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Digital co-construction of relational values: understanding the role of social media for sustainability

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Abstract

There is a deeply relational aspect to the systems people employ for sorting through and prioritizing plural values assigned to social-ecological interactions. Spurred by interpersonal relationships and adherence to societal core values, such as justice and reciprocity, relational values go beyond instrumental and intrinsic approaches to understanding human behaviour vis-à-vis the environment. Currently, this relational dimension of values is entering the spotlight of the Cultural Ecosystem Services (CES) literature focusing on non-material benefits and values people derive from ecosystems, such as aesthetics and sense of place. Relational values foster reflections on appropriateness and morality of preferences and respective behaviours in contributing to collective flourishing across space and time, holding implications for social-ecological justice and sustainability. Recently, several studies explored the potential of using social media data for assessing values ascribed to CES, but did not look at how this emerging approach could contribute to an enhanced understanding of relational values. In order to take up this goal, we conducted a systematic review, screening 140 publications and selecting 29 as relevant for exploring the extent to which relational CES values are inferable through social media. Our results show that social media data can reveal CES values' plural and relational dimension. Social media platforms, thus, can be understood as new arenas for the co-construction of values, where relational values stemming from social-ecological interactions are negotiated and defined. Yet, work on their implications for social-ecological justice and sustainability needs to be extended.

Keywords

Cultural Ecosystem Services, Social Media analysis, Relational values, Sustainability

Introduction

1 Social values, as a system of preferences, principles, and virtues co-constructed and held
2 in common by the members of a social group, are critical to the endeavour of
3 sustainability in that they are closely linked to people's behaviour (Chan et al. 2012b;
4 Manfredi et al. 2016). A subgroup of social values influences which non-material benefit
5 humans prioritize as a result of interactions with and within their natural environment.
6 Since the Millennium Ecosystem Assessment (2005), these non-material benefits are
7 often referred to as cultural ecosystem services (CES) (Chan et al. 2012a; Milcu et al.
8 2013). Values related to CES are increasingly assessed to highlight the importance of
9 natural assets for sustaining human wellbeing through land-use planning, environmental
10 decision making, and ecosystem-based management (MEA 2005; Chan et al. 2012a;
11 Dickinson and Hobbs 2017). This focus on CES represents an important cornerstone of
12 the wider ecosystem services (ES) framework, allowing ES research to move beyond the
13 stalemate between the "new conservationists" advocacy for the instrumental value of
14 nature and the traditional conservationist claim for protecting nature based on its intrinsic
15 value (Klain et al. 2017).

16 Mediated through human senses and perceptions (MEA, 2005), the intangible benefits of
17 CES are shaped by social values and direct human behaviour in ways that defy the
18 intrinsic-instrumental dichotomy. The systems people employ for sorting through social
19 values make certain provisioning and regulating ES more cognitively accessible (Chan et
20 al. 2012a; Milcu et al. 2013; Dickinson and Hobbs 2017) and, thus, motivate nature
21 conservation and stewardship (Andersson et al. 2014). Yet, the intangibility and
22 incommensurability of values ascribed to CES make them ill-suited to be measured in

23 monetary terms and difficult to be appropriately assessed and incorporated into processes
24 of structured decision-making (Chan et al. 2012a; Milcu et al. 2013; Dickinson and Hobbs
25 2017). Monetary approaches for CES valuation - e.g. the travel cost method, hedonic
26 pricing, and willingness to pay - primarily aim to protect nature by internalizing
27 environmental values into markets. However, such approaches compartmentalize ES into
28 discrete units for marginal valuation (Chan et al. 2012b; Milcu et al. 2013) and assume
29 objectivity in measurement (Raymond et al. 2014). This, critics argue, potentially results
30 in a destructive commodification of nature (Kallis et al. 2013; Milcu et al. 2013) and risks
31 obscuring context-dependent, inter-connected, reciprocal, and plural values that actually
32 shape how humans relate to nature (Chan et al. 2012b; Hernández-Morcillo et al. 2013;
33 Raymond et al. 2014).

34 In this context, Chan et al. (2016) describe values assigned to CES as non-consumptive,
35 non-replaceable, socially-constructed and inherently relational.

36 The relational dimension of CES values manifests when people relate with and within
37 nature, and emerges from a set of preferences, principles and virtues that are
38 fundamentally social and ethical (Kenter et al. 2015). Relational CES values may generate
39 a desire to preserve a landscape due to its close connection with a certain cultural identity,
40 or to engage in green stewardship due to a communally-expressed appreciation for such
41 activities. The relational dimension of values ascribed to CES, thus, associates societal
42 choices, principles and corresponding behaviours to people's shared sense of justice, care,
43 reciprocity and responsibility towards one another, including humans, non-humans, and
44 ecosystems (Díaz et al. 2015; Chan et al. 2016; Klain et al. 2017; Pascual et al. 2017).
45 Relational values ascribed to CES are, thus, the central conceptual pathway through

46 which ES connects with efforts to build just and sustainable social-ecological systems.
47 Yet, the implications of relational CES values for social-ecological justice – an emerging
48 notion wherein distributional-, procedural-, and recognition-based claims for justice
49 emanate from neither strictly social nor strictly environmental implications, but always
50 from the interplay between the two - and sustainability are still to be conceptualized in
51 order to provide a well-grounded research framework for empirical studies in this area.

52 Often, non-monetary, participatory and deliberative valuation approaches are proposed to
53 account for the multidimensionality of relational values ascribed to CES, building on the
54 longstanding theories of communicative rationality (Raymond et al. 2014). Such methods
55 consist of individuals taking part in collective and elicited processes of CES valuation
56 and co-construction of meanings (Fischer and Eastwood 2016). From these collective co-
57 constructions the researcher can either assemble stated values (e.g. through survey or
58 focus groups) or deduce revealed values (e.g. by analysing behaviours) (Raymond et al.
59 2014; Kenter et al. 2015). These collective processes of valuation, mostly aiming to assess
60 CES distribution and distributional justice across society and space, can also respond to
61 claims of recognition and procedural justice in that they embrace diverse stakeholders
62 and their preferences in a participatory way (Schlosberg 2007). Nevertheless,
63 participatory and deliberative approaches to CES valuation are highly sensitive to the
64 proper representation and empowerment of different social groups and have limited
65 spatial and temporal scope, which may result in imperfect simulations of the process
66 through which values are negotiated within communities (Schafer and Gallemore 2015;
67 Maraja et al. 2016).

