



Justice-oriented Design Listening: Participatory Ecoacoustics with a Ghanaian Forest Community

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ABSTRACT

Despite a long tradition of ‘non-expert’ participation in ecoacoustics research, asymmetrical distribution of resources and engagement between the Global North and Global South continue, extending to ecoacoustic sensing and design. Whilst there exists a growing body of work in Participatory Design (PD) addressing the technical and social challenges of ecoacoustic research, we find that popular PD methods inadequately address design justice and decolonising agendas. Through participatory ecoacoustic sensing and design engagements with a forest community in Ghana, we highlight the tensions that emerge when employing visual and written modes of PD in a context where an oral approach to creativity and communication is more appropriate. We present Justice-oriented Design Listening, an acoustically-mediated approach to PD, described through three modes: polyphony, pace and transformation. This work contributes to calls for design justice by developing a methodological approach that facilitates pluralistic participation in design when developing conservation technologies in non-Western contexts.

CCS CONCEPTS

• **Human-centered computing** → **Ethnographic studies; Field studies.**

KEYWORDS

Conservation technologies, participatory sensing, participatory design, design justice, decolonial design methods, ecoacoustics

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1 INTRODUCTION

With tropical forests playing a major role in shaping the outcomes of both the climate and biodiversity crises, measuring and monitoring have become essential practices within the field of conservation. As a result of advances in machine learning techniques and reductions in hardware costs, the field of ecoacoustics is playing an increasingly important role in monitoring biodiversity and informing conservation practices. Ecoacoustic research sees autonomous sensors deployed in forest ecosystems over extended periods, to record wildlife and ecosystem sounds. Whilst machine learning techniques enable vast quantities of data to be analysed, data annotation practices for supervised training and model evaluation require labour-intensive manual labelling, where individual calls within a single spectrogram must be box-bounded and classified



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[17, 19, 49]. Much of the classification of calls within large data sets is often conducted by citizen scientists [47]. However, even with this crowdsourced labour, resource constraints limit the volume of data that is explored, interacted with and interpreted by conservation researchers.

The field of ecoacoustics suffers not only technical data challenges but justice challenges too. Despite the long tradition of citizen participation in ecoacoustics research, particularly with bird enthusiasts, there is an asymmetrical distribution of resources, expertise, equipment and engagement between the Global North and Global South. There exists a paucity of African ecoacoustics literature [11] and the local ecological knowledge (LEK) of African forest communities remains largely understudied. In the Ghanaian context, there have been calls [4, 43, 78] to prioritise traditional and Indigenous Asante knowledge and practices as effective forest conservation and management practices in Ghana [4]. The colonial and continued neocolonial exclusion of forest communities and traditional beliefs and practices in tropical forest conservation extends to the development of new technologies that are embedded in forest landscapes. Local communities are “seldom...involved in the technology design of conservation tools which results in the design of non-intuitive systems” [52], often leading to mistrust in the technology itself [51].

There exists an opportunity for Sustainable HCI (SHCI) researchers and Participatory Design (PD) practitioners to expand their methods to attend to both the technical and social challenges of ecoacoustics research and to adequately engage communities across the research and technology design cycle [47]. There is a small but growing collection of works [21, 27–29, 39, 50, 59, 64, 73] making progress on this task within the emerging genre of SHCI and participatory sensing (PS).

Yet, whilst the field of PD seeks to centre community participation in the design process, aiming to balance power dynamics and engage meaningfully with communities and environments [47], current methods inadequately address calls for PD to align with decolonial and justice-oriented goals and approaches, limited by a skew towards methods established with Western workplace user groups [63]. Even within the Western context, Moran et al., 2014 [50] find that there are tensions that exist between ecoacoustics technology and the “established working practices” of community members. When justice and decolonial approaches to PD are neglected, hierarchies of WEIRD¹ researchers over Global South communities are maintained, and the field is deprived of other ways of knowing and designing that add richness to technology development for conservation.

Framed by the core research objective *to understand and generate methods of Participatory Design that elicit and facilitate pluralistic and culturally appropriate and informed community engagements for conservation technology design*, and part of a longer doctoral research project, this work reflects on co-design and participatory sensing engagements with a forest fringe community in the Asante Region of Ghana. This work was technologically

motivated by the dual challenge of designing ecoacoustic interfaces that allow accessible data exploration and that are designed with communities who live where this data is collected. Whilst the participatory workshops initially employed standard participatory approaches, intending to elicit culturally and socially appropriate designs for a community ecoacoustic platform, we present the ways in which these standard methods were inappropriate within the given context. Specifically, we find there to be tensions between popular PD approaches to collaborative interaction design – drawing, sketching and paper prototyping – and the preferred forms of participation and creative practices of community members, which were primarily oral. We find that current PD approaches are at risk of limiting participant expressions of creativity and perpetuating socially unjust dynamics within the design process and advocate for a ‘researcher-as-listener’ [66] approach to PD in non-Western contexts. These methodological contributions arose directly from community members, who pushed back against the PD methods employed by the first author (FA) and their advocacy for more familiar and comfortable forms of communication and creativity. Our findings align with Design Justice and Decolonising Design scholars [1, 2, 15, 30, 41, 53, 61, 75, 76] who advocate for the decentring of Western epistemology in the design process and call for design methods that “amplify, support and extend existing community-based processes” [25, 36, 74]. We find, empirically, that the centring of “Euro-American patterns or expectations of communication” not only overlooks but obscures “vital qualities that can...shape the roots of technology development” [15].

