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REVIEW

Interdependencies between Indigenous peoples, local communities, and freshwater systems in a changing Amazon

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Abstract

Globally, Indigenous peoples and local communities (IPs and LCs) are fighting for the recognition of their knowledge and decision-making authority in freshwater conservation. In the Amazon, decision-making around freshwater management and conservation has often overlooked Indigenous and local knowledge (ILK) and the connections between sociocultural and freshwater systems. We explored interdependencies between IPs and LCs and freshwaters in the Amazonian region through a narrative review of the academic peer-reviewed literature. The review process involved 2 phases: an initial scoping phase, which included the analysis of a large number of articles to identify main topics and develop research questions, and the review of a subset of 187 articles published from 2018 to 2022. We found that 178 studies were carried out in the Brazilian, Peruvian, and/or Bolivian Amazon, and 26 studies were conducted in other countries. A total of 60 studies focused on riverine communities and among them, 16 Indigenous groups were mentioned in 51 articles. Most studies ($n = 148$) emphasized the connections between water quality, fisheries, food security, health, and livelihoods. There was a paucity of studies conducted by IPs and LCs that had Indigenous or local community members among the authors. Recent studies highlighted the active role of IPs and LCs in leading community-based management efforts. We found innovative freshwater conservation and management experiences led by IPs and LCs, that effectively conserved freshwater biodiversity while promoting sustainable livelihoods. Our findings support inclusive and equitable freshwater conservation policies and practices in the Amazon and beyond, by showing the crucial role of IPs and LCs in managing and protecting freshwater resources.

KEYWORDS
Amazon freshwaters, biocultural diversity, conservation, Indigenous and local knowledge, Indigenous peoples and local communities, livelihoods

INTRODUCTION

Indigenous peoples and local communities (IPs and LCs) around the world have fought for increased recognition of their knowledge, rights, and authority in decision-making over freshwater resources and for conservation ethics and policies that are truly inclusive, equitable, and fair (Parsons & Fisher, 2020; Zhang et al., 2023). A pledge for their recogni-

tion and inclusion is reinforced in recent global conservation policies, including the Kunming-Montreal Global Biodiversity Framework (CBD/COP 2022).

In the Amazon region, to date many large-scale biodiversity conservation efforts and policies have been largely based on Western academic science and technical knowledge and on terrestrial ecosystems, with limited consideration of Indigenous and local knowledge (ILK) and the interdependencies among terrestrial, sociocultural, and freshwater systems (Anderson et al., 2019; Athayde et al., 2021a; Castello & Macedo, 2016; Gullison & Hardner, 2018; Junk & Piedade, 2004). Although IPs and LCs hold worldviews and have livelihoods and knowledge intimately connected to freshwaters, these groups have often been overlooked in research, policy, and decision-making linked to Amazon conservation (Lopes et al., 2021). The rapid pace of freshwater degradation and biocultural diversity loss in the Amazon requires the development of integrated knowledge, policy, and practice that centers IPs and LCs as knowledge, language, and rights holders (Varese et al., 2021).

Indigenous peoples and local communities protect large areas across the Amazon basin, which, along with formally recognized protected areas, form biocultural landscapes and waterscapes occupied and managed under diverse territorial rights and tenure systems. Indigenous lands and territories formally that are recognized by all eight Amazonian countries plus the French Guiana overseas territory, total around 2,376,140 km^2, or approximately 27.5% of the Amazon region (RAISG, 2020). Added to officially proclaimed protected areas, they covered approximately 47.2% of the Amazon region in 2019 (RAISG, 2020) (Figure 1). These areas are shaped by the coevolution of cultural and biological diversity over time through the interplay between worldviews, languages, knowledges, practices, and governance regimes (Athayde et al., 2021a; Heckenberger, 2009; Levis et al., 2018; Neves et al., 2021). Indigenous peoples have inhabited the Amazon and interacted with freshwaters for at least 12,000 years (Neves et al., 2021). According to archaeological records, around the time of the European invasion that started near 1492, the densest Indigenous populations occupied resource-rich banks of major rivers, less dense populations lived along minor rivers, and sparse populations lived between rivers (Clement et al., 2015; Denevan, 2001; Neves et al., 2021). The presence of archaeological sites along large rivers and small tributaries suggests that a significant portion of Amazonian forests and freshwater ecosystems were modified by pre-Columbian Indigenous populations to varying degrees and at different times (McMichael et al., 2012; Thomas et al., 2015).

The wealth of worldviews, knowledge, and understandings of freshwater systems historically held by IPs and LCs is expressed through over 300 languages spoken in the Amazon today. Nevertheless, this number is a fraction of the over 1000 languages spoken upon the invasion of European colonizers (van der Voort et al., 2021). Amazonian languages embody the coevolution of biological and cultural diversity through diverse lexicons or species names; medical knowledge; identification, classification, and characterization of places, habitats, and ecosystems; and conceptualization of social-ecological processes and relationships (Athayde et al., 2021a; Cámara-Leret & Bascompte, 2021; van der Voort et al., 2021).

In this review, we focused on how IPs' and LCs' interconnections with Amazonian freshwaters have been studied and represented in the peer-reviewed literature, especially in the last 5 years (2018–2022). We sought to determine the cultural, ethnic, and geographic scope of studies conducted in the Amazon and how IPs' and LCs' voices and languages have been portrayed in the literature. In addition, we explored how IPs' and LCs' worldviews, knowledge systems, and languages may be tied to freshwater ecosystems, species, and processes in the Amazon. Through content analysis, we examined the idea of change as a cross-cutting topic and how various drivers of change intersect with IPs' and LCs' livelihoods, health, and well-being. Finally, we sought to identify examples of management and conservation of freshwater systems led by IPs and LCs that exemplify inclusive and just freshwater conservation policy and practice in the Amazon and beyond.

Defining who constitute IPs and LCs in the Amazon falls beyond this article's scope. We adopted the working definition developed for the Science Panel for the Amazon (SPA) (Athayde et al., 2021b), which was based on international laws and policy instruments, such as the 169 Convention of the International Labor Organization (ILO 169, 1989), the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP, 2007), and the United Nations Committee on the Elimination of Racial Discrimination Recommendation 34 (CERD, 2011). The last of which refers to populations of African descent. These policy instruments recognize the importance of self- and reciprocal recognition as belonging to a collective group or community; the attachment to a specific land, territory, ecosystem, or species; specific rights affirmed by particular groups to their lands and territories; and the interdependence between cultural diversity and biodiversity present in their livelihoods. Each Amazonian country has its own legislation related to IPs and LCs that has important implications for their cultural and territorial rights.

Indigenous peoples and local communities hold governance and knowledge systems that are rooted in their cosmologies and worldviews, cultural traditions, languages, and interconnections with the places and territories they traditionally occupy (IPBES, 2019). We adopted the acronym IPs and LCs to denote Indigenous peoples and local communities as separate sociocultural groups, with distinct identities and rights, as affirmed by Indigenous leaders during the 22nd Session of the UN Permanent Forum on Indigenous Issues.