68 In an attempt to overcome these limitations, revealed values are increasingly derived from
69 more widely representative social media (Hamstead et al. 2018; Ilieva and McPhearson
70 2018; Langemeyer et al. 2018; Lenormand et al. 2018). Already leveraged to empirically
71 test social science theories (De Nadai et al. 2016), social media represents a digital arena
72 where members of virtual communities share and exchange multimedia content. Social
73 media content can include any information shared on a digital platform, including
74 pictures, tags (text descriptions and geolocalization), or running or biking tracks, for
75 instance. At its root, this content reflects individual user values regarding tangible and
76 intangible aspects of the environment, such as landscape aesthetics, outdoor recreation,
77 cultural identity, and sense of place (Guerrero et al. 2016).

78 When aggregated, social media content related to CES becomes doubly relational. First,
79 the content reflects the inherently relational aspect of values ascribed to CES within wider
80 society. People are reflecting their prior communally shaped notions of what should be
81 valued as they post to social media. Also, because digital communication platforms are
82 co-constructed and shared among the members of a community, the process of producing
83 the content is embedded in a given set of norms that adds a second layer of relationality
84 onto social media data. As individuals share their personal experiences, they expose their
85 social-ecological perceptions and activities to public appraisal and comment within the
86 digital community. In doing so, according to findings from social psychology research,
87 they are motivated and affected by the perceived presence of others (Ames and Naaman
88 2007) and, in seeking alignment with social values of the group, implicitly express
89 relationality based on sentiments of care and reciprocity for the preferences of others. For
90 some, deepening this type of communal relationality relative to the environment is

91 essential for efforts to build just and sustainable social-ecological systems (Chan et al.
92 2016).

93 Apart from revealing the relational dimension of values ascribed to CES, this process of
94 co-construction of meaning (Fischer and Eastwood 2016) holds further implications for
95 assessing social-ecological justice and sustainability. Drawing on Kenter et al. (2015),
96 exchanging multimedia data related to CES on social media platforms can be viewed as
97 a “digital”, non-deliberative and collective valuation approach. This approach ideally
98 overcomes the above-mentioned limitations (e.g. representativeness, power relations,
99 etc.) of other participatory and deliberative valuation approaches and allows for a more
100 inclusive elicitation of values (procedural and recognition justice). Also, since each user
101 produces social media data individually, it might provide a finer picture of values held by
102 diverse people or, when aggregated, by different social groups, offer a useful basis for
103 assessing distributional justice. Moreover, the high spatial and temporal frequency and
104 scale at which social media data can reveal relational values attributed to CES allow
105 researchers to account for users’ behavioural response to ecosystem changes and to the
106 cultural *stimuli* expressed through social media. Thus, the increased resolution of social
107 media data will likely provide a wide set of complementary information to plan for
108 sustainable social-ecological systems (Ilieva and McPhearson 2018).

109 In essence, social media data assessments are based on capturing components of social
110 processes through various functions, such as sharing, liking, and commenting, and
111 through multiple types of content including, e.g. photos, tags, and posts that represent the
112 ongoing co-construction of relational values ascribed to CES. Thus, based on a review of

113 existing work on CES and social media, we propose this developing approach as an
114 important new empirical basis on which to conceptualize relational values. In particular,
115 drawing on Kenter et al. (2015), we highlight how multimedia content co-constructed by
116 the users of a social media platform through a non-deliberated process exposes the
117 relational nature of social values assigned to CES, whether those values are classified as
118 transcendental (e.g. symbolic, spiritual), contextual (e.g. aesthetics, recreation), non-
119 monetary, other-regarding and/or communal. In sum, because of being co-constructed
120 through a collective valuation process that aligns individual with communal values
121 ascribed to CES (e.g. landscape aesthetic values negotiated among members of a digital
122 community), social media data is especially suited to exposing relational values (see Fig.
123 1).

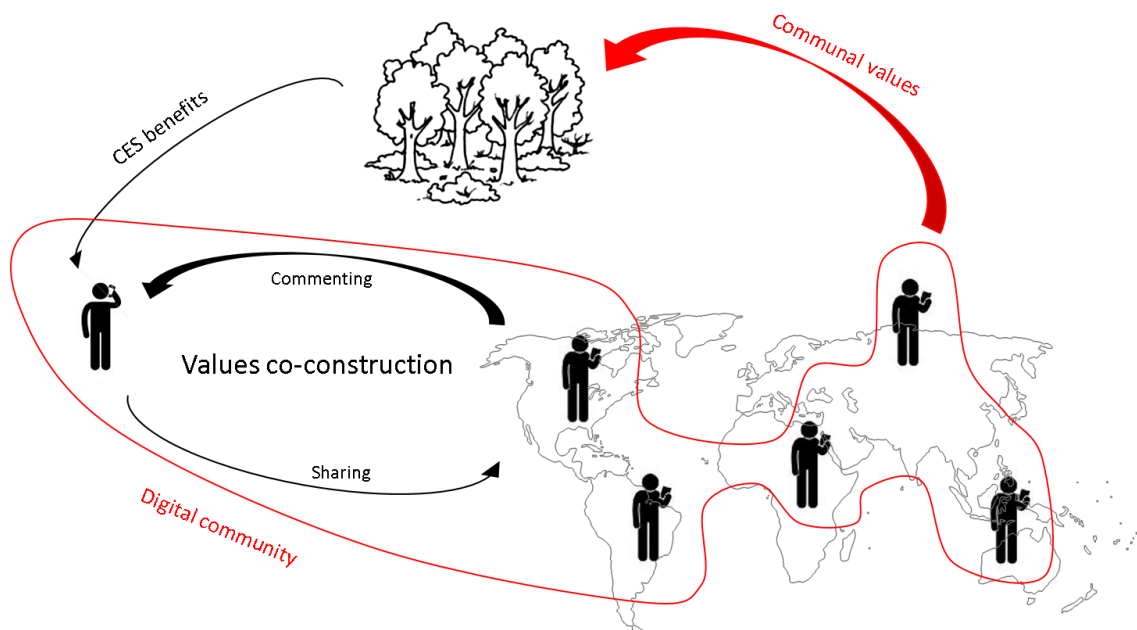


Figure 1. Relational values co-construction through interactions on social media.