This case study makes methodological contributions to HCI research that adopts PD approaches for the design of conservation technologies: (1) we provide ethnographic descriptions of PD engagements with a tropical forest community for the development of ecoacoustics data interfaces and, (2) we describe the tensions that arise when employing visual and written modes of participatory interaction design in a tropical forest context, (3) and present Justice-oriented Design Listening, an acoustically oriented approach to PD that facilitates pluralistic co-design engagements when developing and deploying conservation technologies in non-Western contexts.

2 RELATED WORK

2.1 Participation in Ecoacoustics Research

The field of ecoacoustics has been greatly supported by the labour and expertise of citizen scientists. The majority of this work comes in the form of crowdsourced data collection and annotation for large ecoacoustic databases such as eBird, developed by Sullivan et al., 2009 [67], xeno-canto, developed by Planqué et al., 2008 [56], and Bird Sounds Global, developed by Lifeplan, 2013 [46]. These databases are built by a global network of birders and researchers uploading their sound recordings and identifying the wildlife within them. There also exists a wide and varied body of work at the intersection of citizen science, participation and ecoacoustics, resulting in the design of citizen science apps [44, 50], a better understanding of the sensemaking of ecoacoustic data [27], and the improved identification of wildlife in ecoacoustic recordings using machine learning techniques [71]. However, most of this work has been conducted in the Global North. Despite this geographic research bias there are a growing number of works engaging with Indigenous

¹Henrich et al., 2010 [38] introduced the term WEIRD, which stands for Western, Educated, Industrialised, Rich and Democratic, to describe the societies that within psychology, and across many research fields, are taken to set the universal standards for human behaviour and taken to be representative of the global population.

peoples and local communities in the Global South. Soro et al., 2018 [64] and Dema et al., 2020 [28] both worked at the intersection of PD and acoustic data visualisation, exploring alternative modes of interaction through probes such as ‘Ambient Birdhouses’. These probes engage participants through the annotation of false-colour spectrograms (visualisations of long-duration acoustic data created by combining spectral indices mapped to green, red and blue [71]), species identification games, trivia questions, and species profiles. These methods aim to “shift the foci from tasking people to gather data to enhancing ways for people to learn and share within the community”, a significant problem that is equally relevant in Global North settings. Ritts et al., 2016 [59] worked collaboratively with an Indigenous community in Gitga’at Territory (aka British Columbia) responding to community concerns regarding eco-acoustic disturbances from the growth of the local marine industry. The work aims at “reorienting ecological knowledge as a praxis-based ‘Street Science’ [24]”, to address resource management, academic, and local citizen concerns. In Ghana, the body of ecoacoustic research is limited [26, 37, 69] with little interaction with forest communities.

2.2 Justice-oriented and Decolonial Design and Data Practices

We position our work at the intersection of data science and PD in the forest while drawing on a wider range of literature in the growing field of conservation data justice (CDJ), introduced by Pritchard et al., 2022 [57], which challenges extractive and neocolonial data approaches within conservation research. CDJ introduces the necessity of a data justice view for conservation asking how “people and environments are represented through data and how this could alter the distribution of benefits and harm from conservation actions” [57]. Addressing the justice concerns unique to the “datafication of forests”, Gabrys, 2020 [35] asks us to consider how civic technologies facilitate or impede distinct modes of participation and lead to “significant changes in environmental and planetary governance”. Gabrys advocates for a “plurality of systematic approaches and ontologies” within environmental data science and the democratisation of environmental action with citizen science, while Taylor et al., 2015 [68] highlight how data is inherently linked to place and “underlay and enmesh with communities and their geography”. Pritchard et al., 2022 [57] make clear that whilst participatory monitoring has been proposed as a solution to injustices within conservation research, methodological innovation is needed to “address injustices in ways which do not compound others”.

Within HCI, whilst it is acknowledged that practices and methods are not universal, participatory approaches are still “based on Western epistemologies and applied in developing countries without much consideration of the local knowledge systems” [20]. Sabiescu et al., 2014 [60] note that participation should not be prescriptive or pre-defined, with “different social and cultural values espoused by communities shaping different views of participation”. Bidwell’s 2016 call to decolonise HCI and interaction design [15] highlights how the characterisation of technology as a development tool in Africa “reproduces a master narrative that the continent is deficient in features that signify progress”. There is a failure to acknowledge the diversity of embodied ways of knowing and

expression seen across the African continent, with African communities identifying “themselves through meaningful expressions and acts that involve doing, seeing, hearing, tasting, feeling, touching...[with] the acoustic realm continuing to have important roles in Africa’s anti-colonial movements” [48]. More recent work from Bidwell and Tena [14], highlights the ways in which even justice-oriented approaches in HCI “do not explicitly relate justice and fairness to the inclusion of different knowledge systems or consider what fairness might mean for ways that reality is indicated in different worldviews”, in what Fricker, 2007 [33] introduced as “epistemic injustice”. They highlight the need to centre “epistemic accountability” when designing digital technologies with local communities, motivating future decolonising work within HCI. The authors also suggest finding and exploring “new ways to interpret human beings through practices and philosophies that the discourse neglects” to avoid “the potential for a person’s meanings, contributions and communicative practices to be undervalued, excluded, silenced, misrepresented or systematically distorted [14]”.

Our work specifically attends to the pressing questions raised within the justice-oriented and decolonial HCI literature, and relevant initiatives within ecology and environmental justice. We provide reflections and insight on how to centre participation within data and conservation practices and seek to address the associated lack of documented and implemented approaches to facilitating participation in culturally appropriate ways. This statement brings up important questions regarding whose participation is being centred, how this can be done in culturally appropriate ways and with more attention towards the inclusion of participatory data and conservation practices in the Global South.