Indigenous peoples in the Amazon generally belong to different ethnic groups and may or may not speak a distinct language. They may organize themselves socially under customary laws or through hybrid forms of organization, integrating their own rules and institutions with those of the non-Indigenous society. Traditional or local communities form a very heterogeneous group, which includes populations of African descent, ethnically mixed riverine communities, family farmers, and other communities whose livelihoods are often strongly connected to specific places and resources (e.g., fish, trees). Examples include riverine communities, artisanal freshwater fishers, crab

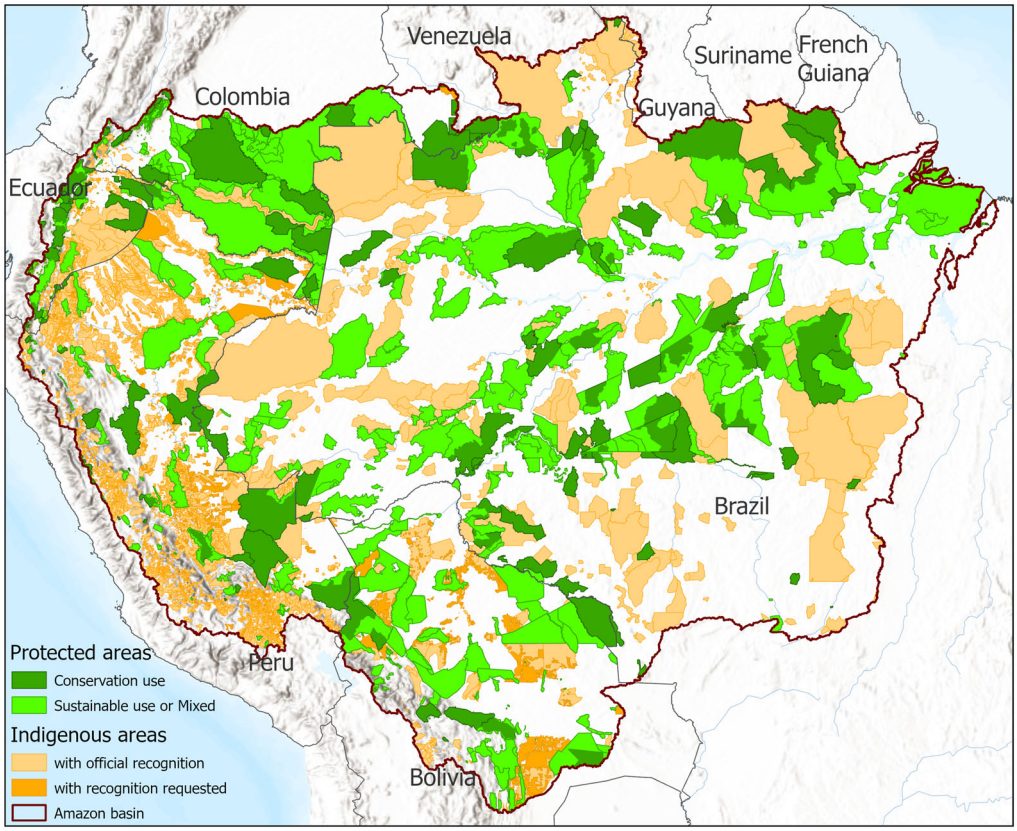

FIGURE 1 Indigenous territories and protected areas in the Amazon basin. Data layers are from RAISG (Amazon Network of Georeferenced Socio-Environmental Information) (https://www.raisg.org/en/).

collectors, rubber tappers, coconut breakers, açaí palm extractors, and others (Athayde et al., 2021b). This category can also include urban populations whose livelihoods are symbolically or physically connected to Amazonian biodiversity and natural resources. Cultural and ethnic categories are often hard to distinguish, given the extent of diversity, fluidity, and overlap within and between these groups.

METHODS

Our narrative literature review (Baumeister & Leary, 1997) was conducted in a 2-step process. All collections in the Web of Science (WOS) database were searched. In the first scoping step, we defined and tested various combinations of search terms, which resulted in different numbers of articles published from 1900 to the present (Table 1). Based on articles identified in this step, we devised questions related to our topic of interest (Table 2), identified emerging themes, and refined terms for the keyword search so as to be inclusive of the diversity of IPs and LCs in the Amazon, and of the array of freshwater ecosystems and critical issues connecting them.

In the second step, we compiled an initial dataset of 1195 publications focusing on connections between IPs and LCs and Amazonian freshwaters published from 2018 to 2022 (Table 1). We screened these articles for those that fell outside our scope and noted those to be discussed among a core group of coders and reviewers (see below), who collectively decided which articles should be removed from the main dataset. This process resulted in a refined subset of 187 articles. We then used Nvivo 13, a qualitative data analysis software, following protocols of thematic content analysis (Boyatzis, 1998; Braun & Clarke, 2013) to further examine these 187 articles. Hereafter, these 187 articles are referred to as recent articles.

For the Nvivo analysis, we determined an initial set of codes based on the main research questions and findings from the scoping phase. Code and subcode categories were defined, revised, and agreed on by a group of 4 coders (S.A., R.U., C.B., and L.V.L.) in monthly meetings. Each coder was responsible for an equal number of articles, and the coding process was regularly revisited and discussed to ensure consistency. We then analyzed and synthesized quantitative and qualitative trends from the recent articles (Table 2). The period of study and article language varied among articles.

To identify the presence or absence of IPs' and LCs' perspectives and voices in the publications, we examined the authors and their affiliations in the recent articles. We noted articles with authors who could be clearly defined as belonging to IPs and LCs groups from the Amazon region. To analyze the institutional and geographical context of articles, we noted authors' institutional affiliations. We considered countries from all the institutional affiliations given in the authors' list. Because peer-reviewed papers usually have more than 1 country listed among

TABLE 1 Search terms and results of an exploratory search in Web of Science (all collections databases) from 1900 through 2022 for articles focusing on Indigenous peoples and local communities' interconnections with Amazonian freshwaters.

Search string	Period	Number of articles
TS = ("indigenous" OR "afro-descendant" OR "riverine" OR "riparian" OR "communit*" OR "traditional" OR "local" OR "maroon" OR "mestizo" OR "caboclo" OR "ribereñ*" OR "ribeirinh*" OR "people*" OR "language*" OR "linguistic*") AND TS = ("river" OR "water" OR "freshwater*" OR "fish" OR "estuar*" OR "wetland*" OR "floodplain") AND TS = ("knowledge" OR "management" OR "governance" OR "polic*") AND TS = ("Amazon*")	1 January 1900 to 31 December 2022	2856
TS = ("indigenous" OR "afro-descendant" OR "riverine" OR "riparian" OR "communit*" OR "traditional" OR "maroon" OR "mestizo" OR "caboclo" OR "ribereñ*" OR "ribeirinh*" OR "people*" OR "language*" OR "linguistic*") AND TS = ("river" OR "freshwater*" OR "fish" OR "estuar*" OR "wetland*" OR "floodplain") AND TS = ("knowledge" OR "management" OR "governance" OR "polic*") AND TS = ("Amazon*")	1 January 2018 to 31 December 2022	1195

TABLE 2 Main questions, codes, and analyses conducted in a review of 187 articles focusing on Indigenous peoples and local communities' interconnections with freshwaters across the Amazon.

Question	Code	Calculation or approach
What is the cultural and ethnic scope and the geographic distribution of studies of IPs and LCs groups and freshwater systems in the Amazon?	Indigenous people and local community (IPs and LCs) type, country, basin, and sub-basin	frequency of occurrence of research or studies by IPs and LCs groups by Amazonian country and watershed, maps
Who are the IPs and LCs mostly represented in published research on Amazonian freshwaters, and how are their voices and languages portrayed in the literature?	IPs and LCs types; Indigenous or local authors' voices; Indigenous and local languages or expressions	word clouds and tree diagrams, types of IPs and LCs mentioned in studies, presence of IPs and LCs authors, literal quotes or languages across the publications
Based on the literature, how do IPs and LCs categorize or classify freshwater ecosystems in academic research? Are there similarities with Western science classification?	IPs and LCs taxonomy classification; Western science classification; freshwater classification; freshwater biodiversity species	frequency of studies including IPs' and LCs' classification or categorization of freshwater ecosystems, linguistic expressions; cross-tabs and matrix queries crossing IPs and LCs type with categorizations, types of freshwater ecosystem, and biodiversity species
What drivers of change and threats to freshwater systems' sustainability have been most studied in recent years, and what connections do they have with IPs' and LCs' ' rights, livelihoods, and well-being?	degradation and overexploitation impacts; climate change and disasters; colonization and migration; biocultural diversity, livelihoods, food, and health; environmental justice and IPs' and LCs' rights	word clouds and tree diagrams; frequency of studies or citation of drivers across articles; co-occurrence of topics with IPs' and LCs' voices and interests (rights, livelihood, well-being); cross-tabs and matrix queries crossing IPs and LCs type with drivers of change
What are some emerging innovations and good practices regarding IPs' and LCs' management and conservation of freshwater systems that could be strengthened and supported in conservation policy and practice?	governance, decision-making, and policies; monitoring, citizen science, participatory monitoring; transboundary issues	word clouds and tree diagrams; specific policy recommendations stemming from articles coded for the governance subtheme

author affiliations, we considered the percentage of occurrence of institutional affiliations by country.