124 We view relational values expressed through social media data through a bounded
125 relativist ontological lens. As content is shared within social groups whose definition is
126 bounded in space and time, values arise from people's interaction with nature and among

127 themselves (Moon and Blackman 2014). These values are constructed from a
128 combination of the subjects' experiences and the wider societal constructs that shape
129 these experiences – in essence, reflecting a process at the interface between constructivist
130 and subjectivist epistemologies. Given this approach, we are motivated by the hypothesis
131 that social media is a fertile ground for observing relational values ascribed to CES and
132 arising from their collective negotiation. To demonstrate this, we first examine the
133 relevance of social media data in assessing plural/multiple values related to CES and in
134 unveiling their relational dimension. In addition, we specifically focus on how social
135 media can sharpen our understanding of social-ecological justice and sustainability
136 related to relational CES values. Finally, we highlight opportunities and limitations in
137 using social media data for assessing relational values.

Materials and methods

138 We performed a literature review of studies using social media data for CES assessment
139 with a focus on the potential for examining relational values. Particularly, we analysed
140 each study's respective achieved goals, the challenges encountered, and further research
141 suggested in order to assess the potential for addressing relational issues. We performed
142 a systematic, structured quantitative literature review of peer-reviewed articles¹,
143 following a replicable procedure. The following criteria guided the search and selection
144 of relevant papers:

145 (i) clear mention of CES;

¹ Including one master thesis (Catana 2016) and one peer-reviewed conference proceeding (Goldberg 2015).

146 (ii) use of data retrieved from social media platforms, such as Flickr, Wikipedia or
147 OpenStreetMap, representing the user's revealed values;
148 (iii) assessment (e.g. quantification, valuation, mapping) of at least one CES, as well as
149 development or discussion of a framework or application.

150 Accordingly, we searched for studies that included in their title, abstract or keywords
151 terms pertaining to two main categories (see Appendix A for details on search terms).
152 The first category restricted the focus of our study to CES. As there are several CES
153 classifications (see Haines-Young & Potschin, 2018; MEA, 2005; TEEB, 2010), we
154 deliberately chose the most general and less detailed search terms. The second category
155 included all the terms that were found to be synonymously used with social media data
156 in scientific publications, e.g. crowdsourced data.

157 We excluded studies not directly relating to the CES framework because we wanted to
158 address the framework's inherent dimension of relationality stemming from nature-
159 society interactions and its specific aim to shape environmental policy-making for
160 sustainability. Other papers referring to, for instance, scenic route or landscape
161 perceptions rather than CES, either focus strictly on the methodological innovation of the
162 assessment (Levin et al. 2015; Hao et al. 2016), on the potential computing advances
163 (Stefanidis et al. 2013; Chen et al. 2017) or do not address nature-society interactions
164 (Girardin et al. 2008; García-Palomares et al. 2015). We also deliberately excluded
165 studies employing active research approaches to collect primary data, including (active)
166 citizen science approaches, participatory GIS, interviews, focus group discussions and

167 questionnaires. In addition, we discarded publications in languages other than English,
168 those whose full-text could not be found and conference abstracts.

169 We ran an advanced search on Web of Science and retrieved 58 publications meeting our
170 criteria in November 2017. We supplemented these articles with an additional 23 articles
171 that were either still in press or were found to have performed CES assessment through
172 social media but not as their main analysis, so the chosen search terms were not in their
173 abstract or keywords and were not extracted by Web of Science. Among those 81 articles,
174 we selected 22 as directly relevant for our study according to criteria i, ii, and iii (above).
175 We then performed a second round of searches based on those 22 articles. We screened
176 the title of the articles cited by and citing the 22 selected articles and identified 48 new
177 potentially relevant manuscripts. Seven of those 48 met our three criteria. Repeating the
178 same procedure of screening the citations of those 7, we found 11 new potentially relevant
179 articles but none met criteria i, ii, and iii and thus were outside of our study focus (see
180 Appendix B for a detailed diagram of the search). Through this iterative three-stage
181 procedure we reviewed a total of 140 potentially relevant articles and reached saturation
182 of those that met our specific criteria.

183 Only the 29 articles that met all three criteria were included in detailed analyses. Among
184 those excluded, 56 were addressing relevant topics (such as tourism and recreation, scenic
185 and cultural value), but not clearly referring to the CES framework (e.g. see Barry, 2014;
186 Dunkel, 2015; Levin et al., 2015; Seresinhe et al., 2017). The remaining 55 articles were
187 related to other topics, mostly because the acronym “CES” used for the search is valid
188 also in disciplines such as medicine or statistics (e.g. Syahid et al. 2016).

189 For conducting the analysis of the relevant articles we used a standardized assessment
190 protocol (see Appendix C) that allowed us to use the most significant and frequent codes
191 to synthesize and explain large segments of data. The assessment protocol was based on
192 predefined questions regarding general information (publication data, case study location,
193 spatial and temporal scales, data sample) and detailed questions concerning the number
194 and type of CES assessed, the method of assessment, the aim and the further gaps
195 identified by the study. In particular, with these questions, we wanted to understand what
196 motivated the study and whether our hypothesis about the suitability of social media in
197 inferring plural and relational CES values was in some way acknowledged or proven by
198 the selected studies. In addition, we coded the publications based on keywords (e.g.
199 “cultural footprint”, “plurality”, “context-specificity”, etc.) and concepts retrievable from
200 the text (e.g. shared conceptualization, co-construction of values, justice, strategy for
201 conservation, etc.) that aligned with our research objectives. The set of keywords and
202 concepts was continuously updated during the course of the analysis by identifying the
203 synonymous terms used by the different authors.