3 STUDY CONTEXT

This research was conducted in a community on the fringe of the Bosomtwe Range Forest Reserve (BRFR) of the Asante Region in Ghana, pictured in Fig 1. BRFR is classified as a Key Biodiversity Area (KBA) and Important Bird Area (IBA) by BirdLife International [10, 40] and covers an area of 79 km².



Figure 1: The community forest in the Bosomtwe Range Forest Reserve, Asante Region Ghana.

The relationship between the community and the FA was established through a series of informal meetings, followed by traditional Ghanaian ‘community entry protocol’ [8, 70], after an initial on-the-ground scoping trip. It is essential in a participatory or community-based project to acknowledge, respect and observe the community entry protocol, as noted by Appiah, 2020 [8], “cultural values and traditional practices of the people form an integral part of the research process, particularly the community entry process”. The expectations of outsiders within a community entry protocol are non-homogeneous and differ nationally, regionally and at the village level. The details of the entry protocol are not public information or available online; access to the information you need about the rules and stipulations of the protocol must be gained through interpersonal relationship building. The FA sought guidance from their Ghana-based academic supervisor at KNUST and members of the district Forestry Commission team to understand the specific entry protocol of the Atatam village. The FA was advised to present the chief with a bottle of schnapps which in Ghana has come to “serve alongside water as ritual fluids for deities” [7], and is poured as a libation to gods at water bodies, presented at weddings, left at shrines and poured at the naming ceremonies of children among other events. The FA was also instructed to present a small amount of money as a token of their generosity addressed to the community. These offerings were presented in a traditional ceremony to the village Opanin (elders) and Nana to whom they were formally introduced by the Forestry Commission official.

The participating community has an approximate population of 200 people, mostly farmers, specialising in cocoa, cassava, plantain, cocoyam and less frequently maize cultivation, depending on agriculture as their main source of income. Whilst there are wider discussions within HCI and across sociology, geography and anthropology about the use of the word community, in the Ghanaian context, referring to community members as “villagers” or to their home as a “village” can be interpreted as derogatory. ‘Community’, in this context, is a crucial term for Ghanaian participants to describe their relations to place. We find it important to make clear who we mean when we refer to the ‘community’. Across the field seasons, a large number of the wider community, at most approximately 70 people, were engaged through community meetings, workshops and semi-structured interviews. For the engagements detailed in this paper, the ‘community’ refers to a group of 12 individuals: Samuel Teye, Kwadwo Appiah, Yohanne Quadoe, Abena Dufie, Isaka Dramani, Comfort Arkoh, Diana Acquah, Yaa Achiamaa, Ama Kohadu, Agnes Yaa Nkonsah, Akwasi Sarfo and Kwaku Amoah.

The main sites for our community meetings occurred in a small wooden church at the head of the village, adjacent to the central area for community gatherings under a large fig tree, and during walks and sensor deployments within the forest itself. All meetings were conducted in the local Akan Twi language and translated by a Wildlife Expert from KNUST as well as, at various points local field assistants, as well as occasionally by the FA who is of Ghanaian heritage and has intermediate comprehension of the language.

4 RESEARCH APPROACH

Here, we provide an overview of the design engagements (see Fig 2) conducted by the FA and Ghanaian collaborators, Ben Ossom and Enock Ba between April and June 2023, noting the influence of activities (semi-structured interviews and participatory sensing workshops) in the previous forest visit between March and June 2022. The objective was to co-design an ecoacoustic data exploration and analysis tool with community members, following popular and grounded methods of Participatory and Interaction Design such as workshops, probes and prototyping in response to concerns raised by community members within the first field season phase. In the interest of brevity and focus, we do not detail all the findings of these interviews here, but note that questioning, concern, agency, self-directed exploration and tangibility were key requirements for trust-building with community members and that prototype design was influenced by the contributions and requests of community members through the interview process.

4.1 Feedback on an Interactive t-SNE Acoustic Interface

With instructions, from the interview phase, to return with an example of an interface that enabled exploration of all collected recordings across all bird species types, a ‘Wizard of Oz’ (WoZ) prototype [13, 16] was designed by the FA and design collaborator Ana Cuza, a data visualisation practitioner working in North America. This prototype, based on an unsupervised machine learning clustering algorithm, t-SNE [72], grouped similar 3-second sound clips from the collected ecoacoustic recordings, with different clusters denoting different species and allowed participants to ‘click’ to play each recording and, ‘hover’ to see images of the associated bird species. The main component of the prototype, the cluster or scatter graph data representation was initially sketched by the FA [31] alongside other alternative data representations (bar charts, pie charts, line graphs etc.). After a discussion on these representations, the prototype was presented digitally on a laptop, with community discussion and feedback prompted by questions from the FA.

4.2 Paper Prototyping Interactive Interfaces

The paper prototyping workshop [55, 62] aimed to allow community members to organise possible interface elements, some taken from the initial prototype, and draw features for an interface they would use to communicate information about and explore wildlife and its sounds, taking inspiration both from the prototype or from apps more familiar and well-used by them e.g. WhatsApp, Facebook, TikTok. After some example sketches were made by the FA, participants were supplied with paper images of local birds, monkeys, trees and plants as well as pens, pencils, crayons, sticky notes, cutouts of different data representations, and blank A3 pieces of paper on which to place their ideas.

