: $X^2(1, N\,703) = 18.31$, $p = 0.00$, $\varphi - 0.16$. Furthermore, 7% of the photos taken in gentrified parks and 21% in non-gentrified parks depicted elements (i.e. buildings, landscape) located outside of the perimeter of the parks.

3.4. Analysis of parks greenness and features

3.4.1. Green vs. Non-green objects

The total area of gentrified parks amounted to 542,562 m^2, while non-gentrified parks totaled 530,057 m^2. However, the average NDVI value of the 406 points measured in the gentrified parks was 0.12 and the average NDVI value of 562 points measured in non-gentrified parks was 0.17. Thus, non-gentrified parks are slightly greener than gentrified parks even though they offer a smaller total surface of green areas, but both groups of parks have similar levels of low to moderate greenness (relative to a non-developed preserved natural area). Therefore, we do not expect much variation in the number of photos tagged as green across the two park types because of underlying physical conditions.

We observed the expected result based on similar NDVI values. The photo analysis results showed that both groups of parks presented similar proportions of green and non-green subjects on photographs: 81% of the photos taken in parks associated with green gentrification were tagged as “non-green,” as were 82% of the photos taken in parks that did not experience green gentrification. This finding indicates that the focus of photos taken within the parks was on non-green aspects of park infrastructure rather than on ecological or nature-based features, and this focus was similar across gentrified and non-gentrified parks.

A chi square test of independence was performed to examine the if the observed green gentrification was related to whether the main object portrayed in the photo is green or not green. The relation between green gentrification and green objects was not significant, $X^2(1, N = 703) = 0.01$, $p = 0.91$, $\varphi < 0.01$. Neither was the relation observed between green gentrification and non-green objects: $X^2(2, N = 703) = 0.01$, $p = 0.91$, $\varphi < -0.01$. In sum, neither the biophysical conditions of the parks (size, NDVI greenness) nor the representation of green in social media photos differ significantly between green gentrified and non-green gentrified parks.

The park feature analysis was conducted by relating the CES subcategories and object-specific tags with the list of park features provided by the municipality. The cross-tabulation revealed that aesthetic and artistic features (e.g. landscaping, art objects, and modern architecture) were associated with parks that experienced green gentrification whilst communal features (e.g. sports facilities and urban gardens) were associated with parks that did not experience green gentrification. As an illustration, in gentrified parks we observed that 55% of the pictures depicted buildings of particular architectural interest, 30% depicted sculptures, 29% landscaping (e.g. gardens, hedges, esplanades), and 11% water structures (e.g. fountains, lakes). Conversely, in non-gentrified parks, we observed ten times more park users participating in cultural events, six times more playing team sports, and five times more engaging in social relations and political demonstrations, in comparison with the same categories for gentrified parks.

4. Discussion

The number of photos taken in the parks is a first indicator of the social processes that the parks’ surroundings went through, showing the potential of this data source in providing a vivid and rapid first outlook at spatial dynamics that can then be explained by integrating further analysis. Despite roughly equivalent area and levels of greenness, gentrified parks displayed more than five times the number of photos (594) than non-gentrified parks (109). This difference in photo counts is a rough measure of the attractiveness of these parks.

The attribution of CES to the photos is one way of drilling down into precisely which aspects of attractiveness link these parks with social changes in their vicinity. While it is not surprising that photos overall most frequently captured the CES of Aesthetic Value, there was a less obvious trend when the four main types of CES were broken down by whether photos were taken in a park associated with gentrification or not. As statistically confirmed in the chi square tests, photos tagged as “Aesthetic” or “Recreation” were more associated with gentrified parks and photos tagged as “Socialization” or “Cultural Identity” were more associated with non-gentrified parks.

When these four broad categories of CES were further broken down according to the features installed in a park, the results suggest that community-focused features (i.e. communal spaces for recreation and social integration) did not seem to engender as much social change as did aesthetic or artistic features (i.e. art installations, modern architecture), which were noticeably associated with gentrified parks. This premise resonates with Mathews (2010), according to whom the installation of artistic features is carried out purposely by city planners and private investors, for their ability to catalyze and naturalize reinvestment in declining or underdeveloped areas, therefore accelerating regional growth and development. It also resonates with previous studies of Barcelona, indicating the role played by architecture and design in neighborhood upscaling and gentrification processes (Borja and Muxí, 2004; Arbaci and Tapada-Berteli, 2012; Anguelovski et al., 2018).

The built environment or the amenities in the park seem to be more significant as valued elements by visitors/users than the ecological elements. The CES analysis showed that, in both types of parks, around 80% of the photos depicted non-green subjects. As well, the chi square tests showed that there is no evidence that green amenities matter differently in gentrified and non-gentrified parks. This echoes previous studies, which showed that there is no clear correlation between parks’ level of greenness and their appeal to visitors (Kothencz and Blaschke, 2017).

