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Fifteen years of research on payments for ecosystem services (PES) : piercing the bubble of success as defined by a Northern-driven agenda

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1 **Fifteen years of research on Payments for Ecosystem Services (PES): Piercing the**
2 **bubble of success as defined by a Northern-driven agenda**

3 **ABSTRACT**

4
5 Payments for ecosystem services (PES) have gained widespread prominence as a flagship
6 solution for ecological challenges and attracts multi-billion-dollar annual investments. This
7 large-scale meta-analysis analyzes the epistemic, methodological, and ethical-political
8 assumptions of over 1,000 peer-reviewed articles on PES from 2005 to 2019. Results highlight
9 that effectiveness of PES outcomes, design of PES policy, and market-based valuation of
10 ecosystem services serve as predominant thematic focus areas for research. Considerations
11 such as gender equality, power asymmetries, and the recognition of multiple relational values
12 around human-nature interactions in PES, have received much less attention. Despite
13 research recommendations from the literature emphasizing the need for greater social
14 contextualization in future PES research, much of the literature remains decontextualized from
15 political histories of the territory shaping local social and ecological relations. Results also
16 demonstrate a clear presence of Global North institutions dominating where the scientific
17 expertise on PES is assembled (representing 73% of studies), while 81% of studies collect
18 their empirical data in the Global South. This asymmetry in where knowledge gets generated
19 is mirrored by methodological homogeneity that risks reproducing a colonial bias of remote
20 expertise. The analysis also demonstrates the extent to which PES gets hyped as a proposed
21 solution to ecological challenges often without any credible evidence. Decontextualized
22 speculation around success, research that ‘helicopters’ into locations to introduce and make
23 PES fit for purpose, and the highly asymmetrical control of the PES research agenda between
24 Global North and South risks worsening social and ecological crises on the ground.

25 **1. Introduction**

26 In the past two decades and in the face of unprecedented ecological breakdown, global
27 conservation policies have increasingly turned to the use of financial incentives to encourage
28 ecologically beneficial land-use practices (Kaiser et al., 2021). These include maintaining
29 forested land in agricultural areas for groundwater recharge and to prevent soil erosion and
30 water contamination, conserving habitats for biodiversity and for pollinators, and planting trees
31 to sequester carbon (Waylen & Martin-Ortega, 2018). While there exists variation in the form
32 and geographical scope of conservation initiatives, there is an increasing trend to mainstream
33 nature conservation around a common science-policy nexus predicated on optimizing
34 strategies to ‘pay for nature’s services’ (Börner et al., 2017; Naeem et al., 2015). Within this
35 nexus, much effort in global environmental governance is being directed to map, measure and
36 predict flows of ecological goods and services through the support of multilateral international
37 initiatives like the Intergovernmental Panel on Biodiversity and Ecosystem Services (IPBES),
38 Reducing Emissions from Deforestation and Forest Degradation (REDD+), and international
39 carbon markets (Chan et al., 2017). The result of these efforts has been the consolidation of
40 a unifying paradigm that describes nature as providing services to humanity (e.g. Costanza et
41 al., 2017, p. 5), and in doing so, risks instilling an economistic logic that facilitates an aspiration
42 towards market creation (Milne & Adams, 2012).

43 In a world where few can deny that ‘money talks’, the lure of monetary transactions through
44 incentives for conservation is both socially normalized and understood as a pragmatic means
45 to achieve conservation gains. This makes financial transactions for ecosystem services and
46 ‘nature-based solutions’ both conceptually attractive and palatable to policy-makers,
47 conservation practitioners, the private sector and the public in general. While this framing has
48 generated new alliances among different stakeholders for conservation, it also risks sidelining
49 incompatible and incommensurable worldviews that define human-nature relationships in
50 fundamentally different ways (Barnaud & Antona, 2014). By framing nature as a service
51 provider, there is an implicit expectation that the economic potential of nature must be proven
52 to justify investment for its conservation (e.g. Dempsey, 2016).

53 Payments for ecosystem or environmental services (PES) has gained widespread prominence
54 as a flagship example of this economistic conservation paradigm (Bishop & Hill, 2014) The
55 overwhelming emphasis of PES is the prioritization of efficient transactions in exchanging
56 financial payments conditional to nature protection and to facilitate “greener” livelihood
57 transitions. As of 2018, the popularity of PES has translated into over 550 active programmes
58 known to operate globally at local, regional, and national levels and with an estimated US\$
59 36-42 billion in annual transactions (Salzman et al., 2018), largely through public sector
60 financing and private investments from the Global North and China (UNEP et al., 2021).

61
62 There have been several meta-analyses that have assessed PES outcomes over time, across
63 regions, or focusing on specific themes. Most of these studies examine particular aspects of
64 PES institutional design (Ezzine-de-Blas et al., 2016; Raes et al., 2016; Schomers & Matzdorf,
65 2013), the additionality of attained ecosystem goods and services of interest through project
66 implementation (Börner et al., 2017; Grima et al., 2016; Prager et al., 2016; Wunder et al.,
67 2018) or the distribution of costs, benefits, and livelihood impacts (Liu & Kontoleon, 2018;
68 Martin-Ortega et al., 2019). These studies largely revolve around PES design principles that
69 include criteria of interest such as contract length, spatial and temporal targeting of payments,
70 appropriate payment vehicles, and policy frameworks that enhance the permanence of
71 financial flows.

72
73 By over-emphasizing design principles, what goes missing in these large-scale studies is the
74 underlying *value frameworks* that shape the politics of knowledge production, informing how
75 and by whom PES “success” is defined and whether these programmes are fit for purpose
76 within specific contexts in the first place. We understand value frameworks as shared sets of
77 assumptions shaping what counts as legitimate knowledge (epistemological assumptions),
78 how such knowledge gets produced (methodological-conceptual assumptions), and how and
79 for what purpose such knowledge is deployed (ethical-political assumptions) (Bromley, 2012).
80 While PES operates within an arena where multiple value frameworks overlap or co-exist and
81 are in constant dialogue or opposition (e.g. Himes & Muraca, 2018; Ishihara et al., 2017), no
82 previous analysis of PES research has comprehensively examined the plurality of
83 epistemologies and methods applied in the process of doing PES research. Furthermore, no
84 previous large-scale analysis has categorized how research on PES engages with political,
85 cultural, and economic histories of particular territories in order to socially legitimize how
86 successful outcomes are framed and understood. There remains a lack of reflexivity in PES
87 research on how adopted value frameworks actively influence and are themselves influenced
88 by research objectives, methodologies, and recommendations of both these programmes and
89 other conservation approaches. This lack of reflexivity begins by understanding the authors’

90 own positionality within the research process. Furthermore, comprehensive analyses on how
91 recommendations or outcomes emerging from the scientific literature on PES has informed
92 subsequent research over time has received very little attention¹. Without such analysis,
93 policies risk becoming socially misaligned, reinforcing power asymmetries that further
94 aggravate environmental and social injustices (Hausknost et al., 2017; Rodríguez de
95 Francisco et al., 2013).

96

97 Our analysis aims to address these gaps in two important ways. Firstly, we examine the extent
98 to which the literature raises concerns about social context and inequality and whether
99 subsequent research responds to these concerns over time or continues to focus on designing
100 and evaluating PES with regards to efficiency and conditional (market-like) transactions
101 criteria, irrespective of context. Secondly, we consider justice concerns in PES as being
102 inherent to the research process itself as well as the consequences of using socially-
103 constructed concepts like ecosystem services (e.g. Barnaud & Antona, 2014; Hausknost et
104 al., 2017) that reduce a myriad of intersubjective relationships² between humans and non-
105 humans to a distinctly Euro-descendent value frame in which non-human nature is viewed
106 only as service provider for human beings (Martin et al., 2016). Quijano (2007), for instance,
107 argues how social constructions as products of Euro-centered colonial domination of human-
108 nature relations, assume objective and even scientific credo, erasing their contingent historical
109 formation and hence ongoing exercise of power. The question remains as to whether PES
110 researchers engage with the history of power in the core concepts they are investigating or
111 rather treat them as natural phenomena.³

112

113 We therefore extend previous research by analyzing how the poor attention to social, political,
114 and cultural contexts revealing uneven impacts of PES programmes may be related to *who*
115 carries out PES research, the authors' research aims and methods used, and their relational
116 proximity to the socio-cultural and political context where PES is being applied on the ground.
117 Put differently, we explore the extent to which PES research is premised upon ensuring the
118 social legitimacy of programmes or whether it serves to perfect programmes as externally-
119 imposed blueprints that intend to achieve ecological, economic, or social effectiveness and
120 efficiency goals in isolation from social context.

121

122 In order to better ground our analysis on the extent to which PES accounts for multiple
123 knowledges and diverse value frameworks, we build off the principles for knowledge co-

¹Some of the exceptions include Blundo-Canto et al. (2018) who analyze 46 PES research articles for the livelihood consequences of these programmes. They find that livelihood impacts disproportionately focus on impact affects while tending to ignore social and cultural impacts of land-users' connection to territory as well as trade-offs between livelihood opportunities and inequality. Jones et al. (2020) attend to the multiple values influencing engagement in PES programmes through a sample of 78 research articles. They highlight how participation in PES is influenced by *a priori* access to various capital assets and thus risks reinforcing existing social and political inequalities between PES participants and non-participants.

²Anishnaabe and Haudenosaunee scholar Vanessa Watts, for instance, describes Indigenous understandings of Place-Thought, in which human beings are extensions of a living, breathing, and thinking land, where human thought can never be separated from place, and where humans and non-humans derive agency (Watts, 2013). Such cosmologies are incommensurable to a utilitarian framing of ES (and much less PES).

³We recognize that in analyzing PES research, we are examining an already narrow ontological worldview associated with adopting the ecosystem service framework, further narrowed as PES transactions. However, our intention is to understand how PES researchers are attentive to historicity, place, power relations, cultural context, and/or their own positionality or role in the research process. In doing so, we show how justice and equity demands for PES begins with the research process, particularly in the ways researchers acknowledge and engage with situated incommensurability in human-nature value frameworks (Martin et al., 2016).

124 production in sustainability research as elucidated by Norström et al. (2020).⁴ These authors
125 identified a set of four general principles for high-quality knowledge co-production informed by
126 diverse value frameworks suitable for sustainability: being *context-based* to a particular place;
127 being *pluralistic* in recognizing multiple ways of knowing and doing; articulating *clearly defined-*
128 *goals* and being *interactive* to encourage adaptive learning. Identifying “deeper leverage
129 points for transformational change”, they argue, requires rethinking how knowledge is created
130 and much closer attention to contested values, politics, and power (p.188). Doing so obliges
131 greater reflexivity on the part of researchers as well as open and deliberative fora to address
132 values and politics in knowledge generation.

133

134 To assess plurality of value frameworks in PES, we assembled what we call the
135 “ePEStemology” database, comprised of PES peer-reviewed scientific articles published up
136 to the end of the year 2019. Through this database, we analyze how trends have altered both
137 geographically and temporally in terms of PES research objectives and thematic focus,
138 methodologies, recommendations and points of concern of researchers designing and
139 analyzing PES projects. Our results demonstrate the uneven way in which primarily US and
140 European institutions perpetuate a dominant value framework premised on a utilitarian
141 approach to thinking about human-nature relations in the assemblage of knowledge on PES
142 conceptualization, agenda setting and evaluation. We further demonstrate how PES is largely
143 a Global North-driven self-fulfilling hype over the time period examined, encouraging
144 investment in the tool as an environmental solution and raising serious concerns about how
145 and by whom success gets defined and how ecological problems are defined and rationalized.
146 In the next section, we briefly describe our methodology, followed by selected results from the
147 database in line with our research objectives in section 3. In section 4, we discuss how and
148 why the apolitical stance of most PES research is itself a political choice and the implications
149 of this choice for both social justice and ecological change. A conclusion is then provided in
150 section 5.

151

152 **2. Methodology**

153 **2.1. Dataset selection**

154 The “ePEStemology” database is populated by International Scientific Indexed (ISI) peer-
155 reviewed journal articles. It includes Anglophone articles in Scopus and Web of Science
156 (WoS), using all of the search terms “Payments for Ecosystem Services”, “Payment for
157 Ecosystem Services”, “Payment for Environmental Service”, or “Payments for Environmental
158 Services” either in the title, abstract, or key words of queried articles. The initial search query
159 (October, 2020) resulted in a total of 1,439 ISI-peer reviewed research articles for the dates

⁴As Norström et al. (2020) articulate, knowledge co-production refers to the involvement of non-academic actors in knowledge generation and research activities; it is “context-driven, problem-focused and require[s] the engagement of multiple disciplines” (p.183) through participatory, interactive and transdisciplinary research approaches. It also explicitly addresses power asymmetries in terms of how certain types of knowledge predominate over others.

160 ranging from 2005 to 2019^{5,6}. We took the year 2005 as the starting point for published
161 research on PES, following the Millennium Ecosystem Assessment (Millennium Ecosystem
162 Assessment, 2005) of the same year as well as an initial seminal publication on the subject
163 (Wunder, 2005).

