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RESEARCH: HUMAN-NATURE CONNECTEDNESS AS LEVERAGE POINT

Indigenous and local knowledge in environmental management for human-nature connectedness: a leverage points perspective

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ABSTRACT

Indigenous peoples are key actors for environmental management because they hold valuable indigenous and local knowledge (ILK) for the sustainable stewardship of nature. However, the consideration of ILK in environmental management is still limited. We explore how environmental government institutions in Colombia have involved indigenous communities in 2212 environmental management projects between 2004 and 2015. Only 1% of these projects involved indigenous peoples as main actors. We applied the Leverage Points (LP) perspective in a content analysis to identify 'where' and 'how' these projects promote transformative changes within indigenous territories. Moreover, we investigated the interactions between projects targeting shallow and deep LP using cluster analysis. Our results show that these projects mainly seek to improve the well-being of indigenous peoples and consider ILK in their interventions, which suggests changes in deep LP. Additionally, these projects usually combined interventions targeting both shallow and deep LP while using ILK to improve environmental management practices (e.g., Life Plans) and developing participatory land-use planning in the indigenous territories. We argue that the involvement of ILK in environmental management can lead to stronger human–nature connectedness and thus to more successful conservation policies. However, this involvement is still at an early stage in Colombia.

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Introduction

Indigenous communities play a key role in environmental management and for biodiversity management. Although indigenous peoples represent only 5% of the world population, they manage and influence at least 28% of the earth's surface, including 20% of the global-protected areas (Garnett et al. 2018). They are the carriers and caregivers of biodiversity and they also hold a unique and invaluable indigenous and local knowledge (ILK) for sustainable stewardship of nature. ILK is defined as the 'cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment' (Berkes et al. 2000). ILK is relational or, situated knowledge (Raffles 2002), which 'embodies claims to authority over land and resources, especially in the face of counter-claims from outsiders' (Berkes 2018). ILK depicts a vital source to learn how to 'reconnect' humans to nature in times of decreasing and altering human–nature connectedness, which is regarded as one of the main issues that amplify unsustainable behaviors (Riechers et al. 2019). An important concept which is frequently associated to ILK is the idea of cosmovision. This describes how 'a view of the world (e.g. past, present and future) is constituted alongside people's place within it. (…) [A] cosmovision animates the world, gives it meaning, and, as such, is a means of survival' (Harris 2017). ILK is a knowledge-practice-belief complex and consequently shaped by the cosmovision of people.

Indigenous peoples and local communities have established long-standing relationships with their surrounding environments. They have accumulated holistic knowledge over centuries, which has allowed them to maintain an equilibrated social-ecological system. They have also overcome a variety of crises and challenges (e.g. livelihood change, climate and ecosystem change, availability of resources) (Pearce et al. 2015; Berkes 2018). Therefore, the involvement of indigenous communities and their ILK are additionally relevant to promote sustainable development and environmental management, especially in rural

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areas (Brondizio and Le Tourneau 2016; Lam et al. 2020a)

International conventions, such as the Aichi Targets and the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), recognize that a proper consideration of the contributions of indigenous peoples to local conservation and sustainable management of ecosystems remains as a big challenge. For example, identifying 'where' and 'how' to involve the indigenous peoples and their ILK in order to intervene in the complex system of human–environmental relations and to foster transformative changes has yet to be properly addressed. Thus, an approach based on the identification of Leverage Points (LP) offers key advantages. LP highlights where specific changes in one part of the system might potentially lead to transformative changes (Meadows 1999). The work of Meadows (1999) proposed 12 different LP to intervene in complex systems Table 1. Here we distinguish between 'shallow' LP, at which interventions are relatively easy but have limited potential to bring about transformative changes; and 'deep' LP, at which interventions are more difficult to implement but have a greater potential to foster transformative changes (Abson et al. 2017). In the case of environmental management and particularly biodiversity conservation, transformative changes are urgently needed for returning to a safe operating space (Rockström et al. 2009), and supporting the achievement of the sustainable development goals (Sachs et al. 2019).

In Colombia, the involvement of indigenous communities in environmental management is implemented within particular areas known as 'resguardos'. A resguardo is defined as 'a legal and socio-political institution of special character, conformed by one or more indigenous communities. In each resguardo, the communities have a title of collective property that offers private properties rights of use, and also a portion of land that is internally managed by an autonomous organization protected by their normative system' (Article 21 MA 1995). In this manner, we focus on the resguardos as our system of interest as they constitute an invaluable source of knowledge in relation to sustainable practices for environmental management carried out by the Colombian indigenous peoples (van der Hammen 2003).

In this study, we aim to explore how environmental government institutions have involved indigenous communities and their ILK in environmental management projects in Colombia. For this, we analysed 2212 environmental management projects from the Colombian Regional Autonomous Corporations (RACs) and applied a LP perspective to explore 'where' and 'how' these projects foster changes in the resguardos. Finally, we discuss our insights and how this work has contributed to further operationalizing the LP perspective.

Methods

Study area and context

Colombia is located in the northwestern region of South America. It has an extension of 1,141,748 square kilometers and presents a high variety of ecosystems, biodiversity, and cultures (Andrade-C 2011; IDEAM, IGAC, IAVH et al. 2017; ONIC 2020a).

Table 1. Leverage points and system characteristics.

	System characteristics that interventions can target		
Effectiveness	Type	Description	Leverage points
Shallow leverage points	Parameters	The relatively mechanistic characteristics or physical elements typically targeted by policy makers (or environmental managers in our case)	12. Constants, parameters, numbers (such as subsidies, taxes, standards) 11. The sizes of buffers and other stabilizing stocks, relative to their flows 10. The structure of material stocks and flows (such as transport networks, population age structures)
	Feedbacks	Interactions between elements within a system that drive internal dynamics	9. The lengths of delays, relative to the rate of system change 8. The strength of negative feedback loops, relative to the impacts they are trying to correct against 7. The gain around driving positive feedback loops
Deep leverage points	Design	The social structures and institutions that manage feedbacks and parameters	6. The structure of information flows (who does and does not have access to what kinds of information) 5. The rules of the system (such as incentives, punishments, constraints) 4. The power to add, change, evolve, or self-organize system structure
	Intent	The underpinning values, goals, and world views of actors that shape the emergent direction to which a system is oriented. Dominant trajectory that the system supports	3. The goals of the system 2. The mindset or paradigm out of which the system – its goals, structure, rules, delays, parameters – arises 1. The power to transcend paradigms

Based on Meadows (1999) and Abson et al. (2017).