The surrounding built environment also seems to play an important role in park attractiveness for gentrified parks, represented by the number of photos taken in the parks depicting elements outside their perimeter. These outcomes are in line with those from previous studies, which revealed that visitors' impressions of the parks are influenced by the scene surrounding the park, in the way that building density, architecture and aesthetics around urban parks are crucial determinants in human perception of urban green spaces (Kothencz and Blaschke, 2017; Nordh, and Østby, 2013).

These results suggest that there are further underlying aspects to green gentrification, which go beyond greenness and the level and/or type of nature present in the space. Urban green spaces intertwine with structural and social elements both inside and outside the parks to generate green gentrification. This conforms with findings by Hamstead et al. (2018), who reported that social media activity in urban parks is positively associated with water bodies, athletic facilities and impervious surfaces, but negatively correlated with green spaces, inferring that while people derive benefits from nature, they might not be mostly motivated to visit a park for the kind of green space and level of greenness that it offers. Our findings also echo Ngom et al. (2016), according to whom a park's shape, geographic location, accessibility and attractiveness are decisive elements to identify socio-demographic inequity and environmental injustices.

4.1. Strengths, limitations, and future directions in using geo-located user content

Social media data analysis of CES has proven to be a valuable and novel resource and data source to address the methodological challenges of both CES and green gentrification studies. The usage of social media data has helped to show that the cultural value associated with urban green spaces can be enumerated within the drivers of green gentrification (as confirmed by the chi square tests performed), and that green gentrification is particularly associated with the Aesthetics and Recreation offered and perceived in the parks. Moreover, social media data, given the close and unique perspective it allows on subjective and otherwise difficult to quantify values, enriches our understanding of CES as not only provided by the ecological elements of the parks but also by anthropic features to which the parks enable access. Therefore, we conclude that the interaction between anthropic and natural features can drive green gentrification.

While theoretically and methodologically novel, our study requires some methodological caveats. First, the representativeness of social media data may depend on the use rate of the internet, cameras with GPS, mobile phones and, for the specific case presented here, Flickr itself (Pastur et al., 2016). However, the current trend of spreading technologies and social media use worldwide and across different social groups looks promising for further integrating this data into research (Guerrero et al., 2016). In addition, Flickr proved more suitable than other social media data sources for assessing CES due to its API openness and accessibility for analysis (cf. Lenormand et al., 2018; Tenerelli et al., 2016), as well as for the higher amount of relevant images compared to similar platforms, such as Panoramio or Instagram, which explains Flickr's popularity in CES research (Ghermandi and Sinclair, 2019). Flickr is the repository of billions of pictures shared worldwide, especially in the USA and Europe, including a big share in Spain (5.6 million in 2011) (Wood et al., 2013).

Yet, the representativeness of social media data may also be affected by the users' demographic distribution and by their rate of participation, meaning that the content shared corresponds to behaviors and perceptions of certain profiles and social groups and depends on age, gender, social power relations, level of income, education and ability or motivation to use social networking services (Oteros-Rozas et al., 2018; Pastur et al., 2016; Tenerelli et al., 2016; Wood et al., 2013). Nevertheless, issues of representativeness may also affect methods relying on more conventional data collection practices, such as surveys or interviews (Tenerelli et al., 2016; Yoshimura and Hiura, 2017). Worldwide, Flickr is most popular among male users between 35 and 39 years old, who earn in the US$40 − 50 and US$75 − 100 K income brackets (Verto Analytics, 2018). However, a place- and time-specific trait bounds this information and impedes generalizations, as demonstrated by contradictory results (Lenormand et al., 2018) or baseline information (Oteros-Rozas et al., 2018) in other studies. Future research would benefit from methods to enhance the understanding of the social and demographic characteristics of social media users (Gliozzo et al., 2016; Lenormand et al., 2018; van Zanten et al., 2016).

Information on the origin of the photographers can be deduced either through an algorithm (as in Lenormand et al., 2018) or from self-reported information on public Flickr profile (Wood et al., 2013). However, the relatively small rate at which this information is available (cf. Hamstead et al., 2018) prevents a complete overview. Thus, we have decided not to account for it in our analyses, as it would require complex additional modeling, which is beyond the scope of this study (as in Lenormand et al., 2015). However, we believe that this information could have improved our understanding of the preferences of residents against tourists and recommend that future research covers this question. Despite that, we expect tourists to take more pictures than residents while abroad, and particularly of aesthetic or recreational subjects, whereas cultural and social services might be more commonly represented among residents. Moreover, this study did not measure how the geographic location, shape, and accessibility of the parks may influence the CES assessed, which might be decisive factors to reveal socio-environmental injustices, as per Ngom et al. (2016).