204 We acknowledge that the screened publications do not include every paper that mentioned
205 CES in relation to social media, and therefore may miss some insights. However, the final
206 sample does allow us to gain a broad and, we believe, representative overview of the most
207 significant literature for drawing reliable conclusions on recent social media-based
208 approaches to CES research. In the sections below we highlight the strongest of these
209 conclusions.

Results and discussion

Overview and general patterns

210 Overall, the number of publications addressing CES through social media has grown
211 conspicuously since 2012 (see Fig. 2). By nationality, the plurality of the 32 case studies
212 addressed in the 29 papers selected for careful study were located in the USA (n=5),
213 followed by the UK and Singapore (n=3), Africa, Argentina, Denmark, Switzerland,
214 France and Finland (n=2) and then Australia, Japan, Estonia, Germany, Greece, Hungary,
215 Ireland, Spain, and Sweden (n=1) (see Fig. 3). The spatial scale of the studies ranged from
216 global (n=2) to regional (n=15) to urban (n=6) and to local (n=6) (see Appendix C), and
217 data were generally analysed across several years (see Appendix C), with the starting year
218 depending on when the different platforms for social media were launched (see Appendix
219 D). Most of the studies used the pictures shared either on Flickr or on Panoramio, with a
220 small number of them combining the two (n=6). Some studies compared Flickr with
221 original (e.g. survey, interviews, participatory GIS) or official data from statistical or
222 cartographic entities (e.g. land cover map) (n=4). A few studies also used Instagram as a
223 data source, some in combination with other platforms (n=3), some others with original
224 or official data (n=2) (see Fig. 4).

225 Regarding the methods of assessment, many studies performed a visual content analysis
226 of geolocated pictures (n=8), several processed the data using statistical (n=11) and geo-
227 statistical tools (n=7), and some used the available data to model the distribution of where
228 data was missing, both across space and time (n=5). The goal of most studies was to
229 perform correlation analyses between CES and either landscape features (n=13), social
230 groups (n=3) or ecosystem stress (n=1). Other studies aimed to compare the differences
231 between social media and traditional data sources in performing CES assessment (n=5)
232 and to evaluate the different advantages in using each social media platform (n=2). In a

233 few other studies, an analysis of trade-offs and co-benefits was performed (n=2) and some
 234 evaluated the spatial distribution of CES (n=6) for either informing decision-makers or
 235 prioritizing areas for scenic conservation (see Appendix C).

Table 1 Summary of the 29 reviewed articles on CES and social media

CES assessed	Study reference	Study description
Landscape plurality of value (recreation , aesthetics, sense of place, social and spiritual values)	Oteros-rozas et al. (2017)	CES assessment, trade-offs and synergies among them and identification of the landscape features underpinning their provision
	Tenerelli et al. (2016)	Assessment of CES distribution and correlation with landscape composition
	Martínez Pastur et al. (2015)	CES hot-spots assessment and trade-offs, synergies and correlation with social and biophysical variables
	Catana (2016)	CES assessment in protected landscapes
	Levin et al. (2017)	Examining the potential of crowdsourced data for assessing protected area importance. Compares and evaluates multiple crowdsourced data with protected area visitor counts
	Richards and Friess (2015)	Assessment of CES distribution and correlation with landscape composition at fine spatial scale
	Thiagarajah et al. (2015)	Assessment of CES change over time
Landscape aesthetics	Guerrero et al. (2016)	Assessment of CES spatial distribution for informing urban green space governance
	Richards and Tunçer (2017)	Development of a novel method for spatial CES assessment

and recreation	Kothencz et al. (2017)	Comparison with surveyed data for assessing CES predictor value for visitors' level of satisfaction and the self-reported quality of life
	Derungs and Purves (2016)	Development of bottom-up approaches to describing landscapes, land cover and land use by building spatial folksonomies
	van Zanten et al. (2016)	Continental comparative assessment of the different social media platforms ability in predicting CES appreciation
Landscape aesthetics	Tammi et al. (2017)	Supplementary, non-monetary mapping of aesthetic ES index
	Tenerelli et al. (2017)	Assessment of the distribution of CES among users with different provenance and correlation with landscape composition
	Yoshimura and Hiura (2017)	Comparison between CES supply and demand
	Figueroa-Alfaro and Tang (2017)	Assessment of CES spatial distribution
	Casalegno et al. (2013)	Assessment of spatial covariation between supporting, provisioning, regulating and cultural ES
	Goldberg, (2015)	Point of Interest identification and prioritization for scenic conservation
Cultural Identity	Gliozzo et al. (2016)	Assessment of CES spatial distribution, hot/cold spots identification and comparison between the spatial behaviour of different platform users
	Sherren et al. (2017)	Description of the interdisciplinary state-of-the-art that is converging to enable new tools for Social Impact Assessment (SIA), using hydroelectricity as a case study
Recreation	Cord et al. (2015)	Assessment of CES distribution and correlation with landscape composition

	Allan et al. (2015)	Quantification of spatial distribution of recreational facilities and correlation with ecosystem stress assessment
	Upton et al. (2015)	Assessment of accessibility to recreational forests and recreation demand modelling
Recreation and ecotourism	Heikinheimo et al. (2017)	Comparison with surveyed data to assess the added value of social media analysis in reveal correlation with social group characteristics
	Hausmann et al. (2017)	Exploration of which socio-economic, geographical and biological factors explain social media use
	Sonter et al. (2016)	Assessment of nature-based recreation within conserved lands using social media, analysing its predictor value for visitation rate and its correlation with landscape composition
	Wood et al. (2013)	Use of data from social media to predict visitation rates at sites around the world comparing it to empirical data, such as type of attraction, income-level, temporal changes, etc.
	Willemen et al. (2015)	combining photo counts with species range data to determine the protected areas with the highest potential to attract wildlife tourists
Recreation and education	Ghermandi (2016)	Investigate patterns of public use in natural treatment systems