Colombia has one of the largest populations of indigenous peoples in Latin America (Albó et al. 2009). Currently, indigenous peoples represent 4.4% of the total Colombian population (1.905.617 people) (DANE 2019), and there are more than 690 resguardos (Mosquera et al. 2016; DNP 2017; IGAC 2020) that reach a 28% of the country's territory (Mosquera et al. 2016). Currently, 28% of the protected areas in Colombia (more than 4 million hectares) are owned, managed, and governed by indigenous communities in the resguardos (PNN 2020).

Since 1991 the National Constitution of Colombia makes the engagement of indigenous peoples a mandatory condition for environmental decision-making. This has been mirrored in the Law 99/93 which promotes the creation of the Ministry of Environment and sets the institutional framework for environmental management in the country. Within this framework, the Regional Autonomous Corporations (hereafter RACs) gain particular relevance. In Colombia there are 33 RACs. They are distributed across the whole country and they receive the highest national environmental budget (Blackman et al. 2005; Sánchez-Triana et al. 2007). The RACs are a key actor to study the involvement of indigenous communities in the implementation of environmental management practices in Colombia. At the national level the Law 99/93 stipulates that the governing board of each RAC must include at least one delegate of the indigenous peoples when their jurisdiction includes resguardos, and it establishes a mandatory consultation process within the indigenous communities to assure they agree with the projects to be implemented in their territories. In addition, the National Biodiversity Action Plan (-2016–2030) (MADS 2017) also promotes the involvement of indigenous communities for a successful environmental management.

Data collection and sampling design

To understand how the implementation of environmental management policies by the RACs has involved the indigenous communities in Colombia, we collected their available environmental management projects developed between 2004 and 2015. Since 2004 each of the 33 RAC has produced Triennial Action Plans (TAPs), which aim to implement their Regional Environmental Management Plans (MAVDT 2004). We analyzed the three TAPs executed by the RACs from 2004 to 2015 (see Figure 1), which compiled all the environmental management projects developed during those years. Additionally, the RACs release a report describing the advances of all these projects included in the TAPs each year, so they can be evaluated by the Colombian Ministry of Environment. We used these environmental projects as sampling units, following four main steps Figure 1. First, we identified all the available annual reports developed by the 33 RACs between 2004–2015. Out of 396 possible annual reports, we obtained 322 reports. After reviewing the annual reports, we created a database of the project report information. Second, following Salafsky et al. (2008) classification of conservation actions (i.e., land/water protection and management; species management; education and awareness; law and policy; and livelihood,

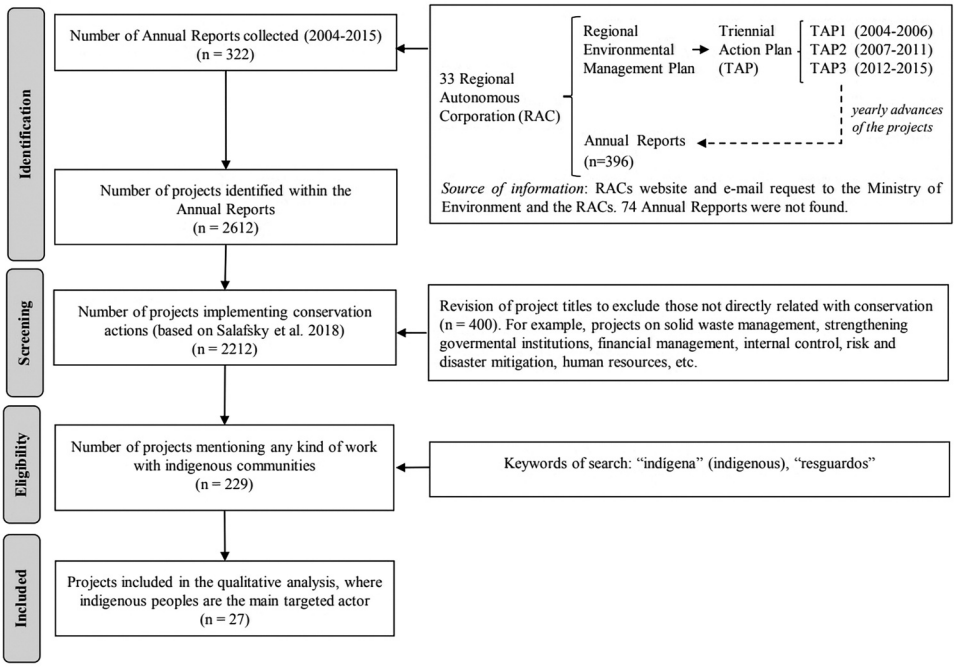

Figure 1. Data collection and sampling design as PRISMA flow diagram (based on Moher et al. 2009)

economic and other incentives), we excluded those projects not directly related to biodiversity conservation (e.g., corporate visibility, internal control or administration). Third, to identify those conservation projects involving indigenous communities, we conducted a systematic search of the relevant keywords to describe our system of interest: 'indígena' (indigenous) and 'resguardo'. Fourth, in order to have a suitable amount of data to perform the LP analysis, we identified projects having indigenous peoples as the main focus of their intervention (see Figure 1 and Appendix 1). Only the latter projects (n = 27) were analysed in this study, while projects where the indigenous peoples were briefly mentioned among a range of other actors were excluded from the analysis.

Data analysis

To explore how the RACs involved indigenous communities in environmental management, we used content analysis on each of the 27 project reports developed in the resguardos with indigenous peoples as their main targeted actor. This type of analysis involves a systematic and replicable examination of the information (in this case environmental management reports) to identify main topics, concepts or variables (Krippendorff 2004; Riffe et al. 2005; Hsieh and Shannon 2005). Content analysis is especially relevant when the terminology on a specific field is not yet well-established (Geneletti and Zardo 2016) and to validate or extend theoretical frameworks (Hsieh and Shannon 2005). Hence, this technique was useful to operationalize the LP perspective (Meadows 1999) in analysing our sample of projects. We used this perspective as a framework to explore 'how' and 'where' environmental management projects intervene in the system and which particular characteristics are addressed (i.e. parameters, feedbacks, design, intent; Abson et al. 2017) to promote transformative changes within the resguardos.

To conduct the content analysis, we operationalized the LP perspective by implementing 12 analytical questions arising from each LP and applied to each project (see Table 2). The questions were based on Meadows (1999)´s seminal work on 12 places to intervene in the system, focusing on the resguardos as our system of interest. All the questions were designed as dummy variables, i.e., requiring a yes/no answer, in which 'yes' means that we found evidence that the project is developing actions to intervene in a specific place of the system, and 'no' means that we could not find evidence in our data. To systematically review the 27 project reports, we used the qualitative analysis software 'NVivo' (www.qsrinternational) to code the paragraphs containing information related to the 12 questions. As all the projects were in Spanish, just relevant information was translated into English for this study. To triangulate the data and avoid bias in the content analysis, evidence from the projects was checked and discussed by the three main authors of this paper in an iterative process.

