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1 **Taking cultural landscapes into account: implications for scaling up ecological restoration**

2

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7

8 **Abstract**

9 Conceptual frameworks for landscape restoration commonly take an approach focused on  
10 ecological (biotic and abiotic) aspects. Yet the recent initiatives demanding that restoration be  
11 scaled up to restore millions of hectares of degraded land often encounter socio-cultural  
12 challenges too, such as competing land-use interests and low stakeholder engagement. Thus,  
13 consideration also needs to be given to cultural landscapes, broadly defined as regions that  
14 reflect the long-term interactions between people and the environment. Based on a literature  
15 survey we here identify and then discuss features from cultural landscapes-ecological restoration  
16 research, which can be relevant to ecological restoration upscaling. Overall, research  
17 encompassing cultural landscapes is revealed as less narrowly-focused than that on landscape  
18 ecology linked with ecological restoration: our selected studies quite frequently considered social  
19 and landscape aspects in addition to ecological aspects. Geographically, research is strongly  
20 biased towards Europe and North America, although the most ambitious restoration targets are in  
21 the tropics. Taking cultural landscapes into account could enhance restoration by (1) moving  
22 towards a transdisciplinary approach thereby offsetting the overemphasis on ecological aspects,  
23 and (2) mitigating issues of land use and stakeholder engagement. Further research, paying  
24 special attention to the tropics, should aim at integrative approaches that would contribute to  
25 scaling up restoration, not only in single large-scale projects but also through the sum of small  
26 but concerted actions.

27 **Keywords**

28 historical land use; landscape approach; landscape restoration; review; stakeholder participation;  
29 traditional practices

30

## 31 **1. Introduction**

32 Following numerous global calls for restoration of vast areas launched for 2020, such as  
33 Aichi targets, Bonn Challenge, REDD+, etc. (Aronson and Alexander, 2013) and an initiative led  
34 by El Salvador, the UN declared 2021-2030 the Decade of Ecosystem Restoration (United  
35 Nations, 2019). The restoration of such extensive areas (restoration upscaling) will no doubt  
36 involve varied socioecological contexts and multiple stakeholders. This means that assessing  
37 completed restoration actions so goals can be compared with achievements (Ruiz-Jaen et al.,  
38 2005; Wortley et al., 2013) is no longer sufficient: landscape-scale restoration must also be  
39 implemented. Landscape-scale restoration, or simply landscape restoration, encompasses various  
40 ecosystem mosaics involving diverse land uses and normally at high spatial scales (e.g.,  
41 watersheds). Restoration at this scale needs to go beyond “assisting the recovery of *an ecosystem*  
42 that has been degraded, damaged, or destroyed” as proposed in the definition of ecological  
43 restoration (SER, 2004). While it has been long recognized that the sustainability of small-scale  
44 projects depends on taking their surroundings, i.e. the landscape context, into account (Naveh,  
45 1994), most large-scale restoration initiatives have sought to restore large contiguous areas of the  
46 same ecosystem, mainly forests (e.g., Cao, 2011; Rodrigues et al., 2011). Often, however, such  
47 large-scale contiguous restoration is not feasible, for instance in landscapes characterized by  
48 numerous small to medium-sized properties with discontinuous degraded areas to be restored  
49 (Powlen and Jones, 2019). Moreover, restoration at a single site to deal with local factors often  
50 reveals important higher-scale factors that need to be addressed (Leite et al., 2013). In some  
51 regions, restoration upscaling could only be achieved through a number of small-scale initiatives,  
52 ideally involving exchanging positive feedback and integrated into a favorable landscape  
53 context.

54 Achieving landscape restoration appears to depend on at least three factors. First,  
55 effective landscape restoration requires a better understanding of two types of landscape  
56 interrelationship: the links first between social, cultural and economic factors, and second  
57 between habitat mosaics and the flow of ecosystem services (Ockendon et al., 2018). This points  
58 to a need for a transdisciplinary approach (Jellinek et al., 2019). Second, conceptual frameworks  
59 for landscape restoration commonly focus on ecological aspects and overlook historical factors  
60 and references, both ecological and cultural (Aronson et al., 2017). This suggests that the overly  
61 ecological slant needs to be redressed. Finally, landscape restoration faces considerable

62 challenges, such as competing interests regarding land use, unstable political contexts and low  
63 stakeholder engagement (Holl, 2017; Latawiec et al., 2015). Each of these three factors has a  
64 strong social component that should be addressed. However, landscapes vary in the degree of  
65 social influence required for their creation and maintenance. Farina (2000) approaches this  
66 through interrelationships between what he calls natural, cultural (social included) and economic  
67 capitals, the three main drivers in landscapes. Thus, landscapes driven by *cultural capital* (i.e.  
68 long-term sociocultural mechanisms), or cultural landscapes, differ from landscapes that mainly  
69 result from economic capital influences (Farina, 2010, p. 123).