Lastly, the perception and assessment of what a photograph depicts is dependent on the reader's interpretation, thus complicating CES assessment through visual content analysis. Our approach focused on analyzing the elements in the pictures and categorizing them into a set of tags. Not only is this approach subjective in a sense, a site as a point for the expression of cultural heritage or socialization is rarely represented in such a way and is often not associated with infrastructure (i.e. benches or picnic tables) in a park (Oteros-Rozas et al., 2018). While we acknowledge that the meanings given to photographs are context-dependent, we recognize that social media can be considered enablers of cultural heritage, as a means for communities to communicate and build a shared history (Calcagni et al., 2019; van Dijck, 2011). Yet, CES assessments should be complemented with other methods that enable a better representation of the social actors underrepresented by social media platforms, such as elderly, poor and other marginalized communities.

Studies with a bigger sample might provide more comprehensive results and allow for more robust statistical tests. To further enrich this new research pathway and expand our understanding of the specific user experiences of green spaces, we and others recommend to combine textual and visual content, such as reviews (i.e. Google Reviews), tags, descriptions, ratings and testimonials (Ilieva and McPhearson, 2018; Oteros-Rozas et al., 2018). Future research, including on the ground observations of park users and uses, surveys, interviews and participatory mapping could be promising approaches to contrast and verify the methodology applied in this study.

4.2. Policy and planning implications

Previous studies have shown that the social and historical conditions in which urban parks are built are determining factors contributing to green gentrification. However, this study has shown that the features present in the parks also play a significant role in determining whether the parks are associated with green gentrification processes or not and in turn produce (or not) new socio-environmental injustices. Parks built in socially disadvantaged neighborhoods, which offered opportunities for socialization and recreation (i.e. sports facilities and urban gardens) seem to be less associated with green gentrification processes. Conversely, parks built in redeveloped industrial

areas with an offer of landscaping, artistic and architectural features within or outside the park seem to be more associated with green gentrification.

This points toward an important policy implication: The existence of green gentrification in a city does not mean that greening is associated with inequitable patterns in every neighborhood. Rather, it is highly dependent on the context of the neighborhood and the type of greening – and its value/benefits for possible gentrifiers.

For the distribution of the benefits of new and redeveloped green areas to be equitable, it is necessary to look beyond park "greenness", into the built infrastructures offered in the park, as it seems to be the combination of green infrastructures with other aspects that triggers or prevents green gentrification, allowing, for instance, residents from historically more marginalized or vulnerable neighborhoods to appropriate the features or amenities of a park for their own needs, uses, and identities. In order to minimize the effects of green gentrification and maximize the benefits of greening, urban green infrastructures should include places that, apart from being aesthetically pleasing, offer opportunities for social cohesion, place-making and socialization, such as sports facilities, resting areas and urban gardens. Such features have already been recognized as valuable and intensively used by residents of working-class neighborhoods such as the Parc de Nou Barris in Barcelona (del Pulgar et al., 2020).

The active involvement of residents alongside urban and environmental planners and designers is vital to create strategies for urban green spaces that improve livability, public health and resilience in the cities, without detriment of environmental equity and social justice in urban communities. In contrast, if green spaces are built in a top down manner and with an attempt to rebrand and redevelop a neighborhood for new more privileged users and uses, environmental improvements will continue to unfairly distribute the benefits of environmental goods toward those who can afford living next to them.

5. Conclusions

In this paper, we aimed at analyzing whether the differentiated, intangible values that visitors attribute to parks contribute to generating social injustices associated with green gentrification at the neighborhood level. Despite potential representativeness biases, we consider our sample in Barcelona to show a significant association between (i) gentrified parks and aesthetics and recreational activities and (ii) non-gentrified parks and cultural and social activities. This was confirmed by both the photo analysis and the chi square tests of independence. These findings support our hypothesis that parks that produced higher aesthetic and recreational values – and thus can be exploited for new high-end real estate development or tourism purposes – are associated with green gentrification processes, whilst parks with higher cultural and social values are not.

Moreover, even though this study did not measure the effect of the geographic location, shape, and accessibility of the parks, we interpret the results to show that rather than the ecological aspects and natural elements, it is the built infrastructures present in or surrounding the parks that most attract people and motivate picture taking. In parks that experienced green gentrification, the mostly photographed subjects were architectural and artistic features, such as sculptures, constructions and general landscape. Photos taken from attractive surrounding buildings proved that there is a correlation between the location of the park and the attractiveness attributed to it: parks located in redeveloping neighborhoods have shown particularly high rates of photos taken of surrounding built landscape.

This study also indicates how processes of green gentrification and socio-environmental injustice go beyond the "green" contained in the park, bringing the discussion to the interconnection between the built and the green – and to the multiple ways in which the two can connect to produce new cultural and economic value – which might (as we have seen in Barcelona), in turn, then be exploited by planners and by investors, with inequitable outcomes for socially vulnerable residents.

Hence, to minimize the effects of green gentrification and maximize the social benefits of urban greening, urban planners and policymakers ought to consider the features and amenities offered in new and redeveloped green infrastructures, prioritizing structural and social elements that foster social cohesion, place-making and cultural identity over aesthetics.