To define the main characteristics of the projects, we used descriptive statistics to 1) outline the number of projects developed by each RAC and the type of conservation actions implemented by them, and 2) analyze the most and least targeted LP in the projects. Afterward, we conducted a hierarchical cluster analysis (HCA) to analyze the interactions between shallow and deep LP in the projects. We used *hclust* with *complete* linkage method in the R stats 3.4.0 package to perform the HCA, applying binary distances to measure the similarity between the projects with the *dist* function (Cornillon et al. 2012). The HCA included 14 dummy variables: the 12 LP targeted by the projects, total number of deep LP and total number of shallow LP targeted by the project. Third, we used qualitative description to explore how the projects targeted different system characteristics.

Results

Main characteristics of the environmental management projects involving indigenous peoples in Colombia

Out of 2212 environmental management projects developed between 2004 and 2015 by the Colombian RACs, 10% conducted some actions involving the indigenous peoples and 1% (27 projects) involved indigenous peoples as their main targeted actor Figure 2. The latter projects were developed in 36 Colombian resguardos in 9 of the RACs, mainly in CDA (North and East of the Amazonia; 37%), CVC (Valle del Cauca; 25%), CORPONOR (Northeastern border; 11%), and CORPOCALDAS (Caldas region; 7%) (see Figure 2). In relation to the conservation actions implemented by these projects, the most common ones were land and water management actions (45% of the projects). Other projects focused on promoting economic and other types of incentives to improve livelihoods in the resguardos (e.g., strengthening agroecological traditional practices and other sustainable agricultural production systems; 21%), fostering environmental education and awareness efforts (12%) and influencing policy-making (e.g. designing and implementing Life Plans; 15%) (see Figure 2).

Shallow and deep places where environmental management projects intervene in the Colombian resguardos

The most frequently targeted LP by the projects was the 'goals of the system' (LP3, n = 20, 74%), followed by 'the mindset or paradigm out of which the system arises' (LP2, n = 17; 63%). Both are deep LP with a great potential to create transformative change. The next most

Table 2. Twelve analytical questions (and brief explanation) to explore the leverage points targeted by the 27 environmental management projects implemented in the resguardos.

Leverage Points	LP Questions (Q)	Brief explanation
12.Constants, parameters, numbers	Q12. Does the project change the number, size or quality of the indigenous resguardos?	The project increases the number, size or quality (in terms of living conditions for the indigenous peoples) of the resguardos.
11.The sizes of buffers and other stabilizing stocks, relative to their flows	Q11. Does the project establish any action to secure biodiversity conservation within the resguardos or surrounded areas?	The project fosters biodiversity conservation as a way to secure indigenous peoples´s lives and life-style in the resguardos in the long time.
10.The structure of material stocks and flows	Q10 Does the project change land use planning within the resguardos or surrounded areas?	The project develops comprehensive strategies to modify land-use distribution and management in the resguardos.
9.The lengths of delays, relative to the rate of system change	Q9. Does the project correct existing delays between the implementation of the National Constitution of Colombia (1991) -in relation to strengthening the autonomy of the resguardos- and its implementation?	The project compensates for the delays on the implementation -on the ground and through further law development- of the National Constitution of Colombia (1991). This Constitution contains a set of principles and articles oriented towards the reinforcement of the cultural diversity and autonomy of the indigenous communities. It is in the former issue, interventions strengthening the indigenous resguardos, that we coded this question.
8.The strength of negative feedback loops, relative to the impacts they are trying to correct against	Q8 Does the project establish social and environmental monitoring systems in the resguardos?	The project implements social or/and environmental monitoring systems to secure the success of the project -and its related interventions- in the long term
7.The gain around driving positive feedback loops	Q7. Does the project try to counteract some of the macro-dynamics causing environmental degradation and threatening indigenous communities territories and ways of living?	The project includes specific actions to counteract (e.g., claims against or slow down) some of the most pressing threats -related with national and international social-ecological dynamics- causing environmental degradation and threatening indigenous communities territories and ways of living (e.g., macro hydroelectrics or mining).
6.The structure of information flows	Q6. Does the project foster knowledge exchange between indigenous peoples and environmental managers?	The project promotes specific interventions to assure knowledge dialogues or exchange between the indigenous communities (who hold an ancestral knowledge on how to manage nature in sustainable ways) and the environmental managers (who hold the technical knowledge)
5.The rules of the system	Q5. Does the project try to change or influence laws, policies or social agreements?	The project promotes change or influence certain laws or policies or establish new (informal or formal) social agreements.
4.The power to add, change, evolve, or self-organize system structure	Q4. Does the project foster new institutional or organizational structures within the resguardos?	The project seeks to reinforce indigenous organizations within the resguardos or establish new strategic links between de resguardos and other institutions or programs on upper levels of environmental management (e.g., regional or national levels).
3.The goals of the system	Q3. Does the goals of the environmental project focus on improving the well-being of indigenous peoples?	The goals of the environmental management project are focused on the welfare of the indigenous peoples living in the resguardos.
2.The mindset or paradigm out of which the system – its goals, structure, rules, delays, parameters – arises	Q2. Does the project apply some concepts related to indigenous cosmovisions and ILK in its environmental management intervention?	The project applies indigenous cosmovisions and ILK to develop some environmental management interventions in the resguardos.
1.The power to transcend paradigms	Q1. Does the project apply indigenous cosmovisions and ILK as a decisive component of the environmental management interventions of the resguardos?	The project applies indigenous cosmovisions and ILK as a central component of its environmental management interventions in the resguardos, transcending the traditional top-down approaches.

frequently targeted LP were the two shallowest ones, namely, 'parameters' (LP12, n = 15; 56%) and 'the sizes of buffers and other stabilizing stocks' (LP11, n = 12; 44%). The least targeted LP were 'the gain of driving positive feedbacks' and 'the length of delays' (LP7 and 9, respectively, n = 3; 11%) followed by 'the rules of the system' and 'the strength of negative feedback loops' (LP5 and 8, respectively, n = 4; 15%) (see Figure 3).

