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CONTRIBUTED PAPER

Enhancing data justice in community-led conservation: A case study from Indonesian Borneo

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Abstract

Biodiversity conservation is undergoing a process of datafication, driven by calls for evidence-based conservation and rapid technological advances. These developments promise to enhance conservation efforts, but they also raise ethical questions. While most existing research on conservation data justice focuses on large data sets and novel technologies, this paper explores data justice in community-led conservation. We build on a conservation data justice framework, which distinguishes five dimensions of conservation data (composition, access, use, control, and consequences), by adding a sixth dimension: data collection. We apply this framework to two community-led programs in Indonesian Borneo, supported by the Non-Governmental Organization (NGO) Planet Indonesia. Through semi-structured interviews with NGO staff and local community members, we examine how data justice is perceived and assessed in conservation practice. Respondents raised a variety of justice concerns. Overall, they viewed data composition and consequences positively, but raised critical concerns about access, use, and control. These findings help illustrate the variety of opportunities and challenges for data to enhance social justice in conservation and reveal the need for practical strategies to address the priorities and tradeoffs identified by ground-level actors.

KEYWORDS

community-based monitoring, data justice, Indonesia, mangroves, rights-based conservation, small-scale fisheries

1 | INTRODUCTION

Recent years have witnessed a transformation in data collection and analysis for nature conservation, driven by new technologies and demands for evidence-based approaches. In this context, "data" has increasingly come to refer to quantified abstractions: "objects that require highly specific forms of literacy and expertise along with access to mediating technologies" (Heatherington, 2024, p. 103). The growing amount and diversity of this type of data could enhance understanding of nature, facilitate informed decision-making in conservation, and bolster advocacy efforts (Allan et al., 2018). However, the increasingly central role of data in environmental

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governance also raises ethical questions (Nost & Goldstein, 2022; Sandbrook et al., 2021; Young et al., 2022). Scholars have highlighted, for example, how biases in important conservation datasets could lead to inequitable distributions of resources and effort (Chapman et al., 2024), how dependency on quantitative data could "crowd out" other forms of knowledge on conservation (Wyborn & Evans, 2021), and how partial or flawed representation of lands through data can lead to conservation responses which negatively impact local peoples (Windey & Van Hecken, 2021). In response to such concerns, conservation data justice has emerged as a research agenda that investigates how data-driven approaches to conservation can aggravate and/or mitigate social injustices (Pritchard et al., 2022).

Of particular concern to this field are the impacts of conservation data on indigenous peoples (IPs) and local communities (LCs) whose negative experiences with various forms of data are increasingly recognized (Kukutai & Taylor, 2016). For example, the increasing application of satellites, drones, and other high-tech sensors is producing detailed scientific insights into forests, but may simultaneously alienate conservation from LCs, who are often unqualified to operate those devices and may find it difficult to access or understand the resulting data (Kiggell, 2021; Sarkar & Chapman, 2021). The growing movement to empower and center IPs and LCs in conservation efforts (Corson & Campbell, 2023; Dawson et al., 2023) may thus be "challenged by emergent technological advances" (Robinson et al., 2023, p. 9).

However, despite its central concern with the impacts of conservation data on IPs and LCs, much of the conservation data justice literature has remained focused on the analysis of new technologies and research practices, with an emphasis on the use and analysis of big datasets (Chapman et al., 2024; Gabrys et al., 2022; Millner et al., 2023; Tuia et al., 2022; York et al., 2023). Consequently, less attention has been given to how community-centered conservation practices and IPs and LCs themselves relate to different dimensions of data and its implications for social justice (although see Robinson et al., 2023).

In this paper, we apply a framework from the conservation data justice literature to explore the perspectives of LCs and conservation practitioners, showing the potential for such grounded applications to enrich and expand discussions in this field. Specifically, we build on the framework by Pritchard et al. (2022), which integrates theories of environmental justice and data justice to distinguish five dimensions of data in conservation: data composition, data access, data control, data processing and use, and data consequences. We extend this framework by adding a sixth dimension: data collection.

TABLE 1 A theoretical framework distinguishing six dimensions of conservation data justice, building on Pritchard et al. (2022).

Dimension of data	Key question
Data composition	Who or what is made visible in the data and who or what is omitted?
Data collection	Who collects the data, and under what conditions?
Data access	Who has the right and ability to access and use the data?
Data processing and use	Who uses the data and how?
Data control	Who determines which data are collected, how they are used, and with whom they are shared?
Data consequences	What choices are informed by the data, with what impacts, and who benefits or bears the costs of these decisions?

The original framework was developed in the context of an analysis of global maps and datasets, which are often disconnected from on-the-ground realities (Vera et al., 2019), such that data collection processes can be invisible to the users of these types of data. For place-based communities and conservation practitioners, however, data collection represents an important site of participation and negotiation (Longdon et al., 2024; Robinson et al., 2023). Our study thus distinguishes six dimensions of conservation data, as summarized in Table 1.

We apply this enhanced framework to a case study of a Borneo-based Non-Governmental Organization (NGO) called Yayasan Planet Indonesia (YPI) and several of the LCs they partner with. YPI's core model is based on the belief that LCs should play leading roles in conservation efforts, as a matter of both justice and long-term effectiveness. Recognizing that inequities in data governance are an important obstacle to local leadership in conservation, YPI aims to develop and implement participatory and democratic conservation data practices. As such, YPI endeavors to empower marginalized communities living in and near highly biodiverse areas to lead in and benefit from data practices, from designing indicators to leading data collection, processing, and use. This study aims to describe these efforts to enhance data justice from the perspective of YPI staff and LC members, explore their concerns and considerations in relation to this approach, and distill lessons to guide future efforts at improving data justice in community-centered conservation.

