Data Sovereignty in Community-Based Environmental Monitoring: Toward Equitable Environmental Data Governance

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Indigenous peoples and local communities have environmental knowledge systems that are fed by different sources of information stemming from their communities' often long histories of place-based living. Such information allows them to monitor environmental status and steward territories and resources (Brondízio et al. 2021). The rapid spread of mobile devices and digital platforms has accelerated the possibility of applying such knowledge to scientific monitoring (Starkweather et al. 2021), particularly in remote areas difficult and expensive to access for scientists (Johnson et al. 2021). Therefore, community-based monitoring is increasingly proposed as a way to further scientific understanding of biodiversity status and trends, land-use changes, habitat loss, local uses of plants and animals, drivers of environmental change, and the presence of pollution or invasive species, among other processes (Danielsen et al. 2021).

A recent special section of *BioScience* highlights that community-based environmental monitoring not only delivers credible and legitimate knowledge in use but also informs local decision-making and empowers Indigenous peoples and other rights holders in environmental governance (Bonney 2021, Tengö et al. 2021). However, articles in the special section and previous research on the topic also note that community-based environmental monitoring projects, when they are externally led, can come with their own challenges and impacts, from relegating local actors to data collectors (Turreira-García et al. 2018) to increasing inequities by engaging only with a local elite (Eicken et al. 2021).

In this Viewpoint, we discuss an additional challenge: adhering to data sovereignty principles. In recognition of the historical and ongoing misappropriation of Indigenous knowledge systems and acknowledging Indigenous peoples' unique rights over their knowledge (article 31 of the United Nations Declaration on the Rights of Indigenous Peoples), we focus on projects drawing from or informed by Indigenous knowledge. However, our argument also applies to other community-based environmental monitoring projects, particularly those involving local communities with long-term cultural connections with their lands and waters.

Understanding Indigenous data sovereignty

Data sovereignty refers to the management and governance of information according to the laws and protocols of the nation-state where information is located (Kukutai and Taylor 2016). However, Indigenous peoples' knowledge systems predate current nation-states and have their own governance rules regulating how peoples, lands, nature, histories, and knowledge should be represented and who has the right to use information and for which purpose (First Nations Information Governance Centre 2014, Carroll et al. 2020). Given the historical power imbalances between knowledge systems, most written documents using or referring to Indigenous data do not explicitly address Indigenous peoples' sovereignty over information, often resulting in misrepresentation, or mistreatment of Indigenous knowledge holders' contributions, and limited opportunities for benefit sharing (Kukutai and Taylor 2016, Carroll et al. 2021, Tengö et al. 2021). In this context, Indigenous peoples and organizations have drawn attention to legal and ethical questions regarding ownership, custody, control, access, and return of Indigenous knowledge and data (First Nations Information Governance Centre 2014, Axelsson and Mienna 2020, Oguamanam 2020, Prictor et al. 2020). Such issues are particularly relevant in relation to existing open data principles in science, because adherence to data-centric research standards often contrasts with Indigenous worldviews, which are typically centered on people, purpose, and place through customary governance processes (Harding et al. 2012, McMahon et al. 2015, Carroll et al. 2021).

Indigenous data sovereignty (IDS) has been defined as "Indigenous people's rights to control data from and

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about their communities and lands, articulating both individual and collective rights to data access and to privacy" (Carroll et al. 2021: 300). Discussions on IDS have gained traction in genomics (e.g., Garrison et al. 2019, Hudson et al. 2020), health (e.g., Schnarch 2004, Griffiths et al. 2021), and ethnobiology (e.g., Fernández-Llamazares et al. 2021, McAlvay et al. 2021) and are emerging in community-based environmental monitoring (Johnson et al. 2021). Some institutional review boards are proposing mechanisms to advance Indigenous research ethics and data sovereignty in research (e.g., Nicholas 2022), but simultaneously, many Indigenous organizations are also developing ethical research guidelines to lay the groundwork for future research with those they represent, including considerations on data use (e.g., Putaiora Writing Group 2010; Nordling 2017). For example, in Sweden, the Indigenous organization Sámiid Riikkasearvi has created a series of questions for researchers to consider before approaching Sámi communities, including questions on data handling and ownership and benefit sharing (Sámiid Riikkasearvi 2019). In Thailand, the Asia Indigenous Peoples Pact and the Open Development Initiative have recently drafted an Asian perspective IDS framework on research involving Indigenous peoples, including the collection, storage, analysis, use, and reuse of data.