The HCA revealed four groups of projects according to the LP they targeted and whether they combined (or not) both shallow and deep LP Figure 4. See Appendix 1 for the list of the 27 projects included in the analysis (numbered from P1 to P27) and Appendix 2 for the complete coding information. Group 1 (n = 7) clustered projects targeting just deep LP. Projects in this group considered indigenous cosmovisions and ILK into their interventions (LP1 and 2), seeking to improve communities well-being (LP3) in the resguardos. It included projects in the first stages of the formulation of Life Plans (e.g., P7 aimed to consolidate the use of Life Plans as a tool to support land-use planning strategies that consider the indigenous perspectives) and projects aimed to strengthen the environmental component in ethnic education (e.g., P21 focused on designing environmental education interventions). Group 2 (n = 3) targeted just shallow LP, mainly securing biodiversity conservation (LP11) and fostering agroecological productivity (LP12) in the resguardos (e.g. P12 focused on recovering degraded areas affected by mining activity through reforestation actions). The other two groups combined both shallow and deep LP. Group 3 (n = 7) was characterized by environmental projects targeting the goals of the system (LP3) by improving the well-being of the indigenous peoples in the resguardos. This was mainly achieved through participatory land-use planning actions (LP10) (e.g. P13 aimed to involve the indigenous communities along the Inírida River in the formulation of a management plan under the Ramsar convention). Finally, group 4 (n = 10) targeted the greater variety of LP. Projects in this group incorporated indigenous knowledge and cosmovisions as part of their intervention (LP2), commonly as a central component (LP1) and by facilitating knowledge dialogues (LP6). These projects also included actions to improve the quality of the resguardos (LP12) and foster biodiversity conservation (LP11). Hence, environmental management strategies and projects in the resguardos were designed and implemented with the communities, considering their needs and ILK (e.g., P23 facilitated indigenous communities involvement in the formulation of the Departmental Plan in Biodiversity and Ecosystem Services, which built on their ancestral knowledge on biodiversity management).

Systems characteristics targeted by environmental management projects in the Colombian resguardos

This section describes how Abson et al. (2017)´s four types of system characteristics were targeted by the