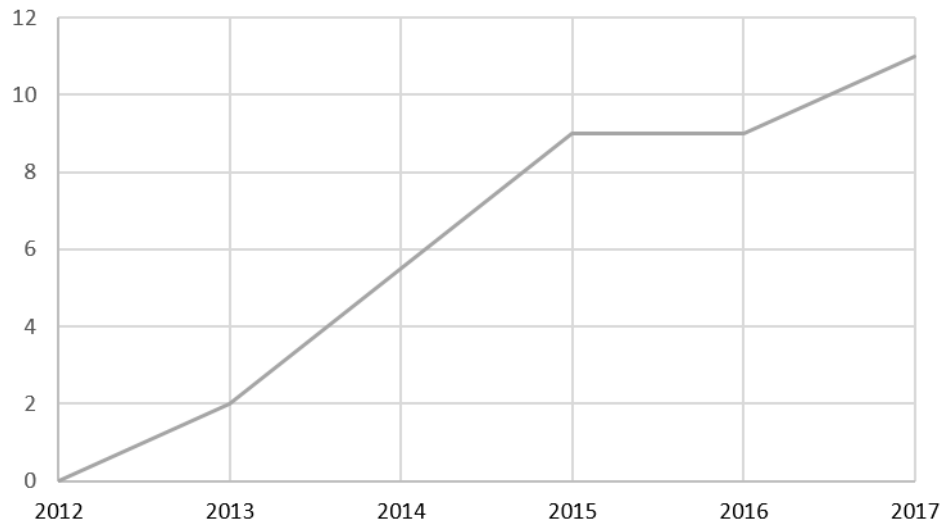


Figure 2. Number of publications per year

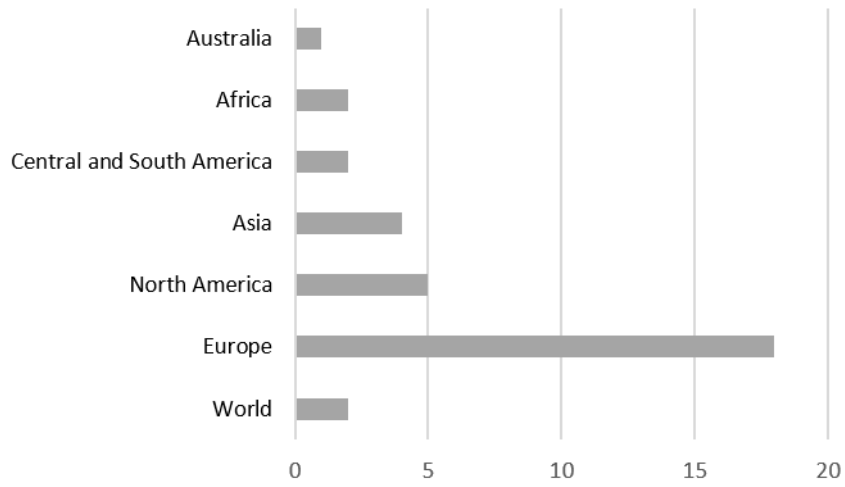


Figure 3. Geographical distribution of the case studies

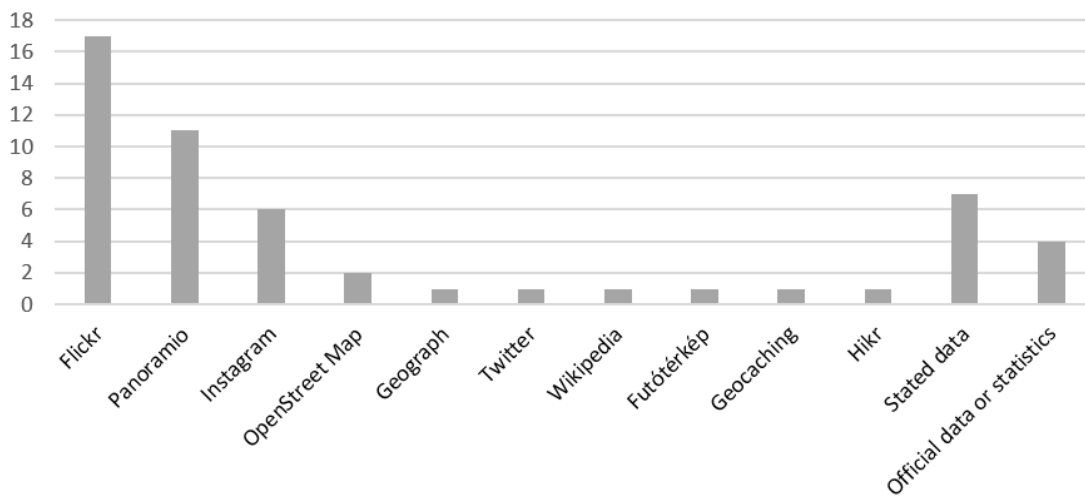


Figure 4. Number of studies adopting the different social media platforms

Social media assessment of plural CES values

236 Quantitatively assessing the plurality of CES values has always challenged researchers,
 237 both timewise and in terms of costs. Here we unveil the advantages in using social media
 238 data for addressing this challenge. Among the selected papers, the majority (more than
 239 60%) include an assessment of multiple CES values and, in some cases, of their spatial
 240 co-presence, ranging from a minimum of two to a maximum of eight values (see Fig. 5).
 241 These studies confirm social media as a suitable data source for understanding the
 242 context-dependency and holistic nature of CES values. Despite the fact that studies
 243 adopted different systems of classification (e.g. Haines-Young and Potschin, 2018; MEA,
 244 2005; TEEB, 2010), it is possible to highlight connections between the CES values
 245 assessed and the methods implemented. Among studies that restricted their analysis to
 246 one or two main CES, there was a general agreement on the need to recognize that there
 247 are many ways in which the environment is perceived (Tenerelli et al. 2017). These
 248 articles express an interest in exploring the multiple means of perception for better

249 integrating non-expert conceptualizations of landscape into policy (e.g. Derungs and
250 Purves, 2016).