4.3 A Listening Session on the Ecological Significance of Adinkra Symbols

We conducted a listening session based on the work of Adom et al., 2018 [5], who explored the utility of Adinkra symbols, Indigenous Ghanaian design concepts that encode proverbs and philosophical

ideologies, for sustainability education in Ghana. The symbols are a source of pride for Ghanaians and adorn private cars, taxis, public buses (*trotro*), hotels, market stalls and public buildings and have been urged to be included in formal biodiversity conservation in Ghana [3, 4]. Printed-out images of a range of Adinkra symbols were shown to community members and, inspired by ecological descriptions detailed in Adom et al., 2018 [4], the discussion explored how the cultural artefact of the Adinkra connects community members to the concept of visualisation, how ecological meanings or lessons were encoded in cultural visual representations, and whether community members saw an opportunity to embed these representations into the resulting ecoacoustic interface.

4.4 Collective Mapping and Ecoacoustic Experimental Design

A community mapping workshop was conducted to present formal ecoacoustic experimental sampling techniques (random sampling, transect lines and stratified sampling) [45] and understand how the community would approach this ecoacoustic experimental design, given their ecological and sociological priorities. The session began with questions about the different areas of the forest including the location of biodiversity hotspots, out-of-bounds regions, sacred areas and the areas most visited by community members. We also discussed what the most important wildlife were to the community members and how they would ordinarily navigate within the forest. Community members were asked to draw or mark areas of the forest that were important for the wildlife they listed, as well as areas that were important for livelihood. This part of the session also served to understand the extent of the forest accessed by community members in day-to-day life to understand the areas within which our sensor deployment should occur.

4.5 Walking Conversations

Following the mapping workshop, we conducted two sensor deployment walks based on the community plan for the sample design. These walks, whilst serving the practical function of collective sensor deployment, and an embodied mapping of the forest, also served the purpose of walking conversations, a method extensively documented and employed within the design and social sciences literature [42, 58]. The FA used these 2-3 hour hikes as an opportunity to listen to conversations as they arose and to probe further when they seemed related to ecology (the kinds of birds we heard) or the material needs of community members (how conservation and livelihood are inextricably linked). Throughout each journey, photographs of the canopy and surroundings were taken and a GPS Tracker app was used to map the routes that were taken.

4.6 Feedback on an Ecoacoustic Interface for Ecotourism

Reflecting on the conversation within the Adinkra and walking listening sessions, the FA designed an updated interface design focused on embedding the previous t-SNE data representations within an app for ecotourism. Before sharing this new design, the FA reflected on what they had heard in the walking sessions and prompted extended conversation based on the prevalence of livelihood concerns and the need for ecotourism initiatives. After these

discussions, the FA presented this new design to community members, walking through each slide of the mobile application on the FA's laptop and pausing after each description to give space to questions and discussions that arose. Community members discussed practical requirements, missing elements, ways in which they could embed their local knowledge and their intended objectives for the interface.

4.7 Listening to and Talking About Ecoacoustic Recordings

In order to bring the environment back into our focused engagements, we expanded our process to study and understand how community members listen to the places where they live and work, and how this also guides their land practices, for instance, farming. The FA, Ossom, Ba and participants listened to sample recordings from the data collected during the sensor deployments. The session was purely acoustic, with no visualisations of the recordings shown. Each example file was played and a set of questions followed including: What time of day is this recording from? Which deployment location in the forest do you think the recording is from? How would you rate (on a Likert scale from 1-5) the biodiversity in each of the recordings? Which recordings do you find the most pleasing?

Throughout these sessions, data collection and analysis were conducted ethnographically, with the FA and Enock Ba taking separate but detailed notes during sessions and, after each session, the FA also wrote a reflection. In line with Coffey, 2018 [22], data collection and analysis were not distinct endeavours, but rather ongoing and reciprocal with the approaches to data collection adapted on reflection of the observations from previous sessions. A cycle of note reading, during and after the field visit was conducted by the FA, with reflections, pattern identification, and theoretical analysis occurring at each stage following an inductive approach. It was through these cyclical periods of reflection that it became clear to the FA that visual modes of engagement, drawing, sketching, marking and prototyping were inappropriate. In the next section, we detail these ethnographic reflections on the various workshops and highlight our key observations.

5 THE EMERGENCE OF JUSTICE-ORIENTED DESIGN LISTENING

Throughout our design engagements, there were several times when the suitability of the methods employed was, directly and indirectly, challenged by community members and proven to be problematic. Not only this, but we observed that when the oral was centred, and the designer took the position of listener, community goals, objectives and priorities came to the fore organically. Throughout these various interactions over the course of the forest visit, it became clear that adopting an acoustic mode, in which the designer assumes the role of 'researcher-as-listener' [66], was more culturally appropriate and conducive to energetic, dynamic and creative design experiences. We note that the workshops were designed iteratively, with each activity a response to conversations and feedback received from community members in previous sessions. It was through this process of iterative listening – to community concerns, points of interest and needs – and the subsequent embedding

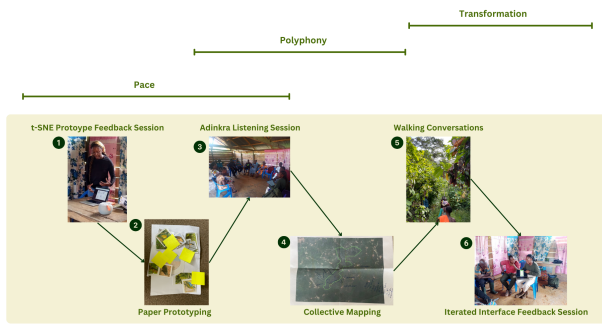


Figure 2: A diagram of the research approach undertaken in this study. Within the yellow box, each of the distinct and consecutive design engagements is detailed with supporting images. Above them, the phases in which the three modes of Justice-oriented Design Listening emerged are labelled.

of these responses in the design of the following workshops that the FA came to the approach of Justice-oriented Design Listening (JoDL). Below, we highlight the three major points of reflection that occurred over the course of the design sessions and how these reflections led to JoDL and its three modes – **Polyphony**, **Pace** and **Transformation** – that facilitate pluralistic design engagements between designers and marginalised communities. Here, polyphony is an approach to pluralism in the design listening process, pace is an approach that privileges slowness and centres community agency and transformation is an act that remakes practices of iteration and adaptation.