70 The literature adopts different terms for the cultural capital in landscapes and restoration,  
71 such as cultural ecosystems (Evans and Davis, 2018), cultural practices (Wehi and Lord, 2017),  
72 cultural ecosystem services (Plieninger et al., 2015), socio-ecological systems (Swart et al.,  
73 2018) and social-ecological restoration (Fernández-Manjarrés et al., 2018). To a large extent,  
74 these studies indicate that considering cultural and/or social aspects may lead to more social  
75 engagement in restoration through an alignment of restoration actions and traditional land use,  
76 including the prevention of conflicts among stakeholder interests, resulting in increased  
77 effectiveness of restoration programs. However, often focused on ecosystems, they fail to adopt  
78 the landscape approach (i.e. “a multi-faceted integrated strategy that aims to bring together  
79 multiple stakeholders from multiple sectors to provide solutions at multiple scales”, Reed et al.,  
80 2016) that we believe is central to restoration upscaling. Taking the cultural landscape into  
81 account should boost ecological restoration (e.g., Moreira et al., 2006; Naveh, 2005) by clearly  
82 integrating cultural capital and the landscape approach.

83 In practice, considering cultural landscapes (CL) in ecological restoration (ER) (hereafter  
84 CL-ER) implies highlighting the role of long-term relationships between societies and their  
85 landscapes. The ultimate aim is to maintain these relationships and to integrate them into  
86 restoration initiatives. In an ever-changing world, conserving CLs might appear unfeasible, while  
87 restoring them might seem sentimental. However, seen from a broader perspective, “landscapes  
88 of the past” can make multiple contributions. For a start, they provide information relevant to  
89 landscape management (Antrop, 2005). Additionally, recent trends in landscape change may  
90 favor CL maintenance. For instance, land use changes involve not only the intensification of  
91 deforestation but also its decrease, with the consequent recovery of forested areas (Aide et al.,  
92 2013; Beilin et al., 2014).

93 CL-ER has been endorsed directly (Macdonald and King, 2018; Moreira et al., 2006;  
94 Naveh, 2005, 1998) and indirectly (through the use of the above-mentioned associated terms). It  
95 also appears fragmented in ER scientific, outreach and policy documents. However, CL-ER itself  
96 has not been systematically reviewed; while landscape ecology in ER was reviewed (Leite et al.,  
97 2013) such an approach lacks a clear focus on the cultural capital. Here, we review how the  
98 literature has reported the consideration of cultural landscapes in various ER contexts in an  
99 attempt to capture features from CL-ER research that are potentially relevant to ER upscaling.  
100 Specifically, we evaluated the sampled literature to: (1) determine the type of research  
101 undertaken on CL-ER (theoretical and practical, i.e. case studies), the different aspects covered  
102 by such research (social, spatial, ecological) and their geographical location; (2) compare our  
103 findings on bibliometric trends with a literature review on landscape ecology in ER (Leite et al.  
104 2013); and (3) identify potential implications and future perspectives for taking CLs into account  
105 so as to scale up ER.

106

## 107 **2. Methodology**

108 We performed a literature survey of the CL-ER link in terms of: (1) number of papers per  
109 year and areas of research, to assess the topic development through time and disciplinary scope  
110 of coverage; (2) research type, scope, and aspects assessed; and (3) geographical location of the  
111 studies, to assess how and where research has been conducted. Specifically, we searched the  
112 literature through the ISI Web of Science platform, looking for papers published up to 2019 that  
113 clearly link cultural landscapes (CLs) and ecological restoration (ER). To access papers, we used  
114 the following search string: TOPIC: (restor\* OR recover\* OR rewet\* OR reforest\*) AND  
115 TOPIC: (cultural near/2 landscape) AND TOPIC: (ecolog\* OR ecosyst\*). Our approach was  
116 partly inspired by Kollmann et al. (2016) for terms related to ER, adding terms associated with  
117 CLs. We found 168 entries spanning 1995-2019 of which 25 were excluded as proceedings  
118 papers or book chapters (quite often not accessible). Thereafter, abstracts were examined for the  
119 presence of both target subjects (CL and ER) and for their relationship (CL-ER). Papers that did  
120 not establish any relationship between CLs and ER in their abstract were discarded (34). We  
121 ended up with 109 papers spanning 1995-2019 that were examined in detail (see Table A.1,  
122 Appendix A for a list of selected papers).

123 For each paper, we accessed the following information: (1) publication year, research  
124 area and journal; (2) research type (theoretical/ practical), theoretical papers being reviews,  
125 opinions/ perspectives or proposing a theoretical framework, basing their assumptions on  
126 evidence from the literature, while practical papers involved data collection, either primary or  
127 secondary (documentary/ modeling analyses, e.g., using historical maps or data on species  
128 occurrences); (3) scope of the paper (general/ location-specific/ baseline/ evaluation), a  
129 subdivision of research type. Theoretical papers were divided into general (applicable to a broad  
130 range of situations) and location-specific (applicable to a specific site or region). Practical papers  
131 were divided into baseline (searching for a baseline or baseline elements that could contribute to  
132 future restoration actions) and evaluation (assessing the outcome of completed restoration  
133 actions); (4) aspects assessed in practical studies, categorized as ecological (vegetation  
134 dynamics, soil dynamics, vegetation types, modeling species, indicator species, biodiversity  
135 changes, carbon stock, conservation and management practices, and traditional practices),  
136 landscape (landscape scenarios, landscape connectivity, land-use history, selection of priority ER  
137 sites) and people (people's preferences on ER, people's general perceptions); (5) location of the  
138 study, categorized as general (not having a focal zone or country), zone (encompassing  
139 supranational regions not specifying countries), and continent/country, and also applied to  
140 theoretical papers with a general scope when such papers presented case studies (for location-  
141 specific papers, the location was the site or region it addressed).