164 [FIGURE 1 ABOUT HERE]

165 Following the different steps prescribed by the Preferred Reporting Items for Systematic
166 reviews and Meta-Analysis (PRISMA) protocol (Moher et al., 2009) (Figure 1), we narrowed
167 this number down to a total of 1,067 published articles between 2005 and 2019. Articles were
168 excluded if they were produced in a language other than English⁷ or if they were book
169 chapters, books, conference papers, reviews, or webpages⁸. While recognizing the caveats of
170 excluding research articles in other languages and the loss of knowledge claims this implies,
171 as well as in other media (e.g. as books or conference papers), we justify our approach in
172 order to ensure consistency and comparability of the body of peer-reviewed research
173 literature.

174 In addition to the language exclusions made, there are various permutations on the PES
175 terminology, including “payments for hydrological services”, “payments for watershed
176 services”, “conservation payments”, “rewards for ecosystem services”, or “agro-ecological
177 incentives”, “agri-environmental schemes” and many others that make it challenging to fully
178 account for every possibly relevant article. However, at this stage our database does not
179 explicitly and comprehensively include all these possible variations but does include many of
180 these terms to the extent that authors relate them to PES in their title, abstract or highlights.

181 **2.2. Variables selection and coding procedure**

182 The ePEStemology database explores a series of iteratively generated variables and
183 corresponding values from the literature roughly spanning over three main components across
184 time and across regional geographies: focus, process, and outcome (Table 1). The *focus*
185 component identifies the main thematic emphasis and research objectives of the PES

⁵While Börner et al (2017) note that a Google Scholar search query in 2017 revealed an average of 1,715 PES articles being published annually, our analysis accounts for only those ISI-peer reviewed articles that clearly raise the profile of PES by including it in the title, abstract, or keywords. Furthermore, the more targeted search capacities of Scopus and WoS were specifically targeted to the types of articles, language medium, and timeline of interest. We therefore believe that our query is a more accurate depiction of targeted research on PES than other assessments.

⁶It is worth noting that Scopus provided the greatest coverage of published articles on PES, accounting for 78% of the total identified. WoS accounted for 66% of the total, but also included 305 articles that did not fall within the Scopus search.

⁷While our focus was only on English-language scientific articles, to test the sensitivity of our assessment and given the predominance of PES research focus in Latin America and China, we also queried for PES articles in Spanish and Chinese using Scopus, Web of Science, and language-specific databases (i.e. cnki.net and Scielo). However, the return of peer-reviewed scientific articles in these languages was negligible (<20 for each language). Most scientific research articles on PES on these regions have been written in English and are already included in the database. The minimal presence of two of the most widely spoken languages in the world (Spanish and Chinese) within the scientific ISI-peer reviewed literature demonstrates the asymmetrical process of knowledge production in PES, as we illustrate in this paper.

⁸It should be noted that this systematic review does not account for every ISI-research article published on PES during the time period considered. Since the database search tools are continuously updated retroactively, the query date alters the number of articles retrieved in the search depending on when the search takes place, increasing them over time despite being limited to specific dates. However, even if the database gets adapted over time, we safely assume that the corpus represents a sufficiently comprehensive account of peer-reviewed published research on PES.

186 literature, as well as the researchers' institutional affiliations, the primary geographical base of
187 the research institutions, and geographical location of empirical focus (where relevant). The
188 *process* component identifies the methodological and conceptual approaches in PES research
189 and includes an assessment of whether research was informed inductively through
190 engagement with local priorities or cultural and political histories of the study site, or whether
191 it sought to deductively theoretically or empirically validate an externally canonized PES ideal
192 type.⁹ Finally, the *outcome* component reveals the primary recommendations or conclusions
193 emerging from PES literature.

194 [TABLE 1 ABOUT HERE]

195 Table 2 lists the variables of interest and corresponding values that have informed subsequent
196 coding of the PES literature database. Some of these variables will be specifically highlighted
197 in the analysis, which we illustrate in the next sections. The coding team, consisting of four
198 experienced scholars working on PES, in a first step identified and defined the relevant
199 variables and their corresponding values through a grounded theoretical open coding process
200 (Strauss & Corbin, 1990) in which they broke down, examined, compared, conceptualized, and
201 categorized the data, based on a random selection of 100 articles. This iterative process
202 determined the most relevant variables, as well as possible values for each of them.

203 Subsequently, and for over a period of 15 months, the coding team revised and coded all
204 articles based on the abstracts or full text in case the abstract did not allow to accurately code
205 some of the variables. The robustness of coding was ensured through a process of
206 investigator triangulation (Denzin, 1970), in which all articles were separately and
207 independently coded by two different team members, and subsequently cross-checked. In
208 case of any discrepancies in coding, the team jointly deliberated to arrive at a consensus.

209 [TABLE 2 ABOUT HERE]

210 The strengths of our methodology lie in the grounded theoretical approach that informed the
211 emergence of codes and subsequent quantitative analysis. The ePEStemology database
212 offers possibilities for closer engagement with the literature in highlighting features of PES
213 research themes and objectives, processes, and outcomes that might otherwise be
214 accomplished simply by relying on article keywords. We also adopt a political ecology lens in
215 claiming that underlying power structures shape and prioritize certain value frameworks of
216 human-nature relations over others in informing particular environmental policy tools like PES.
217 Recognition of these plural subjectivities requires a widening of analysis on diverse
218 interpretations of PES. To this end, our database not only considers more published cases
219 than any other meta-analysis conducted on PES so far (Börner et al., 2017; Brouwer et al.,
220 2011; Ezzine-de-Blas et al., 2016; Grima et al., 2016; Liu & Kontoleon, 2018; Martin-Ortega
221 et al., 2019; Prager et al., 2016; Raes et al., 2016; Salzman et al., 2018; Wunder et al., 2018),
222 but it also includes reflection on perceived expectations of success or hype around PES vis-
223 à-vis transparency on how PES success is defined and by whom. Lastly, the ePEStemology
224 database aims to be an open-access and living document, open for dialogue, debate, and

⁹This ideal type refers to the transfer of payments conditional to specific conditions for land-use or behavioural change on the part of the land user that encourages the protection or delivery of ecosystem services (Wunder, 2015). In the canonized model of PES, the degree of payment is determined to match or marginally surpass the opportunity cost of status quo land-use practices (Ferraro & Simpson, 2002; Wunder et al., 2008).

225 revision among scholars and practitioners interested in analyzing further patterns and
226 contradictions emerging from the scientific literature.

227

228 **3. Results**

229

230 **3.1. Growth of PES studies**

231 We began the analysis by assessing the growth in PES research articles over time. Figure 2
232 shows how the number of publications on PES has been steadily growing between 2005 and
233 2019. In focusing on the variable “Direct-indirect”, it can be seen that roughly 30% (n=320) of
234 these articles do not directly theoretically or empirically engage with PES to any extent. These
235 articles, which we have labeled ‘indirect’, only name drop PES as a potential policy solution to
236 address ecological challenges in research that is not explicitly focused on PES, referring to
237 what we describe below as a PES hype factor. Unless indicated, our analysis only includes
238 those articles that directly empirically or theoretically engage with PES (a total of 747 articles).

239 [FIGURE 2 ABOUT HERE]

240 **3.2. Overall thematic focus, recommendations, and evaluations of PES success**

241 Figure 3 illustrates how PES research thematic focus and objectives, overall
242 recommendations or concerns identified from each study and the studies’ overall evaluation
243 of PES as a potentially successful strategy to achieve its stated objectives are distributed over
244 3 time periods (2005-2009, 2010-2014, and 2015-2019). Figure 3a shows that PES
245 effectiveness of outcomes, design of the policy, and market-based valuation of ecosystem
246 services consistently remain main research focal areas (variable “Thematic Focus”), all
247 predominantly focusing on the technical aspects of implementing and improving PES.
248 Considerations such as gender equality, power asymmetries, and the recognition of multiple
249 relational values around human-nature interactions in PES programmes, have received much
250 less attention (Figure 3a), even though the predominant research recommendations (variable
251 “Recommendation”) from the literature continue to emphasize the need for greater social
252 contextualization (Figure 3b). In assessing authors’ overall evaluation of PES as a (potentially)
253 successful strategy to achieve its stated objective (variable “Author evaluation”), we notice
254 that authors tend to overemphasize the potential of PES as a solution to ecological problems,
255 while ignoring its possible detrimental social and ecological implications. Indeed, only 11% of
256 studies expressed an overall negative outlook towards PES in achieving its stated objectives,
257 while 89% has a positive outlook, albeit with some reservations (49%) (Figure 3c).

258 [FIGURE 3 ABOUT HERE]

259 **3.3. Geographical patterns in knowledge production on PES**

260 The database clearly shows asymmetrical flows in the production of knowledge, as illustrated
261 in Figure 4. This Sankey diagram shows the uneven distribution between where empirical
262 research takes place (variable “Country focus”) and where researchers conducting the PES

263 study are based (variable “Institution country”)¹⁰. It demonstrates a clear presence of Global
264 North institutions dominating where the scientific expertise on PES is assembled (representing
265 73% of studies). These values are conservative estimates since approximately 19% of studies
266 from Global South-based institutions are produced by multilateral bodies (e.g. UNEP and
267 CGIAR Centers) and are largely funded by Global-North governments. Meanwhile, 81% of all
268 empirically-focused PES studies collect data in the Global South. A closer look at this
269 distribution between different regions shows how the USA, Germany, and the UK alone
270 comprise over 46% of where PES knowledge gets generated. Latin America, on the other
271 hand, is the most preferred region to conduct research on PES, representing 37% of all
272 empirical cases. Moreover, most PES data is collected from only 7 PES “darling” countries in
273 the Global South: China, Mexico, Costa Rica, Ecuador, Indonesia, Vietnam and Kenya. Not
274 only is PES research conducted much less commonly by Global South-based institutions, but
275 when it is, it is almost entirely focused domestically or regionally. For instance, 93% of articles
276 authored by Latin American research institutions focus on Latin American contexts. A similar
277 pattern is found for Africa (93%), ‘developing’ Asia (86%), and China (98%). Meanwhile, only
278 2 articles from the Global South analyze a Northern case study, of which both are comparative
279 studies with a case study in the Global South.

280 [FIGURE 4 ABOUT HERE]

281 **3.4. Influence of citation-driven expertise on PES**

282 The top 10 most cited articles in the database follow a similar asymmetry with 8 articles
283 produced in the Global North, and the remaining two produced in multilateral organizations
284 (Table 3). This emphasizes the discursive power of citation-driven expertise reproducing
285 Northern-centered agendas on PES (Pasgaard et al., 2017), mirroring parallel asymmetries in
286 cognate disciplines such as development studies (Demeter, 2022). These uneven patterns
287 shaping where and how knowledge is assembled are characteristic of broader asymmetries
288 in value frameworks around nature conservation, in which discursive narratives, policy
289 approaches, and regimes of expertise in understanding human-nature relationships are most
290 frequently formulated in institutes located in the Global North (Chaudhury & Colla, 2021;
291 Ferdinand, 2019; Nobles et al., 2022). This relation is noteworthy especially given the fact that
292 Northern regions have historically been most responsible for draining value from the South to
293 achieve their own economic development and consumptive needs (Hickel et al., 2021). It is
294 thus particularly striking that PES research parallels such uneven relations of where
295 knowledge is obtained and where it gets accumulated. Identical concerns have recently been
296 made on what has been termed ‘helicopter science’ - when wealthy nations lead research
297 often without consideration of local priorities or without involvement of local participants
298 subjected to research interventions (Dahdouh-Guebas et al., 2003; Nature, 2022).

299 [TABLE 3 ABOUT HERE]

300 **3.5. The rhetoric of success through “helicopter science”**

301 The asymmetries in knowledge production around PES and ‘helicopter’ approaches to science
302 also manifest in the research approaches adopted (Figure 5). In terms of general methods

¹⁰We do not refer here to the authors’ nationality or personal relationship to the locations where the research take place, but to the country where the first author’s primary institution is based.

303 adopted in PES research (variable “Methodological approach”) (Figure 5a), there is a
304 predominant and growing use of quantitative approaches (including randomized control trials,
305 geospatial analyses, framed-field experiments, and contingent valuation or choice
306 experiments) to analyze PES prospects or impacts (41% of all studies). Conceptual and
307 institutional analyses (e.g. prescriptive, legal, or policy-oriented), qualitative analyses (e.g.
308 discourse analysis of interviews), and mixed methods (e.g. social multi-criteria evaluation)
309 have consistently remained a smaller fraction of overall research methods (accounting
310 respectively for 22%, 20%, and 16% of all studies). Comparing these trends to the overall
311 evaluation researchers give to PES as a potential successful strategy in achieving its intended
312 objectives (variable “Author evaluation”), Figure 5b illustrates how studies that use strictly
313 quantitative methods are more likely to give a positive evaluation of PES (57%, $\chi^2(6, n=747)$
314 $= 107.3, p < .001$). This contrasts with studies adopting qualitative approaches, in which only
315 19% offers a positive evaluation. Mixed methods and conceptual and institutional approaches
316 also have lower positive evaluations than quantitative approaches (27% and 38%
317 respectively). These findings suggest that method choice may influence the perception of PES
318 as a viable intervention for conservation. Conversely, only 4% of studies undertaking
319 quantitative methods claim that PES is unsuccessful in achieving its intended objectives; while
320 for studies undertaking qualitative methods, a considerably larger proportion (26%) had an
321 overall negative assessment.