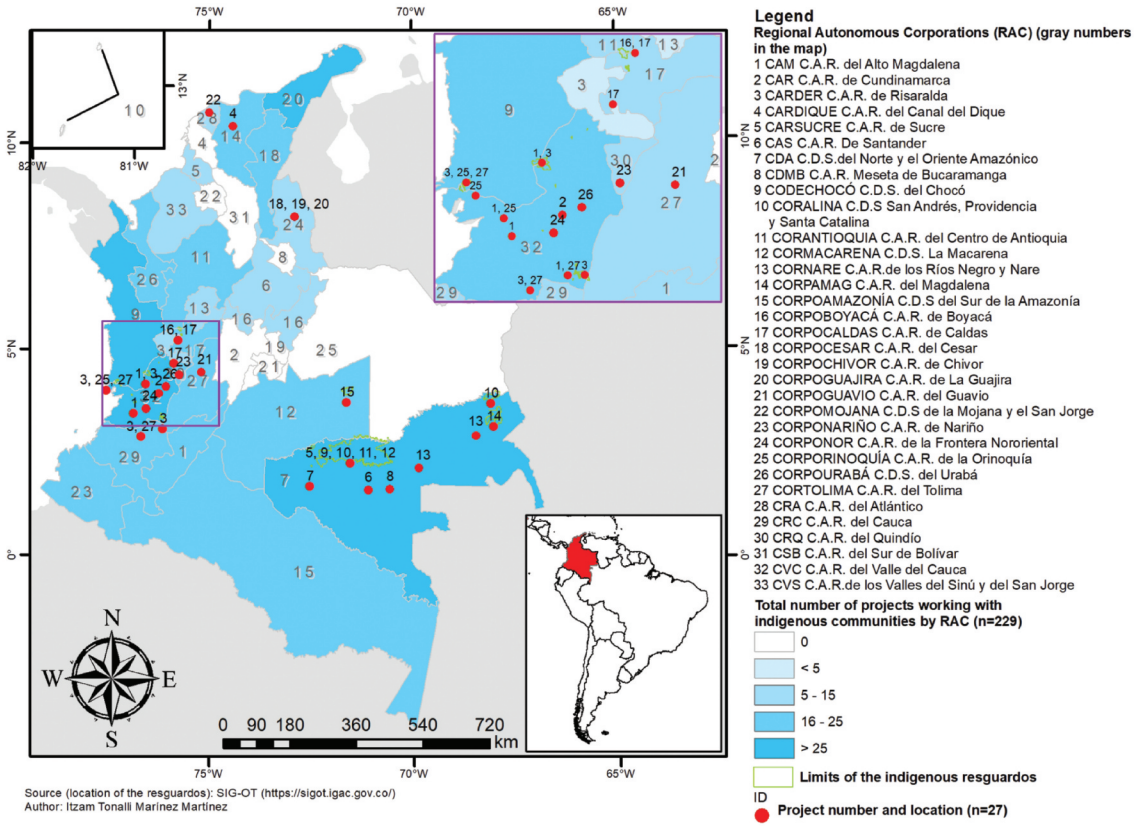

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Figure 2 continues here

ID[1]	Years of implementation[2]	Conservation actions implemented[3]	Indigenous resguardos (R), communities (C) and organizations (O) included in the projects
1	2013-2015	L/WM: restoration of river basin	R: Río Garrapatas, Kwesx Kiwe Nasa, Chachajo, Chonara Huena, Yu Yic Kwe
2	2013-2015	E&A: cultural education (in Spanish "etnoeducación") and culture	O: Association of the Indigenous "Cabildos" in Valle del Cauca (Asociación de Cabildos indígenas del Valle del Cauca)
3	2005	LE&I: sustainable use of natural resources through sustainable agricultural production systems	R: DoXura, Bania Chami, Niasa Nacequia, Río Garrapatas, Kwet Wala, Dachi Drua Monde, Kwes Kiwe Nasa, Triunfo Cristal, Puerto Pizario, Drua-Do C: del Cañon del Río Pepitas, Navera Drua, Dai kwrisia, Paila Arriba, Cueva Loca, Betania
4	2005-2007	L/WM: formulation of river basin management plans (POMCA in Spanish) L/WP: regulation of protected areas	C: Indigenous communities in the basins of the Piedras and Frío rivers (ríos Piedras y Frío), Sierra Nevada of Santa Marta (Sierra Nevada de Santa Marta)
5	2008-2011	L/WM: land use planning, fostering indigenous people return to their territories.	R: Nukak Maku
6	2011	L/WM: recovery, preservation, and environmental monitoring of the basin of Río Vaupés; formulation of other river basin management plans	O: Indigenous Union Cubea del Cuduyarí (Unión Indígena Cubea del Cuduyarí, UDIC), Organization of Central Indigenous Zone of Mitú (Organización Zona Central Indígena de Mitú, OZCIMI), Vaupés
7	2014	L&P: Life Plans (evaluation, monitoring and implementation)	R: Panuré, La Fuga, La Asunción
8	2008	L&P and L/WM: Life Plans (land use planning)	O: Indigenous resgurados of Guainía and Guaviare (Resguardos Indígenas del Guainía y Guaviare), Zonal indigenous organizations of the Vaupés (Organizaciones Zonales Indígenas del Vaupés)
9	2008	LE&I: consolidation of sustainable agricultural systems and "chagras" fostering indigenous people return to their territories	R: Nukak Maku
10	2009	L&P and L/WM: Life Plans (land use planning)	R: Nukak Makú, Paujíl C: Buenos Aires O: Association of traditional indegeous captains of Cananar (Asociación de Capitanes Tradicionales Indígenas del Cananar, ACTIVA)
11	2009-2011	LE&I: restoration of traditional chagras (a sustainable agroforestal system). Fostering indigenous people return to their territories.	R: Nukak Maku
12	2008-2011	L/WM: recovery of degraded lands by the sowing of native timber species and ecologically important species	R: Nukak Makú, Barrancon C: Huesito, Remanso, Venado, Piedra Alta, Sejalito, Zamuro, Chorrobocón
13	2013-2014	L/WM: formulation of the management plan for the Estrella Fluvial Inírida wetlands	C: Indigenous communities of the Estrella fluvial of the Inírida River (río Inírida), Guainía
14	2014-2015	L&P: Life Plan (assistance and strengthening)	R: Morichal viejo and Santa Cruz C: Remanso, Cerro Cocuy, Puerto Cumare, Puerto Pupuña, Puerto Ceiba.
15	2011	L&P: Life Plan (land use planning)	R: Vencedor, Piriri, Guamito. Matanegra
16	2014-2015	L/WM: conservation of natural resources, river basin management plans and recovery of flora and fauna	R: San Lorenzo, Escopetera Pirza
17	2014-2015	L/WM: conservation, recovery, and management of the natural patrimony	R: San Lorenzo, Escopetera Pirza, Albania, Totumal, Nuestra Señora de la Candelaria
18	2012-2015	L/WM: sustainable development programs (use and conservation of natural resources)	R: U´WA C: Karikachaboquira
19	2009	L/WM: Life Plan (protection, recovery and sustainable management of natural resources) LE&I: Life Plan (agricultural production systems)	R: U´WA
20	2005	L/WM: sustainable development programs (use and conservation of natural resources)	R: U´WA, Bari
21	2007-2011	E&A: strengthening the environmental component within ethnic education	C: Barbacoas
22	2012-2015	E&A: environmental education to protect the traditional environmental knowledge	C: Mokaná
23	2013-2015	LE&I: program in use and conservation of natural resources	O: Pueblo Embera chami
24	2008-2011	L/WM: land use planning LE&I: consolidation of sustainable agricultural production systems	O: Indigenous Regional Organization of the Valle del Cauca (Organización Regional Indígena del Valle del Cauca, ORIVAC), and Buenaventura and Sevilla minucipalities of the Asociación de Capitanes Tradicionales Indígenas del Cananar (Asociación de Cabildos del Valle del Cauca, ACTIVA)
25	2008-2009	L/WP: regulation of protected areas	R: Puerto Pizario, Santa Rosa de Guayacán, Chonara Huena
26	2010-2011	L/WM: natural resources conservation and restoration	O: Indigenous Regional Organization of the Valle del Cauca (Organización Regional Indígena del Valle del Cauca, ORIVAC)
27	2014-2015	LE&I and E&A: strengthening agroecological traditional practices in schools	R: Puerto Pizario, Nasa Kiwe

[1] Project number (ID) according to Appendix 1. See this appendix for a brief description of the projects.
[2] The years of implementation for each project have been established according to the first and last years in which an annual report was elaborated for the project (and available for us to conduct the analysis). Please, note that inconsistencies on reporting might cover up the real dates in some cases.
[3] Main conservation actions of the project based on Salafsky et al. (2008). L/WP: Land/water protection; L/WM: Land/water management; E&A: Education and awareness; L&P: Law and policy; LE&I: Livelihood, economic and other incentives.

Figure 2. Location of the 27 environmental management projects analyzed and summary information of the projects (ID, year of implementation, conservation actions implemented, and indigenous resguardos, communities and organizations involved in the project). Projects have been placed in the Colombian map according to the resguardos approximately location, based on data from the Instituto Geográfico Agustín Codazzi (IGAC, https://igac.gov.co). If not possible to define their location, they are place in the middle of the RAC. Same project might be implemented in different locations (e.g., project 13) and different projects might be implemented in the same location (e.g., projects 5, 9, 10, 11 and 12). Color of the Regional Autonomous Corporations (RAC) indicate the total number of projects implemented by the RAC that mention any type of involvement of the indigenous communities. Acronyms in Spanish: C.A.R. Corporación Autónoma Regional, C.D.S. Corporación Autónoma Regional de Desarrollo Sostenible.

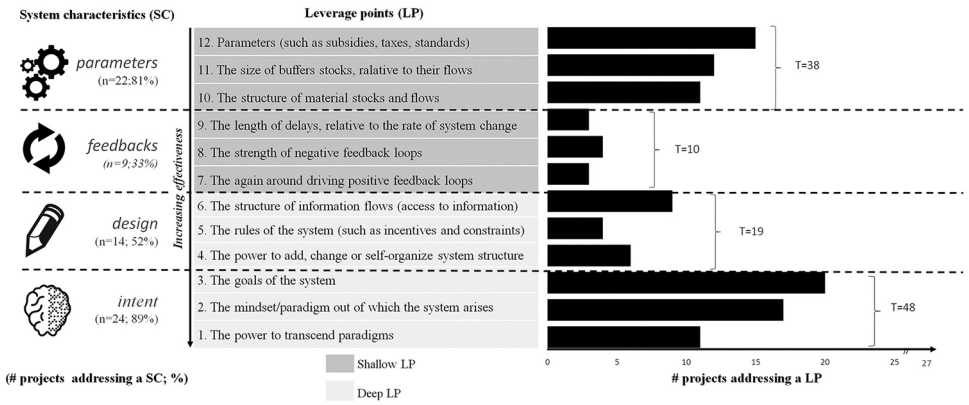
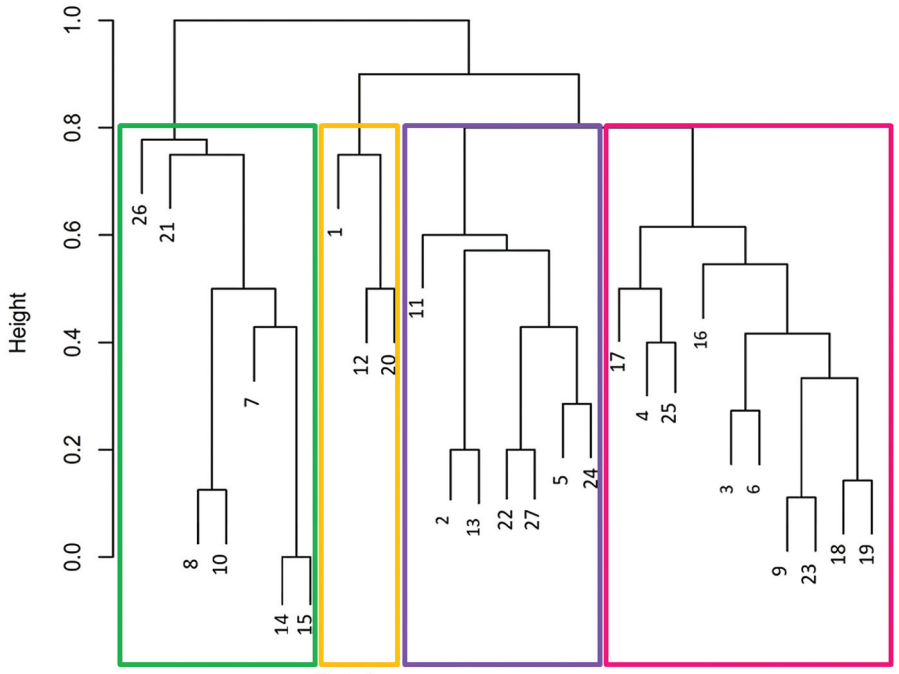


