The Future of Conservation Lies in Justice-led Technology

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Introduction

In March 2022, I travelled Ghana for the first time as an adult, having spent a lot of my childhood visiting family there. Accompanied by three research assistants from the Kwame Nkrumah University of Science and Technology – Joseph Kankam, Priscilla Osei and Abena Fosuaa – and equipped with a rucksack full of acoustic sensors, SD cards and batteries, we headed into the forest. Our destination was a small community located on the fringe of Bosomtwe Range Forest Reserve. The purpose of my PhD research is to explore the benefits, harms and opportunities of ecoacoustic research – a field that combines biological, acoustic and machine learning to analyse acoustic environmental recordings and monitor wildlife – when conducted with marginalised forest communities.

Figure 1. Joycelyn (centre) and Wildlife Expert Ben Ossom (5th from left) pictured with the group of community members engaged in participatory monitoring and design explorations. Community members pictured are: Kwadwo Appiah, Yohanne Quadoe, Abena Dufie, Isaka Dramani, Comfort Arkoh, Ama Konadu, Agnes Yaa Nkonsah, Akwasi Sarfo and Kwaku Amoah, and Ben Ossom. (Enock Ba and Emmanuel Acheampong not pictured)

Aided by falling hardware costs and increasingly advanced methods of AI analysis, the field of ecoacoustics has become an increasingly important tool in biodiversity monitoring, providing essential data for decision-making and planning in applied ecology and conservation. Ecoacoustic research has been significantly supported by the expertise and labour of crowdsourcers or enthusiasts, such as birders (Loureiro et al., 2018; Sullivan et al., 2014; Wood et al., 2022; Zilli 2015). Through data collection and labelling, birders have constructed large acoustic databases, such as Xeno-Canto and eBird, which host thousands of bird recordings. Yet, there remain few documented approaches to justice-oriented participation, especially in the tropics where regions of high biodiversity

Figure 2. Walking in Bosomtwe Range Forest Reserve

and the lands and livelihoods of Indigenous and Local communities (IPLC's) often overlap. With already existing tensions and discrimination within conservation research and practice where Indigenous and Local communities are concerned, computational methods and devices, such as ecoacoustic sensors, can compound and widen the disconnect between conservation projects and forest-dwelling communities, weakening important links to essential local knowledge and limiting the opportunity for effective, equitable and sustainable conservation interventions. Since that first visit, I have spent two consecutive springs, hiking, walking, trekking, listening, and speaking with members of the community in the forest to interrogate, explore and design ecoacoustic technologies that serve community needs.

My work sits as one of many projects within the AI for Environmental Risk Centre for Doctoral Training (AI4ER CDT) at the University of Cambridge which looks to apply cutting edge technologies to critical environmental challenges. It is common for the motivations and objectives of work in this field – the application of AI to environmental issues – to centre the development of more powerful and accurate models and architectures, the improvement of data quality, access and interoperability, and addressing data gaps, scarcity and global coverage. However, my research is more concerned with the interactions between AI technologies, marginalised communities, and the environment. My interest is in understanding how participatory and justice-led methods of AI, data and technology practice can lead to culturally appropriate, equitable, pluralistic and mutually beneficial technologies for conservation.

Beyond the hype of conservation's AI revolution

AI has revolutionised a wide range of industries and the field of conservation is no different. Aided by more powerful and accurate algorithms, larger and growing databases and expanding techniques, AI is playing an overwhelmingly important role in advancing the field of conservation (Borowiec et al., 2022; D Silvestro., 2022). Much of this work, especially where forest conservation is concerned, is facilitated by a suite of increasingly accessible monitoring technologies referred to as 'The Internet of Trees' (Gabrys, 2020). The Internet of Trees includes drones that aid reforestation and monitor forest fires; acoustic, camera and environmental sensor networks to monitor wildlife biodiversity and pollution levels; satellite imaging to monitor forest cover and detect deforestation; Light Detection and Ranging (LIDAR) scanning for assessing changes in forest structure; machine learning methods for predicting extreme weather events or land-use changes; and civic apps and platforms for citizen monitoring of forest conditions and the building of wildlife databases (Gabrys, 2020).

The advancements facilitated by AI and digital technologies have made way for significant progress in biodiversity conservation from ecosystem restoration, ocean conservation, sustainable agriculture and wildlife monitoring. Research in the field spans a wide array of projects. For instance, there's SharkBook, an expansive library and database documenting shark encounters and individually catalogued sharks, maintained by marine biologists. This resource uses "cutting-edge software [that] supports rapid identification using pattern recognition and photo management tools." Additionally, researchers in Central Africa are listening in to Elephant's communication network of rumbles, sounds that are usually imperceptible to the human ear but made visible and interpretable by eco-acoustic sensors and machine learning algorithms. Their work is aimed at supporting anti-poaching conservation efforts in the region.