5.1 Replacing drawing with dialogue

The Interactive t-SNE prototype feedback session (see Fig 3) was one filled with energy and high enthusiasm from community members. Upon reflection, this session had all of the elements comfortable to community members with the FA drawing and sketching herself, as well as presenting interface ideas digitally and with community members orally contributing feedback. It was noted that the session was dialogic, with community members bouncing off the prompt questions of the FA in relation to the data representations and prototype interactions being shown and demonstrated.

In contrast to this conversational and highly engaged session, the paper prototyping session saw community members become withdrawn, quiet and reserved, unable or unwilling to express direct opinions or ideas. Whilst the FA endeavoured to provide as many resources as possible for this session, including pens, pencils, crayons, A1 paper and a booklet of images of local wildlife, plant life, cultural symbols and data representations, community members did not touch the pens or crayons at all. Instead, they opted to cut out images of the wildlife and match them to the different crops they eat and where in the forest, using the map, they could be found. Despite the activity being completed, it was clear that there was a lack of interest and enthusiasm in the session. Having undertaken a long-term collaborative practice with the same community members over two field seasons, the FA had become



Figure 3: Community members giving feedback on the interactive t-SNE interface to the FA

attuned to both the verbal and non-verbal ways of communication from community members. During the first field season, when community members pushed back against semi-structured interviews, uncomfortable with their format and interpreting them as interrogations, they would become non-verbal, refusing to speak or respond to questions. Yet, once the interview sessions concluded and we “re-entered” the open community space, community members became visibly more comfortable and open to conversation. The quietness from community members signalled displeasure and is a form of communication that often signifies disagreement in African cultures [15].

We observed similar responses of discomfort to drawing activities in the community mapping exercise. When invited to come and make markings on the map, community members were resistant, preferring to describe rough areas on the map and for the FA to make the annotations. So, instead of presenting maps for community members to annotate, or draw on, the FA returned to what had always brought comfort to community members: listening to and centring the forest and community members’ lived experiences within it. So, assuming the role of listener, the FA, Ossom and Ba asked probing questions about known biodiversity hotspots within the forest, livelihood regions and sacred sites. After not much time, the community members began to engage in an in-depth conversation, listening and interacting with each other, about the types of wildlife that could be found in different parts of the forest, places we should never go, rivers that have certain taboo days for their conservation and the strategies we should take to choose the acoustic sensor deployment sites. Participant comments included:

“the places in the forest where there are big trees around the water bodies is where we don’t go because it is sacred”, or “these places are very thick and inaccessible, these are the places we wouldn’t go to”.

As they spoke, the FA drew and wrote on the map. Once the community members noticed that the FA had started to note down their ideas, community members physically drew nearer, making the circle of chairs tighter and began to include the FA in the conversation, directing their drawing and annotation of the map. The low interest

and energy had transformed into a community-led discussion about the ecology and geography of the forest and it became clear that an oral mode of communication and creativity was essential for our ongoing collaborative design enquiry.

Reflecting on the varying levels of satisfaction within the first two sessions, the FA realised that their methods, up till this point, were positioning community members as alternative knowledge-holders to extract new design ideas from, rather than as collaborators with existing design processes and practices. It was at this point that the FA sought to follow guidance from Akama and Light, 2018 [6] who describe how designers must stop at a “critical juncture” and “alter [the] methods of interpretation so as to better suit the contingencies of the situation”. All further sessions were conducted in a strictly acoustic mode of engagement, with community members prompted into a discussion by the FA, Ossom and Ba, and it was in this way that Justice-oriented Design Listening (JoDL) emerged. The following four workshops saw community members deepen and inform the FA’s understanding of how this acoustically-oriented method could lead to more culturally and contextually appropriate design engagements, as well as the emergence of the three distinct modes of JoDL.

5.2 The cultural centrality of storytelling



Figure 4: The FA and community members discussing the Ghanaian cultural Adinkra symbols.

In order to provide relief from the taxing and drawn-out sessions that involved drawing, sketching and collaging, a previously planned discussion session based on the Adinkra (see Fig 4), Ghanaian cultural symbols that communicate important proverbs, was brought forward in the research schedule. During this session, community members became highly animated and passionate, sharing ideas back and forth and recounting in detail their perspectives on the teachings of each of the five Adinkra we focused on during the two-hour session. For example, upon seeing the Sankofa Adinkra (see Fig. 5), which “teaches the wisdom in learning from the past to help improve the future” [3], community members shared how the past was being carried forward in the ecological practices.

Participant responses included:

“we continue to believe that if you disobey the taboo and visit the water bodies on sacred days, that it is not good and you will see things you are not supposed to see”.



Figure 5: The Sankofa Adinkra symbol

For community members, the Adinkra discussion allowed for their already existing understanding and practice of design and meaning to come to the fore. Community comments included:

“my favourite is the stories”,

“stories can give us more information on these birds”, and

“we use Adinkra symbols to tell the stories of our culture”.