142 We assessed the research areas of screened studies and attributed them to at least one  
143 corresponding broad category from the ISI Web of Science (Arts & Humanities, Life Sciences &  
144 Biomedicine, Physical Sciences, Social Sciences, and Technology), as shown in detail in Table  
145 A.2, Appendix A. When there was more than one research area in the same broad category, we  
146 counted it as a single record. We compare our results with a similar study on landscape ecology  
147 in ER, by performing the same research area assessment for 52 of the 54 studies screened by  
148 Leite et al. (2013) and provided in their supplementary material (2 studies were not indexed in  
149 the database). We acknowledge methodological differences between our study and that from  
150 Leite et al. (2013), but this comparison was restricted to broad categories and with percentages.  
151 The two studies not indexed in the database were probably captured from the Scopus database  
152 they also assessed, which we considered too low and uninfluential to general focal patterns.  
153 Venn diagrams were made using the R package "eulerr" (Larsson, 2020).

### 154 **3. Results and discussion**

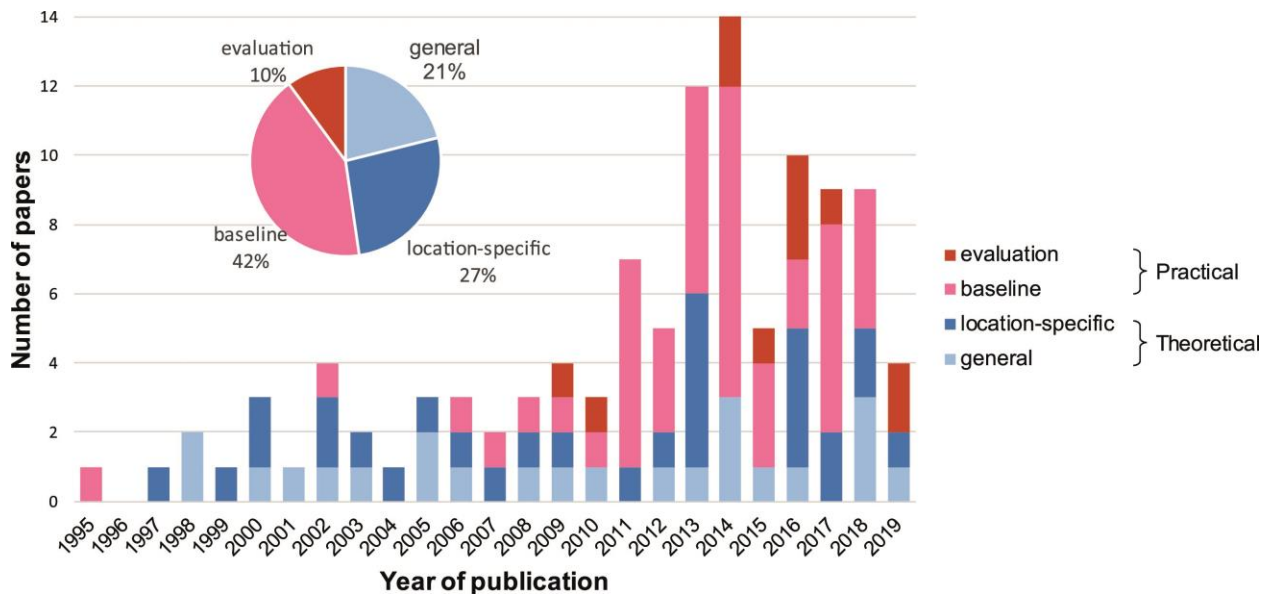
#### 155 *3.1. Bibliometric overview*

156 We reviewed 109 studies published from 1995 to 2019. It represents much less  
157 publications than other subjects related to ecological restoration, such as restoration success  
158 (Wortley et al., 2013) and restoration of ecosystem functions (Kollmann et al., 2016), but, when  
159 comparing the same time span, it is a number of publications similar to that found by Leite et al.  
160 (2013) looking at links between landscape ecology in ER. The limited number of publications  
161 retrieved on CL-ER may be either a sign that CL-ER is being reported using other terms (e.g.,  
162 socioecological systems, socioecological production landscapes, and semi-natural landscapes) or  
163 that it has not reached the scientific arena. Many restoration projects do not highlight links  
164 between environmental objectives and patterns of traditional resource use (economic or  
165 utilitarian benefits) (Wehi and Lord, 2017), and those that do highlight these links often fail to  
166 present their results as scientific outputs. While we did not assess the grey literature and  
167 acknowledge that this would have yielded more publications and reports, we believe that our  
168 review is still representative as we retrieved all the publications found on the subject. We found  
169 studies in 30 countries, compared, for instance, to the 9 and 49 countries covered in peer-  
170 reviewed papers and grey literature, respectively, found by Reed et al. (2017) for integrated  
171 landscape approaches.