We used the articles included in our review to examine the development of studies related to IPs and LCs and Amazonian freshwaters over time (from 1900 to 2018) and to identify the main agencies and programs that funded the research, as declared by the authors. The subdivision of Amazonian watersheds was based on the level 3 classification proposed by Venticinque et al. (2016). We used key references (e.g., relevant chapters of the Science Panel for the Amazon report [SPA,

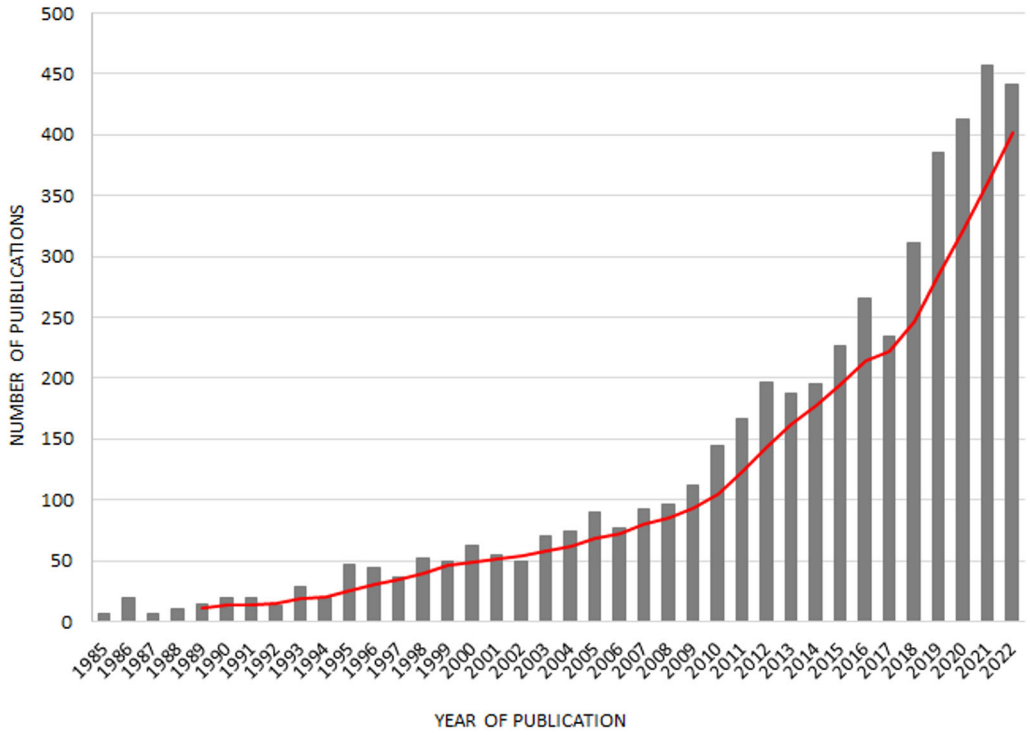

FIGURE 2 Number of publications focusing on Indigenous peoples and local communities' interdependencies with freshwater systems in the Amazon over time (red line, 5-year moving average).

2021]) in this article's introduction and discussion to delineate the scope of our review and frame our results.

We are a multidisciplinary team of primarily biophysical scientists. S.A., an environmental anthropologist, led our efforts. Our diverse backgrounds and expertise allowed us to address the topic from multiple angles. Our positionality—shaped by our academic training, professional experiences, and personal backgrounds—inevitably influenced our approach to this review.

RESULTS

The questions we devised in the first step of our review were: a) what is the distribution of publications over time by country, watershed, and ethnic or cultural groups? b) what are the perspectives of IPs and LCs regarding classification or categorization of freshwaters? c) what are the main drivers of freshwater change and what are their implications for biocultural diversity, health, justice, and livelihoods? and d) what innovations and good practices are evident regarding IPs' and LCs' management and conservation of freshwater systems? Interest and diversification of topics about connections between IPs and LCs and freshwater systems in the Amazon have varied over time. From 1900 to 2010, there was a slow increase in publications (2856 articles). After 2010, the number of publications increased at a faster rate (Figure 2).

Analyses conducted in Nvivo13 for the recent articles showed that the majority of studies were conducted in the Brazilian Amazon; most studies focused on riverine communities or Indigenous groups; many studies centered on the intersections between fisheries and livelihoods; there was a paucity of studies conducted by IPs and LCs or that included them as coauthors; the role of IPs and LCs as protagonists or coparticipants in community-based management (CBM) efforts, especially of *Arapaima gigas*, was featured; and there was an inequitable distribution of authors and institutional affiliations between the Global North and the Global South or Amazonian countries, with Brazil and Global North countries dominating the authors' geographic locations.

Scope and distribution of studies in time and space

The first article connecting IPs and LCs with Amazonian freshwaters was published in 1985 and focused on fishing among the Tukano Uanano Indigenous people of the Uaupes River in Brazil and Colombia (Chernela, 1985). Publications from the 1980s to the 1990s were often authored or led by North American anthropologists or human ecologists and focused on the Indigenous peoples *caboclo* or *mestizo'* livelihoods connected to rivers, flooded forests, riparian vegetation, or fisheries (Balée, 1989; Behrens, 1986; Chernela, 1985; 1989; Eden & Andrade, 1988; Hiraoka, 1985).

In the 1990s, there was an emergence of studies connecting ILK to Amazonian biodiversity through the interdisciplinary subfields of ethnobotany, ethnoecology, and ethnoichthyology.

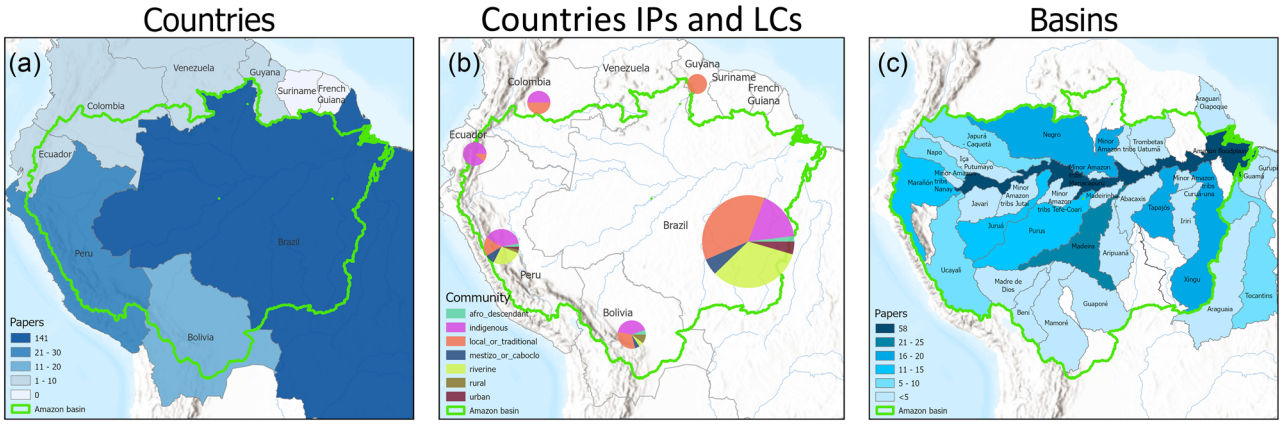

FIGURE 3 Distribution of peer-reviewed publications on Indigenous peoples and local communities' interdependencies with freshwater systems by Amazonian (a) country, (b) group of Indigenous peoples and local communities, and (c) by main basin.