In line with Pritchard et al.'s (2022) framework, this study does not predetermine a definition of justice,

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recognizing that notions of justice in conservation are subjective and place-based (Fisher et al., 2018; Sikor et al., 2014). To avoid occluding this variation by imposing externally defined justice ideals, we invited NGO staff and community partners to discuss data based on their own interpretations of justice. The framework was used only as a way to structure these discussions and our analysis around different dimensions of data. Due to the limited sample size, we do not disaggregate the results by gender or socio-economic status, but pool together the insights from a varied sample of respondents to produce an inclusive narrative of the different dimensions of data and how each dimension supports or challenges social justice. Overall, these findings help illustrate the variety of opportunities and challenges for data to enhance social justice in conservation, and draw particular attention to the question of how IPs and LCs themselves can access, use and control conservation data.

2 | CONTEXT

Indonesia's marine ecosystems face significant challenges, as fish stocks are in many places being overexploited (Dimarchopoulou et al., 2023), and mangrove forests are rapidly disappearing (Arifanti et al., 2022). This has implications not just for biodiversity conservation, but also threatens local livelihoods, as fish are an important source of income and nutrition for coastal communities, especially in mangrove-rich areas (Ickowitz et al., 2023). Small-scale fishers, variously defined as people who catch for daily needs or use smaller boats, contribute between 80% and 95% of total national fisheries (Ayunda et al., 2018), but often lack the resources and support needed for implementing sustainable practices (Napitupulu et al., 2022). These challenges cannot be addressed without serious consideration of issues of justice and "the empowerment of fishers, Indigenous Peoples, and local communities, as leaders of nature stewardship," especially considering marine conservation's problematic legacies of colonialism and fortress conservation (Smallhorn-West et al., 2023, p. 15).

The aspiration to strengthen small-scale fishers' leadership in marine resource management is inseparable from questions of data justice, since data can support as well as undermine locally-led management. For example, formal fisheries frameworks and policies often emphasize Indonesia's "data deficiencies" in terms of the fish stock assessments needed to inform maximum sustainable catch levels (Napitupulu et al., 2022, p. 33). A narrow focus on such data, which follows an implicit "logic of maximum extraction of value" (Liboiron 2021, p. 71), risks marginalizing local and Indigenous ways of relating to fish, which may be grounded in other priorities, obligations, and forms of knowing. At the same time, these forms of data carry weight in national and international governance systems, such that the ability to produce, access, and control such data can strengthen communities' claims for recognition as responsible stewards of nature.

In Kubu Raya, West Kalimantan, Indonesia, YPI supports marine community-conservation efforts in two protected forests, Hutan Lindung Seruat Pulau Tiga and Hutan Lindung Gunung Bongkok, with a total area of 35.509 ha (See Figure 1). This landscape has high levels of biodiversity, including 67 species of mangrove (33 true mangroves and 34 associated mangroves), and rare primates such as Proboscis monkeys (*Nasalis larvatus*). The main livelihoods of the majority ethnic Malay communities living in and around these two protected areas are fishing and plantation farming (palm oil and coconut). In this area, YPI works with seven villages, six of which have obtained management rights for parts of these protected areas from the Ministry of Environment and Forestry. These "Village Forests" cover a total area of 28.889 ha and are managed by Village Forest Management Bodies (LPHD): community organizations established by village government regulations.

YPI's four-pillar approach involves (1) securing management rights for LCs, (2) providing technical support for improved management practices, (3) stimulating democratic forms of natural resource governance, and (4) facilitating increased access to local economic opportunities and basic services (Miller et al., 2020; Novick et al., 2023). Sometimes YPI helps found community-led organizations called PUMK (Pelayanan Usaha Masyarakat berbasis Konservasi). In other cases, YPI partners with existing community-based organizations such as LPHDs. In this paper, we use the term community-led governance bodies (CGBs) as an umbrella term that encompasses both PUMKs and LPHDs.

While YPI facilitates a range of programs in different districts and types of ecosystems, this paper focuses on evaluating data justice in the Community Patrol and Sustainable Fisheries programs in five coastal villages in Kubu Raya. These two programs were selected because of the importance of data, especially monitoring data, in their implementation. One of the main tasks of the Community Patrols is to monitor the mangrove forests, producing data on natural resources, including protected flora and fauna, as well as the prevalence of exploitative practices such as hunting and logging. Additionally, the patrols deter harmful exploitation and inform community members about conservation regulations and activities. The Sustainable Fisheries program monitors the activities and yields of fishers to inform Adaptive Collaborative Management Plans, including temporary closures of