#### 172 *3.2. Type of research and aspects assessed*

173 Theoretical (48%) and practical papers (52%) were rather balanced (Fig. 1). This suggests  
174 that CL-ER is being addressed based not only on opinions but also on practical evidence  
175 obtained from data collection, modelling and assessment of stakeholders' opinions. Theoretical  
176 studies approach the topic in different ways, ranging from merely briefly mentioning the  
177 importance of considering cultural aspects in ER, to more in-depth analysis of the importance of  
178 CL-ER research and application (Kueffer and Kaiser-Bunbury, 2014; Naveh, 2009, 2005, 1998;  
179 Pfadenhauer, 2001; Weinstein, 2008). Yet a central theoretical study, in which the authors  
180 contrast ER focused on ecosystems and on CLs and propose ways of applying ER principles to  
181 CLs, is not included since it was published in a non-indexed journal (Moreira et al., 2006).  
182 However, we were able to capture another study of this kind, which compares the literature on  
183 CLs and ecosystem services and stresses the importance of linking them (Schaich et al., 2010).

184 They advocate taking cultural services into account, and this is followed in several studies which  
 185 either strengthen this recommendation (Collier, 2014; Guo et al., 2016; Rey-Benayas and  
 186 Bullock, 2012; Schirpke et al., 2016) or quantify cultural services to guide future restoration  
 187 efforts (Barbedo et al., 2014; van Berkel and Verburg, 2014). Still, there are fewer theoretical  
 188 studies with a general scope (the present study would fit this category) than location-specific  
 189 ones, suggesting that research is directed more toward specific local or regional issues in CL-ER.  
 190



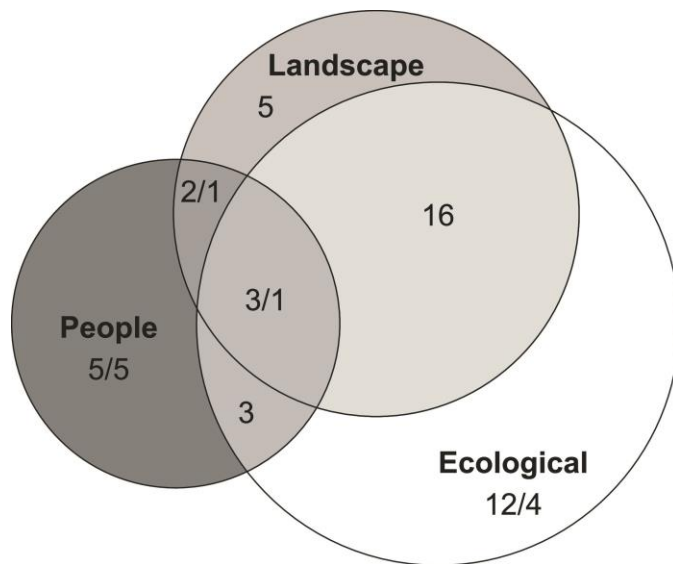
191  
 192 Fig. 1. Number of papers per year linking cultural landscapes and ecological restoration  
 193 (N=109), grouped by type of research into theoretical or practical, and by scope into general  
 194 (applicable to a broad range of situations) or location-specific (applicable to a specific site or  
 195 region) as well as into baseline (seeking a baseline or baseline elements that could contribute to  
 196 future restoration actions) or evaluation (assessing the outcome of restoration actions already  
 197 performed). Total percentages for the different paper categories are shown in the pie upper left.

198  
 199 We examined the practical studies in more detail to identify the aspects actually being  
 200 assessed in CL-ER research. We found widespread assessment of ecological aspects, consistent  
 201 with what is reported by studies on the evaluation of restoration success (Aronson et al., 2010;  
 202 Ruiz-Jaen and Aide, 2005; Wortley et al., 2013). Examples include diversity of plants (Osland et  
 203 al., 2011) and insects (García-Tejero et al., 2013; Verdasca et al., 2012), vegetation dynamics  
 204 through pollen and charcoal records (Pellatt and Gedalof, 2014) and topsoil characteristics  
 205 (García-Tejero et al., 2013). Aspects related to landscapes (e.g., landscape scenarios and



206 connectivity, and land-use history) and people’s perceptions (e.g., general perceptions and  
 207 preferences about ER) are also well represented (Fig. 2). Several studies develop landscape  
 208 scenarios for future restoration (Barbedo et al., 2014; Hainz-Renetzeder et al., 2015) and also  
 209 describe landscape history (Pellatt and Gedalof, 2014; van Mourik et al., 2012) to provide  
 210 baselines for CL restoration. Historical landscapes are investigated through aerial photography  
 211 combined with local knowledge (Rescia et al., 2008), and additionally evaluated through  
 212 people’s perceptions of past social changes together with biodiversity and land-use changes  
 213 (Beilin et al., 2014). Preferences on landscape scenarios are also evaluated, for instance in Swiss  
 214 mountain areas (Soliva and Hunziker, 2009). However, we found less frequent reporting of a  
 215 combined CL-ER approach to assessing the outcome of restoration actions (N=11; although it  
 216 might be happening “on the ground”, see Wehi & Lord 2017). Interestingly, an example of a  
 217 study of this kind encompasses various research categories, assessing people’s perceptions and  
 218 preferences regarding a floodplain restoration project and finding that restoration of historic  
 219 landscapes is perceived positively (Schaich, 2009).