During this period, publications focused mostly on flooded forest ecology and extractivism (Anderson, 1990; Hiraoka, 1999), fisheries (Batista, 1998; Fabré and Alonso, 1998), land use and socioeconomic issues (Furtado, 1993; Brondizio et al., 1994), and human-environmental health, especially mercury contamination by gold mining in Amazonian rivers (Barbosa et al., 1998; Silva-Forsberg et al., 1999). At the end of the 1990s, the first records of CBM of lakes and fisheries agreements were documented for the Amazon (Etchart, 1997; McDaniel, 1997; Tuomisto & Ruokolainen, 1997; Turner, 1993; Padoch & Steward, 2011). These studies highlighted the importance of ILK for freshwater conservation in the Amazon.

The 2000–2010 decade was marked by an increase in publications and diversity of topics considered under IPs and LCs and freshwater themes, including a growth in authors from Amazonian countries. The topics included socioeconomic dynamics of riverine and floodplain settlements, behaviors, and choices, including rural-urban migration (e.g., McClain & Cossio, 2003; Coomes et al., 2010; Futemma, 2009; Parry et al., 2010); ILK connected to river species and ecosystems (Batistella & Moran, 2005; Silvano et al., 2008; Sosnowska et al., 2010); fisheries agreements, comanagement and community-based natural resource management processes and experiences (Almeida et al., 2009; Castello et al., 2009; Gockel & Gray, 2009; Silvano et al., 2009; Sobreiro et al., 2010; Townsend et al., 2005); human-environmental health and mercury contamination (Pinheiro et al., 2007; Silva et al., 2009; Benefice et al., 2010); fisheries conflicts, including human–wildlife conflicts (e.g., Loch et al., 2009; Recharte et al., 2008); aquaculture (Molnar et al., 2000); and socioeconomic and institutional organization among colonists, riverine, and Indigenous communities (Adams et al., 2009; Brondizio, 2009; Pezzuti & Chaves, 2009).

For the recent articles, the geographic distribution of studies by country indicated that Brazil had the most studies (141 articles), followed by Peru (25) and the other countries (range 0–12) (Figure 3). Suriname and French Guiana were the only countries with zero publications. The Amazon mainstem was the most studied sub-basin (58 articles), followed by the Madeira (23), the Negro (20), the Tapajós (20), the Xingu (16), and others.

These findings reflect the magnitude of the Amazon River mainstem in contrast with other sub-basins. In addition, there is a concentration of urban centers along the Amazon River main stem, including Manaus and Belém (capitals of the Amazonas and Pará states), and Santarém in Brazil. These cities host important research centers and universities in the Brazilian Amazon. For Peru, the second country in the ranking, the Amazon mainstem, the Marañon (11), and the Ucayali (9) were the sub-basins with the higher number of studies, with Iquitos (Loreto department) figuring as an important location that hosts important research centers in the Peruvian Amazon. Minor basins and those located in areas with remote access were generally poorly studied.

For the recent articles, we found 361 author institutional affiliations distributed across 33 different countries (Figure 4). Most of the articles (93%) were authored by institutions from one of the 8 Amazonian countries, plus French Guiana. Brazil led with 73% of occurrences, followed by Peru (10%), Colombia (5%), Ecuador (3%), and Bolivia (2%). Guiana, French Guiana, Suriname, and Venezuela did not have any institutional affiliations connected to the authors. The results highlighted the incipient academic production and visibility of research institutions located in Amazonian, except for Brazil. Among the non-Amazonian countries, the United States led with 28% of occurrences, followed by England (18%), Canada (8%), and Norway (6%). Collaborative international author teams often involved persons from Amazonian countries collaborating with researchers from the Global North (North America and Europe), rather than with other Amazonians.

We found 600 funding agencies or sources for the 1195 articles published from 2018 to 2022. Two Brazilian research agencies, the National Council for Scientific and Technological Development (CNPq) and the Coordination for the Improvement of Higher Education Personnel (CAPES), funded 28.7% of the studies. Other agencies included the São Paulo Research Foundation (FAPESP) (3.5% of studies), the US National Sci-

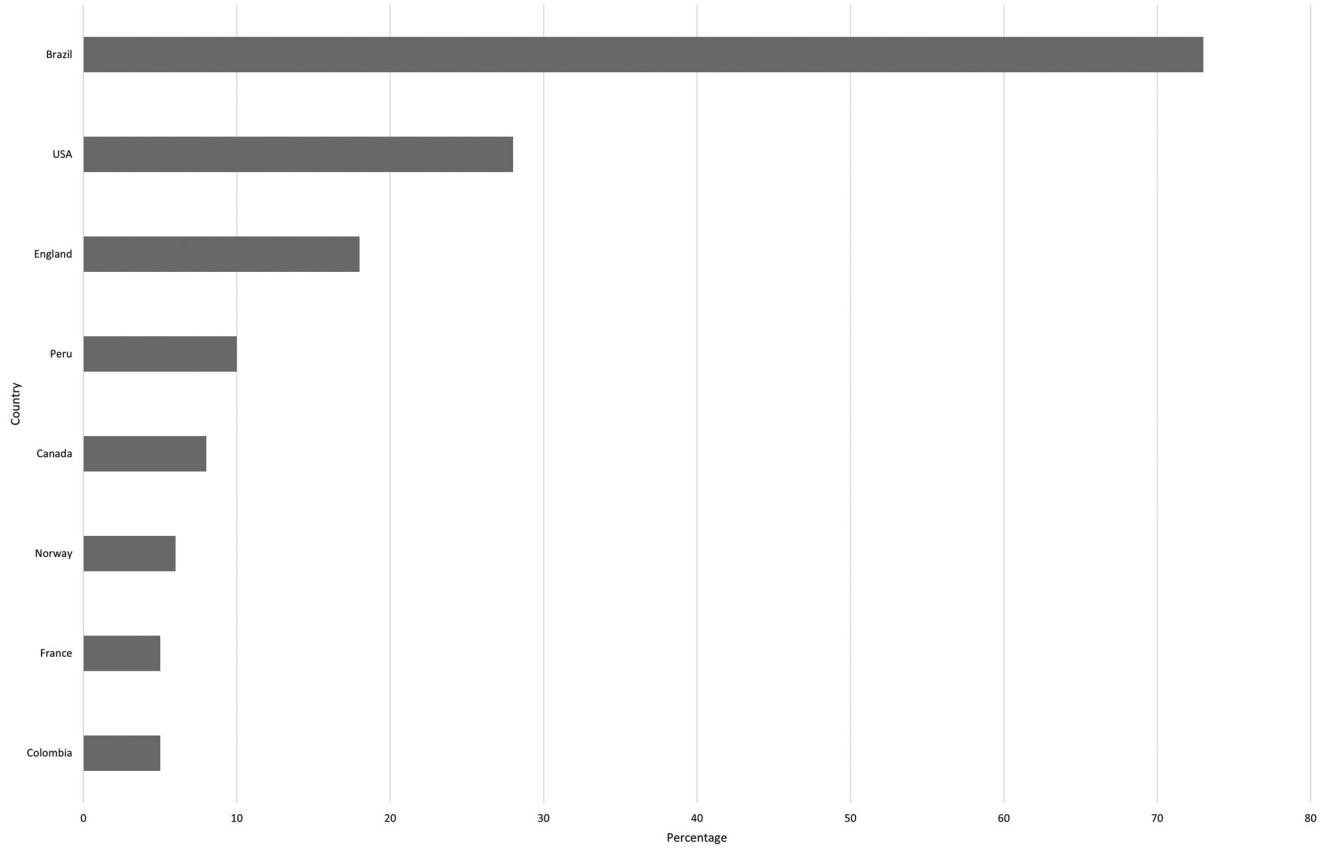

FIGURE 4 Authors' institutional affiliations (>5%) for the subset (publication date range 2018 through 2022) of 187 peer-reviewed articles on Indigenous peoples and local communities' interdependencies with freshwater systems in the Amazon.

ence Foundation (3%), and the UK Research and Innovation Fund (1.2%). Only 20 agencies were listed as funders of over 50% of the studies.