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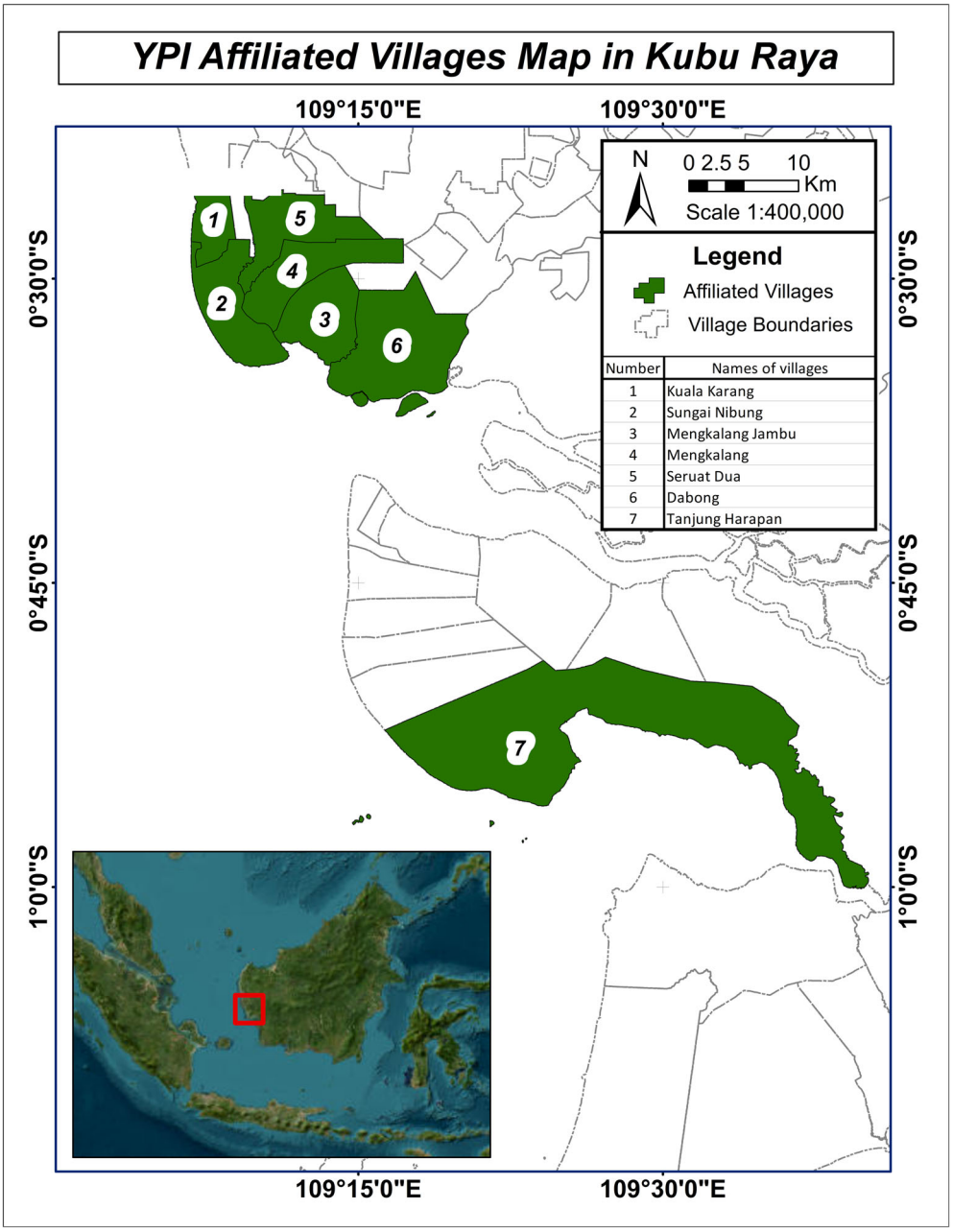


FIGURE 1 A map showing the location of the five villages surveyed in Kubu Raya, West Kalimantan, Indonesia (see insert).

certain fishing sites to allow fish stocks to recover. In this way, the program aims to improve the income of fishers while maintaining biodiversity. Section 4.1 draws on the research findings to describe the data dimensions of both programs in more detail.

3 | METHODS

This paper is based primarily on semi-structured interviews with selected stakeholders. The interview team consisted of five YPI Field Facilitators (FF), three men and two women, each of whom was responsible for conducting interviews in the village where they worked. Despite the methodological risk that interviewer affiliations with YPI might influence responses, we chose not to use volunteers or other external surveyors because deep knowledge of the programs was required to successfully conduct the interviews. Moreover, the research was an opportunity for FFs to solidify their understanding of data justice, gain experience in conducting semi-structured interviews, and expand their relations with community members. These advantages, to us, outweighed the risk of potential biases in the results. Moreover, we felt that there were no obvious reasons to expect that FFs or participants would consistently skew the results in one way or another.

Prior to conducting interviews, FFs participated in 1.5 days of training about data justice, objectives of the evaluation, interview practices, and writing up the

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interview results. During these training sessions, FFs conducted interviews with other YPI staff members under the supervision of the first and second author to ensure alignment on concepts and methods. We have included the results of these training interviews in the analysis.

The interviews started with an explanation of the goals and aims of the survey, and asking for consent to be interviewed and recorded. Recordings were deleted after transcribing the results, and the identities of interviewees have been kept confidential in the analysis. Each interview focused on either the Fisheries or the Patrols program, whichever was most relevant to the interviewee. The interview guide (see Supporting Information S1: A) contained three types of questions for each dimension of data in that program:

1. Questions about personal involvement asked whether respondents had ever been the object of data collection, had participated in collecting data, had used the data, could access the data, had control over the data, and personally felt any consequences of the data.
2. Descriptive questions asked respondents to describe each dimension of data.
3. Evaluative and reflective questions invited respondents to articulate an opinion about whether the program was just for each dimension of data, and to reflect on why things were the way they were. In these prompts, "justice" was translated as "baik dan adil" (good and fair), which was considered more approachable than the term "keadilan" (justice), which FFs indicated might be perceived as heavy and abstract. No further definitions of justice were provided, but we allowed each respondent to answer based on their own understanding of justice.

Each FF was asked to interview one YPI staff member, one village government official, two resource users who were CGB members, and two resource users who were not CGB members, and to include at least two women. Between July and November 2023, a total of 31 interviews were conducted, lasting 15–60 min (40 min on average, over 22 h in total). Sixteen interviews discussed the fisheries data, and 15 interviews discussed forest patrol data. Table 2 summarizes the characteristics of the respondents on each program.