220



221

222 Fig. 2. Venn diagram of the aspects assessed by practical studies (N=57). Numbers before the  
 223 slash or alone indicate the number of baseline studies (seeking a baseline or baseline elements  
 224 that could contribute to future restoration actions); numbers after the slash indicate the number of  
 225 studies on evaluation of restoration actions (assessing the outcome of restoration actions already  
 226 performed).

227

### 228 3.3. Trends in geographical distribution

229 Although the papers report studies performed on all long-term inhabited continents (thus  
230 excluding Antarctica), in 30 countries and three zones (Mediterranean, temperate and boreal  
231 forests, and temperate zone) we found that 65% of the studies were from Europe and North  
232 America (Fig. A.1; Table A.3, Appendix A). This appears to be a general pattern in ER research,  
233 as reported several times by literature reviews on ER (e.g., Kollmann et al., 2016; Wortley et al.,  
234 2013). It is not surprising that 50% of the studies are based in Europe, as the concept of cultural  
235 landscapes emerged there (Kirchhoff et al., 2012), so we expected to find more Europe-related  
236 research and practice in CL-ER. However, only one paper was found for France, where we know  
237 such projects have taken place or are on-going (Liron, 2018). In addition to the literature search  
238 limitations described above, an explanation may be that CLs are often not mentioned because  
239 they are considered inherent to the European context, in line with the more holistic European  
240 view of the landscape concept. This might have reflected upon the clear difference in numbers of  
241 papers for the two types of research being only observed for Europe, where there has been twice  
242 as much practical research (Table A.3, Appendix A). This could be interpreted as an effect of the  
243 implementation of the European Landscape Convention, signed in 2000 and implemented in  
244 2004 (Déjeant-Pons, 2006), which almost coincides with the increase in practical studies since  
245 2006 (Fig. 1). Trends in CL-ER research in Europe and elsewhere are discussed in more detail  
246 below (section 4.2). Yet regions such as the Biancane badlands in Italy (Marignani et al., 2008;  
247 Torri et al., 2013) and the Stubai Valley in Austria (Fondevilla et al., 2016; Schirpke et al., 2016)  
248 are the focus of two studies each.

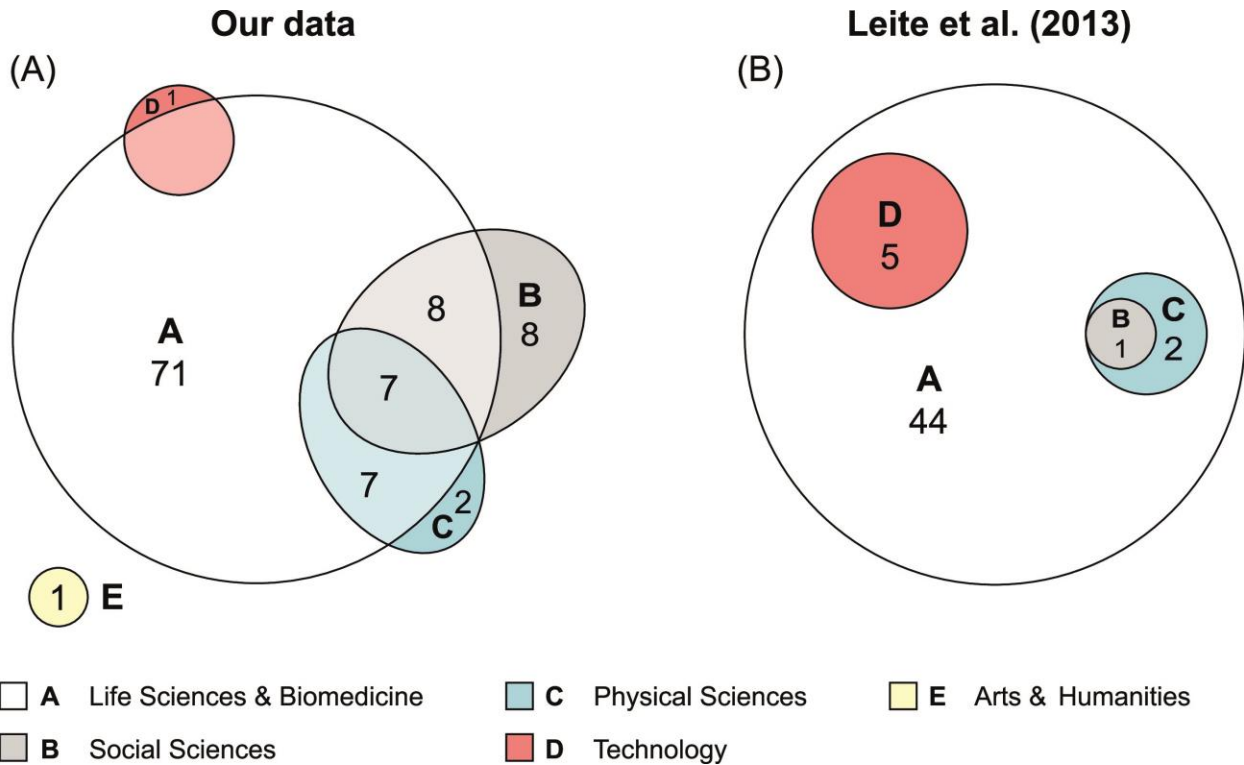
249 A good number of papers addressing CLs are from North America (16% of the studies),  
250 which is strange given that the SER Primer (SER, 2004) states “the North American focus on  
251 restoring pristine landscapes makes little or no sense in places like Europe where cultural  
252 landscapes are the norm”. However, cultural landscape preservation has been one of the US  
253 National Park Service missions for decades (Page, 2009) and indigenous peoples have embraced  
254 restoration challenges (Higgs, 2003; Martinez, 2003). Indeed, in North America as in most  
255 places in the world, native peoples have shaped the landscapes (e.g., Keeley, 2002; Vale, 2002).  
256 This mismatch frames a recent discussion over whether there is a “nature-culture  
257 dichotomization” (Evans and Davis, 2018) or a nexus (McDonald et al., 2019) in SER  
258 documents referring to cultural ecosystems and landscapes.