We found a heterogeneity of IPs and LCs groups described in the published literature (Figure 5). Some of these groups or categories (defined in "Methods") encompassed or overlapped with each other, making the distinction between them difficult or impossible. In some cases, the author-supplied information on funding was incomplete or missing. The majority of articles reviewed focused on non-Indigenous or mixed, undistinguished riverine communities (32.09%) and on IPs (27.27%). We found a paucity of articles referring to communities of African descent (1.60%). The distribution of articles per IPs and LCs type across different Amazonian countries followed the general pattern of occurrence of studies per country. Brazil had the most studies in all categories; 24 studies involved IPs and 50 studies involved non-Indigenous or mixed riverine communities. The country with the second greatest occurrence for these categories was Peru; 10 studies involved IPs and 7 involved riverine communities. Few to no articles focused on Venezuela, Guyana, French Guiana, and Suriname.

Non-Indigenous or mixed riverine communities had high heterogeneity, including people of different ethnic descent and cultural background. We found a variety of subcategories or designations for riverine communities, which may include place-based or resource-based designations or self-designations. Among them, Brazilian communities inhabiting riverbanks of several Amazonian rivers sometimes self-identified as *beiradeiros* (Balée et al., 2020). Artisanal harvesters of invertebrates who often work in shallow and intertidal waters sometimes self-identified as *marisqueiros* (mussel pickers) or *catadores de caranguejo* (crabbers) (da Silva Ladislau et al., 2021; Fernandes et al., 2018; Silva et al., 2020).

Worldviews, languages, and biocultural connections with freshwaters

Interconnections of IPs and LCs with freshwaters across the Amazon were diverse, dynamic, and context-based. The IPs' and LCs' distinct cosmologies, worldviews, and knowledge systems affected how sociocultural groups may categorize, use, manage, and make decisions about rivers and freshwater ecosystems and species (Moreira & Colombier, 2019; Schulz et al., 2019; Zanotti, 2018). An important academic discussion regarding these groups' interdependencies with terrestrial and aquatic ecosystems in the Amazon relates to the concept of landscape domestication. Prestes-Carneiro et al. (2021) approached the idea of waterscapes domestication from a coevolutionary perspective, discussing how Amazonian freshwaters have

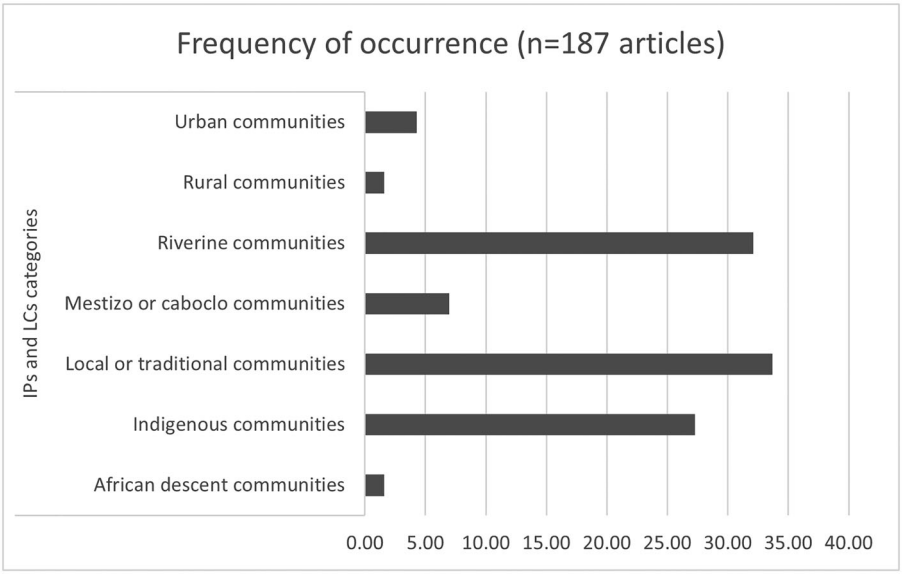

FIGURE 5 Frequency of occurrence of articles (percentage) based on different Indigenous peoples and local communities (IPs and LCs) for a subset (publication date range 2018 through 2022) of 187 peer-reviewed articles on Indigenous peoples and local communities' interdependencies with freshwater systems in the Amazon.

been coproduced through human–environmental interactions. Related to this perspective, Franco-Moraes et al. (2021) proposed a historical-ecological approach to identify and integrate sociocultural and environmental elements in the understanding of landscape transformation in the Amazon. They explained how IPs' and LCs' sociocultural aspects have influenced ecological processes to create or produce inheritances, which reflect their worldviews and associated norms, practices, and knowledge.

Only 19 of the recent articles focused on some aspect of IPs' and LCs' classification of freshwater ecosystems. These groups classified freshwater ecosystems according to several criteria, including hydrologic regime (water connection or influence), level of past or ancestral use, existence of dominating species, spiritual connections with specific species or places, or physiognomy (Schulz et al., 2019; Barros et al., 2021; Franco Moraes et al., 2019; Hoffman et al., 2021; da Silva Ladislau et al. 2021; Schmidt et al., 2021).

Studies described how IPs' views of the universe (cosmologies) and ways to perceive and relate to the world (worldviews) are based on a lack of distinction between the human, the social, the spiritual, and the natural dimensions. According to these studies, relationships of kinship, respect, and reciprocity between humans and the other-than-human world can involve coinhabiting the world with rivers, mountains, different species, and other beings (Davalos, 2020; Zanotti, 2018). According to the Shuar, Candoshi, Kichwa, and Kayapo perspectives, a person can be a relative of a deer, have a *paujil* (Curassow bird species) brother-in-law, a jaguar ancestor, or establish an interdependent relationship with a hill or a waterfall (Davalos, 2020). According to Zanotti (2018), among the Kayapo Indigenous people from Brazil, rivers and riparian areas provide a foundation for people's lifeways in a "community of coinhabitants" that includes humans, fishes, animals, plants, waters, and other nonhuman beings.

We found evidence of ILK connected to the classification of fish, aquatic species, trees, and other plant species. Riverine fishers from the Negro river in Brazil group species in "ethnospecies categories" based on morphological (color, shape), behavioral, or ecological attributes (da Silva Ladislau et al., 2021). Riverine communities from Porto de Moz in the lower Xingu river of the Brazilian Amazon classify the manatee in 3 main ethnospecies according to their color or amount of fat (Hoffman et al., 2021). Residents of the Sitiruba Island in Brazil have a sophisticated system of classification of the Miriti palm (*Mauritia flexuosa*, also known as *buriti* in Portuguese or *aguaje* in Spanish) based on age, color, shape, and flavor (Barros et al., 2021).

Schulz et al. (2019) studied the classification of peatland and wetland ecosystems by the Urarina Indigenous community in the Peruvian Amazon and reported they recognize eight ecosystem types and use multiple criteria to classify these freshwater-based ecosystems. These may include abiotic factors, such as the hydrologic regime (especially floods), soils, and topography, and biotic factors, such as individual palm and tree species (which according to the authors can be understood as cultural keystone species), and vegetation physiognomy. This study also showed the cultural and spiritual importance and values of freshwater systems held by the Urarina and how these values may inform management and conservation practices. For example, the Urarina believe that the "mother" of the ecosystem (*leuuaku*) is an anaconda (*Eunectes* spp.), an important cultural keystone species considered sacred among many Amerindian groups (Franco Moraes et al., 2019; Schulz et al., 2019). Spirits have supernatural powers and may be typically feared for their evil character and tricks, but they are also seen as defend-

ers, masters, or owners of their specific ecosystem or species. They may serve as deterrents for environmentally unsustainable behavior, such as the overharvesting of natural resources or hunting (Fernández-Llamazares & Virtanen, 2020).