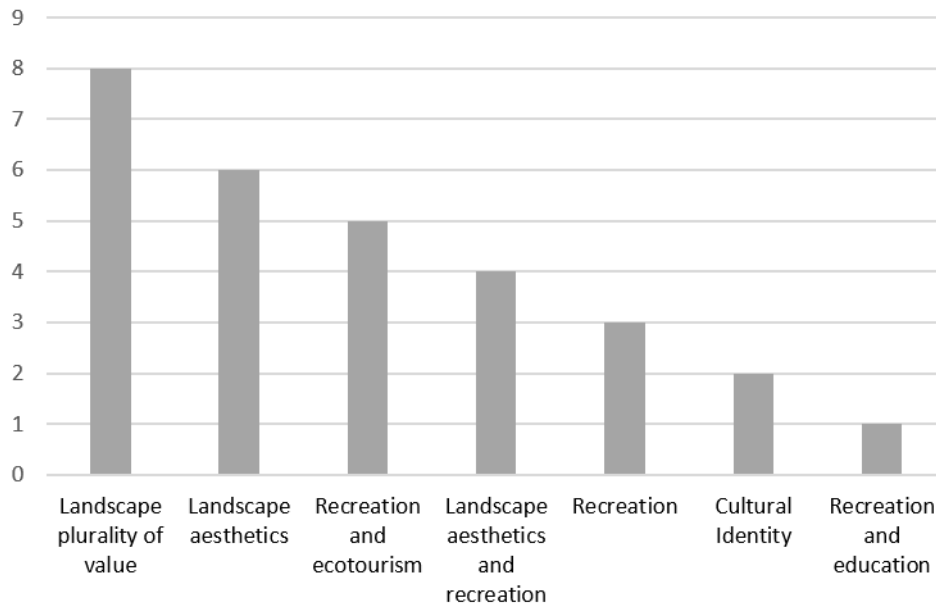


Figure 5. Number of studies assessing the different CES

251 Among the studies assessing more than two CES, visual content analysis of geolocated
252 crowdsourced pictures is the most applied methodology. Visual content analysis allows
253 the researcher to assess a wide spectrum of CES, including landscape aesthetics (Martínez
254 Pastur et al. 2015; Thiagarajah et al. 2015; Catana 2016; Guerrero et al. 2016; Tenerelli
255 et al. 2016); recreation and ecotourism (Catana 2016; Tenerelli et al. 2016; Oteros-Rozas
256 et al. 2017); cultural heritage and social and spiritual values (Oteros-Rozas et al. 2017);
257 social relation and species existence value (Richards and Friess 2015; Catana 2016), local
258 identity (Martínez Pastur et al. 2015); and sense of place (Guerrero et al. 2016). In
259 addition, studies complementing social media data with primary crowdsourced data, such
260 as those obtained from a public participation GIS (PPGIS) workshop (Levin et al. 2017)
261 or surveyed and mined from archives (Thiagarajah et al. 2015), reveal the potential to

262 provide a wider spectrum of CES values, adding conservation, therapeutic, wilderness
263 and inspirational values to the list.

264 Yet, confirming previous findings (Hernández-Morcillo et al. 2013; Milcu et al. 2013),
265 among CES studies aesthetic and recreational values are, in general, the most frequently
266 quantified, either in single or multiple value assessments. Many of the studies assessed
267 either only aesthetics (more than 30%) (Casalegno et al. 2013; Goldberg 2015; Figueroa-
268 Alfaro and Tang 2017; Tammi et al. 2017; Tenerelli et al. 2017; Yoshimura and Hiura
269 2017), only recreational values (more than 30%) (Allan et al. 2015; Cord et al. 2015;
270 Upton et al. 2015), or both (more than 20%) (van Zanten et al. 2016; Kothencz et al. 2017;
271 Richards and Tunçer 2018).

272 Apart from the multiple CES values that social media have thus far proven suitable to
273 assess, many studies showed also the potential of these methods to account for the
274 different predictors or explanatory variables that help to understand how CES values are
275 constructed. Some studies explore the environmental variables that enable specific CES
276 values, such as how complexity and “naturalness” determine attractiveness in landscape
277 aesthetics (Tenerelli et al. 2017), while others focus on the extent to which species
278 richness (Willemen et al. 2015; Hausmann et al. 2017) or landscape features (Tenerelli et
279 al. 2016) influence recreation, tourism, or aesthetic potential. In addition, social media
280 data allow researchers to correlate plural CES presence to predictor variables, such as
281 accessibility (Thiagarajah et al. 2015; Upton et al. 2015; Willemen et al. 2015; Ghermandi
282 2016; Guerrero et al. 2016), population density (Hausmann et al. 2017), type of habitat
283 and the presence of human artefacts (Gliozzo et al. 2016; Guerrero et al. 2016), scenic

284 spots (Tenerelli et al. 2016), and natural protection areas (Levin et al. 2015; Catana 2016).
285 Similarly, Oteros-Rozas et al. (2017) recognize the context-specificity of CES and their
286 results show a positive relationship between landscape diversity and CES diversity,
287 thereby, verifying previous findings (Casalegno et al. 2013; Gliozzo et al. 2016; Tammi
288 et al. 2017). Moreover, Yoshimura and Hiura (2017) and Tenerelli et al. (2017) found
289 further evidence of the different preferences expressed by foreign and local users,
290 although this finding is not confirmed by other works (Richards and Friess 2015).