259 Additionally, representability of papers on CL-ER for continents such as Africa and Latin  
260 America, where large-scale restoration projects are being implemented, is strikingly low: for  
261 example, Brazil (Brazil's Atlantic Forest Restoration Pact, PRMA, 2016; and Rodrigues et al.,  
262 2011) is represented by only one study (Barbedo et al., 2014). We did not find any studies  
263 mentioning South Africa (Working for Water programs) or Rwanda (Forest & Landscape  
264 Restoration program) (Aronson and Alexander, 2013). Interestingly, all but one (Velázquez-  
265 Rosas et al., 2018) of the papers from Africa and Latin America involve a North American or a  
266 European researcher (based on institution affiliation). This is further discussed in section 4.2.

### 267 *3.4. Comparing research on cultural landscapes and landscape ecology*

268 We found that 2/3 of the studies (71 studies) fall exclusively into the broad category of  
269 life sciences (Fig. 3), the majority concerning ecology (Table A.2, Appendix A). Twenty-one  
270 percent (21% or 23 studies) of the studies fall into the social sciences category solely or in  
271 combination with other categories. Several studies fall exclusively into one of the other  
272 categories (one study solely in arts & humanities, Fig. 3). These proportions differ somewhat  
273 from the findings of Leite et al. (2013) in their review on the landscape ecology perspective in  
274 ER, where the distribution among research areas (Table A.2, Appendix A) is even more skewed  
275 towards life sciences (44 studies or 85% of the studies exclusively in life sciences), particularly  
276 ecology, with only one study concerning the social sciences (Fig. 3, Table A.2, Appendix A).  
277 Moreover, 26 of our CL-ER studies (24%) encompass two to three broad research categories,  
278 contrasting with only eight (15%) such studies found in the Leite et al. (2013) landscape ecology  
279 in ER review (Fig. 3). In our review, one set of papers stood out by encompassing three or more  
280 broad research categories, and these papers contained unusual features. For instance, the research  
281 included within an ER approach subjects like changes at the landscape level (Pelorosso et al.,  
282 2011), sometimes associated with diversified parameters for ER planning (Marignani et al.,  
283 2008; Meurk and Swaffield, 2000) or social-ecological systems (Rescia et al., 2008), and  
284 perceptions by local residents (Schaich, 2009). On the other hand, the sole study common to both  
285 our review and the Leite et al. review is classified under the Environmental Sciences & Ecology  
286 research category (i.e. Life Sciences broad category) and explores management techniques,  
287 including one traditional technique ("fangueo") used in this case to enhance biodiversity (Osland  
288 et al., 2011).

289



290

291 Fig. 3. Venn diagrams of research areas in broad categories for (A) 109 papers from the present  
 292 literature survey on cultural landscapes and ecological restoration, and (B) 52 papers from a  
 293 literature review on the landscape ecology perspective in ecological restoration (Leite et al.,  
 294 2013). Numbers indicate the number of studies in each broad category or their combinations.  
 295 Papers fitting in more than one research area in the same broad category were counted as a single  
 296 record.

297

298 Regarding journal of publication, 43% were published in 12 journals (three or more  
 299 papers) out of a total of 66 journals (Table A.4, Appendix A). Although our review differs from  
 300 that of Leite et al (2013) in total number of papers (109 vs. 54), CL-ER research clearly appears  
 301 to be more evenly represented over a range of journals. This points to a broader disciplinary  
 302 scope for research on CL-ER compared with landscape ecology in ER (Fig. 3).