The analysis was kept simple. First, we compiled all the answers to descriptive questions to arrive at a synthesized description of the different dimensions of data justice in the two programs (Section 4.1). Second, we counted the number of times community members indicated they did not know the answer to a descriptive question, to get a picture of levels of knowledge about program data (Section 4.2). Third, we counted the number of times community members affirmed that they had been personally involved with the data, to measure levels of community engagement with the data (Section 4.3). Fourth, we coded all narrative responses to evaluative and reflective questions into four groups, as indicating a dimension of data was "fair," "not fair," "mixed," or "unknown," to create a snapshot of levels of perceived data justice (Section 4.4). Finally, we did a thematic analysis of the answers to evaluative and reflective questions, by grouping together similar responses to arrive at a list of different concerns about data justice and then distilling six underlying considerations of justice (Section 4.5). These results were presented to the Kubu Raya field team and YPI office staff, as well as an international group of data justice scholars in Barcelona, to share the results and enrich our interpretation (Section 5).

The research design followed established principles of ethical research in conservation social science (ConSoSci, n.d.; Brittain et al., 2020; Picot & Grasham, 2022). Measures taken to obtain informed consent included an Indonesian-language script with a simple explanation of the aims of the research and what participation would entail (see Supporting Information S1: A). This was read out to respondents prior to starting interviews, and oral consent was recorded on the response sheets. To protect the privacy of respondents, audio recordings were deleted after transcription, and the identities of interviewees have been kept anonymous in the analysis. Personal information about the interviewees has been stored on an internal database co-managed by the first and second author for potential use in follow-up studies. This data is inaccessible

TABLE 2 Characteristics of interview respondents.

		YPI staff	Village government officials	(Other) CGB members	Other resource users	Total
Patrols	Female			1	3	4
	Male	3	2	3	3	12
Fisheries	Female		1	2	1	4
	Male	3	2	6	1	11
	Total	6	5	12	8	31

Abbreviations: CGB, community-led governance bodies; YPI, Yayasan Planet Indonesia.

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to third parties, but an anonymized version can be prepared on reasonable request. Further details on research ethics protocols are provided in Supporting Information S1: B. At the time of data collection, Universitas Tanjungpura did not yet have a human ethics research board. When the University set up a research ethics committee in 2024, this committee retroactively provided ethical approval (570/UN22.Senat/TU.01.08/2024).

4 | RESULTS

4.1 | Data governance in the two programs

4.1.1 | Fisheries

The fisheries program routinely collects data on fish caught by small-scale fishers. This includes information on fishing location, fishing gear, species caught, total weight, grade, and selling price per kilo. Data is collected 3 days a week from the fishers at the landing sites where the fish are first sold. LC members who work at the landing sites act as enumerators, who record the data on a tally sheet. From the tally sheet, the PUMK fisheries working group inputs the data to Open Data Kit and sends it on to YPI through the FF. YPI processes and analyzes the data, which is then used as a basis for shared decision-making by YPI, village governments, and communities regarding fisheries management, such as determining no-take zones and temporary river closures, and for evaluating the effectiveness of these efforts. The data are also used by village governments to create synergies with regional government agencies, such as establishing collaborations, making reports, or creating profiles of village economic potential. This has, for example, enabled fishers to get assistance from the Provincial Marine and Fisheries Office. Some fishers have accessed the data by asking the enumerators or fisheries working group and used the data to understand what types of catch are in season and which rivers are most visited. YPI also endeavors to regularly present the processed data to the community, although some respondents said that data feedback had not yet been (properly) implemented.

4.1.2 | Community patrols

Four of the villages have Village Forests, which are patrolled by teams consisting of trained community members using the Spatial, Monitoring and Reporting Tool (Cronin et al., 2021). Patrols use The Global Positioning System (GPS) to track their routes and various types of observations made during the patrols. Recorded observations include plants, animals (birds, proboscis monkeys, crocodiles, monitor lizards, etc.), human–wildlife conflict, geological features, and artificial features such as wells, fish ponds, and boundary markers. The patrols also record evidence of extractive activities such as land clearing, forest and land fires, logging, trawling, and netting. When encountering a person extracting natural resources, their identity and place of residence are also recorded.

Patrol activities are carried out 12 days a month. Routes are informed by recommendations from the previous month's patrol. The data are checked and validated by the Village Forest Management Body (LPHD). The data is then processed and analyzed by YPI. The village government and the Regional Planning and Development Agency (Bappeda) also use this data to plan development programs. As with the fisheries data, YPI aims to present the results of the data back to community members, although actual data feedback is limited because (1) some of the data is deemed to be sensitive, for example, containing information about the location of potentially valuable protected species, and (2) there is no obvious (legitimate) way that community members can directly use this data. Patrol data was used primarily by the village government, village assembly, and LPHD to make decisions about no-take zones and temporary river closure while minimizing conflicts with existing patterns of resource use.

4.2 | Levels of knowledge about data

Community members had varying levels of knowledge about the conservation programs and the role of data in them, as reflected in their varying ability to answer the 10 descriptive questions in the interviews. On average, community respondents could answer 65% of these questions. Seven of 25 community respondents could answer 5 (50%) or fewer descriptive questions. Levels of knowledge about patrol data were relatively lower, with respondents able to answer 48% of descriptive questions on average, compared to 81% for fisheries data. Village government officials and CGB leaders were relatively confident in their understanding of the data, answering 86% of the descriptive questions on average, much more than other CGB members (63%) and non-CGB members (30%). Among the last-mentioned, four individuals could not answer any of the descriptive questions.