Whilst the symbols are graphic in nature, they are made perceptible only through storytelling. A key observation was the way in which each Adinkra, whilst being a visual representation of culturally important proverbs, was close to meaningless without being spoken. Reflecting on this fact, and the patterns that were arising, with activities involving visual abstractions gaining low interest and those that gave space to the oral mode being greatly welcomed, again, the FA shifted their role from facilitator to listener and it was here that the mode of Polyphony came to the fore. By prioritising listening, the FA was able to observe how community members facilitated their own conversations and made design decisions outside of the confines of methods seen as foreign, Western or necessarily elitist given the varying levels of formal education within the group. Centring storytelling proved to encourage multiplicity within the design sessions, with ideas generated in a non-linear, asynchronous but energetic manner. This was audibly observable, with sessions where visual, written or makerly modes of engagement were centred being very quiet, with little input from community members, in contrast to the loud, energetic and dialogic nature of the sessions that centred discussion and storytelling. Polyphony was observed in the way conversations unfolded between community members, with different voices contributing simultaneously and non-linearly resulting in a wide variety of ideas and points of interest.

It was also, at this stage that Pace was solidified as a mode of JoDL. Whilst the need for slower pacing became evident in the 2022 field visit and was prioritised from the first community engagements in 2023, the Adinkra session extended the meaning of pace in the design context. Initially planned as a one-hour workshop, the Adinkra listening session extended over two hours. Community members recognized these symbols and felt very comfortable

engaging in collaborative conversations through them. When listening was prioritised, community members felt safe enough to talk for many hours, and to see ideas and discussions through to the end. This contrasted with the paper prototyping sessions lasting only around 30 minutes due to a lack of engagement from community members.

5.3 Walking to find meaning

The resistance and reticence shown by community members when presented with empty pages of paper and crafting materials and the comparative enthusiasm exhibited during discussion sessions made clear that completely bottom-up approaches to design were uncomfortable. During the walking sessions that followed, this listening and conversation was casual and unconstrained. Rather than leading with premeditated questions, the FA listened to the various points of conversation that arose and asked for clarification or probed further when interesting points came up.

The most significant of which was the repeated discussion around livelihood and the prompting from a few community members that this should be the focus of the ecoacoustic data app. In the first walking conversation, as the community led the FA, Ossom and Ba to the first location of the sensor deployment, “The Rocks”, community members began a conversation about livelihood and how their connection to and protection of the forest relies on income. One community member noted:

“it will help conserve the species and the forest because if people are to come and visit and pay something that will develop our livelihood and the community, we would do all we can to prevent the illegal activities and protect the forest and the species because that would be our livelihood”.

They began to ask whether our research could address the pressing issue of income and directly asked the FA whether the app could be designed to attract eco-tourists to the region. Ideas started to percolate, with one community member sharing that:

“the technology will help us to know where different species are in this way the technology helps with the information and then the local knowledge can be imparted during walks with tourists”.

The conversation arose because the rocks were the nesting site for the rare *Picathartes* (White-necked Rockfowl), which a group of conservationists had previously visited the community to find.

During these walks, community members were less interested in talking about specific design features and more concerned about the goal and objectives of a possible interface or tool. The ability for technology, embedded with ecoacoustic data exploration, to provide an alternate livelihood through tourism became the topic of conversation. Taking seriously community members’ comments the FA saw an opportunity to integrate the discussion into the design process but instead of requiring participants to create designs in this very standard and formal way – which had already been observed to be unsuccessful – the FA took the time between those walks and the next session to iterate on the original prototype with a focus on an ecotourism app.

This prototype embedded the t-SNE cluster visualisation and also included the Adinkra symbol stories and the sites of sensor deployment chosen by the community members. These designs were

presented to the group at the next meeting (see Fig 6) and were met with great enthusiasm. The FA listened to the ensuing conversation which continued for around an hour and was propelled largely by community members, and noted down all contributions shared throughout the discussion, including:

“I really like the app, it’s neat”, and

“this app is going to be really helpful”.

Flicking through and exploring the designs of each app screen, community members gave a stream of positive feedback and pointed out current limitations that could be improved upon. For instance, whilst the t-SNE visualisation was seen as a useful tool for learning about the species in the forest, one community member noted that they wanted to:

“be able to record the animals we see throughout our walks”.

Community members were also confident in asserting limits and boundaries that the app should embed, noting that whilst:

“the technology gives a lead for people to come to this village to see the species that are here...we will need to have two different sections, one for the tourist and one for the community so they don’t have access to the maps of where to be taken into the forest otherwise they will go by themselves”.

Rather than set an expectation for an artefact draft or design by community members within the session, the designer would save this work for the ‘between-time’, ready to present an iteration at the next session. It was through this process, of using the ‘in-between’ phases in the design process that the necessity of the mode of Transformation became apparent. Transformation, not only of community member’s thoughts, concerns and ideas into designs to aid more engaged and generative design engagements but also to create a sense of trust and excitement in community members. Transformation became a sign of care and an honouring of the agency of community members to shape the design focus.



Figure 6: The FA presenting the ecotourism app sketches and responding to feedback.

6 THE THREE MODES OF JUSTICE-ORIENTED DESIGN LISTENING

Through the related work, three important considerations arose regarding PD approaches in Global South settings. The need for adaptability, for methods to refrain from being rigid or predefined and instead respond, with flexibility, to participant needs was made clear. As was the importance of plurality, with the need for PD methods to respect, embrace and centre a wide variety of worldviews and modes of interaction often highlighted. Finally, scholars working in Global South settings made clear the need for participant agency, where practitioners move past the power dynamics between the “designer” and “participant” towards a design process that is equally constructed, led and paced by all collaborators. These three considerations towards justice-oriented and decolonised modes of participation are specifically represented in the three modes of Justice-oriented Design Listening (JoDL) – **Polyphony, Pace and Transformation** – that emerged through our engagements with Ghanaian forest community members and “build on and strengthen[s] underrepresented, oppressed forms of knowledge” and participation [12].