322 [FIGURE 5 ABOUT HERE]

323 Figure 5c demonstrates the trend of how researchers engage with the context of their study
324 sites (variable “Contextual engagement”). Degree of engagement refers to the attentiveness
325 that researchers give to the myriad relationships between people, non-humans and their
326 territory both spatially (geographically) and historically. Such an approach goes beyond
327 treating ecosystem services as fetishized “objects” to be maximized or conditionally delivered
328 (Kosoy & Corbera, 2010). Meanwhile, studies “Informed by setting” explicitly consider the
329 processes and relationships that have emerged historically and as a result of a specific socio-
330 cultural arrangement or political strategy within the territory of consideration and which result
331 in particular socio-ecological configurations. “Externally-driven” studies, on the other hand,
332 depict situations when researchers enter into particular settings to collect data adopting the
333 ES and PES concepts as normalized lenses whose origins are not acknowledged (Barnaud &
334 Antona, 2014) and/or are introduced with no reference to situated circumstances, priorities or
335 local needs that reflect the cultural and political histories of the study site¹¹ (Milne et al., 2019).
336

337 Results indicate how externally-driven approaches have consistently dominated the research
338 landscape over the past 15 years. When engagement with context is compared with the overall
339 evaluation researchers give to PES (variable “Author evaluation”), Figure 5d shows that 85%
340 of research informed by local priorities, cultural, and social contexts suggests negative (29%)
341 or mixed (56%) evaluations ($\chi^2(4, n=747) = 170.6, p < .001$). Conversely, only 3% of
342 externally-driven studies conclude that PES interventions are unlikely to achieve their intended
343 objectives. The data therefore suggests that when PES research is socially-embedded and
344 grounded in the specificities of a particular context, understandings of success are
345 considerably different as compared to when studies are externally-defined *a priori*.

¹¹We should emphasize that the variable “Contextual engagement”, just as any other variable, is independently coded. Variables such as “Methodological approach”, “Institution country” or “Author evaluation” do not by themselves presuppose the type of engagement with social, cultural or political context and dynamics.

346 When these results are compared to the trends associated with the top-10 cited articles (Table
347 3), we observe a similar pattern of externally-driven research (6 articles), and positive
348 evaluations of PES success (6 articles evaluate PES positively, only 1 negatively). Moreover,
349 top-cited articles also mirror the general trends of main research focal areas and objectives
350 and recommendations from Figure 3, with 6 of the 10 articles having an initial objective to
351 improve PES design and half recommending greater economic efficiency of PES schemes.
352 With the exception of a few studies, this suggests that seminal work in directing reflections on
353 PES success tends to overlook the actual contexts from where these interventions are being
354 applied and the voices of who are being made to engage with them on the ground. When well-
355 cited research circulates success through epistemologically and methodologically uniform
356 narratives, future research risks spring-boarding off speculation or hype. Put differently, the
357 promulgation of PES resides in its *believed* success, rather than its contextual and situated
358 evidence base, while overlooking how success is defined and crucially by whom.

359 **3.6. Hying the success of PES**

360 Unsubstantiated signaling of success is not just a hypothetical situation. Figure 6a illustrates
361 how studies that propose PES as a potential solution to address ecological problems (even
362 with possible reservations) (variable “Author evaluation”) without engaging theoretically nor
363 empirically in its potential application (variable “Direct-indirect”), contributes to inflating a ‘hype’
364 around PES and in furthering the gap between expectation and reality on the ground. For
365 instance, a paper working on technical aspects of watershed management which proposes
366 PES as a solution in the conclusion or recommendation to address some of the technical
367 challenges identified, is a clear example of hying. This hype can be seen as the number of
368 indirect studies that ‘name drop’ PES and attribute positive (n=163) or mixed evaluations of it
369 (n=132), together representing 28% of the entire database, without offering any evidence to
370 substantiate these claims¹². As discussed in the next section, while hype could be mostly
371 accounted for in positive evaluations of PES research that indirectly engage with the concept,
372 we argue that the possibility of success (“mixed evaluation”), albeit with potential
373 consequences or caveats, also portends experimentation with this tool even if it may not be
374 contextually appropriate (Chambers et al., 2022).

375 [FIGURE 6 ABOUT HERE]

376 Figure 6b takes a closer look at the top hyped countries, also having the highest frequency of
377 indirect PES studies: Brazil, India, South Africa, and Spain. In these countries indirect studies
378 outnumber direct studies and give predominantly positive evaluations of them. Some
379 countries, like Botswana, Suriname, Guyana, and Sweden with only 1 or 2 published studies,
380 are entirely hyped; PES is suggested as a solution to ecological challenges, yet no direct
381 research on PES exists for them at all. The positive evaluations of PES in indirect studies
382 inflates PES as an *a priori* bonafide conservation strategy while contributing to the proliferation
383 of unsubstantiated solutions. Table 4 provides several examples to illustrate how this hype
384 unfolds.

¹²Name-dropping occurs when PES is either mentioned or incorporated into a study that has an entirely different focus (i.e. a study that does not engage with PES in any substantial way). Meanwhile, hype in PES happens when this name-dropping is related with an unsubstantiated positive or potentially positive assessment of PES (articles classified as “positive” or “mixed evaluation”).

385 [TABLE 4 ABOUT HERE]

386 **4. Discussion: The anti-politics of making PES “successful”**

387 Our analysis shows that most empirical experimenting on PES takes place in the Global South
388 and by researchers based in the Global North. This lack of diversity and asymmetrical relation
389 between where research is carried out and where it obtains its raw data reveals clear
390 hierarchies in knowledge production (Demeter, 2019). This finding is especially concerning
391 given that ecological crises have been largely driven by US and Euro-led conceptions of
392 human-nature relationships (Plumwood, 2018) as well as asymmetries in material and energy
393 appropriation that define both historic ecological degradation and ongoing ecologically
394 damaging lifestyles (Chancel, 2022; Hickel et al., 2022). When value frameworks to address
395 environmental problems become globalized as if reflecting a neutral or objective position (i.e.
396 a “view from nowhere”) and assumed to be broadly applicable and worth testing in any region
397 of the world (i.e. a “view from everywhere”) the result risks obfuscating the situated cultural
398 and political histories (i.e. “views from somewhere”) that define entire landscapes and
399 ecologies (Jasanoff, 2017, p. 3). Moreover, and as other studies have highlighted, the
400 geographic dislocation between where PES studies are conducted and where knowledge is
401 assembled exists alongside the agendas of powerful elites in PES recipient countries with
402 whom research institutions, often unwittingly, align in shaping momentum and support for a
403 universal PES agenda (Asiyanbi, 2016; Lansing et al., 2015; Nelson et al., 2020).

404 With regards to the principles of knowledge co-production for sustainability (Norström et al.,
405 2020) these findings illustrate the minimal extent to which the PES literature prioritizes context-
406 specificity or multiple ways of knowing and being, and which may deviate from an externally
407 idealized archetype. The first two principles of co-produced knowledge for complex and
408 socially-contested arenas for sustainability are thus largely overlooked when considering this
409 sample of peer-reviewed PES studies. Instead, much of the sampled research is centered on
410 expert refining or optimizing of PES interventions in terms of design and efficiency, a largely
411 technical task “to improve implementation within the bounds of a given approach” (Chambers
412 et al., 2022, p. 6).

413 Systemic or structural causes of ecological problems that embrace complex social, cultural,
414 and political realities on the ground represent only a small proportion of peer-reviewed
415 published studies. Moreover, while attention to social context and the need to embrace
416 flexibility in the face of complexity has been raised as an important recommendation in the
417 literature (Norgaard, 2010), most articles that were reviewed disregarded or enrolled aspects
418 of the social context as a technical fix through efforts such as ‘equity targeting’. This
419 contributes to the expectation that PES will *eventually* be successful if enough future research
420 is dedicated to it (Chambers et al., 2022). Debate on the inadequacies of the PES model is
421 considered only to the extent that experts can *better tweak* models to represent the concerns
422 of stakeholders. They leave little to no room for autonomous actors, otherwise subjected to
423 externally defined programmes, to collectively decide to abandon PES altogether for more
424 contextually-appropriate and socially-informed alternatives, and which may better reflect
425 territorial histories of ecological stewardship (Machen & Nost, 2021).

426 These findings are embedded within broader debates on the history of conservation
427 interventions since the colonial era (Ross, 2017), mirroring how expert-driven interventions

428 external to situated context have been introduced to fix problems generated by previous
429 rounds of external intervention. Ferguson calls the technical work of external interventions as
430 'anti-politics', referring to how proposed solutions get dropped onto populations without
431 responding to the underlying political and economic drivers of local to global environmental
432 change (Ferguson, 1994). This 'anti-politics' has also been described in relation to ecosystem
433 service policies (Myers et al., 2018; Wilshusen, 2019), as well as for climate finance (Bracking,
434 2015; Ciplet et al., 2022) and conservation interventions (Büscher, 2010).

435 Our analysis echoes some of the findings of Milne et al. (2019), who highlight how qualitative
436 evaluations of the PES-related research body yield very different outcomes than meta-
437 analyses that focus on studies with similar objectives, methods, disciplinary bias, and
438 especially strictly quantitative approaches. By considering a more interdisciplinary array of the
439 PES research body, the authors illustrate how qualitative analyses tend to depict less rosy
440 outlooks of PES than quantitative studies do. Our analysis similarly highlights how the author's
441 appreciation of PES success, and their methodological strategies are correlated (see
442 especially Figures 5b and 5d). Mixed-methods and contextually engaged, power-sensitive
443 analyses often related to more interdisciplinary perspectives may produce different evaluation
444 of PES success as demonstrated by a growing body of literature stemming from critical
445 geography and political ecology (e.g. Fletcher & Büscher, 2017; Kull et al., 2015; Matulis,
446 2017; Muniz & Cruz, 2015; Osborne, 2013; Rodríguez-de-Francisco et al., 2019). Given the
447 vast and growing sums of investment in PES over two decades, there is an urgent need to
448 take these findings seriously in future research and practice around PES.

449 Furthermore, the epistemic circulation of Northern-driven external blueprints continues to lock-
450 in a divide between Northern-based experts and perceived inert nature and people in the
451 Global South as goods and services to be extracted or subjects to be governed, respectively.
452 These trends are accentuated by the fact that scholars from the Global South have to
453 overcome structural constraints (such as conditional financing) and are expected to obtain
454 training from Northern institutions, adopt Euro-descendent intellectual frameworks to facilitate
455 publication in peer-review journals in the first place (Demeter, 2019; Kvangraven & Kesar,
456 2022). While beyond the scope of the present paper, there is a need to better understand how
457 asymmetries in knowledge production occur.

458 At the same time as value frameworks from the North are privileged and adopted the world
459 over, the political and economic drivers of ecological collapse continue to be sidelined. These
460 include industrial monoculture for commodity crops, large-scale mining, timber, and fisheries,
461 land speculation for urbanization, growing inequality in terms of resource consumption and
462 waste production, and the financialization of rent value by tapping into emotional affect,
463 aesthetics, and eco-anxiety (e.g. Andreucci et al., 2017). Meanwhile, the ecological
464 reductionism and continued colonial legacy of this overall direction in PES research requires
465 immediate attention, especially given the vast annual sums being invested in PES-related
466 interventions (Salzman et al., 2018; UNEP et al., 2021).

467 Our findings also beg the question as to whether a research agenda of endlessly optimizing
468 programmes like PES continues to make sense, without first paying closer attention to *why*
469 ecological relations are historically imbalanced and whose voices get prioritized in providing
470 solutions to historically and geographically uneven development. By asking these questions,
471 we are not suggesting that shortcomings in the PES research agenda should become new

472 opportunities to “do better” using the same value framework (Chambers et al., 2022). We are
473 neither suggesting simply redistributing research production patterns so that more PES
474 research is produced by Global South-based institutions; the dilemma is not one of a lack of
475 inclusivity among PES researchers. Global asymmetries in knowledge production can
476 continue, irrespective of a diversity of faces doing the research, if universal “one-size fits all”
477 models are blindly adopted, ill-suited to context. Revealing alternative theories connected to
478 place will aid in dismantling universalized and highly privileged utilitarian framings that have
479 been largely responsible for ecological degradation to date. At the same time, plurality in
480 knowledge claims is an important yet insufficient step to ensure recognition justice in settings
481 where PES is being applied or researched (Kvangraven & Kesar, 2022). As Indigenous thinker
482 Esme Murdock (2018) claims, sustainable and equitable reconciliation (i.e. justice) requires
483 both acknowledging that Euro-descendent values have caused and continue to generate
484 ecological violence. She further argues that restorative justice can take place through co-
485 management modalities that encourage exchange with Western framings, such as ES, and
486 encompass “non-dominative ways of relating that necessitate the discomfort of difficult
487 conversations” [and] are essential for coalition building and transcultural understanding.” (p.
488 16).