Unfortunately, as with many new technologies, the radical advancements often come with unintended risks. The advancements are exciting, and efforts continue to create more efficient and accurate algorithms and produce more quality datasets in efforts to monitor and protect large swathes

of essential biodiversity. However, there remain real social risks that perpetuate already existing inequalities and oppressive systems.

Many of these risks lie in the history, and perpetuation of, conservation's dark colonial history, that saw marginalised communities across the tropics treated not as humans but as flora and fauna (collections of plants and animals). Approaches to conservation often rely on the separation of humans from natural ecosystems, based on outdated and colonial theories such as terra nullius, a concept that saw Europeans declare land uninhabited and free for the taking based on their prejudices against local and Indigenous communities. While we like to believe that the colonial era lies firmly in the past, forest communities are still widely and routinely excluded from conservation research, and as we add more and more technology to the mix, we embed colonial and discriminatory approaches to conservation into the algorithms and technologies meant to protect the planet.

To give one example, in a 2018 paper, Sandbrook et al., report on the concept of 'human bycatch', an analogy to bycatch of non-target species in fisheries with a focus on unintentional and intrusive images of humans captured by camera traps as part of conservation research. They found that over 90 percent of the respondents they engaged reported that their projects had captured, usually unintentionally, images of people, including the capture of illegal activities or protest. Despite being unintentionally captured, "were widely used to inform conservation practice, demonstrating that camera traps are a key tool in emerging regimes of conservation surveillance" (Sandbrook et al., 2018, 493). Their work raises important points on how "technological change transforms the possibilities of surveillance" (Sandbrook et al., 2018, 494) and in some cases can be exploited to breach the rights and privacy needs of communities living in biodiverse ecosystems.

Figure 3. Forest Cover

The emerging field of conservation data justice

In the summer of 2022, a few weeks after returning from my first research trip to Ghana, I attended an interdisciplinary workshop on area-based conservation alongside a wide range of researchers from land systems science, political ecology and biology. I was invited to provide insight into the concerns of data justice within future conservation policy. It was here that I first met Rose Pritchard, Presidential Fellow in Social-Environmental Systems in the Global Development Institute (GDI) at The University of Manchester. Earlier that year, alongside colleagues Laura Aileen Sauls, Johan A. Oldekop, Wilhelm Andrew Kiwango, Dan Brockington, she had published a paper introducing the concept and field of Conservation Data Justice (CDJ). Reading their paper was the first time during my PhD where I felt that the methods and approaches that I was taking organically, were being reflected in the literature I was reading. As an interdisciplinary scientist, bridging ecology, sociology and the computer sciences, often it had been hard to find literature and methods that acknowledged and responded to challenges across the domains I was working in. CDJ brought me closer to an accurate description of my research and practice that welcomed nuance, complexity and interdisciplinarity in ways I had not yet encountered fully.

The scope and nuances of CDJ are far reaching, spanning concerns and enquiries regarding data privacy, ownership and governance, as well as the protection and integration of community participation and Indigenous knowledge (Robinson et al., 2023; Greiber et al., 2010; Longdon, 2020). This work acknowledges that environmental data is not neutral, but laden with power and builds on the ideas and philosophies of Data Justice and Environmental Data Justice. Data Justice is a field that is multi-faceted and multi-authored, and moves beyond the narrow focus on bias, privacy, and data security towards deeper engagement with questions of "power, politics, inclusion and interests" (Denick et al., 2019, 874). Environmental Data Justice moved these conversations to the environmental sphere. Introduced by the Environmental Data and Governance Initiative (EDGI) in the aftermath of the 2016 US Election, and implemented through a variety of archival and action based techniques, the field of Environmental Data Justice (EDJ) challenges and replaces extractive logics and approaches to environmental data practices and infrastructures (Vera et al., 2019).

With a focus on technology-led conservation research, CDJ researchers acknowledge that whilst AI, and technology more generally, provide real opportunities for conservation research, they also present significant risks and build on oppressive conservation practices such as surveillance (Adams, 2017; Sandbrook, 2018; Simlai and Sandbrook, 2021;) and militarisation (Lunstrum, 2015; Simlai, 2015; Duffy et al., 2019; Dutta and Simlai, 2022). In their 2022 paper, Pritchard et al., presented five interacting elements that shape Conservation Data Justice research: data composition, data access, data control, data processing/use, and data consequences. My work interacts primarily with questions around composition, control, and consequences.