Figure 3. Number and percentage of projects (n=27) targeting the 4 types of system characteristics (Abson et al. 2017) and the 12 leverage points (Meadow 1999) . T refers to the total number of interventions in each system characteristic.

environmental management projects, in relation to Meadows (1999)´s 12 places where the projects intervened in the resguardos.

Intent of the project: embracing indigenous cosmovisions in environmental management

Out of the 27 environmental management projects analysed, 24 projects (89%) targeted LP related to the underpinning values, goals and worldviews of the system 'intent' (see Figure 3). Hence, 'intent' was the most frequent type of system characteristic targeted by the projects. It clusters the three deepest LP, in our case study related to applying and acknowledging the value of indigenous cosmovisions and ILK for sustainable environmentalt management in the resguardos. The deepest LP, 'the power to transcend paradigms', was the least common type of



	Early phases of Life Plans & ethnic education (Group1)	Fostering agroecological productivity & conservation (Group 2)	Participatory land use planning (Group 3)	ILK to improve environmental management in the resguardos (Group 4)
N. of projects	7	3	7	10
Deep LP	1, 2, 3	-	3	1, 2, 3, 6
Shallow LP	-	11, 12	10, 12	11, 12
Presence of both Shallow & Deep LP	No	No	Yes	Yes

Figure 4. Hierarchical Cluster Analysis (HCA) of the 27 environmental management projects analyzedaccording to the 12 leverage points (LP) targeted by the projects and the presence (or not) of bothshallow and deep LP. LP describing the groups have a median and mean ≥ 0.5.

LP under 'Intent' (11 out of 48 intent-related LP1; 23%). This LP was targeted by projects implementing bottom-up interventions in the resguardos, rather than more traditional top-down approaches to project design and, decision-making in environmentalt management. Hence, the interventions were solely driven by the indigenous peoples´ knowledge and cosmovisions (Q1), mostly by designing or implementing Life Plans (n = 7), i.e., 'a plan made by indigenous peoples in an effort to maintain traditions, customs, and the hope of having a society with its own identity based on the traditional knowledge of its people' (P15). Life Plans deeply transcend traditional management paradigms, being:

> "key to advancing the institutional commitments and duties of the state regarding environmental management, which must be supported by bottom-up processes, where the autonomy of indigenous peoples is strengthened, based on their definition of their own development and with it, the strengthening of environmental planning" (P8).

Other projects also showed a deep change in their perspectives by considering some indigenous cosmovisions and knowledge in their environmental practice (Q2; 17/48 intent-related LP; 35%). For example, designing a land-use planning strategy based on the ancestral indigenous visions (P4) or reconverting productive systems in the resguardos based on the establishment of 'custodios de semillas' (seeds custodians) and medicinal and artisanal orchards (P16). Finally, almost half of the intent-related LP targeted by the projects focused on changing the goals of the system (20/48; 42%), namely, developing and implementing conservation strategies that engage with the well-being agendas of the indigenous communities (Q3). For example, conservation interventions based on the restoration of traditional chagras (P9), a shifting agriculture system practiced since pre-Columbian times (Fonseca-Cepeda et al. 2019)

Design of the project: fostering new organizational structures, social agreements and knowledge exchange

'Design' was targeted by 14 projects (52%; see Figure 3). 'Design' relates to new organizational structures and institutions with the agency to manage shallower LP. In the context of environmental management in the resguardos, it referred to new organizational structures (LP4) and social agreements (LP5) within the indigenous communities or between the projects and other actors/processes outside the resguardos. It also referred to the spaces created for knowledge dialogues between environmental managers and indigenous peoples, to improve environmental management practices by considering indigenous cosmovisions and knowledge (LP6). The latter LP was the most frequent within this group (Q6; 9 out of 19 design-related LP; 47%). Most projects described it as conversations (P5), 'mesas' (discussion tables; P4, P13 and P17) or knowledge exchange (P9); however, information regarding the processes underpinning the knowledge dialogues was scarce.

In relation to fostering new organizational structures (Q4; 6/19 LP; 32%), interventions focused on both reinforcing indigenous organizations in the resguardos and developing collaboration strategies at different levels to strengthen the impact of the projects. For example, organizing a regional encounter to exchange experiences and build a common agenda (P17). The creation of new social agreements (Q5) was the less targeted type of LP in this group (4/19; 21%). P11 fostered 'regional and local humanitarian dialogues and agreements to avoid the presence of armed actors' in the resguardos. Changes in laws or broader policies were not addressed by any project (Q5).

Changing feedbacks: counteracting major threats to the indigenous communities and their territories

The interactions between the elements of the system driving internal dynamics, i.e., 'feedbacks', was the least targeted system characteristic by the projects (n = 9; 33%). This group clusters LP 7 to 10 (see Figure 3). LP7, 'reducing the gain around driving positive feedback loops' describes self-reinforcing feedback loops where 'the more it works, the more it gains the power to work some more' (Meadows 1999, p. 11). In our study, it refers to interventions counteracting the major hazards threatening the resguardos and their indigenous communities (Q7; 3 out of 10 feedback-related LP; 30%). For example, in P23, the RAC ratified the decision of the Departmental Government to reject large-scale mining 'as an accompaniment to the legacy promoted by indigenous peoples'.

The 'strength of negative feedback loops' (a self-correcting feedback loop) and the 'length of the delays' of the feedback loops (LP 8 and 9, respectively) were the least targeted of this group, and generally, the least targeted LP by the projects. In our study, they refer to the social or ecological monitoring systems implemented by the projects (Q8; 4/10 LP; 40%) and the actions to counteract the delays on indigenous rights law's implementation (Q9; 3/10 LP; 30%). The latter actions consisted on fostering indigenous autonomy, which we considered as a counteracting action to the delay on the implementation of the National Constitution of Colombia (National Constitution of Colombia, 1991) to convert the resguardos into indigenous territorial entities. These territorial entities aim to give more political and administrative autonomy to the resguardos. While some project reports stated their willingness to support the indigenous autonomy and identity; how these processes were developed was not described in detail. For example, P8 emphasized the key role of Life Plans to strengthen the autonomy of indigenous peoples.