489 Reversing inequalities in knowledge production around PES requires breaking with selling
490 PES success through speculative ‘hype’ to justify further rounds of financing where it may not
491 be fit for context to begin with. Given that the scale of global ecological degradation has been
492 intensifying annually and set to worsen in the coming decades (Bradshaw et al., 2021), it is
493 imperative to avoid locking-in value frameworks that continue to treat human-nature
494 relationships strictly in terms of economic rent. There is little evidence to suggest that this
495 framing has abated environmental problems and may have indeed worsened them (Hickel et
496 al., 2022). Indeed, if the growth in PES research articles (e.g. Figure 1) was to be juxtaposed
497 with the rise in global atmospheric concentration of CO₂, as a proxy for global environmental
498 problems, we would witness a parallel growth in both over the same time period.

499 **5. Conclusion**

500 In this piece, we examined the value frameworks underlying how and by whom knowledge
501 and expertise on PES is created, sustained, and circulated by assessing a sample of the PES
502 scientific literature since its initial popularity. Our intention with the compiled database on PES
503 research is to generate debate on differing understandings of territory, human-nature relations,
504 and the historical patterns of resource extraction shaping particular ecosystems. We hope this
505 research demonstrates the importance of bringing the politics of uneven knowledge generation
506 back into the debate on conservation interventions and opens new questions on how and by
507 whom such interventions get locally legitimized and territorially embedded (or not). For
508 instance, the choice of authors to use and adopt the terminology of “PES” or to opt for
509 alternative formulations such as “rewards” or “compensations” may itself be a political decision
510 shaped by geographic and historical attention to context (Shapiro-Garza, 2013). Many PES
511 initiatives emerging in the Global South, such as China’s “*Grain for Green*” (Feng et al., 2005)
512 and Costa Rica’s and Mexico’s national PES programmes (Figueroa & Caro-Borrero, 2019;
513 Matulis, 2013) highlight the disjoint between how scientific knowledge on PES is assembled
514 and the political economic realities of why these programmes were initiated in the first place
515 (see also Shapiro-Garza et al., 2020). Greater attention is needed to understand why this
516 incoherence between the promotional literature on PES and the political and economic

517 realities driving PES programmes in practice is occurring. By understanding PES as the
518 product of a *specific*, rather than a universal value framework, it becomes possible to
519 recognize, for instance, how asymmetries of PES programme design and implementation
520 between the Global North and South are baked into values around human-nature relations
521 underpinning PES and not merely technical details that could be refined (Nobles et al., 2022).
522

523 Our analysis pierces the bubble of how success is defined in the PES research body and by
524 whom. Amidst increasingly urgent ecological crises and growing net-zero pledges for “nature-
525 based solutions” or rewilding intensively produced landscapes, we share in the hope that 15
526 years of research on PES is *sufficient* to go beyond merely refining an instrument always
527 already assumed to be the answer to our prayers. Instead, maybe it is time to ask
528 uncomfortable, yet vital questions about the historical and structural roots of ecological
529 problems and the role of PES in realistically responding to them.

FIGURES

Figure 1. PRISMA 2009 flow diagram (following Moher et al., 2009).

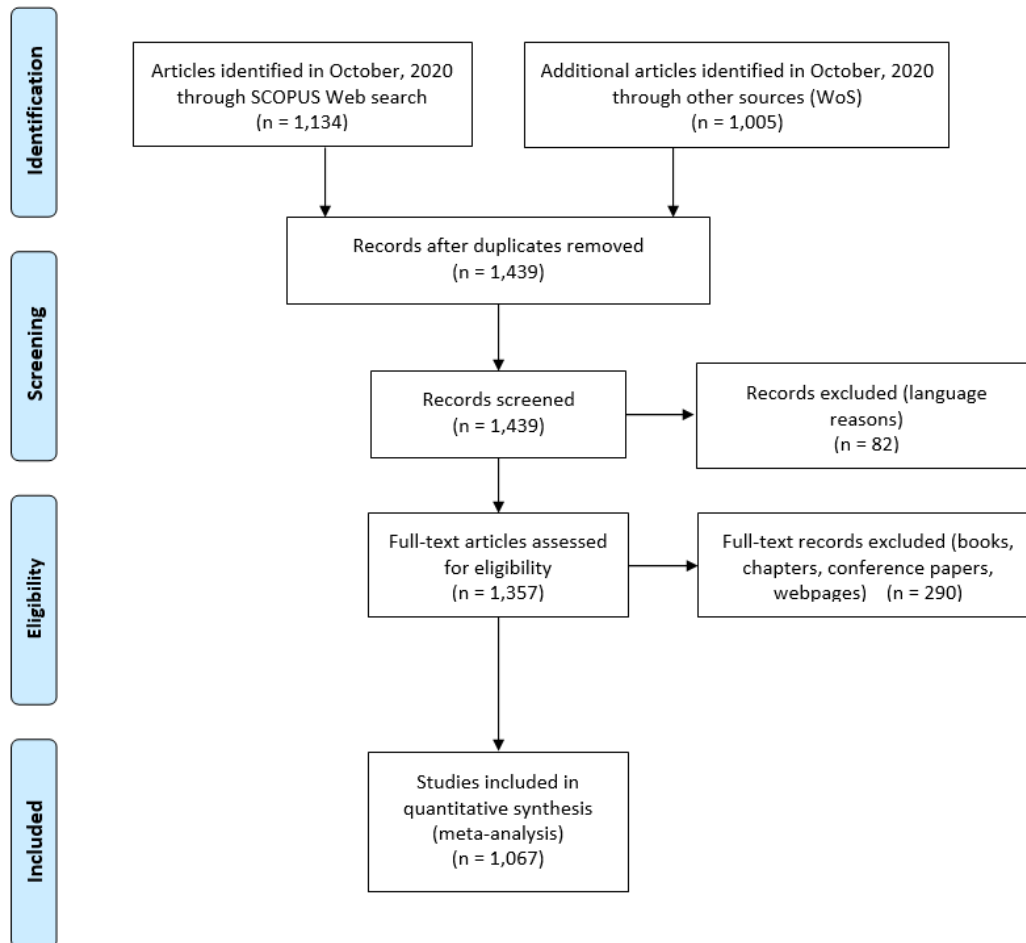


Figure 2. Number of peer-reviewed scientific publications (Anglophone) that directly or indirectly engage with PES between 2005 and 2019. *Direct studies* (n=747) focus on PES, either theoretically or empirically; *Indirect studies* (n=320) do not directly theoretically or empirically engage with PES to any extent; they merely mention PES as a potential policy solution to address ecological challenges.

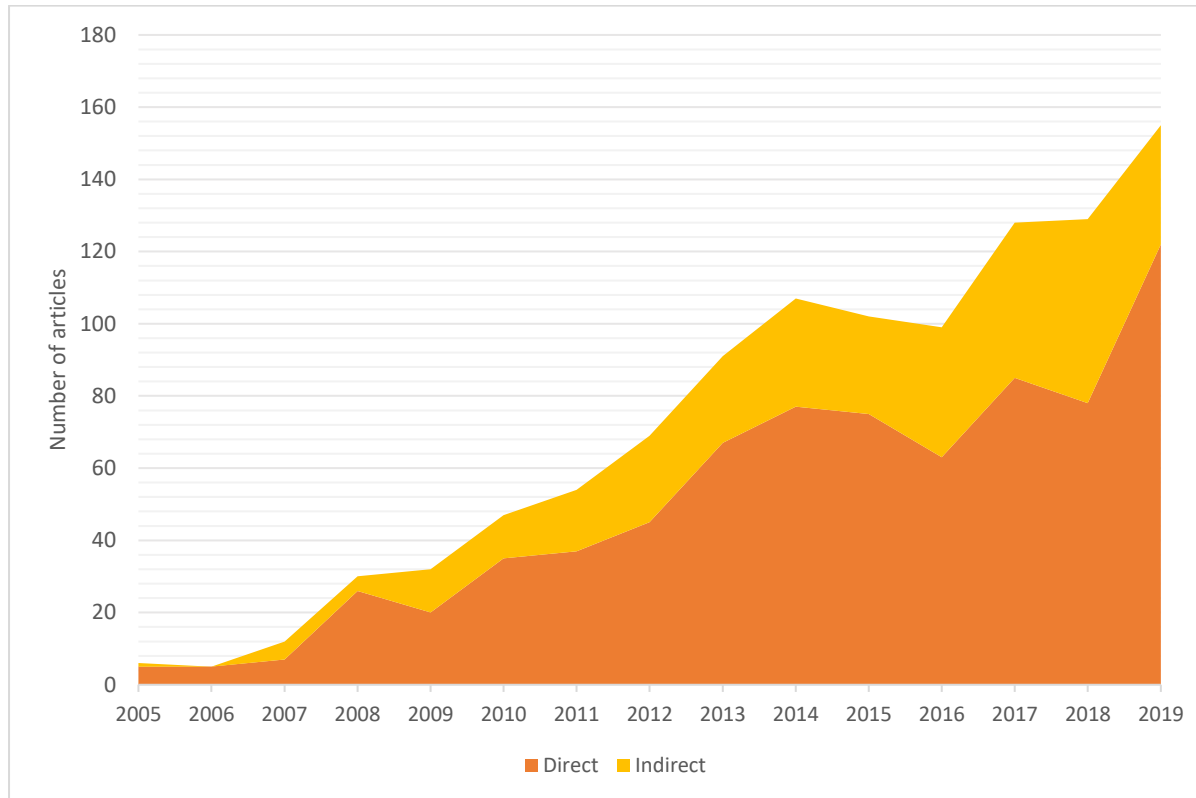


Figure 3. Thematic focus, recommendations and overall evaluation of PES success between 2005 and 2019. Selected studies only include direct articles (n=747) and are distributed over three 5-year time periods: 2005-2009, 2010-2014, 2015-2019. **a**, Study's main thematic focus; Individual publications may contain multiple main thematic focus areas; Total observations: 1,220. **b**, Study's main conclusion, recommendation or concern for PES; Individual publications may contain multiple recommendations or concerns; Total observations: 1,391. **c**, Authors' overall evaluation of PES as a (potentially) successful strategy to achieve its stated objectives; *Mixed evaluations* refer to PES as offering potential but with some reservations/concerns to be addressed.