Funding

This research received funding through the 2015–2016 BiodivERsA COFUND project ENABLE with the national funder Spanish Ministry of Science, Innovation and Universities. We acknowledge financial support from the Maria de Maeztu Unit of Excellence grant (MDM-2015-0552) from the Ministerio de Ciencia, Innovación y Universidades (es). A.T.A.M received funding from the Joint European Master's in Environmental Studies - Cities and Sustainability (JEMES CiSu) Consortium Scholarship via the Autonomous University of Barcelona (UAB) (contract number JEMES CiSu UAB 2016/No1). I.A. and J.C. further acknowledge the ERC Starting Grant (GA678034) from the European Research Council and the Naturvation grant (< GN5 > 730243 < /GN5 >) by the European Commission. J.C. acknowledges support from Juan de la Cierva (< gn6 > IJCI-2016-31100 < /gn6 >) - Ministerio de Ciencia, Innovación y Universidades (es), and F.C. from the AGAUR Catalan governmental agency (Grant number 2018FI_B00635). JL further received funding through the ERC Consolidator Grant: 818002-URBAG.

CRediT authorship contribution statement

Ana Terra Amorim Maia: Conceptualization, Methodology, Validation, Formal analysis, Investigation, Writing - original draft, Writing - review & editing, Visualization. **Fulvia Calcagni:** Methodology, Software, Validation, Resources, Writing - review & editing. **James John Timothy Connolly:** Conceptualization, Methodology, Validation, Formal analysis, Resources, Writing - review & editing, Supervision. **Isabelle Anguelovski:** Resources, Writing - review & editing, Supervision, Funding acquisition. **Johannes Langemeyer:** Conceptualization, Methodology, Validation, Resources, Writing - review & editing, Supervision.

Declaration of Competing Interest

None.

Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.envsci.2020.05.021.

References

Calcagni, F., Maia, A.T.A., Connolly, J.J.T., Langemeyer, J., 2019. Digital co-construction of relational values: understanding the role of social media for sustainability. Sustainability Sci. 14 (5), 1309–1321.

Breuste, J., Haase, D., Elmqvist, T., 2013a. Urban landscapes and ecosystem services. Ecosystem Services in Agricultural and Urban Landscapes. pp. 83–104.

Chan, K.M., Guerry, A.D., Balvanera, P., Klain, S., Satterfield, T., Basurto, X., ... Hannahs, N., 2012a. Where are cultural and social in ecosystem services? A framework for constructive engagement. BioScience 62 (8), 744–756.

Alkemade, R., Burkhard, B., Crossman, N.D., Nedkov, S., Petz, K., 2014. Quantifying ecosystem services and indicators for science, policy and practice. Ecol. Indic. 37, 161–162.

Andersson, E., Tengö, M., McPhearson, T., Kremer, P., 2015. Cultural ecosystem services as a gateway for improving urban sustainability. Ecosyst. Serv. 12, 165–168.

Andersson, E., Langemeyer, J., Borgström, S., McPhearson, T., Haase, D., Barton, D., Davis, M., Kronenberg, J., Naumann, S., Röschel, L., Stange, E., Baró, F., 2019. Enabling green and blue infrastructure to improve contributions to human well-being and equity in urban systems. BioScience 58.