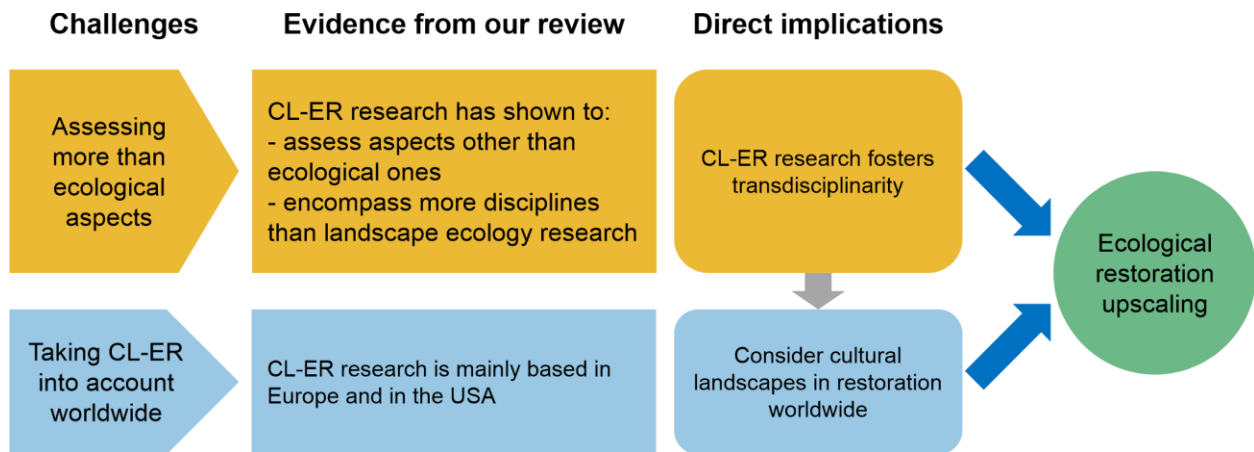
303

#### 304 4. Implications for ecological restoration upscaling

305 Since CLs are landscapes characterized by a social influence in their creation and  
 306 maintenance, stakeholders play an important role in the achievement of restoration outcomes.

307 Landscape restoration relies on the collective engagement of multiple stakeholders (Jellinek et  
 308 al., 2019), through CL-ER as we propose here, with the ultimate aim of scaling up restoration so  
 309 that it shifts from single isolated to multiple concerted initiatives (Fig. 4). Our literature survey  
 310 afforded a comprehensive overview of how CL-ER research has been performed, and we now  
 311 point to the main challenges for the restoration of CLs and landscapes in general (Fig. 4): (1)  
 312 building a transdisciplinary approach, especially to balance the overemphasis on ecological  
 313 aspects; and, for major world regions, (2) coping with competing interests regarding land use,  
 314 with unstable political contexts, and with low stakeholder engagement.

315



316

317 Fig. 4. Overview of challenges, evidence from our review, and direct implications to ecological  
 318 restoration upscaling gathered from considering cultural landscapes in ecological restoration  
 319 (CL-ER). Yellow forms correspond to challenges related to assessing more than ecological  
 320 aspects; Blue forms correspond to challenges related to where CL-ER is being considered.  
 321 Potential benefits from fostering transdisciplinarity through CL-ER research could imply that it  
 322 is worth considering cultural landscapes in restoration worldwide.

323

324 *4.1. Towards transdisciplinarity*

325 ER has strong ecological foundations, which is fairly reasonable in view of its definition  
 326 (SER, 2004). Yet much more is being demanded from the discipline, and it can no longer remain  
 327 restricted to ecology with a strong focus on natural capital (Fig. 4). Ecology needs to be  
 328 integrated with other disciplines to support the quest for sustainability, as repeatedly suggested  
 329 (Aronson and Van Andel, 2012; Jellinek et al., 2019; Naveh, 2005). Landscape restoration  
 330 clearly requires transdisciplinarity, even regarding the conceptual basis of both landscape (Wu

331 and Hobbs, 2007) and restoration ecology (Andel and Aronson, 2012). This applies even more to  
332 CLs and their long-term mechanisms based on inter-relationships between natural, cultural and  
333 economic capitals. In fact, we found that the representability of research areas is less biased  
334 towards life sciences when research is focused on CL-ER (as in our study) than on landscape  
335 ecology in ER (as in Leite et al., 2013) (Fig. 3). For instance, the establishment of reserves can  
336 generate conflicts that could be attenuated if integrative and more holistic approaches were  
337 implemented, as suggested for a Norwegian case (Daugstad et al., 2006). In another example,  
338 one study evaluating ER actions in a floodplain restoration project in Luxembourg and  
339 presenting results on people's perceptions comprises five research areas: Environmental Sciences  
340 & Ecology; Geography; Physical Geography; Public Administration; Urban Studies (Schaich,  
341 2009). Being transdisciplinary allows different perspectives to be combined in a manner likely to  
342 enhance ER upscaling.

343 Ideally, landscape restoration goes beyond ecological aspects, i.e. biotic and abiotic  
344 factors related to ecosystem functioning (e.g., Holl, 2017; Macdonald and King, 2018), because  
345 it involves stakeholders with competing interests regarding land use and different degrees of  
346 engagement. Therefore a concerted effort on their part is required when scaling up ER.  
347 Moreover, cultural aspects are essentially integrated into stakeholder engagement and landscape  
348 approaches through the recognition of traditional practices, often embodied within concepts  
349 related to CLs, such as cultural ecosystems (e.g., Evans and Davis, 2018), cultural practices (e.g.,  
350 Wehi and Lord, 2017), or cultural ecosystem services (e.g., Plieninger et al., 2015). CL-ER  
351 research tackles this through the assessment of people's perceptions and landscape features (Fig.  
352 2), which implies in contributing more towards transdisciplinarity and, ultimately, to ER  
353 upscaling (Fig. 4). Interestingly, of the 57 studies evaluated for three categories of assessed  
354 aspects (i.e. ecological, landscape, people), only 16 (28%) are restricted to ecological aspects,  
355 while more than half (N=31, 54%) assess a combination of aspects from two or even from all of  
356 our three categories. One study stands out, assessing aspects within all three categories and  
357 performed in three countries: Portugal, Sweden and Australia (Beilin et al., 2014). The authors  
358 assessed plant species diversity (ecology), historical changes in land cover (landscape) and  
359 farmers' perspectives on landscape, land use or abandonment, and their current and future  
360 activities (people). They found that the drivers of agricultural land abandonment (viewed as an  
361 opportunity for ER) in the study areas are related to social and historical contexts.