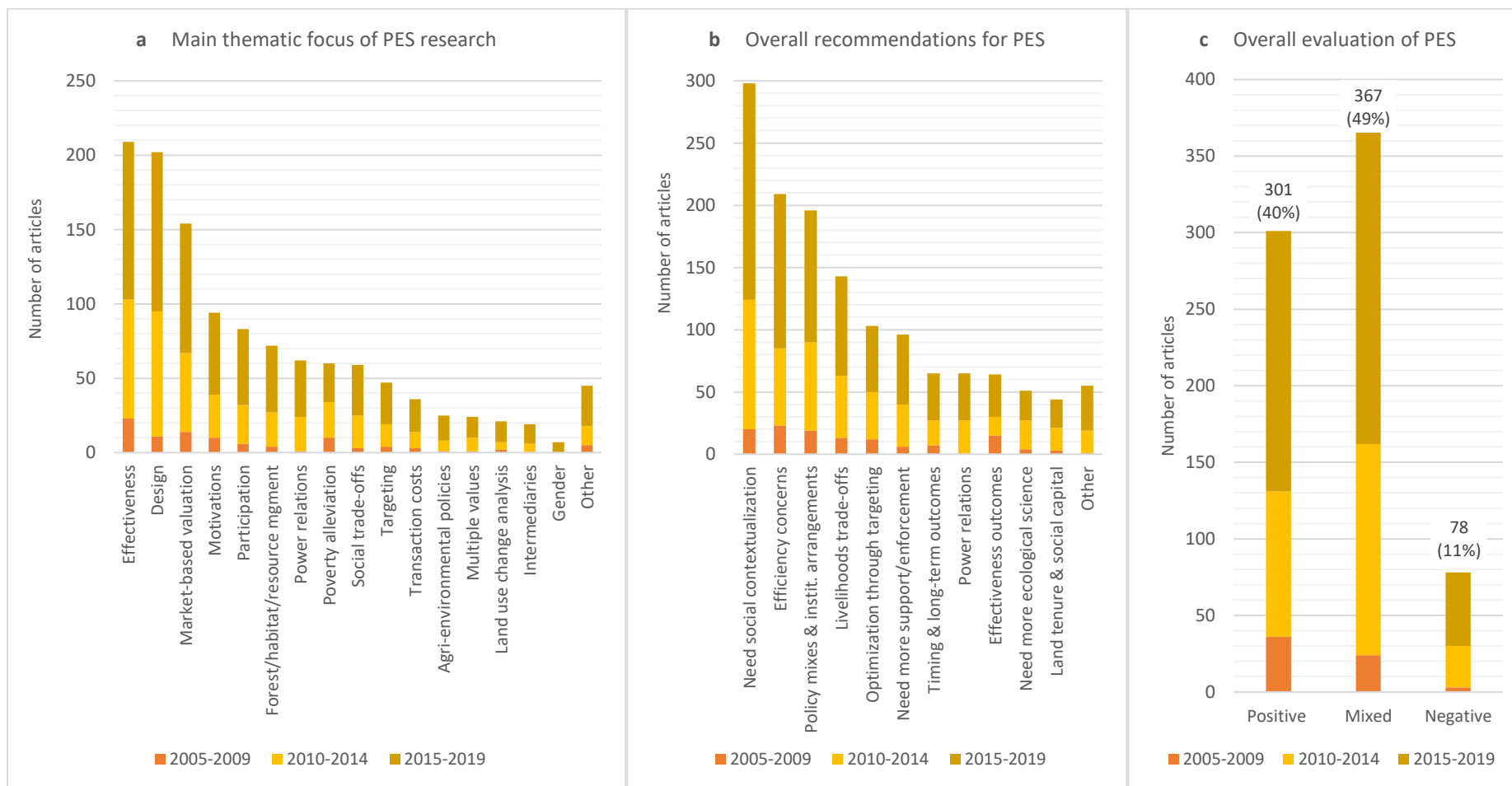
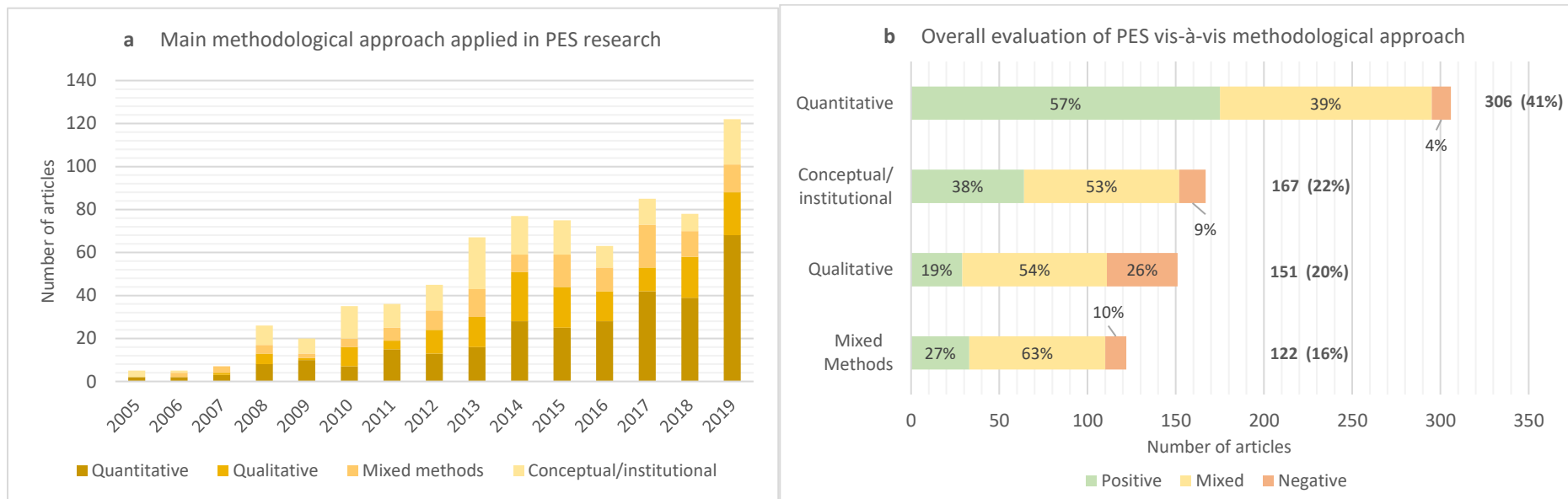


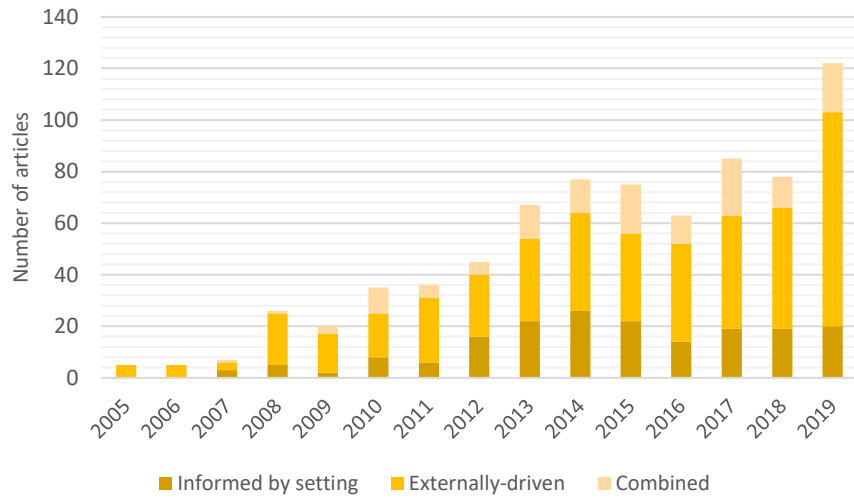
Figure 4. Geographic distribution of knowledge production sites and empirical data collection sites in PES research between 2005 and 2019. Knowledge production sites (left-hand side) display the main countries and regions in which the study’s first author’s institution is based. Empirical data collection sites (right-hand side) display the main countries and regions locating where each study empirically focuses. Selected studies only include direct, empirically-focused articles (n=597). Studies that empirically focus on multiple countries are counted multiple times, resulting in 616 pairwise observations depicted in the graph. For region classification, we follow Demeter’s (2019, p. 246) geopolitical classification. For Global North/Global South classification, we follow Hickel et al. (2022, p. 11) who use the IMF’s “advanced economies” grouping (as of 2015) to characterize the “Global North”, and the IMF’s “emerging and developing economies” as the “Global South”.



Figure 5. Methodological approaches, contextual engagement and overall evaluation of PES success between 2005 and 2019. Selected studies only include direct articles (n=747). **a**, Study's overarching main methodological approach, including *quantitative analyses*, *qualitative analyses*, *conceptual and institutional analyses*, and *mixed methods*. **b**, Authors' overall evaluation of PES as a (potentially) successful strategy to achieve its stated objectives *vis-à-vis* the main methodological approach applied in the study. **c**, Study's type of engagement with context; *Studies informed by the setting* engage with the social, cultural and political context and/or the qualitative, lived or emotional experiences of a particular setting or context; *Externally-driven studies* are based upon broad policy analyses and/or largely employ external expert-developed models or strategies to interpret data or implement programmes and policies with an idealized design; *Combined studies* use both strategies by introducing an external model, while at the same time ensuring that such a model is informed and dependent on the social, political, or cultural context of where the model is applied. **d**, Authors' overall evaluation of PES *vis-à-vis* the study's type of engagement with context.



c Type of contextual engagement in PES research



d Overall evaluation of PES vis-à-vis contextual engagement

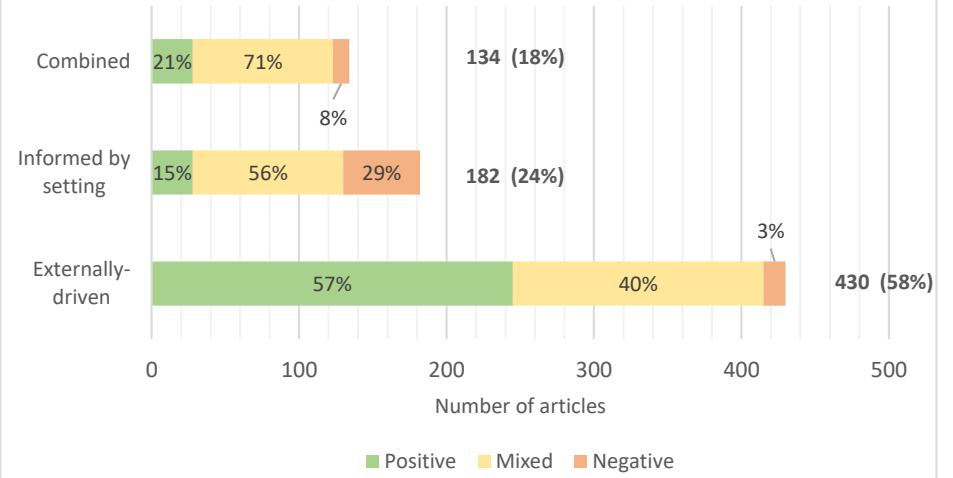
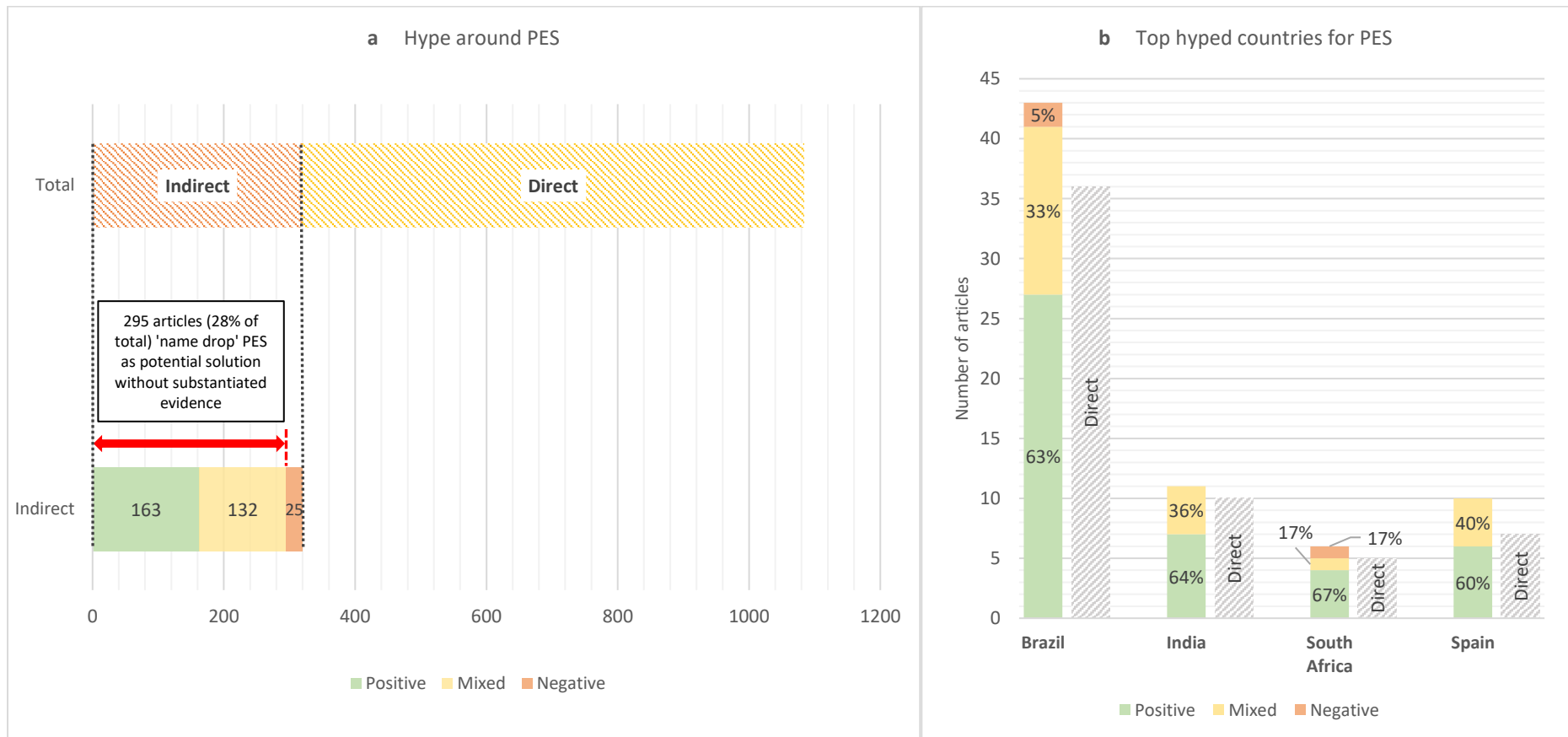


Figure 6. PES as speculative ‘hype’ in peer-reviewed published research (2005-2019). Speculative ‘hype’, or unsubstantiated signaling of success, takes place when studies ‘name drop’ PES as a potential solution to ecological problems without any theoretical or empirical analysis. **a**, Hype around PES is represented by authors’ positive (n=163) or mixed (n=132) evaluation of PES for indirect articles (n=320); the red arrow indicates how 295 articles (28% of total) contribute to hype around PES. **b**, Top hyped countries for PES include countries that are the focus of at least 10 published articles and where indirect articles outnumber direct articles; of these indirect studies, more than 60% of them attribute a positive evaluation towards PES application in each country, without any evidence to substantiate the claim; indirect articles are juxtaposed with articles directly engaging with PES in each country for comparison.