Where data composition is concerned, questions of visibility/invisibility arise. The ways in which established methods of sampling, e.g. random sampling, in ecology can cause tensions and disrupt research in the long- term when employed without community input or agency. Here, I work with community members to identify ways in which monitoring design (e.g. where and how sensors are placed in forests) align with community preferences whilst providing high quality data, mapping sensor placement and conducting deployment collectively and collaboratively.

Where control and consequences are concerned, my research asks how extractive patterns of data collection and control can be counteracted in

community-based ecoacoustic data collection and made more participatory or democratic. Every stage of the research, from programming sensors, deploying sensors and analysing the data is engaged through participatory workshops that act as a dynamic consent process. Rather than a static process, or a one-time response, consent is sought at each stage of the research through activities that provide transparency on the methods that will be used. Instead of rolling out pre-planned research, with agendas specific to the academy, this approach puts agency and control into the hands of community members, providing them with essential information into the practices being presented and the subsequent ability to question, shift or mould these practices. For example, where data analysis was concerned, the goals and process of supervised and unsupervised machine learning algorithms, both of which support different research agendas and questions, were demonstrated to community members. The former focuses on the monitoring of species. Here researchers train machine learning algorithms on thousands of labelled acoustic recordings species and then apply that algorithm to the recordings they collect in the field to identify and monitor important species in their data. The latter focuses on the analysis of soundscapes and ecosystem health. Here, acoustic environmental datasets are analysed without labelled data, often by creating clusters that group together similar sounds. Analysing these clusters over time, space and place, researchers can understand the health and rhythms of ecosystems. Supervised machine learning is the most popular approach to analysing ecoacoustic data, but with information on both approaches, community members made it clear that their interest was to understand the variety of species within the soundscape rather than a focus on a single one. These requests created the basis of all further enquiries and technology design.

These are just a few examples of how my work interacts with and is influenced by CDJ, a framing that, alongside other theories, and practices such as Participatory Design, allow me, and researchers from a wide range of expertise, to challenge the status quo of technology design, data practices and discriminatory conservation practices. At a time where increasingly more investment is being made into conservation technology, not just financially but academically, with more and more researchers being trained to apply computational techniques to environmental challenges, the field of CDJ becomes an essential pillar to ensure that data practices for the protection of essential biodiversity do not come at the expense of marginalised communities; those whose lives, counter to the colonial and Western insistence of separation between humans and the natural world, are inextricably intertwined with the ecosystems we are trying to conserve.

The future of conservation is justice-led

This year, I will be travelling to Catalunya, Spain, alongside a select group of 20-30 researchers, for the inaugural Conservation Data Justice Symposium. Having put CDJ and justice-led conservation considerations on the map and centering it in our research in varying ways, we will gather to share state-of-the-art research and advance conceptual, ethical, methodological and substantive understanding of Conservation Data Justice. Organised by Lourdes Vera, Laura Aileen Sauls, Rose Pritchard, Eric Nost, Jenny Goldstein, Lauren Drakopulos and Dan Brockington and funded by an Advanced ERC Fellowship, the symposium will bring together a diverse set of researchers drawing from a variety of fields, from political ecology to land systems science and citizen science. Together, we will help to generate new research agendas, coalitions, teaching resources, practical initiatives, and publications.

As a researcher, my work with bioacoustics is niche but the applications of CDJ are shaping the future of conservation methods across ecosystems, technologies and methods. Ahead of the symposium, I got in contact with a handful of the researchers I'll

be meeting in person, interested in the ways that CDJ had influenced and inspired work in other essential domains and to understand how it was being used by other researchers to challenge systems of oppression and create new and equitable ways to use technology for conservation. Through my conversations and explorations of some of the other researchers' work, there seem to be three core ways conservation data justice scholars are ushering in justice-led conservation futures, through: methods and practices, community engagement and theories.

In exploring the question of methods, specifically those that enhance conservation data justice in practice, I spoke to Paul Hasan Thung and Putri Damatashia two researchers at Planet Indonesia, an NGO that partners with rural communities to enhance local well-being and protect natural ecosystems in West Kalimantan, Indonesia. Applying Pritchard et al. (2022)'s CDJ framework to the work of Planet Indonesia, they offer valuable insights into the intricacies of data management, access and control in participatory conservation projects.