We found a paucity of linguistic studies connecting different peoples and ethnicities with rivers and freshwater ecosystems in the recent articles (22 articles coded for languages and linguistic diversity). This sparseness could indicate a gap of knowledge or a disciplinary gap or that the WOS database did not include a significant number of linguistic-related articles in specific knowledge fields. The articles we examined pertained to 16 Indigenous ethnicities (linguistic stock or language family in parentheses): Baniwa (Aruak); Ikpeng (Karib); Jamamadi (Arawá), Kawaiwete, Kokama and Wajãpi (Tupi-Guarani); Kayapó and Kisêdjê (Jê); Kichwa (Quechua, 4 branches); Maijuna and Tukano (Tucano); Munduruku and Sateré-Mawé (Tupi); Shuar (Jivaro); Tikuna (Tikuna); and Urarina (Urarina). Of the 22 articles coded for languages and linguistic expressions, only 5 explicitly included Indigenous persons as authors (Franco-Moraes et al., 2019; Jackson et al., 2022; Munduruku & Chaves, 2020; Pimenta et al., 2018; Schmidt et al., 2021).

Many terms and expressions were used to name, describe, or classify biocultural connections related to stories, myths, places (toponymy), ecosystems, species, climatic phenomena, or sociocultural activities connected to freshwater ecosystems. Table 3 contains a collection of expressions tied to the Amazonian freshwater systems we found. Some expressions were used to describe collective activities or reciprocal connections between communities and among communities and rivers, habitats, or species. These expressions sometimes included values or moral principles associated with religious practices or spiritual connections with freshwater ecosystems, species, or rivers (Moreira & Colombier, 2019; Schulz et al., 2019; Almudi & Sinclair, 2022). For example, among the Tikuna people living around the transboundary area between Brazil, Colombia, and Peru in the western Amazon, the term *ajuri* is used to refer to community gatherings or task forces to rebuild houses destroyed by climatic or catastrophic events, such as flooding (Almudi & Sinclair, 2022). Other expressions used by riverine communities are neologisms or new words and expressions originating from Indigenous languages or a hybridization between Indigenous languages and dominant colonial languages (e.g., Spanish and Portuguese). The *aguajales*, aSpanish word used to designate *Mauritia* spp. palm clusters refers to freshwater peatlands, which are economically, ecologically, and culturally important across the Amazon. The Urarina Indigenous people and mestizo riverine communities in Loreto, Peru, have a rich nomenclature to designate various types of *aguajales* and *aguaje* fruits according to their characteristics and uses (Schulz et al., 2019). For the Urarina, aguajales are also sacred places, connected to their creation myth (Dean, 1994 in Schulz et al., 2019).

In the Loreto region of the Peruvian Amazon, Moreira and Colombier (2019) describe linguistic expressions used by the Kukama Indigenous people that reflect their cosmological and social organization connected to rivers and underwater worlds. For example, the Kukama fishers of Marañón river refer to the *quirumas* (wood trunks buried in the river channel) as fish houses. They also talk about cities located in the subaquatic world, where fish build homes and develop sociability networks with other-than-human beings, such as the *karuara* or *yacuruna* (water people), the mermaids, and the *purawas* (mother anacondas). The word *iya* (literally translates to *heart*) is also a metaphoric expression of something central or in the center, and it is used for some river names in the Peruvian Amazon, including Samiria (center of the small leaf), Pacaya (center or agouti's heart), and Ucayali (house-heart or heart of houses).

Livelihoods, health, and well-being in a changing Amazon

In the recent articles, a variety of factors drove social-ecological change and affected IPs' and LCs' livelihoods, human-environmental well-being, and health across the Amazon. These include mainly changes in policies and violations of IPs' and LCs' rights (37 articles); infrastructure development, with a special reference to hydropower (41 articles); extractive activities, such as mining and oil extraction (33); illegal activities and wildlife conflicts (36); deforestation, degradation, pollution, and ecological changes in floodplains and other ecosystems and aquatic species (mainly fish) (32); and climate change (22). Studies also highlighted IPs' and LCs' leadership in resisting and managing degradation and overexploitation of freshwater ecosystems and species through strategies that included regional coordination and multiethnic governance (e.g., Rice 2022), as well as various community-based efforts.

The main driver of change identified in 41 articles from 2018 to 2022 was hydropower development. Special reference was made to the Madeira and Xingu River dams (Santo Antônio/Jirau and Belo Monte, respectively), which have contributed to river fragmentation and led to a variety of impacts on fisheries and IPs' and LCs' livelihoods in upstream and downstream areas (Arantes et al., 2022; Araujo et al., 2020; Doria et al., 2021; Santos et al., 2020). Recent studies related to impacts on fisheries have contributed to the understanding of downstream effects of hydropower plants (Baird et al., 2021; Runde et al., 2020; Santos et al., 2018). Studies also spotlighted the invisibility of IPs and LCs in decision- and policy-making related to hydropower planning and implementation and their role in resisting and claiming their rights in response to socioenvironmental injustices and rights violations (Doria et al., 2021; Freitas et al., 2020; Munduruku & Chaves, 2020; Walker and Simmons, 2018).

Studies reporting changes in fisheries included descriptions of changes in fish species' population, abundance, and diversity; analyses of migratory and valuable commercial fishes; and the implications of invasive species for social-ecological connectivity and sustainability (Gurdak et al., 2019; Goulding et al., 2019; Miranda-Chumacero et al., 2020; Nagl et al., 2021). Other topics related to fisheries included the overexploitation of fishery resources by urban expansion or the cumulative impacts of climate change and other human-driven processes on freshwater ecosystems (Keppeler et al., 2020). The importance of subsistence fishing in food provision and security for river-

TABLE 3 Main linguistic expressions connected to Amazonian freshwater systems based on a review of 187 peer-reviewed articles on Indigenous peoples and local communities' interconnections with freshwater ecosystems published in the academic literature from 2018 to 2022.

Indigenous people or local community group and language, when applicable	Region; country	Linguistic expression	Connection with freshwater species, ecosystems, or processes	Reference
Tikuna, (Tikuna)	upper Solimões; Brazil, Colombia, Peru	Ajuri	traditional collective work, for instance, for rebuilding houses after floods	Almudi and Sinclair (2022) Avila et al. (2021)
Riverine communities	state of Pará; Brazil	Vizinhar	sharing products with neighbors, including fish and game	El Bizri et al. (2020)
Riverine communities, (Beiradeiros)	middle Iriri River, Pará state; Brazil	acariquara tree minquartia guianensis: nem terra, nem água come …—neither earth nor water can eat it	local nomenclature for flooded forests trees, such as the Acariquara tree (*Minquartia guianensis*), referring to its sturdiness	Balée et al. (2020)
Multiethnic riverine communities	Indigenous Reserve in the corregimiento of La Pedrera in the department of Amazonas; Colombia	chagra de orilla and Chagra de isla	used to classify agricultural fields practiced on the riverbank and on temporary river islands	Cruz Gracia et al. (2019)
Kukama/Tupi-guarani	Loreto; Peru	ta uka churan, ta iya nua Uka means house and iya means heart or, metaphorically, something central	refers to the physical and spiritual spaces that form the terrestrial, subaquatic, and sky worlds	Moreira and Colombier (2019)
Kukama/Tupi-guarani	Loreto; Peru	quirumas	wood logs embedded in river beds that are considered fish houses	Moreira and Colombier (2019)
Kukama/Tupi-guarani		Karwara or Yacurunas, purawas, tsukuri	Karwara or Yacuruna Peoples from the waters and rivers Purawas—mother snake (boas) Tsukuri—boas from the *Eunectes* genus	Moreira and Colombier (2019)
Kukama/Tupi-guarani		pacaya samiria river	Pacaya—center of heart of the agouti; samiria-small leaf	Moreira and Colombier (2019)
Kukama/Tupi-guarani		ucayali river	Uka = house; iya = heart or center; house-heart or heart of the houses, in reference to the diversity of people and other-than-human beings that inhabit this region and the subaquatic world	Moreira and Colombier (2019)
Tupi language	not specified, across the Amazon	piracema	fish exist, migration or movement in the Tupi language	Goulding et al. (2019)
Riverine communities	Mamirauá sustainable use reserve, Amazonas state; Brazil	paranãs	main riverbed or channel	Pimenta et al. (2018)
Riverine communities	Mamirauá sustainable use reserve, Amazonas state; Brazil	pitiu	strong odor typical of botos (river dolphins)	Pimenta et al. (2018)
Riverine communities and Bare Indigenous communities/Nheengatu language derived from Tupi	Madeira, Solimões, Negro and Tapajós rivers; Brazil	buritizal, bacabal, umarizal (Portuguese) iwakátíwa (Nheengatu)	suffix added to the name of a dominant species that may identify a forest patch of useful species based on their traditional knowledge; Buritizal is the Portuguese reference to clusters of the Mauritia flexuosa palm (Aguajal in Spanish), an important freshwater ecosystem in the Amazon	Levis et al. (2018)
Riverine communities	city of Belém, state of Pará; Brazil	sepacuema	specific tide that occurs around 0600 every day, showing the detailed knowledge of rivers and waters by Amazonian riverine communities	Cozzi (2020)
Riverine communities	city of Belém, state of Pará; Brazil	pororoca	strong sound produced by the encounter of the river and ocean waters	Cozzi (2020)

ine communities and other Amazonian IPs and LCs was also highlighted, including analyses of the decrease of artisanal fishers' income and conflicts among fishers and other stakeholders (Doria et al., 2020; Torres-Vitolas et al., 2019).