TABLES

Table 1: Key research objectives, and guiding questions for meta-analysis

Key objective	Guiding questions
FOCUS	Primary focus of PES research: what are the research objectives and thematic focus areas; where and by whom is the research conducted?
PROCESS	How are PES projects being defined and (empirically) analyzed (e.g. research methods and approach)?
OUTCOMES	Main research outcomes, recommendations or concerns from PES studies: How do these relate to subsequent research objectives; how do they change over time and across regions?

Table 2: List of selected ‘ePEStemology’ variables. [The complete list of variables will be made available in an online protocol database]

Variable	Description	Values
Author	Name of the author(s) of the article	Author name
Title	Title of the article	Title article
DOI	Official Digital Object Identifier (DOI) of the article	DOI links
Year	Year of publication of the article	2005, 2006, ..., 2019
Journal	Name of journal in which the article is published	Journal name
Volume	Volume of journal in which the article is published	Journal volume
Institution name	Name of main institution to which the first author of the article is affiliated	Institution name
Institution type	Type of main institution to which the first author of the article is affiliated	University (1); Government or government-financed institute (2); Independent organization / NGO (3); Private consultancy / think tank (4); Other (5)
Institution country	Country in which the first author’s main institution is based. For simplicity and assuming greater responsibility of the research effort in the contributions of the first author, we use first author as a proxy for institutional basis.	Country name
Direct-indirect	<i>Direct</i> studies focus on PES, either theoretically or empirically; <i>Indirect</i> studies do not directly theoretically or empirically engage with PES to any extent; they merely propose PES as a potential policy solution to address ecological challenges.	Indirect (0); Direct (1);
Thematic focus	Main thematic focus or objectives addressed in the article (<i>multiple entries possible</i>)	Market-based valuation of PES (1); Effectiveness of PES (2); PES design (3); Spatial or social targeting in PES (4); Payment entitlements (5); (Collective) participation in PES (6); Transaction costs (7); PES and poverty alleviation (8); PES and power relations (9); PES and forest/habitat/natural resource management (10); PES and degrowth (11); Motivations around PES (12); Private sector, Corporate Social Responsibility and PES (22); PES and the role of intermediaries (14); Multiple/relational/indigenous values in PES contexts (15); Gender and PES (16); PES social/equity trade-offs (17); Uncertainties in PES (18); Land use change analysis in PES (19); PES and agri-environmental policies (20); Climate change and PES (21)

Methods	Primary method(s) used in the study (<i>multiple entries possible</i>)	Case study (1); Document review (secondary sources) (2); Theoretical/analytical modeling (3); Natural science (modeling) & bio-resource engineering (4); Choice experiments, contingent valuation & auction approaches (5); Interviews, focus groups and discursive approaches (6); Survey/regressions (7); Econometric modeling (8); Framed field experiments based on behavioral models (9); Descriptive statistics (t-test, non-parametric) (10); GIS spatialization / remote sensing (11); Scenario analysis (12); Deliberative methods/analysis (13); Value Chain Analysis (14); Multi-criteria analysis (15); Other (16)
Methodological approach	Overarching main methodological approach applied in the study ranging from <i>quantitative analyses</i> (including randomized control trials, geospatial analyses, framed-field experiments, and contingent valuation or choice experiments), <i>qualitative analyses</i> (e.g. discourse analysis of interviews), to <i>conceptual and institutional analyses</i> (e.g. prescriptive, legal, or policy-oriented), and <i>mixed methods</i> (e.g. social multi-criteria evaluation)	Quantitative (1); Qualitative (2); Mixed methods (3); Conceptual/institutional/prescriptive (4)
Theoretical-empirical	<i>Theoretical studies</i> only discuss PES theory, theoretical concepts, or broad overarching policy discussions without reference to grounded examples; <i>Empirical studies</i> discuss PES on the basis of empirical information or examples; <i>Combined studies</i> use both strategies	Theoretical study (1); Empirical study (2); Combined study (3)
Contextual engagement	The type of engagement with social, cultural and political contexts and dynamics in the PES study. <i>Studies informed by the setting</i> engage with the social/cultural/political context and/or the qualitative, lived or emotional experiences of a particular setting or context (e.g. local meanings of 'nature', and/or power asymmetries of diverging positionalities of actors); <i>Externally-driven studies</i> are based upon broad policy analyses and/or largely employ external expert-developed models or strategies to interpret data or implement programmes and policies with an idealized design (e.g. a choice experiment to uncover values for stylized development scenarios); <i>Combined studies</i> use both strategies by introducing an external model, while at the same time ensuring that such a model is informed and dependent on the social, political, or cultural context of where the model is applied (e.g. a social multi-criteria model)	Informed by setting (1); Externally-driven (2); Combined (3)
Recommendation	Main conclusion, recommendation or concern of the study related to PES scholarship and/or specific programmes. This could include points of attention for future research, recommendations regarding PES application and/or the applicability of PES more broadly. (<i>multiple entries possible</i>)	Efficiency concerns (1); Timing of PES and influence on long-term outcomes (2); Need of social contextualization (3); Optimization through targeting (4); Livelihood consideration and trade-offs (5); Need of more precise ecological science-backing (6); Need of more support and enforcement (7); More attentiveness to policy mixes and institutional arrangements across scales (8); More attentiveness to power relations (9); Concerns about effectiveness of outcomes (10); Concerns about land tenure and/or access to social

		capital (11); PES ineffectiveness (12); Risk aversion influencing PES (13); PES as state control/securitization (14); Gender concerns (15)
Author evaluation	Authors' overall evaluation of PES as a (potentially) successful strategy to achieve its stated objectives. <i>Mixed evaluations</i> refer to PES as offering potential but with some reservations/concerns to be addressed	Positive evaluation (1); Negative evaluation (2); Mixed evaluation (3)
Country focus	Country on which the study is focused (<i>multiple entries possible</i>)	Country name

Table 3. Top ten cited PES studies between 2005 and 2019. The search was conducted in May, 2022 using Scopus.

Article details	Institution name & country	Thematic focus	Methodological approach	Contextual engagement	Recommendation	Author evaluation of PES
Engel, S., Pagiola, S., Wunder, S. (2008). Designing payments for environmental services in theory and practice: An overview of the issues. <i>Ecological Economics</i> , 65(4), 663–674.	ETH Zurich, Switzerland	PES design	Conceptual/institutional/prescriptive	Externally-driven	More attentiveness to policy mixes and institutional arrangements	Positive
Farley, J., Costanza, R. (2010). Payments for ecosystem services: From local to global. <i>Ecological Economics</i> , 69(11), 2060–2068.	University of Vermont, USA	PES design; (Collective) participation in PES	Qualitative	Combined	More attentiveness to policy mixes and institutional arrangements	Positive
Ferraro, P. J. (2008). Asymmetric information and contract design for payments for environmental services. <i>Ecological Economics</i> , 65(4), 810–821.	Georgia State University, USA	Transaction costs	Conceptual/institutional/prescriptive	Externally-driven	Efficiency concerns	Mixed
Vatn, A. (2010). An institutional analysis of payments for environmental services. <i>Ecological Economics</i> , 69(6), 1245–1252.	Norwegian University of Life Sciences, Norway	PES design	Conceptual/institutional/prescriptive	Combined study	Efficiency concerns; Need of social contextualization	Mixed
Wunder, S., Engel, S., Pagiola, S. (2008). Taking stock: A comparative analysis of payments for environmental services programs in developed and developing countries. <i>Ecological Economics</i> , 65(4), 834–852.	Center for International Forestry Research (CIFOR), CGIAR, Brazil	PES design; Effectiveness of PES	Qualitative	Externally-driven	Efficiency concerns; Concerns about effectiveness of outcomes; Livelihood consideration and trade-offs	Positive
Kosoy, N., & Corbera, E. (2010). Payments for ecosystem services as commodity fetishism. <i>Ecological Economics</i> , 69(6), 1228–1236.	United Nations Environment Programme (UNEP), Kenya	PES and power relations; Multiple/relational/indigenous values in PES contexts	Conceptual/institutional/prescriptive	Informed by setting	More attentiveness to power relations; Need of social contextualization	Negative
Muradian, R., Corbera, E., Pascual, U., Kosoy, N., May, P. H. (2010). Reconciling theory and practice: An alternative conceptual framework for understanding payments for environmental services. <i>Ecological Economics</i> , 69(6), 1202–1208.	Radboud University, The Netherlands	PES design; PES and power relations	Conceptual/institutional/prescriptive	Combined	Need of social contextualization	Mixed
Pagiola, S. (2008). Payments for environmental services in Costa Rica. <i>Ecological Economics</i> , 65(4), 712–724.	The World Bank, USA	PES design	Conceptual/institutional/prescriptive	Externally-driven	Optimization through targeting	Positive
Pattanayak, S. K., Wunder, S., Ferraro, P. J. (2010). Show Me the Money: Do Payments Supply Environmental Services in Developing Countries? <i>Review of Environmental Economics and Policy</i> , 4(2), 254–274.	Duke University, USA	Effectiveness of PES	Conceptual/institutional/prescriptive	Externally-driven	Efficiency concerns; Need of more precise ecological science-backing	Positive
Pagiola, S., Arcenas, A., & Platais, G. (2005). Can Payments for Environmental Services Help Reduce Poverty? An Exploration of the Issues and the Evidence to Date from Latin America. <i>World Development</i> , 33(2), 237–253.	The World Bank, USA	Market-based valuation of PES; PES and poverty alleviation	Conceptual/institutional/prescriptive	Externally-driven	Efficiency concerns; Livelihood consideration and trade-offs	Positive

Table 4. Illustrations of PES hype effect. The table identifies quotes from indirect articles

Article	References to PES	Explanation of hype
<p>Mattos, J. B., Silva, K. B., Silva, R. J., Almeida, T. H. M., Póvoas, H. S. S., Silva, P. V. R., Góes, I. M. de A., & Matos, I. S. (2019). Natural factors or environmental neglect? Understanding the dilemma of a water crisis in a scenario of water plenty. <i>Land Use Policy</i>, 82, 509–517.</p>	<p>“In face of the approach presented in this study, for the dam and their reservoir as an effective and long-lasting solution to the water needs of the Itabuna city, we suggest that bold recovery and conservation plans for the watershed would have to be designed and executed. The payment for ecosystem services (PES) program can be a mid- to long-term solution that could guarantee forest restoration, river flow rate regulation, and improve water quality (Pagiola et al., 2007; Osuna et al., 2014; Zolin et al., 2014)”. (p. 514)</p> <p>“The search for water security through PES programs is a challenging strategy that requires effort, dedication, boldness, and awareness, but is capable of producing durable benefits.” (p. 515-516)</p>	<p>This article analyzes multiple dimensions of a water crisis in Brazilian medium-sized city. While PES is not part of their analysis, it is assumed to be an optimistic and ambitious way forward as a possible solution.</p>
<p>Varsha, K. M., Raj, A. K., Kurien, E. K., Bastin, B., Kunhamu, T. K., & Pradeep, K. P. (2019). High density silvopasture systems for quality forage production and carbon sequestration in humid tropics of Southern India. <i>Agroforestry Systems</i>, 93(1), 185–198</p>	<p>“In comparison to conventional grass monoculture practices, well managed silvopasture systems with high tree densities have greater potential for quality forage production and climate change mitigation via carbon sequestration in humid tropics, but needs quantification on above aspects for popularizing among farmers and for payment of ecosystem services.” (p.185)</p>	<p>This study focuses on comparing forage and crude protein yields and carbon stocks in different fodder production systems.</p> <p>PES is mentioned only once in the article, in the abstract and is assumed from the outset to be a self evident solution.</p>
<p>Badola, R., Barthwal, S., & Hussain, S. A. (2012). Attitudes of local communities towards conservation of mangrove forests: A case study from the east coast of India. <i>Estuarine, Coastal and Shelf Science</i>, 96(1), 188–196.</p>	<p>“The current debates on REDD and payment for ecosystem services provide ample scope for providing sustainable livelihood options to local communities from conservation of critical ecosystems such as mangroves (Redford and Adams, 2009; Cattaneo et al., 2010). These options are already in place in some countries (Jack et al., 2008b; Corbera et al., 2009) and need to be tapped in others.” (p.195)</p>	<p>This research analyzes attitudes and perceptions of local communities towards mangrove forests.</p> <p>PES is mentioned only in the last part of the conclusion, and is proposed solely because it exists in other countries and because it has yet to be replicated in other countries.</p>
<p>Perkins, J. S. (2019). ‘Only connect’: Restoring resilience in the Kalahari ecosystem. <i>Journal of Environmental Management</i>, 249</p>	<p>“Indeed, some of the poorest communities in the country are today found at the location of the proposed wildlife corridors in the Kalahari System - the Boteti, Schwelle, areas adjacent to the KTP [Kgalagadi Transfrontier Park], as well as in the Okavango and north western Botswana (World Bank, 2015). All of the latter areas have high incidences of HWC [Human Wildlife Conflicts], and yet the people residing there receive little or no benefits from living with wildlife. Payments for ecosystem goods and services schemes are likely to be necessary, in order to protect these areas from encroachment by other land uses (Naidoo et al., 2016; Ola et al., 2019).” (p.6)</p>	<p>The article focuses on ecosystem management, human wildlife conflict and mobility in relation to climate change in the Kalahari ecosystem. In just one sentence in the paper, authors promote PES a self evident possibility to address human wildlife conflicts.</p>
<p>Xie, Y., Wen, Y., & Cirella, G. T. (2019). Application of Ostrom’s social-ecological systems framework in nature reserves: Hybrid psycho-economic model of collective forest management. <i>Sustainability</i>, 11(24).</p>	<p>“The model indicated the scenario with the harmonious NR [Nature Reserve] as having less CF [Collective Forests] value at the resource level, less dependence on villagers for CF resources, stronger environmental awareness, lower levels of involvement from new actors, overarching governance control (i.e., by the NR administration), greater levels of self-organization (i.e., within villages), and augmented economic compensation and regulation from outside influences. The conflict-oriented NRs mostly revealed opposite</p>	<p>The study deals with collective forest management and behavioral economics in Fujian province, China. PES is mentioned once only in the abstract as a proposed solution for improving collective forest management.</p>