Adjusting parameters: increasing the quality of the resguardos, land-use planning and biodiversity conservation strategies

Twenty-two out of 27 projects (81%) focused on changing the mechanistic or physical characteristics of the system, i.e., 'parameters'. This group clusters the shallowest types of LP (see Figure 3), and it was the second most frequent type of system characteristics addressed by the projects. In this study, 'parameters' referred to land-use planning strategies (Q10; 11 out of 38 parameters-oriented LP; 29%), biodiversity conservation strategies (Q11; 12/38 LP; 32%) and improving the quality of the resguardos (Q12; 15/38 LP; 39%). For example, P12 implemented an environmental management plan to recover deforested and degraded areas of forest within the resguardo. This project aimed to improve indigenous well-being and foster biodiversity conservation. P3 implemented agroecological productive systems and built a system for disposal, collection and treatment of domestic wastewater generated by the indigenous community. Just two projects focused on increasing the number of indigenous peoples in the resguardos by fostering the return of the displaced indigenous peoples to their native land (P9, P11).

Discussion

The involvement of indigenous peoples is crucial for the success of environmental management (Brondizio and Le Tourneau 2016; Mistry and Berardi 2016) and environmental conservation (Thaman et al. 2013). However, our results show that indigenous peoples have hardly been involved in the environmental management projects led by the Colombian RACs (only 10% considering 2212 identified projects) and just a small percentage of these projects involved them as the main actors of the intervention (1%). This depicts a gap between the guidelines defined by the government and its current implementation in the resguardos by the RACs.

By applying the LP perspective, we analyzed 27 environmental management projects from the Colombian RACs that involve indigenous peoples as their main targeted actor. In the following section, we discuss 1) the LP addressed by the environmental management projects implemented by the RACs, 2) argue why applying ILK can potentially be a leverage for stronger human-nature connectedness in environmental management and, 3) discuss the methodological approach of our study and its potential for research on environmental management.

Places to intervene in the resguardos

In sustainability transformations research there is a growing interest in understanding how shallow and deep interventions occur and interact in different contexts (Fischer and Riechers 2019). Current sustainability interventions often target the shallower LP, a common strategy adopted by policy makers and managers as they are easier to address despite their limited potential for transformative change (Abson et al. 2017; Dorninger et al. 2020). Our results show a different tendency for the environmental management projects involving indigenous peoples as their main actor. Both shallow and deep LP were frequently targeted within the projects, combining deep interventions with more concrete actions in two different ways. On the one hand, projects focused on participative land-use planning were less frequent, despite participative actions being highly promoted by the environmental management practice in Colombia (e.g., watershed management plans include since the first stages of public consultation a diagnosis involving the affected communities). However, Burgos-Ayala et al. (2020) highlighted the lack of information about the participation processes conducted by the projects implemented by the RACs in their annual reports. The limited reporting is an obstacle to improve the participation praxis and therefore to secure the proper involvement of the indigenous peoples in land-use planning. On the other hand, projects focused on implementing environmental management interventions were more frequent. Those were based on the local knowledge and cosmovisions of the indigenous peoples (suggesting changes in deep LP) and securing proper life conditions in the resguardos (shallow LP). Rodriguez (2017) reported similar experiences from Venezuela, where regional fire management practices were based on ILK through dialogues between indigenous communities and environmental managers. This type of projects seek to agree upon and implement common agendas, which is a key strategy to navigate complex anthropogenic-related environmental problems (Rodriguez 2017; Hartel et al. 2019); and might reflect a higher transformative potential. Nevertheless, although that kind of project was the most common group in our analysis, this group was composed by only a small number of projects (n = 10). These results suggest that there is still a great need to overcome the trends on environmental management and policies, which usually tend to suppress non-scientific forms of knowledge of nature rather than bridging ILK with scientific knowledge (Rodriguez 2017). Additionally, further research would be required to evaluate whether deep transformative changes were actually promoted within the resguardos as a result of these projects.

Although we found projects targeting only deep or only shallow LP, these were less common. When targeting only deep LP, we found projects on the first stages of development, setting their approaches for involving indigenous peoples and their knowledge (including environmental education strategies) rather than implementing specific interventions. Acting on deep LP has higher transformative potential, but also seems to be insufficient in practice, where more concrete steps need to be taken (Fischer and Riechers 2019). For example, it

is not enough to foster indigenous peoples' involvement in conservation, if there are other basic needs and issues to be secured and addressed in the resguardos, e.g., food security, violence, forced displacement and, as recently occurred, Covid-19 vulnerability and associated risks (Brondizio and Le Tourneau 2016; ONIC 2020b). However, it is likely that in the future these projects will address shallower LP as part of more specific interventions jointly agreed with the indigenous communities and, therefore, enhancing their transformative potential. In contrast, only three projects targeted exclusively shallow LP, and it is unlikely that they will generate deep transformations in the resguardos.

Our results also found that environmental projects that involve indigenous peoples targeted few feedback-related LP. First, despite the relevance of understanding social-ecological feedbacks operating in a system, this information was not explicitly described in the environmental management reports. For example, in relation to the correction of the delays in law implementation, no information was found directly referring to this issue. But some interventions did focus on strengthening the autonomy of the resguardos, which might pave the way for a smoother implementation of the indigenous territorial entities (Article 287 of the National Constitution of Colombia), a territorial unit specifically oriented towards the reinforcement of the indigenous resguardos. Second, in relation to counteracting macro system dynamics threatening the resguardos, this is a positive feedback loop in which more degradation processes in the resguardos, leads to less rights for the indigenous peoples living in these areas, which leads to more environmental degradation in these areas. García et al. (2018) provide an example of this positive feedback in the case of carbon extraction in the Sierra Nevada of Santa Marta. This extraction is affecting the environmental quality of this territory, modifying the right to have clean water, as well as altering this sacred place of connection with the Mother Earth. In this sense, we found some projects counteracting these destructive dynamics (hence targeting positive feedback loops) by, for example, rejecting large-scale mining in the resguardos (P23). In some regions, decision-makers have agreed to adopt actions against these macro-level dynamics; however, it is unknown how the implementation of such actions might happen and their possible effectiveness. Moreover, reports do not elaborate on the complex governmental environmental and economic measures that might be operating in the resguardos, e.g., to give certain portions of land to the indigenous peoples, but approving mining projects in the same lands, simultaneously.