4.3 | Personal involvement with the data

Levels of personal involvement with data varied across data dimensions (see Figure 2). Among community members, most respondents reported having been the object

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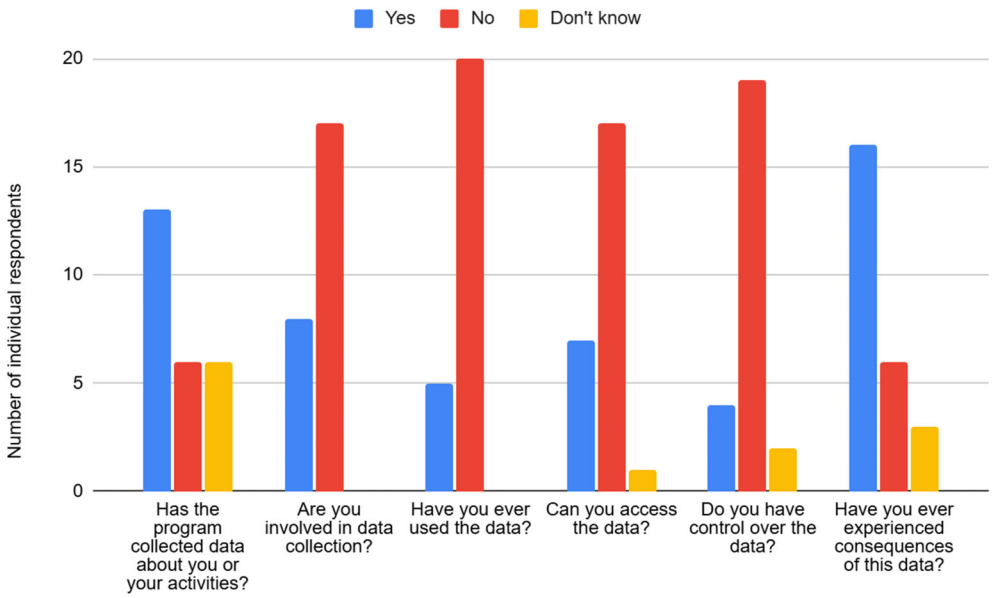


FIGURE 2 Community member responses to questions about personal involvement with six dimensions of data justice.

of data collection (12), and experiencing (predominantly positive) consequences of the data (16). However, only a minority was involved in data collection (8), had ever used (5) it, or felt like they had access to (7) or control over (4) the data. Village government officials and CGB leaders were the most likely to have used data. However, several specified that they only used the data to make reports and presentations to YPI, related government institutions, and community members, which suggests that data was used to fulfill bureaucratic responsibilities rather than to make natural resource management decisions. Community members without access or control often did not know who did have access or control or thought that this was restricted to YPI and the CGB working group collecting the data.

There were strong differences (not shown in Figure 2) between the fisheries and the patrol data in terms of the first two dimensions. Of the community respondents who were interviewed about fisheries data, 85% said they had been the object of data, versus 17% of community respondents talking about patrol data. Furthermore, 46% of community respondents talking about fisheries data said that they had been personally involved in the data collection process, versus 17% of respondents talking about patrol data. These differences might be partly explained by the composition of respondents, as relatively more non-CGB members discussed patrol data. The two programs had similar scores for the other four dimensions of data.

4.4 | NGO and community perceptions of data justice in the programs

Evaluations of fairness similarly varied across dimensions of data (see Figure 3). Both YPI and the communities were most positive about data composition. The percentage of community respondents who said that data composition was fair was lower than the percentage of YPI respondents, mostly because many community respondents felt they did not sufficiently understand the data composition to assess its fairness (32%). Both YPI and community respondents were critical about the fairness of data use, control, and especially access, both for fisheries and for patrol data, but there was an interesting difference in evaluations of data consequences. Community members were relatively positive about data consequences, whereas YPI staff were more critical. To understand what these patterns in perceptions of justice mean, the next section summarizes the content of the responses in more detail.

4.5 | Concerns and considerations

Since we did not provide a definition of justice, respondents raised a variety of concerns and considerations, sometimes accompanied by specific requests and recommendations. Through our analytical process of grouping together similar concerns, we identified six justice considerations. We labeled these as follows:

- *Inclusiveness*: Are all relevant actors, especially LC members, involved?
- *Technique*: Is it accurate, effective, and straightforward?
- *Responsibility*: Are all actors fulfilling their legal and proper roles?
- *Responsiveness*: Do systems and actors address feedback and requests?
- *Transparency*: Is it clear to everyone what is happening?
- *Impacts*: Are harms avoided and benefits provided?

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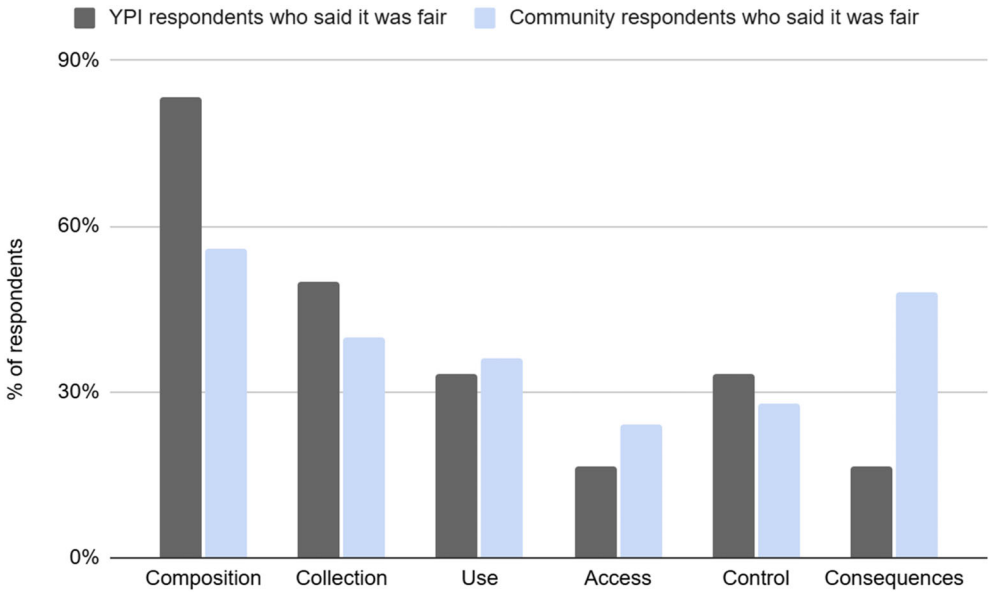