	sets of interaction. Different public policies, including the ecosystem service payment, are recommended for improving management of CFs in NRs.” (p.1)	
Shukla, S., Shukla, A., Knowles, J. M., & Harris, W. G. (2017). Shifting nutrient sink and source functions of stormwater detention areas in sub-tropics. <i>Ecological Engineering</i> , 102, 178–187.	“A payment for environmental services project to treat additional P through biomass harvesting is a sustainable approach, especially under future climate projections of more frequent high-intensity storms for the Everglades and beyond.” (p.178)	This paper examines the potential of stormwater detention areas in Florida’s Everglades region. PES is promoted as a sustainable approach, mentioned in the abstract only, without any further analysis.
Slee, B., Brown, I., Donnelly, D., Gordon, I. J., Matthews, K., & Towers, W. (2014). The “squeezed middle”: Identifying and addressing conflicting demands on intermediate quality farmland in Scotland. <i>Land Use Policy</i> , 41, 206–216.	“The appropriate scale for delivery of integrated ecosystem services may therefore be more local than current pilot projects, and may require more active participation of land managers. It may also require policy instruments that are more flexible in adapting to the local context, including payments for ecosystem services.” (p.206)	The article analyzes the multiple drivers of land use choices in the Scottish Government’s development of a Land Use Strategy to resolve conflicts and enhancing synergies in land use. PES is proposed to be a flexible instrument to address land-related conflicts without any substantiated evidence.

523 REFERENCES

- 524 Andreucci, D., García-Lamarca, M., Wedekind, J., & Swyngedouw, E. (2017). "Value
525 Grabbing": A Political Ecology of Rent. *Capitalism Nature Socialism*, 28(3), 28–47.
526 <https://doi.org/10.1080/10455752.2016.1278027>
- 527 Asiyambi, A. P. (2016). A political ecology of REDD+: Property rights, militarised
528 protectionism, and carbonised exclusion in Cross River. *Geoforum*, 77, 146–156.
529 <https://doi.org/10.1016/j.geoforum.2016.10.016>
- 530 Barnaud, C., & Antona, M. (2014). Deconstructing ecosystem services: Uncertainties and
531 controversies around a socially constructed concept. *Geoforum*, 56, 113–123.
532 <https://doi.org/10.1016/j.geoforum.2014.07.003>
- 533 Bishop, J., & Hill, C. (2014). *Global Biodiversity Finance: The Case for International*
534 *Payments for Ecosystem Services*. Edward Elgar.
- 535 Blundo-Canto, G., Bax, V., Quintero, M., Cruz-Garcia, G. S., Groeneveld, R. A., & Perez-
536 Marulanda, L. (2018). The Different Dimensions of Livelihood Impacts of Payments for
537 Environmental Services (PES) Schemes: A Systematic Review. *Ecological Economics*,
538 149, 160–183. <https://doi.org/10.1016/j.ecolecon.2018.03.011>
- 539 Börner, J., Baylis, K., Corbera, E., Ezzine-de-Blas, D., Honey-Rosés, J., Persson, U. M., &
540 Wunder, S. (2017). The Effectiveness of Payments for Environmental Services. *World*
541 *Development*, 96, 359–374. <https://doi.org/10.1016/j.worlddev.2017.03.020>
- 542 Bracking, S. (2015). The Anti-Politics of Climate Finance: The Creation and Performativity of
543 the Green Climate Fund. *Antipode*, 47(2), 281–302. <https://doi.org/10.1111/anti.12123>
- 544 Bradshaw, C. J. A., Ehrlich, P. R., Beattie, A., Ceballos, G., Crist, E., Diamond, J., Dirzo, R.,
545 Ehrlich, A. H., Harte, J., Harte, M. E., Pyke, G., Raven, P. H., Ripple, W. J., Saltré, F.,
546 Turnbull, C., Wackernagel, M., & Blumstein, D. T. (2021). Underestimating the
547 Challenges of Avoiding a Ghastly Future. *Frontiers in Conservation Science*, 1.
548 <https://doi.org/10.3389/fcosc.2020.615419>
- 549 Bromley, D. W. (2012). Environmental Governance as Stochastic Belief Updating: Crafting
550 Rules to Live by. *Ecology and Society*, 17(3). [https://doi.org/Artn 14 Doi 10.5751/Es-](https://doi.org/Artn%2014%20Doi%2010.5751%2FES-04774-170314)
551 [04774-170314](https://doi.org/10.5751/ES-04774-170314)
- 552 Brouwer, R., Tesfaye, A., & Pauw Pieter. (2011). Meta-analysis of institutional-economic
553 factors explaining the environmental performance of payments for watershed services.
554 *Environmental Conservation*, 38(4), 380–392.
555 <https://doi.org/10.1017/S0376892911000543>
- 556 Büscher, B. (2010). Anti-Politics as Political Strategy: Neoliberalism and Transfrontier
557 Conservation in Southern Africa. *Development and Change*, 41(1), 29–51.
558 <https://doi.org/10.1111/j.1467-7660.2009.01621.x>
- 559 Chambers, J. M., Massarella, K., & Fletcher, R. (2022). The right to fail? Problematizing
560 failure discourse in international conservation. *World Development*, 150.
561 <https://doi.org/10.1016/j.worlddev.2021.105723>
- 562 Chan, K. M. A., Anderson, E., Chapman, M., Jespersen, K., & Olmsted, P. (2017). Payments
563 for Ecosystem Services: Rife With Problems and Potential—For Transformation
564 Towards Sustainability. *Ecological Economics*, 140, 110–122.
565 <https://doi.org/10.1016/j.ecolecon.2017.04.029>
- 566 Chancel, L. (2022). Global carbon inequality over 1990–2019. *Nature Sustainability*.
567 <https://doi.org/10.1038/s41893-022-00955-z>

- 568 Chaudhury, A., & Colla, S. (2021). Next steps in dismantling discrimination: Lessons from
569 ecology and conservation science. *Conservation Letters*, 14(2).
570 <https://doi.org/10.1111/conl.12774>
- 571 Ciple, D., Falzon, D., Uri, I., Robinson, S., Weikmans, R., & Roberts, J. T. (2022). The
572 unequal geographies of climate finance: Climate injustice and dependency in the world
573 system. *Political Geography*, 99, 102769. <https://doi.org/10.1016/j.polgeo.2022.102769>
- 574 Costanza, R., de Groot, R., Braat, L., Kubiszewski, I., Fioramonti, L., Sutton, P., Farber, S.,
575 & Grasso, M. (2017). Twenty years of ecosystem services: How far have we come and
576 how far do we still need to go? *Ecosystem Services*, 28, 1–16.
577 <https://doi.org/10.1016/j.ecoser.2017.09.008>
- 578 Dahdouh-Guebas, F., Ahimbisibwe, J., van Moll, R., & Koedam, N. (2003). Neo-colonial
579 science by the most industrialised upon the least developed countries in peer-reviewed
580 publishing. *Scientometrics*, 56(3), 329–343. <https://doi.org/10.1023/A:1022374703178>
- 581 Demeter, M. (2019). The World-Systemic Dynamics of Knowledge Production: The
582 Distribution of Transnational Academic Capital in the Social Sciences. *Journal of World-*
583 *Systems Research*, 25(1), 111–144. <https://doi.org/10.5195/jwsr.2019.887>
- 584 Demeter, M. (2022). Development Studies in the World System of Global Knowledge
585 Production: A Critical Empirical Analysis. *Progress in Development Studies*, 22(3), 239–
586 256. <https://doi.org/10.1177/14649934211060155>
- 587 Dempsey, J. (2016). *Enterprising Nature: Economics, Markets, and Finance in Global*
588 *Biodiversity Politics*. John Wiley & Sons.
- 589 Denzin, N. K. (1970). *The research act*. Aldine .
- 590 Ezzine-de-Blas, D., Wunder, S., Ruiz-Pérez, M., & Moreno-Sanchez, R. del P. (2016).
591 Global Patterns in the Implementation of Payments for Environmental Services. *PLOS*
592 *ONE*, 11(3), e0149847. <https://doi.org/10.1371/journal.pone.0149847>
- 593 Feng, Z., Yang, Y., Zhang, Y., Zhang, P., & Li, Y. (2005). Grain-for-green policy and its
594 impacts on grain supply in West China. *Land Use Policy*, 22(4), 301–312.
595 <https://doi.org/10.1016/j.landusepol.2004.05.004>
- 596 Ferdinand, M. (2019). *Une écologie décoloniale-Penser l'écologie depuis le monde caribéen*.
597 Seuil.
- 598 Ferguson, J. (1994). *The anti-politics machine: "development," depoliticization, and*
599 *bureaucratic power in Lesotho*. U of Minnesota Press.
- 600 Ferraro, P. J., & Simpson, R. D. (2002). The Cost-Effectiveness of Conservation Payments.
601 *Land Economics*, 78(3), 339–353. <https://doi.org/10.2307/3146894>
- 602 Figueroa, F., & Caro-Borrero, A. (2019). Neoliberalización de la naturaleza a través del
603 programa de Pago por Servicios Ambientales en México: diversidad de efectos y
604 multiplicidad de visiones. In L. Durand, A. Nygren, & de la Vega-Leinert Anne Cristina
605 (Eds.), *Naturaleza y Neoliberalismo en America Latina* (pp. 33–80). Universidad
606 Nacional Autónoma de México.
- 607 Fletcher, R., & Büscher, B. (2017). The PES Conceit: Revisiting the Relationship between
608 Payments for Environmental Services and Neoliberal Conservation. *Ecological*
609 *Economics*, 132, 224–231. <https://doi.org/10.1016/j.ecolecon.2016.11.002>
- 610 Grima, N., Singh, S. J., Smetschka, B., & Ringhofer, L. (2016). Payment for Ecosystem
611 Services (PES) in Latin America: Analysing the performance of 40 case studies.
612 *Ecosystem Services*, 17, 24–32. <https://doi.org/10.1016/j.ecoser.2015.11.010>
- 613 Hausknot, D., Grima, N., & Singh, S. J. (2017). The political dimensions of Payments for
614 Ecosystem Services (PES): Cascade or stairway? *Ecological Economics*, 131, 109–
615 118. <https://doi.org/10.1016/j.ecolecon.2016.08.024>