ILK as a leverage for human–nature connectedness in environmental management

Applying ILK in environmental management can be a leverage for human–nature connectedness. Berkes (2018) describes ILK as a knowledge–practice–believe complex about the relations between living beings and their environment. Therefore, we argue that the application of ILK can advance environmental management by drawing on knowledge that has been developed over generations. ILK has a strong relation to nature and has insights in dealing with human–nature connectedness. Thus, we see two main reasons for this.

First, ILK can add the relational perspective to environmental management. Berkes (2018) describe that indigenous peoples often do not have a word such as 'management' with regard to nature. Instead, the words 'reciprocity', 'respect', and 'stewardship' may be more applicable. These three examples show an inherently relational character of interacting with nature and they can inspire relational approaches in environmental management (Enqvist et al. 2018). Restall and Conrad (2015) conducted a literature review on human–nature connectedness and its relevance for environmental management, which shows that our understanding of and research on this topic is still somewhat limited. A look at the papers that they have reviewed indicates that almost none of them explicitly focused on the relevance of ILK. ILK has the potential to inform intercultural environmental management approaches that reconnect people to nature by contributing a relational perspective that emphasis care. Care refers to the feeling of people being attached and responsible that can underpin environmental management approaches, especially in stewardship literature (Enqvist et al. 2018).

Second, ILK can inform new approaches in environmental management. Brondizio and Le Tourneau (2016) argue that the application of ILK in environmental governance can lead to a more effective management, if national goals (e.g., Colombian Biodiversity Action Plan 2016–2030, MADS 2017) and international commitments (e.g., Aichi Targets) are reconciled with the needs of indigenous peoples and their cultural perspectives. One example is the involvement of the Pemon indigenous peoples in the environmental management of the Canaima National Park, Venezuela. The ILK from the Pemon indigenous peoples has informed a counter-narrative on how the local use of fire changes the landscape, which led to the development of an intercultural fire management approach (Rodriguez 2017).

Therefore, ILK about the environment can add a relational perspective to environmental management projects, which can lead to new approaches in such projects. Increasing the involvement of indigenous peoples and their ILK in environmental management projects, such as in the resguardos of Colombia, might therefore promote the consideration of the human–nature connectedness during the design and implementation of projects.

A leverage points perspective in environmental management

In sustainability science, applying an LP perspective has demonstrated to be a useful tool to generate new insights in diverse contexts. For example in the context

of gender equality and human well-being among small-scale farmers in Ethiopia (Manlosa et al. 2019), amplification of impact from local sustainability initiatives driven by non-governmental organizations in Southern Transylvania (Lam et al. 2020b), or improving coexistence between humans and large carnivores in Europe, Asia and South America (Hartel et al. 2019).

In this study, we presented a new contribution to the operationalization of the LP perspective in sustainability science by using it to analyze environmental management projects from the RACs in Colombia that intervene in indigenous territories. We have developed a practical approach for a systematic and contextual analysis of the different LP (or places) that environmental management projects can address while working with indigenous peoples in projects that intervene in their territories. This practical approach is based on 12 contextualized questions, which we derived from the 12 LP defined by Meadows (1999). The questions were used to analyze environmental management reporting documents. Even though currently, we have only tested this approach to analyze environmental management projects in the context of Colombian resguardos, we see its potential to be adapted to other contexts to analyze and design future environmental management projects.

Our operationalization of the LP perspective might be useful in two different but complementary ways. First, by providing a systemic, structured, and theory-driven way to analyze and critically reflect on environmental management projects that intervene in indigenous territories. This potentially reveals, from a scientific perspective, whether environmental management projects follow a shallow LP approach (e.g. change the size of a resguardo) or take a deep LP approach (e.g. the project explicitly recognizes the value of the knowledge and cosmovisions of the indigenous peoples as a decisive component in environmental management) while fostering change in indigenous territories. Second, by providing guidance to design and develop future environmental management projects that are sustainable, inclusive, and equitable. Our approach can be used to develop future environmental management projects that have a deep LP approach. For instance, by developing environmental management projects together with indigenous peoples and considering their knowledge, experiences, practices, and cosmovisions as equally relevant.

The potential weakness of our approach is that it builds on the analysis of available information reported by the environmental managers, which might skew the results of the analysis. Previous work conducted by our research team using environmental management reports in Colombia has shown the lack of systematic organization and description of the information. For example, with many projects lacking a proper definition of their goals or specific objectives (Burgos-Ayala et al. 2020). Finding the environmental reports among the various involved governmental institutions was another obstacle to overcome: out of the 396 annual reports (presumably) developed between 2004 and 2015 (12 years x 33 RACs), only 322 were found. Weak reporting and lack of proper evaluation in environmental projects have been widely acknowledged (e.g., Jiménez-Aceituno et al. 2014; Zorrilla-Pujana and Rossi 2014; Burgos-Ayala et al. 2020). Furthermore, the environmental management reports show only the governmental perspective on the projects and their outcomes. They do not provide any information from the indigenous peoples concerning their participation, the actual project development, implementation or outcomes. In addition, it is unclear how these projects have been experienced by the indigenous peoples, how the power relations between governmental implementors and indigenous peoples have operated, and if the outcomes are perceived positive from their perspective and worldview. These reports are focused on describing their specific tasks, activities or measurable results (as shown by the high quantity of interventions changing 'parameters'), but there is a lack of information on how the processes are developed.

Concluding remarks

Indigenous communities have a close human–nature connectedness. They hold traditional, environmental, and local knowledge which is increasingly recognized as a valuable contribution to sustainable environmental management. In this sense, it is important to promote the integration of ILK from an early stage in the design and implementation of environmental management projects that intervene in indigenous territories, such as the resguardos in Colombia. In this study, we argue that a LP perspective has a great potential for providing a structured way to improve the design of different territorial interventions (e.g. environmental management projects) based on a sustainability approach. At the same time, the LP perspective might also support a more critical assessment of environmental management projects in terms of their ability to effectively drive transformative changes in the targeted system by differentiating between interventions that target 'shallow' or 'deep' LP.

In the case of environmental management projects from Colombia, our results suggest that there is an interplay between interventions that target shallow and deep LP, mainly associated to the 'parameters' and the 'intent' of the system. However, interventions in deep or shallow LP independently, have less potential for transformative change, unless additional actions are implemented. For instance, concrete actions related to food security, violence or forced displacement in the resguardos in the case of interventions targeting deep LP and, environmental management based on the ILK in the case of interventions

targeting shallow LP. Despite the requirement of indigenous involvement in environmental management in Colombia, there is a considerable gap between the government guidelines and the practical implementation. We strongly suggest a collaboration between policy, science, and indigenous peoples that is able to include the current evidence for enhancing the environmental management practices, as well as the design and assessment of environmental management projects intervening in territories of indigenous communities in Colombia.

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