Studies of fish and game species related to food security included those examining how changes in diets and fisheries biodiversity affect food security and consumption patterns (Begossi et al., 2018; Blundo-Canto et al., 2020; Torres-Vitolas et al., 2019). For example, Heilpern et al. (2021) found that an increased consumption of chicken and aquaculture-produced fish in response to changes in wild fisheries could exacerbate existing malnutrition in riverine and urban communities. They discussed how food security is a multidimensional issue that influences environmental justice and just aquatic conservation and governance (Lopes et al., 2021). Machado et al. (2021) discussed how Amazonian women have been disproportionately affected by changes in nutrition, with implications for social and intergenerational justice. They emphasized the role of seasonality in food production, food security, and food sovereignty among IPs and LCs. Finally, some studies discussed the role of IPs and LCs and of ILK in contributing to filling knowledge gaps and to conservation practices and policies regarding fish biology and ecology, including fish migration patterns (Nunes et al., 2019), river dolphin conservation (Filgueira et al. 2021), and fish trophic relations (Pereyra et al., 2021).

Analyses of interdependencies between human and environmental health connecting IPs and LCs and freshwaters were common in the set of recent articles considered. These included, for instance, the linked impacts that development projects, such as dams and mines, have on people and the environment. These impacts include, for instance, how mercury contamination (Miranda-Chumacero et al., 2020), oil exploitation, waterway construction, and land use change are associated with deforestation, mechanized agriculture, and cattle ranching; and affect both IPs and LCs and freshwater ecosystems, including in transboundary regions (Bauer et al., 2022; Castello et al., 2018; Doria et al., 2018; Pelicice et al., 2021). Mercury contamination from gold mining is a common problem across many parts of the Amazon (Hacon et al., 2020), affecting fishing resources and food security and contaminating local residents (Silva-Junior et al., 2018). Basta et al. (2021) documented mercury contamination among the Munduruku Indigenous people in Brazil through a multidisciplinary and interinstitutional study. Guzmán-Gallegos (2021) explored mercury and manganese contamination perceptions among Shuar Indigenous communities in Ecuador, and considered how the toxic effects of gold mining have been intertwined with the history of colonization in the region.

Few articles (6) addressed climate-change-related events, such as extreme floods and droughts and local adaptive responses. This could represent a gap in understanding about how IPs and LCs perceive and adapt to climate change, especially in connection to freshwater ecosystems. Changes in Amazon freshwater systems were also related to studies documenting water quality deterioration, including contamination (e.g., mercury) and pollution (Basta et al., 2021); hydrological changes (impoundments, changes in seasonal flood pulse, pluviosity, and river flow decrease) (Correa et al., 2020); river fragmentation as a barrier for fish migrations; and habitat change, for instance, how changes in riverscapes affect species' feeding and breeding processes (Nunes et al., 2019). Besides the ichthyofauna, chelonians are also threatened and hence a target for local management initiatives (Andrade et al., 2022).

Community-based management (CBM), governance, and conservation of freshwater systems

Several recent articles focused on the prominent role of IPs and LCs in freshwater management, governance, and conservation across the Amazon, highlighting innovations and good practices that could inspire ethical, just, and inclusive conservation practices and policies in the region (Gambon & Rist, 2018; Lopes et al., 2021; Rice, 2022; Sousa & Vieira, 2021). These practices are generally connected to institutional innovation and hybrid governance systems (reflecting a combination of traditional knowledge and practices of countries or nonprofit organizations); CBM; achieving biodiversity conservation and social well-being in sustainable-use protected areas; comanagement; citizen science and territorial monitoring of fires; oil extraction; and use of fisheries and aquatic resources (Campos-Silva et al., 2021b; Facchinelli et al., 2022; Mena et al., 2021).

Gambon and Rist (2018) described a hybrid institutional building process for natural resource governance and conservation in Bolivia connected with the establishment of the Tierras Comunitarias de Origen (Indigenous territories) and state-led protected areas. They highlighted the important role played by Indigenous movements and the coordination between Indigenous groups, mestizos, and settlers in the establishment of comanagement regimes with governmental organizations. This study showed how IPs and LCs may develop hybrid forms of formal and informal institutions, including de jure and de facto governance arrangements to "dynamically regulate the access to territory and natural resources" (Gambon & Rist, 2018, p. 36) when top-down institutional arrangements fail to fit local realities. Rice (2022:620) explored the concept of Indigenous regionalism as a "process of amalgamation of Indigenous autonomies within and/or between countries" in the Andes and Amazon, considering the enactment of plurinational states in Bolivia and Ecuador and the expansion of Indigenous organizations as essential elements for this amalgamation. Building on the experience of implementation of the Coordination of Indigenous Organizations of the Amazon Basin (COICA), the authors explain how self-determination and self-government can emerge through regional representative arrangements and organization through a bottom-up approach to configuring more just and inclusive governance systems. Linking freshwater conservation and social justice, Lopes et al. (2021) propose a "just aquatic governance framework" for the Amazon that contains 3 pillars: recognitional justice (consideration of biocultural and livelihood diversity); procedural justice (to achieve autonomy and participatory governance); and distributional justice (for fair distribution of economic benefits, and gender equity).

We identified 75 of the 187 recent articles focused on CBM of freshwaters in the Amazon. Many (22) focused specifically on fisheries comanagement. Specific topics covered included the management of small-scale fisheries affected by large infrastructure projects (Lopes et al., 2019); fish zoning strategies, such as no-take zones and catch quotas (Jimenez et al., 2021); and fishery agreements (Lopes et al., 2019). Many of these studies (16) were centered around *Arapaima* spp. (locally known as *paiche* in Spanish-speaking countries or *pirarucu* in Brazil), a valuable cultural and commercial fish species across the Amazon. *Arapaima* management is informed by fisher and Indigenous and riverine local ecological knowledge. Activities include monitoring of *Arapaima* populations that are recovering in lake systems (Campos-Silva et al., 2019; Castello et al., 2009; Gurdak et al., 2019). Besides the documented success of *Arapaima* comanagement, fisheries agreement processes for population recovery and habitat restoration (Campos-Silva et al., 2019; Gurdak et al., 2019), and collateral benefits for biodiversity across the Amazon (Campos-Silva et al., 2021a), these comanagement and CBM strategies also provide socioeconomic and social well-being benefits to the involved communities (Campos-Silva et al., 2019). Gurdak et al. (2019), based on a comparative study of *Arapaima* comanagement in 3 sites (2 in Brazil and 1 in Guyana), offered lessons learned that can guide management of *Arapaima* and other inland fisheries in the Amazon: "manage even when faced with uncertainties; monitor, evaluate, and adapt management efforts; bridge knowledge systems; foster genuine interest and cooperation of various stakeholders to ensure long-term success; and move toward an ecosystem-based approach" (Gurdak et al., 2019:2).