Paul explains that while NGOS acknowledge the importance of justice-led data practices guiding "decision-making at the individual and community level", much of an NGO's resources are concentrated on securing support from donors and governments. Despite the essential nature of such funding, without resources or expertise properly assigned to addressing the data needs and requirements for participatory conservation, these kinds of projects often fall short of their empowering] intentions. With accessible data practices neglected, the data used in these projects are not always "directly useful to the village partners leading these programmes and is perceived to be controlled and owned by Planet Indonesia". Here, power dynamics can become further engrained, with the projects working towards the agendas of the NGO with little space for community agency, ownership, or decision making.

Thung and Damatashia are actively working to build more "democratic systems for managing data" by assembling an internal working group focused solely on data justice, engaging team members across the board, from field staff, technical support, and communications professionals. Their work is motivated by the power held within environmental data and the knowledge that "the model of community-led conservation which Planet Indonesia operates on and advocates for depends on enhancing data justice for a more just balance of power."

There is growing consensus that Indigenous land rights and conservation leadership, globally are essential in halting biodiversity loss – knowledge Indigenous communities have had and voiced for decades. Moving away from paternalistic research practices or helicopter science, where researchers conduct data collection on Indigenous lands with consent but minimal collaboration, there is a rise in Indigenous-led conservation technology projects. Emerging from community need, these projects serve the priorities of Indigenous communities in the face of continued state exploitation and extraction. Working closely with First Nation communities in Gitga'at Territory (British Columbia, CA), Max Ritts' research shows how Indigenous communities are "negotiating the power and persuasions of today's environmental data regime". The territory is home to a wide array of "new state and quasi-state environmental data initiatives". Ritts is interrogating the ways in which the growing 'datafication' of the region, through "novel software architectures, digital platforms, and distributed sensor networks" is influencing and reshaping the role of Indigenous participation and Traditional Ecological Knowledge (TEK) in conservation data practices. Where conservation technology projects are state-led, Indigenous tools and practices are neglected and there emerge increased and distracting bureaucratisation of community activity, "delimiting space for alternative stewardship practices, and augmenting already extensive desk work with additional tasks".

Ritts' changes his work in response to community

needs. The project began as an Ecological and Cultural Monitoring Program, conducting an ecoacoustic baseline of the Gitga'at Territory, but has now evolved in line with community interests and needs. Several months into the research, the Nation proposed a new course of action. Motivated by the overwhelming number of actors producing environmental data and developing sensing technologies in and around the Territory – from marine mammal population trends, food inventories, changing levels of marine pollutants, community-based ecosystem assessments and hydrophone data to name a few – the Gitga'at community leadership reasoned that a kind of inventory would be a necessary task. Co-editing the report Ritts is now working on The State of the Gitga'at Ocean Report, a community-led report building on the previous baseline ecoacoustic study. The report will cover not only work done by the Nation (and its various departments), but also collaborators in government, industry, and NGOs. Ritts tells me that "while the report's main focus is environmental assessment, it doubles as a way of coming to terms with all the data and information the community decision-makers must manage, and which they have managed quite well to manage, in spite of all the work demands imposed".

Extending the Conservation Data Justice focus to the more-than-human world, a growing concern for conservationists who highlight the need to de-center the human and ecological enquiry, Leah Govia, is a social researcher from the University of Guelph, who is bringing the work of Animal Computer Interaction to the fore. Animal Computer Interaction (ACI) is a field focused on studying and designing interactions between animals and computer-based technologies. There is a wide range of tech explored through ACI, but some popular examples include smart collars for pets, zoo animal enrichment such as interactive branches and touchscreens, as well as sensors and monitoring techniques like drones and camera traps commonly seen in conservation. Her work considers a "multispecies research/design ethics for conservation technology." The field of ACI is focused on addressing power dynamics between humans and other animals, "often incorporating critical reflection on technology design/use as a result" and highlighting the ways in which "data is a multi-species concern." This work asks important questions about how human values influence what and how data about animals is collected, and how conservation technologies such as drones, impact and disturb the welfare of wildlife. "In the end", Leah tells me, "data about the animals is intertwined with data about human lives too. Depending on who is designing and applying the tech, certain species and humans are being made visible while others are not." ACI provides an opportunity for conservationists' to engage with and expand "the who included in the design of conservation tech". Major highlights from the scenarios include questions about multispecies 'user' experience, as well as analysis regarding data, privacy, consent, and shared welfare for wildlife and humans alike. Ultimately, this paper provides space for interested parties to consider alternative ideas around ethics and conservation technologies.

The featured case studies sit alongside a vibrant and growing body of work addressing the ethical challenges posed by the application of AI and sensing technologies to essential conservation issues. By continuing to share methods, experiences, challenges, and resources, at the Conservation Data Justice Symposium and beyond, researchers in the field shape the future of conservation, building practices that are transformative sociologically, as much as, ecologically.

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