Social media assessments revealing relational values

291 A person's perspective on place or landscape has recently been argued to result from
292 interactions that bridge transcendental (or held) and contextual (or assigned) values
293 (Levin et al. 2017). The argument builds on the concept of relational value, which,
294 although already present in the environmental psychology and sociology literature
295 (Stephenson 2008; Graham et al. 2013), was first explicitly attributed to CES in Chan et
296 al. (2016) and is, thus, relatively new and clearly not present in the relevant articles
297 published before that date, nor explicitly assessed by those analysed in this study. Only
298 Catana (2016) refers to the dimension of relationality in order to show how human values
299 are connected to perceptions, preferences, and ultimately to well-being. However, in
300 order to verify our hypothesis on the specific potential of social media data to infer this
301 so far neglected value dimension, we looked for similar concepts or for promising
302 assessment methods in the reviewed articles, despite the fact that they were primarily
303 addressing other objectives.

304 Many studies expressed the need to capture the meanings that people collectively assign
305 to landscapes and that regulate inter-societal relationships involving nature. In this regard,

306 social media data is seen as a valuable source of information about shared
307 conceptualizations and about the process of culture creation relative to the natural
308 environment, as in the case of frequently used tags and hashtags (Derungs and Purves
309 2016; Guerrero et al. 2016). More specifically, some studies suggest that sharing a
310 landscape picture on a social media platform is a form of “digital interaction” that adds
311 another collective dimension to social values, contributing to peoples’ shared image of
312 landscapes and, consequently, attachment to nature and to one another (Oteros-Rozas et
313 al. 2017). These attachments may also be based on their historical and cultural
314 background (Guerrero et al. 2016). People sharing content on social media are, indeed,
315 responsible for influencing their “digital receptors” with what is referred to as their
316 cultural ecosystem footprint (Gliozzo et al. 2016). In addition, social media not only
317 serves as a platform to dispute and share relational CES values, but also stores the process
318 of value creation that generates heritage, allowing the persistence of CES values and
319 counteracting the “extinction of experiences” of nature in modern societies (Miller 2005).

320 In addition, the different forms of interaction allowed on social media, motivate people
321 to co-construct values in diverse manners (Cord et al. 2015). In this regard, we also found
322 some evidence of a correlation between the relational and plural attributes of values. In
323 platforms allowing voluntary and non-restricted participation, such as *Flickr*, *Instagram*
324 and *Panoramio*, people are motivated to share data because of the global visibility they
325 obtain and, thus, tend to express plural and context-specific values (Gliozzo et al. 2016;
326 Guerrero et al. 2016). On the contrary, when a platform has a compiling purpose intended
327 to provide a specific output to decision-makers, such as *Geograph*, data are more
328 homogeneously distributed and less informative of people’s multiple held values (Gliozzo

329 et al. 2016). Therefore, across the reviewed literature, the majority of the authors
330 recognize the correlation between the collective process of co-construction of meaning
331 associated with social-ecological interactions and the expression of relational principles
332 of care, reciprocity and responsibility towards nature and others. This strain of findings
333 in the literature affirms that social media platforms are suitable arenas for negotiating and
334 capturing relational values assigned to CES.

Furthering social-ecological justice and sustainability by inferring relational values from social media platforms

335 The production of values is part of a socialization process that occurs through repeatedly
336 engaging in countless experiences and phases of learning, either formal or informal. This
337 process “embrains” the spontaneous responses and cultural practices that allow
338 individuals and groups to adapt to their social-ecological surroundings without much
339 effort or deliberation (Gliozzo et al. 2016; Manfredo et al. 2016). Therefore, since we
340 assume that value attachment to places motivates people’s actions and the consequent
341 effects on their surroundings (Yoshimura and Hiura 2017), we look at this process with
342 particular attention.

343 In social media, apart from their values and emotions, people share digital and geolocated
344 traces of actions driven by underlying values and, further eased by Internet functionalities,
345 influence each other (Gliozzo et al. 2016). The process of mutual influence in ascribing
346 values to CES provided by places or activities can lead others to personally experience
347 them (Cord et al. 2015) or not (Goldberg 2015; Gliozzo et al. 2016), such as for CES that
348 do not require a physical interaction to be experienced (e.g. cultural heritage, existence
349 value, and spiritual values) (Richards and Friess, 2015). Hence, some studies show

350 empirical evidence of these processes of co-construction of values, mutually influenced
351 behaviour in interacting with nature, and consequent co-production of ES (Fischer and
352 Eastwood 2016), demonstrating that CES values expressed on social media cluster around
353 popular scenic (Goldberg 2015) or recreational spots (Cord et al. 2015) and widely known
354 species (Willemen et al. 2015).

355 In this regard, some studies suggest using “likes” and ratings associated with social media
356 data (Gliozzo et al. 2016; Hausmann et al. 2017) or simply the number of times each
357 picture posted on a social media platform has been visualized (Goldberg 2015), or its
358 location has been reached (Cord et al. 2015), by another user as a proxy for CES hot-spot
359 identification. Mapping CES hot-spots helps identify areas where the services are most
360 highly valued (Goldberg 2015; Guerrero et al. 2016) and whether this results in ecosystem
361 stress (Allan et al. 2015), providing useful information to prioritize areas for conservation
362 (Hausmann et al. 2017) and cultural services management (Guerrero et al. 2016).

363 In addition, several of the reviewed studies have highlighted the lack of methodological
364 approaches for addressing social-ecological justice and sustainability. Some argue for
365 performing a demographic profile of social media users in order to account for procedural
366 and recognition justice in the assessment, as well as assessing distributional justice by
367 accounting for variables such as gender, social class, age or area of residence (Gliozzo et
368 al. 2016) and specifically seeking to reach less represented user groups (Guerrero et al.
369 2016). Others propose to perform an assessment of cross-cultural differences (Cord et al.
370 2015). Some studies recommend monitoring the trends of social preferences towards CES
371 exploring their evolution across geographic and temporal scales (Wood et al. 2013;
372 Martínez Pastur et al. 2015; Derungs and Purves 2016; Guerrero et al. 2016), or to

373 perform scenario-based simulations (Wood et al. 2013) and develop means for
374 quantifying ecosystem resilience over time (Allan et al. 2015). This would help correlate
375 changes in visitation rates with changes in ecosystem health, site access, infrastructure
376 development and alternative management regimes. Finally, some studies recognize the
377 potential of social media data for revealing city dwellers' preferences and values in order
378 to respond to important challenges for place-based culture and well-being (Guerrero et al.
379 2016; Tenerelli et al. 2017), and plan for healthy green spaces (Kothencz et al. 2017). All
380 of these are promising directions for translating CES knowledge derived from social
381 media data into a more coherent and systematic understanding of relational CES values
382 and of their role for social-ecological justice and sustainability.