362 *4.2. Towards a more realistic consideration of historical land use outside Europe*

363 Ambitious restoration aims have been established worldwide, and for regions facing  
364 important issues such as unstable political and socioeconomic contexts, sometimes directly  
365 related to ER (Ceccon et al., 2015; Fernández-Manjarrés et al., 2018), as well as conflict of  
366 interests regarding land use. For instance, there are regional agreements for Africa (AFR100)  
367 (WRI, 2019). However, we found only two CL-ER studies in Africa and only one fits our  
368 category of practical studies (Fig. A.1, Table A.3, Appendix A). This is not surprising: the  
369 general trend is for ER research to be biased towards northern countries (e.g., Kollmann et al.,  
370 2016; Wortley et al., 2013). Yet the lack of research where it is needed most is an important  
371 issue that should be seriously addressed, as already recommended for conservation (Wilson et  
372 al., 2016).

373 In Europe, there are well-established continent-wide regulations and directives, such as  
374 the European Landscape Convention and the Habitats Directive (European Commission, 2017;  
375 Ockendon et al., 2018), which consider CLs. Moreover, Natura 2000, the European ecological  
376 network of protected areas and a pillar of the EU's Biodiversity Strategy, highlights and  
377 enhances the links between cultural and natural heritage (European Commission, 2017).  
378 However, this is not common in other parts of the world, with the exception of the United States  
379 (Page, 2009). Native Americans and indigenous people worldwide have managed landscapes  
380 through traditional practices implemented over millennia (e.g., Martinez, 2003). Thus, it is  
381 reasonable that cultural capital (i.e. CL) should be taken into account in regions where such long-  
382 term social mechanisms still operate, acknowledging that such consideration is not specific to  
383 Europe (Fig. 4). For instance, recent studies on the Chilean Espinal call for consideration of CLs  
384 in ER, after concluding that reinstating the traditional silvopastoral system is likely to yield  
385 conservation benefits for that cultural landscape (Root-Bernstein et al., 2017; Root-Bernstein and  
386 Jaksic, 2013), especially if combined with an affirmative image of this landscape as a cultural  
387 landscape (Root-Bernstein, 2012).

388 We should also bear in mind those situations where a minimum essential standard of  
389 living needs to be restored (Fernández-Manjarrés et al., 2018). The Primer on Ecological  
390 Restoration (SER, 2004), states that for many regions in Africa, Asia and Latin America  
391 “ecological restoration is untenable unless it manifestly bolsters the ecological base for human

392 survival.” For such regions, approaches centered on ecosystem-services (e.g., focused on carbon  
393 and invasive species control) should be applied with caution, since they can often be  
394 disconnected from local social issues. Integrative approaches such as CL-ER can be preferable,  
395 offering trade-offs between sociocultural and ecological needs. This is illustrated by a case study  
396 on the control of coconut trees in the Indian Ocean archipelago of Chagos, where a compromise  
397 between removal and management of coconut trees was proposed as the most conciliatory option  
398 for conservationists and Chagossians (Jeffery, 2014). In tropical countries, taking CLs into  
399 account could thus contribute to a wider perspective in ER, allying landscape and cultural  
400 approaches. A more limited perspective not taking CLs into account could otherwise result in  
401 conflicts and reduced chances of ER sustainability, which could undermine upscaling efforts.

402

## 403 **5. Conclusions**

404 We reviewed the literature on how CLs are given consideration in ER research and  
405 explored two possible implications for taking CLs into account in ER to scaling up restoration.  
406 First, CL-ER research shows signs of expanding towards a somewhat wider range of disciplines,  
407 which amounts to a move towards transdisciplinarity. This is aligned with the recurrent call for a  
408 more holistic approach in ER, and in particular for consideration of aspects other than the purely  
409 ecological, aimed at restoration upscaling for multiple-use landscapes under long-term cultural  
410 influence. Second, scant consideration has been given to historical land use in regions with less  
411 scientific coverage, where there is often an assumption of fewer local cultural influences.  
412 Transcending traditional perspectives in historical land use could enhance restoration upscaling,  
413 through trade-offs between dynamism, local needs and heritage. This is of particular interest for  
414 tropical regions, usually characterized by unstable contexts (social, economic and political) while  
415 at the same time often the focus of international agreements on restoration with ambitious  
416 targets.

417

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425

## 426 **Appendix A.**

427 Supporting information Supplementary data associated with this article can be found in the  
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