Anguelovski, I., 2016. From toxic sites to parks as (green) LULUs? New challenges of inequity, privilege, gentrification, and exclusion for urban environmental justice. J. Plan. Lit. 31 (1), 23–36.
Anguelovski, I., Connolly, J.J., Masip, L., Pearsall, H., 2018. Assessing green gentrification in historically disenfranchised neighborhoods: a longitudinal and spatial analysis of Barcelona. Urban Geogr. 39 (3), 458–491.
Anguelovski, I., Connolly, J.J., Garcia-Lamarca, M., Cole, H., Pearsall, H., 2019. New scholarly pathways on green gentrification: what does the urban 'green turn' mean and where is it going? Prog. Hum. Geogr. 43 (6), 1064–1086.
Anthony, A., Atwood, J., August, P., Byron, C., Cobb, S., Foster, C., ... Kellogg, D.Q., 2009. Coastal lagoons and climate change: ecological and social ramifications in US Atlantic and Gulf coast ecosystems. Ecol. Soc. 14 (1).
Arbaci, S., Tapada-Berteli, T., 2012. Social inequality and urban regeneration in Barcelona city centre: reconsidering success. Eur. Urban Reg. Stud. 19 (3), 287–311.
Breuste, J., Schnellinger, J., Qureshi, S., Faggi, A., 2013b. Urban ecosystem services on the local level: urban green spaces as providers. Ekologia 32 (3), 290–304.
Chan, K.M., Satterfield, T., Goldstein, J., 2012b. Rethinking ecosystem services to better address and navigate cultural values. Ecol. Econ. 74, 8–18.
Barcelona City Council, 2014. Vegetable Cover of the City of Barcelona (Accessed 4 May 2020): https://opendata-ajuntament.barcelona.cat/data/en/dataset/cobertura-vegetal-ndvi.. .
Borja, J., Muxí, Z., 2004. Urbanismo En El Siglo XXI: Una Visión Crítica: Bilbao, Madrid, Valencia, Barcelona Vol. 30 Univ. Politèc. de Catalunya.
Burkhard, B., Kandziora, M., Hou, Y., Müller, F., 2014. Ecosystem service potentials, flows and demands-concepts for spatial localisation, indication and quantification. Landsc. Online 34.
Camps-Calvet, M., Langemeyer, J., Calvet-Mir, L., Gómez-Baggethun, E., 2016. Ecosystem services provided by urban gardens in Barcelona, Spain: insights for policy and planning. Environ. Sci. Policy 62, 14–23.
Canedoli, C., Bullock, C., Collier, M.J., Joyce, D., Padoa-Schioppa, E., 2017. Public participatory mapping of cultural ecosystem services: citizen perception and park management in the Parco Nord of Milan (Italy). Sustainability 9 (6), 891.
Casalegno, S., Inger, R., DeSilvey, C., Gaston, K.J., 2013. Spatial covariance between aesthetic value & other ecosystem services. PLoS One 8 (6), e68437.
Chan, K.M., Goldstein, J., Satterfield, T., Hannahs, N., Kikiloi, K., Naidoo, R., ... Woodside, U., 2011. Cultural Services and Non-use Values. Natural Capital: Theory & Practice of Mapping Ecosystem Services. Oxford University Press, Oxford, UK, pp. 206–228.
Chan, K.M., Balvanera, P., Benessaiah, K., Chapman, M., Díaz, S., Gómez-Baggethun, E., ... Luck, G.W., 2016. Opinion: why protect nature? Rethinking values and the environment. Proc. Natl. Acad. Sci. 113 (6), 1462–1465.
Checker, M., 2011. Wiped out by the "greenwave": environmental gentrification and the paradoxical politics of urban sustainability. City Soc. 23 (2), 210–229.
Connolly, J.J., 2019. From Jacobs to the just city: a foundation for challenging the green planning orthodoxy. Cities 91, 64–70.
Cord, A.F., Roeßiger, F., Schwarz, N., 2015. Geocaching data as an indicator for recreational ecosystem services in urban areas: exploring spatial gradients, preferences and motivations. Landsc. Urban Plan. 144, 151–162.
Crossman, N.D., Burkhard, B., Nedkov, S., Willemen, L., Petz, K., Palomo, I., ... Alkemade, R., 2013. A blueprint for mapping and modelling ecosystem services. Ecosyst. Serv. 4, 4–14.
Curran, W., Hamilton, T. (Eds.), 2017. Just Green Enough: Urban Development and Environmental Gentrification. Routledge.
Dale, A., Newman, L.L., 2009. Sustainable development for some: green urban development and affordability. Local Environ. 14 (7), 669–681.
Daniel, T.C., Muhar, A., Arnberger, A., Aznar, O., Boyd, J.W., Chan, K.M., ... Grêt-Regamey, A., 2012. Contributions of cultural services to the ecosystem services agenda. Proc. Natl. Acad. Sci. 109 (23), 8812–8819.