FIGURE 3 Percentage of Yayasan Planet Indonesia (YPI) respondents (dark gray) and community members (light blue) who indicated that the data was fair, for each dimension of data.

Here, we summarize how these six justice considerations shaped respondents' evaluations for each dimension of data (see Table 3 for an overview). First, in assessments of data composition, the most important considerations were technique, responsibility, and impacts. Despite minor concerns about missing or superfluous fisheries data, respondents generally indicated that data composition was technically sound and in line with the aims and responsibilities of those involved, namely to inform natural resource management. In terms of impacts, the avoidance of harm was mentioned as a salient aspect of fairness. As a male crab fisher who refrained from rating the fairness of data composition explained: "I don't know if it [data composition] is good or not, the important thing is that it doesn't harm us fishers."

Second, data collection was seen as effective and in line with actors' responsibilities. The involvement of community members in data collection was valued as an opportunity to gain new insights and skills, but there were concerns about transparency and inclusivity in patrols, where some community members lacked clarity about what the patrols were doing or how to join. For example, a female respondent, who worked as a clam collector in the mangroves, complained: "Only the SMART patrol team has been involved in data collection, and women have never been involved." There were also concerns in both programs about a lack of responsiveness to data collectors' requests for technical guidance and equipment.

Third, respondents liked that the data could be used to fulfill reporting responsibilities. A female village government official, for example, was positive about the fisheries data, "because the Village [i.e., village government] does indeed need that data," to create a "village profile" and report to the provincial Fisheries Service. However, respondents felt a need for better analysis and drawing lessons from the data. Respondents highlighted a potential negative impact of patrol data about valuable resources through misuse by hunters and loggers, but noted that so far this had been avoided.

Fourth, access to both fisheries and patrol data was criticized for its lack of inclusivity and transparency, as many community members could not or did not know how to access the data. However, some community members did not perceive this as unfair if they benefited from the programs in other ways. Moreover, some felt that unequal access to patrol data was justified because it contained sensitive information about protected species that are vulnerable to illegal exploitation. A male YPI respondent explained: "Not all data should be made accessible to the public because there are concerns it might be misused." Neverthless, some respondents recommended making a restricted version of the data accessible to all community members, although capacity for implementing this idea was currently lacking. Several community respondents requested (more) regular data feedback of fisheries data, for example, on public notice boards.

Fifth, YPI's control over data was seen to help ensure data quality and avoid misuse, but some argued that community members had a right to control the data themselves. As a male YPI staff member noted: "according to the Permit from the Ministry, LPHD has the right to manage their area, and the [patrol] data originates from them too." Concerning fisheries data, some community members were pleased that YPI quickly responded to requests for correcting faulty data, whereas others felt that community members should have the control to correct mistakes themselves.

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TABLE 3 A list of the different data justice considerations raised by respondents, responses from both Yayasan Planet Indonesia (YPI) and community members, regarding the patrols as well as the fisheries data. Notes in brackets indicate which principle of justice we grouped the consideration under, and whether respondents who raised the consideration affirmed (+), denied (−), or gave mixed evaluations of (+/−) the fairness of that dimension of data justice.

Composition	Is data composition complete and fit for purpose? (*Technique*; +/−)
	Are all components of the data necessary? (*Technique*; +/−)
	Is the data easy to collect? (*Technique*; +)
	Is the data in line with YPI's responsibilities? (*Responsibility*; +)
	Is data composition based on community needs? (*Responsiveness*; +)
	Is there an absence of complaints from community-members? (*Impacts*; +)
Collection	Are community members involved in data collection? (*Inclusiveness*; +/−)
	Are recruitment criteria and procedures clear and open? (*Inclusiveness*; +/−)
	Does data collection ensure valid and justifiable data? (*Technique*; +/−)
	Do data collectors have the required equipment and facilities? (*Technique*; +/−)
	Does data collection take place in accordance with instructions? (*Responsibility*; +)
	Are needs and requests from data collectors addressed? (*Responsiveness*; −)
	Is the collection process transparent for the community? (*Transparency*; −)
	Does data collection provide learning opportunities for the community? (*Impacts*; +)
Use	Is the data used by community members? (*Inclusiveness*; +/−)
	Is the data properly analyzed? (*Technique*; +/−)
	Is the data used to address the needs of the community? (*Responsiveness*; +/−)
	Is it clear to everyone how the data is used? (*Transparency*; −)
	Is misuse of the data avoided? (*Impacts*; +)
	Is there an absence of complaints from community-members? (*Impacts*; +)
Access	Is the data accessible to all members of the community? (*Inclusiveness*; +/−)
	Has there been a data feedback process? (*Technique*; −)
	Do community members know how to access the data? (*Transparency*; −)
	Is access restricted to avoid misuse? (*Impacts*; +)
Control	Do community members have sufficient control over the data? (*Inclusiveness*; +/−)
	Is data quality ensured? (*Technique*; +/−)
	Is misuse of the data controlled? (*Impacts*; +)
	Is there an absence of complaints? (*Impacts*; +)
Consequences	Are the benefits equally distributed? (*Inclusiveness*; −)
	Has the data facilitated participatory natural resource management? (*Impacts*; +)
	Has the data helped preserve biodiversity? (*Impacts*; +)
	Has the data helped address the basic needs of the community? (*Impacts*; +/−)
	Has the data avoided negative impacts on the community? (*Impacts*; −)