Justice-oriented Design listening (JoDL), is an approach to PD characterised by the way in which storytelling, meaning-making, and the prioritisation of the oral, shape design engagements in contexts where people have distinctly oral modes of engaging with, narrating and analysing their land practices, the surrounding environment and the data that arises from sensing those environments. JoDL emerges by taking into consideration not only the methods taken to design specific conservation technologies but also foregrounding how PD practitioners might “ready themselves” [6] for working with communities where conversation and storytelling are the foundation of knowledge exchange and ideation. In alignment with O’Neill and Rivera Crespo, 2018 [54], our method is less about doing design and more about how we generate knowledge from design in non-Western contexts.

We note that our acoustic orientation and approach to PD are in some ways aligned with the work of Weiss et al., 2021 [18] who introduced the method of Design Listening (DL) as a phenomenon in design-led innovation practice and presented the three ‘facets’ of DL – challenge, probe and shape – that describe how design facilitators ‘respond to what they hear’ in rapid design-led interventions where designers ‘support organisations in tackling wicked problems in a limited amount of time’. Whilst both ours and the work of Weiss et al., 2021 [18] share a focus on approaching design through an acoustic modality, within Weiss’ work, listening is employed as a method that allows designers to glean information from participants in focus group settings, whereas in our work we see listening as a transformation of researchers, participants, and the research process, informed by the cultural importance and practice of oral knowledge creation and communication. Here, the act of ‘listening to’ is reciprocal, with both community members and researchers hoping to be ‘listened to’ so that a collective approach to design can be developed. Listening goes beyond merely giving attention to sound but becomes something textured, relational and narrative.

JoDL can be seen as a “retooling” [25, 34] of the methods that shape PD research and an extension of the considerations of adaptability, plurality and agency highlighted in the related work.

In this section, we describe and characterise JoDL through three distinct modes; **polyphony**, **pace** and **transformation**, that facilitate pluralistic Participatory Design. Here, we extend our previous reflections, to discuss how the three modes unfold and the considerations they present for justice-centred PD.

6.1 Polyphony

Polyphony is an approach to pluralism in the JoDL process. It responds to calls for plurality in the design process by decentring the designer to allow community communication mechanisms to flow in non-linear, unstructured and multi-faceted ways.

As noted by the ethnomusicologist and anthropologist Steven Feld, “one hears no unison in nature” [32] and indeed, our community conversations and discussions were polyphonic, mimicking the acoustic qualities of the forest beyond. In this work, a polyphonic approach to conversation was adopted as a consequence of the FA moving from facilitator to listener.

When listening was prioritised, design sessions became a cacophony of ideas, questions and rebuttals. Our conversations would follow an arc that began with one member of the group responding to a prompt question and then one by one, other voices being added to the mix, at times in unison and others with multiple conversations occurring in parallel. During this time, the designer must become comfortable with the emergence of disharmony in conversations; there must be tolerance for different types of cadences. In PD we often believe there should be a harmonious positive cadence where the result is a finalised artefact that represents the combined ideas of the group, but sometimes a cadence that is dissonant or leaves a feeling of not being quite finished (an imperfect cadence) acts as a comma and suggests that more conversation is needed. What the FA observed though was that this polyphony, whether holding harmony or tension, returned to a place of stillness, and without external input, once the discussion was exhausted.

Weiss et al., 2021 [18] refer to the need for design facilitators to “hear through the noise”, where noise is characterised as ‘content overload...abstractions, buzzwords or jargon’. However, our engagements presented a different perspective. Following the lead of community members, we find that “noise” is not something adversarial, but essential to the creative process. In contrast with the often negative connotations of noise, take for instance that noise often represents unwanted sounds that must be removed using pre-processing techniques in ecoacoustics, community members demonstrated and encouraged non-linear discussions, where many individuals speak at once. In this mode, JoDL asks the designer to be aware of their own perception of “noise”, which we understand to refer to ‘unuseful’ and ‘unnecessary’ remarks or contributions and reflect on how these perceptions might be tied to distinctly Western worldviews. The skill of the designer lies in the ability to ‘tune in’ to each different part or melody and note them down so as to not interrupt the flow or harmonisation between participants.

The designer must listen for “emergence rather than extraction” as put forward by Ardoin et al., 2022 [9] who employed similar “community listening sessions” to facilitate community reflections on environmental learning. These listening sessions were inspired by three theoretical underpinnings, Focus Groups, Participatory

Research and Learning Circles. Whilst similar in format to “community listening sessions” our observation specifically advocates for designers to embrace polyphony within the sessions themselves.

Aligning with Wyld and Fredericks, 2013 [77] we find that “connecting to the harmony and melody of the song of difference represents an Indigenous worldview within Academia”, and as Akama and Light, 2018 [6] highlight, “design situations are characterized by messy, uncertain, indeterminate dilemmas”, which we find emerge through this polyphonic approach to facilitated design conversations. Accepting, encouraging and facilitating polyphony gives agency to the community and centres already existing ways in which they approach discussion, deliberation and creative thinking, rather than imposing a more Western or organisational expectation on what design sessions look, or sound, like.