Derungs, C., Purves, R.S., 2016. Characterising landscape variation through spatial folksonomies. Appl. Geogr. 75, 60–70.
Donahue, M.L., Keeler, B.L., Wood, S.A., Fisher, D.M., Hamstead, Z.A., McPhearson, T., 2018. Using social media to understand drivers of urban park visitation in the twin cities, MN. Landsc. Urban Plan. 175, 1–10.
Dooling, S., 2009. Ecological gentrification: a research agenda exploring justice in the city. Int. J. Urban Reg. Res. 33 (3), 621–639.
Dunkel, A., 2015. Visualizing the perceived environment using crowdsourced photo geodata. Landsc. Urban Plan. 142, 173–186.
Eicken, H., Lovecraft, A.L., Druckenmiller, M.L., 2009. Sea-ice system services: a framework to help identify and meet information needs relevant for Arctic observing networks. Arctic 119–136.
Garcia-Lamarca, M., Anguelovski, I., Cole, H., Connolly, J.J., Argüelles, L., Baró, F., ... Shokry, G., 2019. Urban green boosterism and city affordability: for whom is the 'branded'green city? Urban Stud., 0042098019885330.
Gatzweiler, F.W., Boufford, J.I., Pomykala, A., 2018. Harness urban complexity for health and well-being. The Urban Planet: Knowledge Towards Sustainable Cities. pp. 113.
Ghermandi, A., Sinclair, M., 2019. Passive crowdsourcing of social media in environmental research: a systematic map. Glob. Environ. Chang. Part A 55, 36–47. https://doi.org/10.1016/j.gloenvcha.2019.02.003.
Girardin, F., Fiore, F.D., Ratti, C., Blat, J., 2008. Leveraging explicitly disclosed location information to understand tourist dynamics: a case study. J. Locat. Based Serv. 2 (1), 41–56.
Gliozzo, G., Pettorelli, N., Haklay, M., 2016. Using crowdsourced imagery to detect cultural ecosystem services: a case study in South Wales, UK. Ecol. Soc. 21 (3).
Gómez-Baggethun, E., Gren, Å., Barton, D.N., Langemeyer, J., McPhearson, T., O'Farrell, P., ... Kremer, P., 2013. Urban ecosystem services. Urbanization, Biodiversity and Ecosystem Services: Challenges and Opportunities. Springer, Dordrecht, pp. 175–251.
Goodling, E., Green, J., McClintock, N., 2015. Uneven development of the sustainable city: shifting capital in Portland, Oregon. Urban Geogr. 36 (4), 504–527.
Gould, K.A., Lewis, T.L., 2016. Green Gentrification: Urban Sustainability and the Struggle for Environmental Justice. Routledge.
Guerrero, P., Møller, M.S., Olafsson, A.S., Snizek, B., 2016. Revealing cultural ecosystem services through Instagram images: the potential of social media volunteered geographic information for urban green infrastructure planning and governance. Urban Plan. 1 (2), 1–17.
Haase, D., Kabisch, S., Haase, A., Andersson, E., Banzhaf, E., Baró, F., ... Krellenberg, K., 2017. Greening cities–to be socially inclusive? About the alleged paradox of society and ecology in cities. Habitat Int. 64, 41–48.
Hamstead, Z.A., Fisher, D., Ilieva, R.T., Wood, S.A., McPhearson, T., Kremer, P., 2018. Geolocated social media as a rapid indicator of park visitation and equitable park access. Comput. Environ. Urban Syst. 72, 38–50.
Heikinheimo, V., Minin, E.D., Tenkanen, H., Hausmann, A., Erkkonen, J., Toivonen, T., 2017. User-generated geographic information for visitor monitoring in a national park: a comparison of social media data and visitor survey. ISPRS Int. J. Geoinf. 6 (3), 85.
Hernández-Morcillo, M., Plieninger, T., Bieling, C., 2013. An empirical review of cultural ecosystem service indicators. Ecol. Indic. 29, 434–444.
Ilieva, R.T., McPhearson, T., 2018. Social-media data for urban sustainability. Nat. Sustain. 1 (10), 553–565.
Jennings, V., Johnson Gaither, C., Gragg, R.S., 2012. Promoting environmental justice through urban green space access: a synopsis. Environ. Justice 5 (1), 1–7.
Kabisch, N., 2019. Urban ecosystem service provision and social-environmental justice in the City of Leipzig, Germany. Atlas of Ecosystem Services. Springer, Cham, pp. 347–352.
Kabisch, N., Haase, D., 2014. Green justice or just green? Provision of urban green spaces in Berlin, Germany. Landsc. Urban Plan. 122, 129–139.