Several organizations are also working on the operationalization of these guidelines. In that line, the Global Indigenous Data Alliance has proposed the CARE (for *Collective benefit, Authority to control, Responsibility, and Ethics*) principles for Indigenous data management and stewardship (Carroll et al. 2020). Similarly, the principles of the First Nations Information Governance Centre (2014) are based on knowledge holders' ownership, control, access, and possession of data, and the Local Contexts (2021) initiative has created labels and notices that allow the embeddedness of published data in Indigenous worldviews and contexts to be recognized. Although data governance rules vary substantially across Indigenous groups and most initiatives are context specific, the core principles for IDS include rights to Indigenous ownership of knowledge in relation to its use, Indigenous authority to control and access knowledge, prioritizing collective over individual benefit, recognizing context specificity, a value-based approach going beyond consent, and consideration for future generations.

Examples of IDS in community-based monitoring projects

Several practices have been proposed to improve Indigenous peoples' sovereignty over data collected through community-based monitoring projects. Such practices include continuous consultation of project's relevance, guaranteeing that community requests are considered and resourced during project planning and execution, ensuring findings are in communities' hands, hiring local staff, and budgeting to build long-term community autonomy over projects (e.g., Flemmer and Schilling-Vacaflor 2015, Merino 2018, Austin et al. 2019).

Beyond these common practices, and probably as a result of the existence of numerous and diverse legal landscapes (Rainie et al. 2019), community-based monitoring projects have used a diversity of approaches towards IDS. Some community-led environmental monitoring projects working in the context of environmental justice are applying IDS principles. For example, the Prey Lang Network (Cambodia) has developed a forest monitoring application to fight illegal deforestation (Brofeldt et al. 2018). The network decides what data to collect and data collected are owned and managed by users. Although the network receives analysis support from research institutions, none of the data are made public unless approved by the network. The digital toolset MAPEO (www.digital-democracy.org/mapeo), an offline-first application jointly developed by Digital Democracy and Indigenous Peoples around the world, enables users to map their lands and collect evidence of environmental and human rights threats. MAPEO ensures local data ownership and sovereignty via a peer-to-peer database, allowing the local exchange of data without the use of a central, external server. The forms, categories, icons and maps are also customizable by communities to ensure they remain culturally relevant.

Some projects aiming to improve environmental stewardship have also embraced IDS principles. For example, in Canada, the Arctic Eider Society is developing an ice-monitoring application, SIKU, to improve safety by featuring knowledge on local climate and environmental changes (https://siku.org/about). The platform is conceived as an instrument to "empower Indigenous self-determination," for which users maintain full access, ownership and control over data, meaning that even the Arctic Eider Society must request knowledge holders' permissions for data use. SIKU privacy features are embedded on a post-by-post basis and include an option to assign "Indigenous stewardship" to user content, giving granular data access to specific communities, regional, and other affiliated local organizations. In Brazil, national research and nonprofit organizations in partnership with customary institutions have developed Tô no Mapa (https://tonomapa.org.br), an application that allows to map customary land. Tô no Mapa has recently introduced a feature allowing communities to choose whether or not to authorize the current or future disclosure of registered territory details, with the option of making this information public should they later need it for negotiation purposes. If users choose this option, their partner research institutions can only disclose information in aggregate form and combining it with national data, which can facilitate progress for public programs while safeguarding sensitive community information.

The way ahead

In the current context of open data, community-based environmental monitoring projects face the challenge of recognizing IDS to avoid the perpetuation of extractive knowledge practices often leading to Indigenous knowledge misuse or misappropriation. The voluntary and not legally binding nature of many IDS principles creates a space for Indigenous peoples to assert their own sovereignty over data without seeking permission from nation-states, but it also results in the absence of public accountability mechanisms to ensure the respect of IDS principles. Recognizing the inherent rights of Indigenous peoples to govern the collection, ownership, access and use of data related to their land and cultural heritage and applying IDS principles in community-based monitoring projects can help reframe power imbalances both in science and in environmental management. This will assist all actors in moving from recognizing rights to developing mechanisms to enact, enforce, monitor and uphold such rights.

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