6.2 Pace

Pace is an approach that privileges slowness and centres community agency. It advances conversations on and considerations of agency highlighted in the related work by following the lead of community members with respect to the timing, duration and tempo of design activities. We find, also, that Polyphony and Pace are interconnected. When plurality, through storytelling, local knowledge sharing and dialogue are centred, increased capacity and willingness for extended periods of ideation are observed; engagements not only unfold more slowly but more deeply and dynamically.

More significantly, it was observed that lengthy discussions and deliberations were exemplified as an internal justice mechanism between community members as a way to ensure each other’s needs and concerns were taken into consideration before any decisions were made. Prior to a day of sensor deployment in the forest and after a completed listening session, community members entered a deliberation about when we should convene. The day that was proposed, a Friday, was a day that most participants would have spent on farming duties – we only met on Tuesdays and Thursdays for our meetings as these represented the taboo day when all community members refrained from farming or entering the forest and the market day where the majority of community members were able to find time for activities. Despite this, community members were keen to engage in the mapping exercise to plan our sensor deployment, so deliberations began, taking into consideration, in a polyphonic manner, the duties of each person. Whilst the FA, Ossom and Ba were only observers of the conversation, not participants, community members also represented their interests stating that:

“5 am is too early, they are coming from far”.

The conversation took approximately 45 minutes to reach a conclusion and at its close all parties verbally confirmed their agreement on the agreed-upon time. It was this observation that brought to the fore the necessity of pace and stamina for community interactions. This approach was taken for logistical decisions such as, where each of the acoustic sensors should be deployed, but also for what could be perceived as more trivial decisions such as the time we should meet for the next session.

In order for the design process to be community-led and facilitate community agency, JoDL requires that design sessions align with the pace set by community members. It is here that we are in

alignment with observations from Weiss et al., 2021 [18] who note that “designers navigate...at a pace dictated by the design situation and the responses they receive from the participants”. We find that pace, particularly a slower mode of engagement, results in a finer, more sensitive attunement, of the PD practitioner to community needs and preferences. The researcher’s capacity for responsiveness to community needs is built in an extended period of slow, intentional and non-extractive interaction that does not result in direct answers to any preconceived research questions. Feedback on the pace of engagements will not always be verbally communicated, so it is important for the PD practitioner to constantly be tuning in to the body language, enthusiasm or lack thereof, and resistance of community members to design activities. Importantly, the ability to listen over a sustained period of time, not just during the course of the project but also within individual design sessions was essential. Through the mode of pace, we highlight the importance of receptiveness and stamina in the designer, the receptiveness to preferred pacing, and the stamina to stay focused and engaged during long conversations whilst refraining from interfering with the process of discussion that unfolds.

6.3 Transformation

In the JoDL process, transformation is an act that remakes practices of iteration and adaptation as tasks ‘in-between’ community engagements to actively rethink artefact designs. It contributes to the consideration of adaptability identified in the related work, prioritising and valuing the fluid, undefined evolution of design practices, methods and requirements.

The ‘listening’ insight here is two-fold. Firstly, community response, both positive and negative, comes from how the designer moves with shared knowledge between sessions. We find that acknowledging and giving space for this ‘in-betweenness’ of transformation prevents the designer from becoming fixed to certain ideas or positions. Instead, the designer must respond to the constantly shifting rhythm of the “relational contexts and conditions” [6].

Secondly, we find the approach of transformation to address injustices of labour imposed on community members during design sessions. Oral methods, due to their ubiquitous nature in community interactions, appeared less fatiguing and confronting. They did not require community members to spend time addressing areas of knowledge or ways of being that were uncomfortable for them. Additionally, moving the heavy design work to the ‘in-between’ and incorporating the learnings from ‘pace’, allowed community members ample time and agency to critique, comment and ideate orally during design sessions.

Transformation is a dialogic approach, core to our conception of JoDL. The designer is always in conversation with community members, not just mirroring back what they have said but transforming it into something new. Whilst the iterative nature of emergent designs is familiar to PD practitioners (Spinuzzi, 2005), we find that transformation in this way is required in order to build trust with community members. Whilst the results of iterative approaches are seen to be “co-interpreted by the designer and the participants” [65], transformation requires the designer to take the oral contributions of community members and through active listening, turn them

into new, tangible ideas that community members can interact with and orally iterate on in further sessions.

7 CONCLUDING REMARKS

This paper details ecoacoustic data interface co-design and participatory sensing engagements with a forest fringe community in the Asante Region of Ghana. We detail how the method of Justice-oriented Design Listening emerged directly from community members, who pushed back against common PD approaches while advocating for more familiar and culturally appropriate forms of communication and creativity. We developed and refined Justice-oriented Design Listening into three key models: polyphony, pace and transformation. Here, polyphony is an approach to pluralism in the design listening process, pace is an approach that privileges slowness and centres community agency and transformation is an act that re-makes practices of iteration and adaptation. Through these modes, we offer a practical set of reflections and recommendations to help designers centre “non-Western ways of thinking and being” [23] to facilitate culturally appropriate co-design engagements when developing and deploying conservation technologies. We argue that, just as much as a diversity of voices must be heard within PD, the way those voices are heard and listened to is critical to enable PD practice to be more equitable and in line with justice and decolonising agendas. Justice-oriented Design Listening is not just about designers hearing community members but about entering into dialogues that transform design projects and practices toward more equitable and just processes and outcomes. Such an approach engages with the plurality of voices and cultural specificity that inform design projects, while also being open to modification. Listening to the forest, in this way, involves more than measuring and monitoring biodiversity. Instead, it requires tuning in to a multiplicity of forest livelihoods and worlds.

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