Kenter, J.O., Hyde, T., Christie, M., Fazey, I., 2011. The importance of deliberation in valuing ecosystem services in developing countries—evidence from the Solomon Islands. Glob. Environ. Chang. Part A 21 (2), 505–521.
Kisilevich, S., Krstajic, M., Keim, D., Andrienko, N., & Andrienko, G. (2010, July). Event-based analysis of people's activities and behavior using Flickr and Panoramio geotagged photo collections. In *Information visualisation (IV), 2010 14th international conference* (pp. 289-296). IEEE.
Kohn, M., 2004. Brave New Neighborhoods: the Privatization of Public Space. Routledge.
Kothencz, G., Blaschke, T., 2017. Urban parks: visitors' perceptions versus spatial indicators. Land Use Policy 64, 233–244.
Kothencz, G., Kolcsár, R., Cabrera-Barona, P., Szilassi, P., 2017. Urban green space perception and its contribution to well-being. Int. J. Environ. Res. Public Health 14 (7), 766.
La Rosa, D., Spyra, M., Inostroza, L., 2016. Indicators of cultural ecosystem services for urban planning: a review. Ecol. Indic. 61, 74–89.
Langemeyer, J., Baró, F., Roebeling, P., Gómez-Baggethun, E., 2015. Contrasting values of cultural ecosystem services in urban areas: the case of park Montjuïc in Barcelona. Ecosyst. Serv. 12, 178–186.
Langemeyer, J., Camps-Calvet, M., Calvet-Mir, L., Gómez-Baggethun, E., Barthel, S., 2018a. Stewardship of urban ecosystem services. Understanding the value(s) of urban gardens in Barcelona. Landsc. Urban Plan. 170, 79–89.
Langemeyer, J., Calcagni, F., Baró, F., 2018b. Mapping the intangible: using geolocated social media data to examine landscape aesthetics. Land Use Policy 77, 542–552.
Langemeyer, J., Connolly, J.J.T., 2020. forthcoming). Weaving notion of justice into urban ecosystem service research and practice. Environmental Science and Policy 109, 1–14 (this issue).
Łaszkiewicz, E., Czembrowski, P., Kronenberg, J., 2019. Can proximity to urban green spaces be considered a luxury? Classifying a non-tradable good with the use of hedonic pricing method. Ecol. Econ. 161, 237–247.
Lees, L., 2000. A reappraisal of gentrification: towards a 'geography of gentrification'. Prog. Hum. Geogr. 24 (3), 389–408.
Lees, L., Shin, H. B., & Morales, E. L. (Eds.). (2015). *Global gentrifications: Uneven development and displacement*. Policy Press.Lenormand, M., Luque, S., Langemeyer, J., Tenerelli, P., Zulian, G., Aalders, I., … & van Eupen, M. (2018). Multiscale socio-ecological networks in the age of information. *arXiv preprint arXiv:1805.00734*.
Lenormand, M., Gonçalves, B., Tugores, A., Ramasco, J.J., 2015. Human diffusion and city influence. J. R. Soc. Interface 12 (109), 20150473.
Lenormand, M., Luque, S., Langemeyer, J., Tenerelli, P., Zulian, G., Aalders, I., Chivulescu, S., Clemente, P., Dick, J., van Dijk, J., van Eupen, M., Giuca, R.C., Kopperoinen, L., Lellei-Kovács, E., Leone, M., Lieskovsky, J., Schirpke, U., Smith, A.C., Tappeiner, U., Woods, H., 2018. Multiscale socio-ecological networks in the age of information. PLoS One 13 (11), e0206672. https://doi.org/10.1371/journal.pone.0206672.
Mathews, V., 2010. Aestheticizing space: art, gentrification and the city. Geogr. Compass 4 (6), 660–675.
Meerow, S., Newell, J.P., 2017. Spatial planning for multifunctional green infrastructure: growing resilience in Detroit. Landsc. Urban Plan. 159, 62–75.
Milcu, A.I., Hanspach, J., Abson, D., Fischer, J., 2013. Cultural ecosystem services: a literature review and prospects for future research. Ecol. Soc. 18 (3).
Millennium Ecosystem Assessment, 2005. Ecosystems and Human Well-being. Island Press, Washington, D.C.
Mitchell, D., 2003. The Right to the City: Social Justice and the Fight for Public Space. Guilford Press.
Ngom, R., Gosselin, P., Blais, C., 2016. Reduction of disparities in access to green spaces: their geographic insertion and recreational functions matter. Appl. Geogr. 66, 35–51.
Nordh, H., Østby, K., 2013. Pocket parks for people–a study of park design and use. Urban For. Urban Green. 12 (1), 12–17.