- 616 Hickel, J., Dorninger, C., Wieland, H., & Suwandi, I. (2022). Imperialist appropriation in the
617 world economy: Drain from the global South through unequal exchange, 1990–2015.
618 *Global Environmental Change*, 73, 102467.
619 <https://doi.org/10.1016/j.gloenvcha.2022.102467>
- 620 Hickel, J., Sullivan, D., & Zoomkawala, H. (2021). Plunder in the Post-Colonial Era:
621 Quantifying Drain from the Global South Through Unequal Exchange, 1960–2018. *New*
622 *Political Economy*, 26(6), 1030–1047. <https://doi.org/10.1080/13563467.2021.1899153>
- 623 Himes, A., & Muraca, B. (2018). Relational values: the key to pluralistic valuation of
624 ecosystem services. *Current Opinion in Environmental Sustainability*, 35, 1–7.
625 <https://doi.org/10.1016/j.cosust.2018.09.005>
- 626 Ishihara, H., Pascual, U., & Hodge, I. (2017). Dancing With Storks: The Role of Power
627 Relations in Payments for Ecosystem Services. *Ecological Economics*, 139, 45–54.
628 <https://doi.org/10.1016/j.ecolecon.2017.04.007>
- 629 Jasanoff, S. (2017). Virtual, visible, and actionable: Data assemblages and the sightlines of
630 justice. *Big Data & Society*, 4(2), 205395171772447.
631 <https://doi.org/10.1177/2053951717724477>
- 632 Jones, K. W., Powlen, K., Roberts, R., & Shinbrot, X. (2020). Participation in payments for
633 ecosystem services programs in the Global South: A systematic review. *Ecosystem*
634 *Services*, 45, 101159. <https://doi.org/10.1016/j.ecoser.2020.101159>
- 635 Kaiser, J., Haase, D., & Krueger, T. (2021). Payments for ecosystem services: a review of
636 definitions, the role of spatial scales, and critique. *Ecology and Society*, 26(2), art12.
637 <https://doi.org/10.5751/ES-12307-260212>
- 638 Kosoy, N., & Corbera, E. (2010). Payments for ecosystem services as commodity fetishism.
639 *Ecological Economics*, 69(6), 1228–1236.
640 <https://doi.org/10.1016/j.ecolecon.2009.11.002>
- 641 Kull, C. A., Arnauld de Sartre, X., & Castro-Larrañaga, M. (2015). The political ecology of
642 ecosystem services. *Geoforum*, 61, 122–134.
643 <https://doi.org/10.1016/j.geoforum.2015.03.004>
- 644 Kvangraven, I. H., & Kesar, S. (2022). Standing in the way of rigor? Economics' meeting with
645 the decolonization agenda. *Review of International Political Economy*, 1–26.
646 <https://doi.org/10.1080/09692290.2022.2131597>
- 647 Lansing, D. M., Grove, K., & Rice, J. L. (2015). The Neutral State: A Genealogy of
648 Ecosystem Service Payments in Costa Rica. *Conservation and Society*, 13(2), 200–
649 211. <https://doi.org/10.4103/0972-4923.164206>
- 650 Liu, Z., & Kontoleon, A. (2018). Meta-Analysis of Livelihood Impacts of Payments for
651 Environmental Services Programmes in Developing Countries. *Ecological Economics*,
652 149, 48–61. <https://doi.org/10.1016/j.ecolecon.2018.02.008>
- 653 Machen, R., & Nost, E. (2021). Thinking algorithmically: The making of hegemonic
654 knowledge in climate governance. *Transactions of the Institute of British Geographers*,
655 46(3), 555–569. <https://doi.org/10.1111/tran.12441>
- 656 Martin, A., Coolsaet, B., Corbera, E., Dawson, N. M., Fraser, J. A., Lehmann, I., &
657 Rodriguez, I. (2016). Justice and conservation: The need to incorporate recognition.
658 *Biological Conservation*, 197, 254–261. <https://doi.org/10.1016/j.biocon.2016.03.021>
- 659 Martin-Ortega, J., Dekker, T., Ojea, E., & Lorenzo-Arribas, A. (2019). Dissecting price setting
660 efficiency in Payments for Ecosystem Services: A meta-analysis of payments for
661 watershed services in Latin America. *Ecosystem Services*, 38, 100961.
662 <https://doi.org/10.1016/j.ecoser.2019.100961>

663 Matulis, B. S. (2013). The narrowing gap between vision and execution: Neoliberalization of
664 PES in Costa Rica. *Geoforum*, 44, 253–260.
665 <https://doi.org/10.1016/j.geoforum.2012.09.001>

666 Matulis, B. S. (2017). Persistent Neoliberalisation in PES: Taxes, Tariffs, and the World Bank
667 in Costa Rica. *Conservation and Society*, 15(2), 147–156. <https://doi.org/10.4103/0972-4923.204073>

668

669 Millennium Ecosystem Assessment. (2005). *Ecosystems and Human Well-being: Synthesis*.
670 Island Press.

671 Milne, S., & Adams, B. (2012). Market Masquerades: Uncovering the Politics of Community-
672 level Payments for Environmental Services in Cambodia. *Development and Change*,
673 43(1), 133–158. <https://doi.org/10.1111/j.1467-7660.2011.01748.x>

674 Milne, S., Mahanty, S., To, P., Dressler, W., Kanowski, P., & Thavat, M. (2019). Learning
675 from “actually existing” REDD+: A synthesis of ethnographic findings. *Conservation and*
676 *Society*, 17(1), 84–95. https://doi.org/10.4103/cs.cs_18_13

677 Moher, D., Liberati, A., Tetzlaff, J., & Altman, D. G. (2009). Preferred Reporting Items for
678 Systematic Reviews and Meta-Analyses: The PRISMA Statement. *PLoS Medicine*,
679 6(7), e1000097. <https://doi.org/10.1371/journal.pmed.1000097>

680 Muniz, R., & Cruz, M. J. (2015). Making nature valuable, not profitable: Are payments for
681 ecosystem services suitable for degrowth? *Sustainability*, 7(8), 10895–10921.
682 <https://doi.org/10.3390/su70810895>

683 Murdock, E. G. (2018). Unsettling Reconciliation: Decolonial Methods for Transforming
684 Social-Ecological Systems. *Environmental Values*, 27(5), 513–533.
685 <https://doi.org/10.3197/096327118X15321668325948>

686 Myers, R., Larson, A. M., Ravikumar, A., Kowler, L. F., Yang, A., & Trench, T. (2018).
687 Messiness of forest governance: How technical approaches suppress politics in REDD+
688 and conservation projects. *Global Environmental Change*, 50, 314–324.
689 <https://doi.org/10.1016/j.gloenvcha.2018.02.015>

690 Naeem, S., Ingram, J. C., Varga, A., Agardy, T., Barten, P., Bennett, G., Bloomgarden, E.,
691 Bremer, L. L., Burkill, P., Cattau, M., Ching, C., Colby, M., Cook, D. C., Costanza, R.,
692 DeClerck, F., Freund, C., Gartner, T., Goldman-Benner, R., Gunderson, J., ... Wunder,
693 S. (2015). Get the science right when paying for nature’s services. *Science*, 347(6227),
694 1206–1207. <https://doi.org/10.1126/science.aaa1403>

695 Nature. (2022). Nature addresses helicopter research and ethics dumping. *Nature*,
696 606(7912), 7–7. <https://doi.org/10.1038/d41586-022-01423-6>

697 Nelson, S. H., Bremer, L. L., Meza Prado, K., & Brauman, K. A. (2020). The Political Life of
698 Natural Infrastructure: Water Funds and Alternative Histories of Payments for
699 Ecosystem Services in Valle del Cauca, Colombia. *Development and Change*, 51(1),
700 26–50. <https://doi.org/10.1111/dech.12544>

701 Nobles, M., Womack, C., Wonkam, A., & Wathuti, E. (2022). Science must overcome its
702 racist legacy: Nature’s guest editors speak. *Nature*, 606(7913), 225–227.
703 <https://doi.org/10.1038/d41586-022-01527-z>

704 Norgaard, R. B. (2010). Ecosystem services: From eye-opening metaphor to complexity
705 blinder. *Ecological Economics*, 69(6), 1219–1227.
706 <https://doi.org/10.1016/j.ecolecon.2009.11.009>

707 Norström, A. v., Cvitanovic, C., Löf, M. F., West, S., Wyborn, C., Balvanera, P., Bednarek, A.
708 T., Bennett, E. M., Biggs, R., de Bremond, A., Campbell, B. M., Canadell, J. G.,
709 Carpenter, S. R., Folke, C., Fulton, E. A., Gaffney, O., Gelcich, S., Jouffray, J.-B.,
710 Leach, M., ... Österblom, H. (2020). Principles for knowledge co-production in

711 sustainability research. *Nature Sustainability*, 3(3), 182–190.
712 <https://doi.org/10.1038/s41893-019-0448-2>

713 Osborne, T. (2013). Fixing Carbon, Losing ground: Payments For environmental services
714 and Land (in)security in Mexico. *Human Geography*, 6(1), 119–133.

715 Pasgaard, M., van Hecken, G., Ehammer, A., & Strange, N. (2017). Unfolding scientific
716 expertise and security in the changing governance of Ecosystem Services. *Geoforum*,
717 84, 354–367. <https://doi.org/10.1016/j.geoforum.2017.02.001>

718 Plumwood, V. (2018). Ecofeminist Analysis and the Culture of Ecological Denial. In *Feminist*
719 *Ecologies* (pp. 97–112). Springer International Publishing. [https://doi.org/10.1007/978-](https://doi.org/10.1007/978-3-319-64385-4_6)
720 [3-319-64385-4_6](https://doi.org/10.1007/978-3-319-64385-4_6)

721 Prager, C. M., Varga, A., Olmsted, P., Ingram, J. C., Cattau, M., Freund, C., Wynn-Grant, R.,
722 & Naeem, S. (2016). An assessment of adherence to basic ecological principles by
723 payments for ecosystem service projects. *Conservation Biology*, 30(4), 836–845.
724 <https://doi.org/10.1111/cobi.12648>

725 Quijano, A. (2007). Coloniality and Modernity/Rationality. *Cultural Studies*, 21(2–3), 168–
726 178. <https://doi.org/10.1080/09502380601164353>

727 Raes, L., Loft, L., le Coq, J. F., van Huylbroeck, G., & van Damme, P. (2016). Towards
728 market- or command-based governance? The evolution of payments for environmental
729 service schemes in Andean and Mesoamerican countries. *Ecosystem Services*, 18, 20–
730 32. <https://doi.org/10.1016/j.ecoser.2016.01.005>

731 Rodríguez de Francisco, J. C., Budds, J., & Boelens, R. (2013). Payment for Environmental
732 Services and Unequal Resource Control in Pimampiro, Ecuador. *Society & Natural*
733 *Resources*, 26(10), 1217–1233. <https://doi.org/10.1080/08941920.2013.825037>

734 Rodríguez-de-Francisco, J. C., Duarte-Abadía, B., & Boelens, R. (2019). Payment for
735 ecosystem services and the water-energy-food nexus: Securing resource flows for the
736 affluent? *Water*, 11(6). <https://doi.org/10.3390/w11061143>

737 Ross, C. (2017). *Ecology and Power in the Age of Empire*. Oxford University Press.
738 <https://doi.org/10.1093/acprof:oso/9780199590414.001.0001>

739 Salzman, J., Bennett, G., Carroll, N., Goldstein, A., & Jenkins, M. (2018). The global status
740 and trends of Payments for Ecosystem Services. *Nature Sustainability*, 1(3), 136–144.
741 <https://doi.org/10.1038/s41893-018-0033-0>

742 Schomers, S., & Matzdorf, B. (2013). Payments for ecosystem services: A review and
743 comparison of developing and industrialized countries. *Ecosystem Services*, 6, 16–30.
744 <https://doi.org/10.1016/j.ecoser.2013.01.002>

745 Shapiro-Garza, E. (2013). Contesting the market-based nature of Mexico’s national
746 payments for ecosystem services programs: Four sites of articulation and hybridization.
747 *Geoforum*, 46, 5–15. <https://doi.org/10.1016/j.geoforum.2012.11.018>

748 Shapiro-Garza, E., McElwee, P., Van Hecken, G., & Corbera, E. (2020). Beyond Market
749 Logics: Payments for Ecosystem Services as Alternative Development Practices in the
750 Global South. *Development and Change*, 51(1), 3–25.
751 <https://doi.org/10.1111/dech.12546>

752 Strauss, A. L., & Corbin, J. (1990). *Basics of Qualitative Research: Grounded Theory*
753 *Procedures and Techniques*. . Sage. .

754 UNEP, WEF, ELD, & VIVID ECONOMICS. (2021). *State of Finance for Nature Tripling*
755 *investments in nature-based solutions by 2030*. [https://www.unep.org/resources/state-](https://www.unep.org/resources/state-finance-nature)
756 [finance-nature](https://www.unep.org/resources/state-finance-nature)

- 757 Watts, V. (2013). Indigenous place-thought & agency amongst humans and non-humans
758 (First Woman and Sky Woman go on a European world tour!). *Decolonization:*
759 *Indigeneity, Education & Society*, 2(1), 20–34.
- 760 Waylen, K. A., & Martin-Ortega, J. (2018). Surveying views on Payments for Ecosystem
761 Services: Implications for environmental management and research. *Ecosystem*
762 *Services*, 29, 23–30. <https://doi.org/10.1016/j.ecoser.2017.11.007>
- 763 Wilshusen, P. R. (2019). Environmental governance in motion: Practices of assemblage and
764 the political performativity of economic conservation. *World Development*, 124,
765 104626. <https://doi.org/10.1016/j.worlddev.2019.104626>
- 766 Wunder, S. (2005). *Payments for environmental services: some nuts and bolts*. Center for
767 International Forestry Research (CIFOR). <https://doi.org/10.17528/cifor/001760>
- 768 Wunder, S. (2015). Revisiting the concept of payments for environmental services.
769 *Ecological Economics*, 117, 234–243. <https://doi.org/10.1016/j.ecolecon.2014.08.016>
- 770 Wunder, S., Brouwer, R., Engel, S., Ezzine-de-Blas, D., Muradian, R., Pascual, U., & Pinto,
771 R. (2018). From principles to practice in paying for nature's services. *Nature*
772 *Sustainability*, 1(3), 145–150. <https://doi.org/10.1038/s41893-018-0036-x>
- 773 Wunder, S., Engel, S., & Pagiola, S. (2008). Taking stock: A comparative analysis of
774 payments for environmental services programs in developed and developing countries.
775 *Ecological Economics*, 65(4), 834–852. <https://doi.org/10.1016/j.ecolecon.2008.03.010>

776