Sixth, both YPI staff and community members noted that the data enabled the continuation of YPI support and enabled requests for government support, which positively impacted the community. Community members also found the data intrinsically valuable; for instance, as an insight in the condition of fish stocks or, as a male patrol team member said, "to learn about wildlife and plant species." However, some YPI respondents expressed concerns that the programs had been insufficiently attentive to the basic needs of community members whose livelihoods did not depend on natural resources. Moreover, YPI staff reported that some resource users had complained about negative impacts from restrictions on logging, while others believed that data collection efforts had contributed to lower crab prices.

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5 | DISCUSSION

5.1 | Successes and challenges in enhancing data justice

The results show that most respondents thought the data was important and useful, and that it was collected and analyzed properly. Even though the data composition was determined in large part by YPI, community members also recognized its value in providing information about natural resources on village territory, which could help guide decisions about natural resource use and management by or for the community. Moreover, the data was seen as an asset for improving relations between the village and the state, strengthening the village profiles and development plans produced by village authorities and thereby attracting more government assistance.

Despite these benefits, the results also suggest that most community members had a passive relationship with the data. Many did not know how to use or access the data, and saw the data as being controlled by YPI or village leaders, rather than a resource they could engage with directly. Some community members did not see their lack of access to and control over data as unjust, so long as the program had beneficial or at least an absence of negative consequences for them. YPI staff related this observation to a tendency among some community members to see the programs in terms of a donor-beneficiary relationship, in which the collection of data is a service CGBs perform for YPI in exchange for the disbursement of funding or technical support. However, for other community members, limitations in data access, use, and control conflicted with principles of inclusivity and transparency. These assessments differed by program: relatively more respondents expressed desire to directly access and use fisheries data than patrol data, probably because the former has a direct connection to local livelihoods, whereas the patrol data primarily covers protected areas where livelihood activities are restricted.

5.2 | Contextualizing the findings

The model of community-led conservation on which YPI operates differs significantly from the eco-centric conservation models around which concerns about conservation data justice have primarily developed (Pritchard et al., 2022). YPI's approach is informed by rights-based approaches to conservation (Tauli-Corpuz et al., 2020) and draws on ongoing innovations in fisheries management, in which advanced data systems with active participation of fishers increasingly play a central role (Bradley et al., 2019). This model of reflexive engagement with data and questions of social justice explains why we have found that YPI staff were highly responsive to questions about data justice, and why many community members, especially those actively involved in the community organizations, were moderately positive in their assessments of data justice. Nevertheless, we have also seen that significant challenges remain, especially in enabling community members to take ownership of the data. These may be explained in part by the wider social and economic contexts and relations in and through which YPI and the communities operate.

First, there is a gap in data literacy between the university-educated YPI program staff and the community members they work with, who face logistical and economic challenges in accessing formal education. In 2023, 24% of residents of the regency of Kubu Raya over the age of 15 had never finished primary education, and for another 23% primary school was the highest education they had finished (Badan Pusat Statistik [BPS], 2023). In this context, YPI staff take the lead in designing the data dimensions of conservation programs, even if they listen to LC members for input. Consequently, many CGB members lack the technical training required to actively engage with the program data in its current format.

Second, the current funding model for CGBs relies largely on international development aid and philanthropy, requiring YPI to manage relations with donors on behalf of CGBs. Despite YPI's ambition to engage in a partnership with communities on equal terms, this funding model puts YPI in a position of control and power, which may reinforce the perception among some community members that CGBs, and by extension the data they collect, are owned and controlled by YPI.

Third, such unequal relations are also shaped by a legacy of projectification, which has shaped both the conservation sector and rural development in Indonesia (Li, 2016; Sayer & Wells, 2004). By targeting small, technical problems with a promise of high return on investment, the project model aims to make the impact of conservation and development finance more tangible. However, critics find that projects also serve as vehicles for rent-seeking and political patronage (Aspinall, 2013). YPI staff have observed that the collection of data has often been a prelude to the disbursement of aid by government or NGO actors, which may have created an expectation among communities that the data collected as part of YPI's programs are a requirement for accessing hand-outs, rather than a basis for decision-making at the community level.

Fourth, perceptions of data justice are influenced by Indonesia's historical context, marked by a paternalistic state asserting control over the country's natural resources, ostensibly for the benefit of the nation but often favoring particular political-economic interests

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(Berenschot et al., 2023). Actors close to the central government in Jakarta have thus long had legal authority over forest areas, with the right and responsibility to produce and manage data about forests. Despite being contested (Peluso, 1993), this legal status quo still sets a powerful norm. Respondents often referenced official roles and hierarchies when evaluating data justice, for example, by stating that certain practices were fair because they were in accordance with instructions from higher-ups, even though these "responsibility" considerations were sometimes at odds with other considerations such as inclusivity or transparency. At the same time, where community groups had secured legal rights to manage forest areas through Indonesia's Social Forestry Policy (Moeliono et al., 2023), this was invoked as an argument for why they should gain more control, rights, and benefits in relation to the data.

5.3 | Lessons for YPI and similar conservation initiatives

The survey results reveal that, even in a conservation program which aspires to be community-led, critically evaluating data justice reveals various areas for improvement. Here we highlight some lessons for YPI, which are also relevant for similar organizations.