O'Brien, L., De Vreese, R., Kern, M., Sievänen, T., Stojanova, B., Atmiş, E., 2017. Cultural ecosystem benefits of urban and peri-urban green infrastructure across different European countries. Urban For. Urban Green. 24, 236–248.
Oteros-Rozas, E., Martín-López, B., Fagerholm, N., Bieling, C., Plieninger, T., 2018. Using social media photos to explore the relation between cultural ecosystem services and landscape features across five European sites. Ecol. Indic. 94, 74–86.
Pastur, G.M., Peri, P.L., Lencinas, M.V., García-Llorente, M., Martín-López, B., 2016. Spatial patterns of cultural ecosystem services provision in Southern Patagonia. Landsc. Ecol. 31 (2), 383–399.
Pearsall, H., 2009. Linking the stressors and stressing the linkages: human—environment vulnerability and brownfield redevelopment in New York City. Environ. Hazards 8 (2), 117–132.
Pearsall, H., 2010. From brown to green? Assessing social vulnerability to environmental gentrification in York City. Environ. Plann. C Gov. Policy 28 (5), 872–886.
Pearsall, H., Anguelovski, I., 2016. Contesting and resisting environmental gentrification: responses to new paradoxes and challenges for urban environmental justice. Sociol. Res. Online 21 (3), 1–7.
del Pulgar, C., Anguelovski, I., Connolly, J.J., 2020. Online). Towards a green and playful city: Understanding the social and political production of children's relational well-being in Barcelona. Cities . 96, 102438.
Pleasant, M.M., Gray, S.A., Lepczyk, C., Fernandes, A., Hunter, N., Ford, D., 2014. Managing cultural ecosystem services. Ecosyst. Serv. 8, 141–147.
Richards, D.R., Friess, D.A., 2015. A rapid indicator of cultural ecosystem service usage at a fine spatial scale: content analysis of social media photographs. Ecol. Indic. 53, 187–195.
Riechers, M., Barkmann, J., Tscharntke, T., 2016. Perceptions of cultural ecosystem services from urban green. Ecosyst. Serv. 17, 33–39.
Samuelsson, K., Giusti, M., Peterson, G.D., Legeby, A., Brandt, S.A., Barthel, S., 2018. Impact of environment on people's everyday experiences in Stockholm. Landsc. Urban Plan. 171, 7–17.
Satz, D., Gould, R.K., Chan, K.M., Guerry, A., Norton, B., Satterfield, T., ... Basurto, X., 2013. The challenges of incorporating cultural ecosystem services into environmental assessment. Ambio 42 (6), 675–684.
Scullion, J., Thomas, C.W., Vogt, K.A., Pérez-Maqueo, O., Logsdon, M.G., 2011. Evaluating the environmental impact of payments for ecosystem services in Coatepec (Mexico) using remote sensing and on-site interviews. Environ. Conserv. 38 (4), 426–434.
Sherren, K., Parkins, J.R., Smit, M., Holmlund, M., Chen, Y., 2017. Digital archives, big data and image-based culturomics for social impact assessment: opportunities and challenges. Environ. Impact Assess. Rev. 67, 23–30.
Smith, N., 1986. Gentrification, the frontier, and the restructuring of urban space. Gentrification City 15, 17.
Smith, N., 2008. On 'the eviction of critical perspectives'. Int. J. Urban Reg. Res. 32 (1), 195–197.
Solecki, W.D., Welch, J.M., 1995. Urban parks: green spaces or green walls? Landsc. Urban Plan. 32 (2), 93–106.
Sonter, L.J., Watson, K.B., Wood, S.A., Ricketts, T.H., 2016. Spatial and temporal dynamics and value of nature-based recreation, estimated via social media. PLoS One 11 (9), e0162372.
Stephenson, J., 2008. The Cultural Values Model: an integrated approach to values in landscapes. Landsc. Urban Plan. 84 (2), 127–139.
Tenerelli, P., Demšar, U., Luque, S., 2016. Crowdsourcing indicators for cultural ecosystem services: a geographically weighted approach for mountain landscapes. Ecol. Indic. 64, 237–248.
Thiagarajah, J., Wong, S.K., Richards, D.R., Friess, D.A., 2015. Historical and contemporary cultural ecosystem service values in the rapidly urbanizing city state of Singapore. Ambio 44 (7), 666–677.
Tratalos, J., Fuller, R.A., Warren, P.H., Davies, R.G., Gaston, K.J., 2007. Urban form, biodiversity potential and ecosystem services. Landsc. Urban Plan. 83 (4), 308–317.
Triguero-Mas, M., Dadvand, P., Cirach, M., Martínez, D., Medina, A., Mompart, A., ... Nieuwenhuijsen, M.J., 2015. Natural outdoor environments and mental and physical health: relationships and mechanisms. Environ. Int. 77, 35–41.
Triguero-Mas, M., Donaire-Gonzalez, D., Seto, E., Valentín, A., Martínez, D., Smith, G., ... Ambròs, A., 2017. Natural outdoor environments and mental health: stress as a possible mechanism. Environ. Res. 159, 629–638.
USGS, United States Geological Survey, 2018. NDVI: The Foundation for Remote Sensing Phenology (Accessed 5 May 2020): https://www.usgs.gov/land-resources/eros/phenology/science/ndvi-foundation-remote-sensing-phenology?qt-science_center_objects=0#qt-science_center_objects.. .
van Dijck, J., 2011. Flickr and the culture of connectivity: sharing views, experiences, memories. Mem. Stud. 4, 401–415.
van Zanten, B.T., Van Berkel, D.B., Meentemeyer, R.K., Smith, J.W., Tieskens, K.F., Verburg, P.H., 2016. Continental-scale quantification of landscape values using social media data. Proc. Natl. Acad. Sci. 113 (46), 12974–12979.
Verto Analytics. *The Demographics of Social Media Properties: Looking Beyond Downloads*. (Retrieved 13 August 2018: from https://www.vertoanalytics.com/the-demographics-of-social-media-properties-looking-beyond-downloads/.
Voigt, A., Kabisch, N., Wurster, D., Haase, D., Breuste, J., 2014. Structural diversity: a multi-dimensional approach to assess recreational services in urban parks. Ambio 43 (4), 480–491.
Willemen, L., Cottam, A.J., Drakou, E.G., Burgess, N.D., 2015. Using social media to measure the contribution of red list species to the nature-based tourism potential of African protected areas. PLoS One 10 (6), e0129785.
Wolch, J.R., Byrne, J., Newell, J.P., 2014. Urban green space, public health, and environmental justice: the challenge of making cities 'just green enough'. Landsc. Urban Plan. 125, 234–244.
Wood, S.A., Guerry, A.D., Silver, J.M., Lacayo, M., 2013. Using social media to quantify nature-based tourism and recreation. Sci. Rep. 3, 2976.
Yoshimura, N., Hiura, T., 2017. Demand and supply of cultural ecosystem services: use of geotagged photos to map the aesthetic value of landscapes in Hokkaido. Ecosyst. Serv. 24, 68–78.
Zukin, S., 1987. Gentrification: culture and capital in the urban core. Annu. Rev. Sociol. 13 (1), 129–147.