Opportunities and limitations in the use of social media data

383 Because social media data can be collected passively, its greatest benefit for questions of
384 internal validity is that it provides a research route that compensates for shortcomings
385 affecting data obtained through more active collection approaches, such as surveys,
386 interviews or photo elicitation (Guerrero et al. 2016). Geolocated social media data,
387 indeed, reveals perspectives that arise from directly experiencing the environment at the
388 same time as it is being evaluated (Tenerelli et al. 2017) and is less costly and time-
389 consuming (Yoshimura and Hiura 2017). In addition, because it is collected across a wide
390 variety of the population and can have high spatial resolution thanks to the embedded
391 geotag (van Zanten et al. 2016; Oteros-Rozas et al. 2017) and be reported in real-time
392 (Gliozzo et al. 2016; Oteros-Rozas et al. 2017), it has higher representativeness over space
393 and time than many alternatives.

394

395 Moreover, geolocated social media data are especially useful because the digital
396 interactions that they allow are believed to spur participants to mutually influence gradual
397 changes in their values, associated behaviour and, eventually, produced environment.
398 Such changes, to the extent that they are transferred to the policy level, have been often
399 indicated as necessary to achieve global environmental sustainability (Stern et al. 1999;
400 Manfredo et al. 2016). In addition, given that most of the people using social media are
401 urban dwellers (Guerrero et al. 2016; International Telecommunication Union 2016), this
402 data source is valuable in that it allows researchers to assess CES values held by people
403 with gradually declining opportunities of interaction with nature (Dickinson and Hobbs
404 2017).

405 Of course, there are limitations to the use of geolocated social media data as well. For
406 example, some studies recognize the limitations that arise when the researcher interprets
407 data in a one-directional way (Derungs and Purves 2016; Oteros-Rozas et al. 2017) and
408 because of the temptation to see patterns in the available data where none actually exist
409 (what is known as *apophenia*) (Wood et al. 2013). This limitation could be partly
410 addressed through the establishment of unified coding protocols for social media data.
411 Others highlight the spatial bias as a result of data gaps in places characterized by poor
412 data (Catana 2016; Levin et al. 2017) or poor reliability of the geotag (Oteros-Rozas et
413 al. 2017). Questions emerge also due to data representativeness. Several existing digital
414 divides and fashions in the use of certain social media platforms, such as those related to
415 age, gender and income level, might mislead the analyst because the data accounts only
416 for behaviours and perceptions of certain profiles and social groups (Wood et al. 2013;
417 Allan et al. 2015; Martínez Pastur et al. 2015; Willemen et al. 2015; Oteros-Rozas et al.

418 2017; Tenerelli et al. 2017). For example, recent studies found a strong gender imbalance
419 (64% male; 36% female) in the users of the photo-sharing platform *Flickr* who responded
420 to a user questionnaire (Lenormand et al. 2018). Such perceptions might further be
421 influenced by specific individuals, groups or private corporations that, by implementing
422 communication or market strategies on social networks, reach their target audience and
423 influence values creation and data availability (Oteros-Rozas et al. 2017).

424 All of these limitations direct us to consider how social media deals with issues of uneven
425 power relations, which is perhaps the central issue impacting recognition, procedural,
426 distributional justice outcomes (Schlosberg 2007). Especially with regard to procedural
427 justice, a poor accounting of the effect of uneven social power relations has long been
428 central to the urban scholarship critique of communicative rationality (Huxley and
429 Yiftachel 2000). These limitations are believed to decrease with the continuing increase
430 in number and awareness of social media users and in data accuracy allowed by newer
431 technologies (Guerrero et al. 2016; Tenerelli et al. 2017) and the combination of different
432 data sources. However, private monopolies on social media data bare the risk of
433 restricting the scientific analysis of data, for instance by platforms like *Facebook* and
434 *Instagram*, and, thus, limit a less biased societal representation of relational values
435 through social media-based research. This relates to questions of ethics, privacy and
436 copyright, which have been raised in relation to accessing social media data (Guerrero et
437 al. 2016), concerns also addressed by the latest European General Data Protection
438 Regulation (COM/2018/043), and which so far lack a more specific discussion from the
439 angle of sustainability science.

Conclusions and further recommendations

440 With this study, we aimed to contribute to the emerging questions of relationality within
441 sustainability research. We found evidence of social media platforms serving as valuable
442 data sources for revealing the multiple values that people assign to the environment. In
443 addition, we showed the dimension of relationality within plural CES values. We propose
444 a novel conceptualization that relates relationality to the collective processes of co-
445 construction of values ascribed to CES and, which is visible within social media data. We
446 found that the reviewed literature frequently points at the ability of social media data to
447 reveal people's willingness to share their experiences online. This is believed to be
448 significant in influencing the co-construction process of plural CES values, people's
449 interactions with and within the environment and, consequently, the co-production of ES,
450 proving useful information on value and behaviour for landscape and urban planning.

451 However, social disparities are reproduced in this process and, once translated into action,
452 can have implications for social-ecological systems justice and sustainability (e.g.
453 increased visitation rate in touristic spots and consequent gentrification and ecosystem
454 stress). Hence, this study calls for further exploring the different social and environmental
455 factors at play, and specific biases characterizing data sources, in order to enable the
456 potential of social media data to inform just and sustainable landscape planning and
457 management. Future research should also focus on the potential of social media-based
458 approaches to explore the path from value to action, assessing the influence of values
459 created on social media in enhancing people's agency toward the collective improvement
460 of their well-being (see Hicks et al. (2016)) and, eventually, to activate citizens in a
461 process of co-production of nature (Linders 2012; Guerrero et al. 2016).

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