To start, we found among YPI's staff an ambition for community members to become active users and owners rather than passive beneficiaries of the data, enabling YPI to transition from a leading to a supporting role in data management. To this end, there is a need to improve community access to and control over data, coupled with ongoing technical support. At the same time, efforts to promote community ownership over data should be responsive to the finding that not all community members have a desire to access or manage data. We have seen that not all data is equally valuable to communities. For example, certain types of data may fulfill important roles in running conservation programs and reporting to international donors but may not be directly useful for community members. This suggests that limiting data access and control to certain sections of a community, even outsourcing aspects of data management to external actors, can in some cases support the ideals of community-led conservation.

In response to the variation in levels of understanding about program data, field teams suggested organizing village-level workshops to raise levels of understanding about the role of data in the programs and their potential usefulness to community members. This could form a basis for developing, communicating, and enforcing rules on local data governance. Other investments may involve raising data literacy, introducing innovative technologies for data management, and adapting the data composition to better align with community priorities. Periodically, YPI could help CGBs in analyzing the data to answer community-relevant questions and in visualizing the results for clear and effective communication with the larger community (Levontin et al., 2017).

Another lesson is that different datasets present their own data justice implications. There may be privacy and security reasons why data should not be made publicly accessible to everyone. The patrol data, especially, was perceived as at risk of being (mis-)used for environmentally destructive activities, thus requiring careful access management (cf. Sarkar & Chapman, 2021). Efforts aimed at avoiding misuse, however, conflicted with the need for inclusivity and transparency. This could become a barrier to more widespread understanding about the patrols and ultimately lead to distrust. Balancing the demands for transparency with the need to avoid misuse calls for sophisticated data feedback systems that tailor access to different audiences. For example, large-scale data showing trends in overall patrol encounters with extractive activities over time could be made publicly available, enhancing transparency without revealing specific locations or individuals involved. On the other hand, community members deemed fisheries data as highly relevant for daily use, and there were no concerns about misuse mentioned here. Therefore, quicker and greater transfer of control over fisheries data to community members may be appropriate. An immediate measure, suggested by respondents, would be to publish and regularly update yield data for different species on public notice boards.

Finally, efforts at enhancing data justice are not just technical exercises but require grappling with considerable structural and contextual challenges. When the work of enhancing data justice runs up against the boundaries of current structures, conservationists may need to join forces with other agents of reform to work toward wider societal and sectoral transformation. Recognizing the importance of legal arrangements and funding relationships in shaping different aspects of data justice, for example, it would help to work toward new funding and governance models that shift power and authority toward the community. This could take the form of facilitating community organizations to obtain a stronger legal foundation and identifying sustainable sources of funding that CGBs can create or access independently.

5.4 | Theoretical implications

These findings advance the field of conservation data justice by expanding on Pritchard et al.'s (2022) framework and demonstrating how it can effectively evaluate and

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inform community-led conservation efforts. Although FF initially feared it would be difficult to explain the six dimensions of data to respondents, most interviews addressed each dimension in a meaningful way. Interviewees who struggled to answer the questions were mostly those who were not involved in the programs, which indicates that their inability to respond was due to a lack of familiarity with the programs more than confusion about the questions. The variations in responses across different dimensions show that the framework can be helpful in structuring research and evaluation efforts, encouraging its continued application in community-based conservation. This will help refine and ground conservation data justice theory in the perspectives and experiences of those living and working in conservation landscapes.

Additionally, the research draws attention to the complex question of which and whose notions of justice should guide conservation efforts. In this paper, we chose to let community and NGO staff articulate their own criteria for justice, rather than impose an external definition. The variety of considerations raised by respondents confirmed the relevance of research on plural notions of justice in ecosystem governance (Fisher et al., 2018; Sikor et al., 2014) to questions of conservation data justice.

Finally, the results also show that questions of data are inevitably entangled with wider socio-economic contexts and dynamics. For social scientists, therefore, conservation data justice can offer a useful lens for examining the complexities of community-conservation relationships and the socio-economic contexts in which conservation is embedded.

AUTHOR CONTRIBUTIONS

Paul Hasan Thung and Putri Damatashia conceptualized the study with input from Rose Pritchard. Paul Hasan Thung led the writing of the manuscript, Putri Damatashia coordinated data collection and contributed to the writing, and Muflihati, Siti Masitoh Kartikawati, and Rose Pritchard provided critical feedback and textual edits. All authors contributed critically to the drafts and gave final approval for publication.

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DATA AVAILABILITY STATEMENT

For privacy reasons, the data that support the findings of this study are not publicly available, but an anonymized version is available from the corresponding author, Paul Hasan Thung, upon reasonable request.

ETHICS STATEMENT

The research design followed established principles of ethical research in conservation social science (ConSoSci, n.d.; Brittain et al., 2020; Picot & Grasham, 2022). Measures taken to obtain informed consent included an Indonesian-language script with a simple explanation of the aims of the research and what participation would entail (see Supporting Information S1: A). This was read out to respondents prior to starting interviews, and oral consent was recorded on the response sheets. To protect the privacy of respondents, audio recordings were deleted after transcription, and the identities of interviewees have been kept anonymous in the analysis. Personal information about the interviewees has been stored on an internal database co-managed by the first and second author for potential use in follow-up studies. This data is inaccessible to third parties, but an anonymized version can be prepared on reasonable request. Further details on research ethics protocols are provided in Supporting Information S1: B. At the time of data collection, Universitas Tanjungpura did not yet have a human ethics research board. When the university set up a research ethics committee in 2024, this committee retroactively provided ethical approval (570/UN22.Senat/TU.01.08/2024).

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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