Other studies (10) exploring non-fish CBM initiatives (8) focused on chelonians, especially on the Amazon river turtle (*Podocnemis expansa*) and the yellow-spotted river turtle (*Podocnemis unifilis*), as important food sources and species of cultural importance to different IPs and LCs. Some studies reported monitoring of chelonian nesting areas on beaches (Norris et al., 2018, 2020; Pezzuti et al., 2018). These studies highlight the importance of studying overfishing, low-fecundity, and endangered species, as well as the importance of managing species of cultural importance to IPs and LCs (Freitas et al., 2020).

We found a paucity of articles linking CBM to flooded forests and wetlands, which are ecologically important areas with high carbon stocks that provide nursery grounds for many species. Schulz et al. (2019) explored Indigenous and mestizos uses of peatland in Peru and emphasized the importance of comanaging culturally relevant species, including palm trees such as *aguaje* (*Mauritia* spp., *buriti* or *miriti* in Portuguese). Only 6 articles mentioned citizen science, although many studies focused on CBM activities that may be considered as such. According to Correa et al. (2020), participatory monitoring and citizen science allow horizontal management of information, may reduce research costs, and can generate locally relevant knowledge in data-scarce regions.

Gender issues were addressed in 41 articles, including research with IPs and LCs women as participants, cultural differentiations, gender-based social roles, and differentiation of outcomes of management processes between women and men. There was a scarcity of articles (5) with a specific focus on gender issues. These articles addressed gender and ecosystem services linked to freshwaters among IPs in Colombia (Cruz-Gracia et al., 2019); gender-differentiated impacts of dams on female fishers (Castro-Diaz et al., 2018); female fisher's quality of life in lake regions (Souza & Vieira, 2021); gender equity and fisheries comanagement (Freitas et al., 2020); and Indigenous women's struggles during the Covid-19 pandemic (Munduruku & Chaves, 2020). Munduruku and Chaves (2020) was the only recent article with an Indigenous woman as an author.

The main topics approaching gender and fisheries (14 articles), highlighted the important role of women in artisanal fishing. Freitas et al. (2020) voiced the need to incorporate the active participation of different stakeholders in fisheries management, especially women, who are frequently neglected in fisheries management and governance.

DISCUSSION

Our goal was to identify, synthesize, and share information about how the interdependencies between IPs, LCs, and Amazonian freshwater systems have been studied, portrayed, and represented in the peer-reviewed literature, primarily in articles published from 2018 to 2022. We found that IPs and LCs have pursued complex and diverse sociocultural and economic interdependencies with Amazonian freshwaters.

The reviewed articles primarily focused on a limited number of countries, major Amazonian watersheds, and just 16 Amazonian Indigenous ethnicities, reflecting a concentrated cultural, ethnic, and geographic scope. Most studies focused on fisheries knowledge, management, and conservation by riverine communities, a category that encompasses a diversity of populations of mixed descent. Despite the inherent diversity represented in the riverine category, we noticed a general lack of more in-depth descriptions of the socioeconomic and sociocultural characteristics of these communities in many studies. Limited details about Amazonian riverine communities can propagate a misleading idea of homogeneity among them.

A handful of studies focused on IPs' and LCs' classification and categorization of freshwaters, which was found to be often intertwined with their worldviews, languages, and traditional management practices (Schulz et al., 2019). Indigenous peoples and local communities have gone through several socioenvironmental changes that have threatened or harmed their rights (dams, illegal mining, policies, etc.), health, and food security (mercury contamination, overfishing, pollution, droughts) in different ways. To face these threats and increase their authority over freshwaters, they have organized and formed important regional coalitions (e.g., COICA), and IPs and LCs have engaged in different CBM of freshwater resources, with a special emphasis on the *Arapaima* fish. These documented community-based arrangements and comanagement schemes hold critical lessons and opportunities for the research and practice of inclusive conservation and increased recognition of IPs'

and LCs' knowledge, rights, and authority in decision-making over Amazonian freshwaters.

Our results revealed large gaps in knowledge and inequities regarding IPs' and LCs' interdependencies with freshwater systems across the Amazon. Most of the reviewed articles were for studies conducted in the Brazilian, Peruvian, and Colombian Amazon. However, because we did not look for publications in databases other than WOS or include studies published in languages other than English, our results can be considered exploratory.

We found a lack of inclusion of IPs' and LCs' voices and perspectives in research and decision-making related to Amazonian freshwaters (Doria et al., 2018; Freitas et al., 2020). Although identifying IPs' and LCs' authorship was methodologically challenging, and could have caveats, we found a lack of IPs and LCs authors and voices represented in the academic literature on Amazonian freshwaters. This shortfall can be interpreted from diverse angles. On the one hand, it may reflect a lack of opportunity and social policies for greater inclusion of these groups in intercultural education, universities, and scientific research. On the other hand, it may reflect the way research is designed and carried out, which can, sometimes, contribute to homogenization or misrepresentation of the diversity of IPs and LCs across the Amazonian region. There was also a notable lack of recognition for Indigenous and Local Knowledge (ILK) and traditional sciences as valid epistemologies, capable of being validated within their own contexts. (Athayde et al., 2017). Cultural and geographic differences and inequities deserve further investigation and attention, especially because drivers of change and threats to IPs' and LCs' rights and to freshwater ecosystems, species, and habitats compound and cross geopolitical borders (Rice, 2022).

We recognize several limitations of our approach. First, we did not aim to synthesize and share the voices of IPs and LCs under their own terms and perspectives. Thus, our results do not represent the depth and breadth of IPs' and LCs' perspectives on Amazonian freshwaters. Second, we did not include different social science databases in our literature search, which could have offered other disciplinary perspectives on this topic, for example, from Anthropology (including linguistic anthropology), economics, psychology, and political science. Third, the potential for coder bias is an inherent risk in any qualitative analysis. Despite restricting the coding process to a small team and by meeting monthly to check on codes and address questions, subjectivities may have persisted in the coding process and in the interpretation of results. Finally, we considered only academic publications in the languages most commonly included in WOS; thus, articles in other languages or gray literature authored by IPs and LCs were likely underrepresented in this review. There is a vast array of gray literature and publications authored by or conducted in collaboration with IPs and LCs focusing on their connections with freshwaters that we did not include. This literature may include, for instance, territorial management plans, poetry, books, opinion articles, and policy-oriented products, a search of which would be a huge undertaking and would merit its own separate publication. We suggest that this important research gap reflects equity and ethical issues that must be addressed by decision-makers and Amazonian peoples as they define policies and funding structures for research in the Amazon.

Our review showed the fragmentation of academic knowledge around the plurality of worldviews represented in the Amazon and of coevolutionary processes among biological, linguistic, and cultural diversity of Amazonian freshwaters (Prestes-Carneiro et al., 2021; Santafe-Troncoso & Loring, 2021). The historic interdependencies between sociocultural and ecological processes shaping Amazonian waterscapes is a topic that deserves further attention (Prestes-Carneiro et al., 2021). The role of ILK and linguistic diversity for freshwater understanding and conservation was another emerging topic, including the importance of ILK in contributing critical information for the management and conservation of freshwater species. Potential complementarities between academic and ILK-based categorizations of freshwaters provide opportunities for collaborative research that can improve understanding and help classify and manage Amazonian freshwater ecosystems in a more holistic and contextualised way (Schulz et al., 2019).

Regional coordination, CBM, comanagement strategies, and inclusive conservation arrangements have emerged as IPs' and LCs'-led strategies that support the resilience of Amazonian freshwaters under change (Gambon & Rist, 2018; Rice, 2022). Evaluation of the opportunities for CBM and large-scale monitoring systems for integrating biodiversity conservation and human well-being across the region is needed. An inclusive conservation ethic for the Amazon requires centering IPs and LCs as key actors of freshwater governance (Lopes et al., 2021; Sousa & Vieira, 2021). This entails recognition and appreciation of the diversity of worldviews, languages, understandings, and relationships with freshwaters held by them, as well as ensuring their equitable participation in research and decision-making processes.

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