

A Cross-Sectional Study of Communication Technologies Underpinning Environmental Institutions

Matt Ziegler

Allen School of Computer Science and Engineering
University of Washington
Seattle, Washington, USA
mattzig@cs.washington.edu

Abstract

Managing shared environmental resources requires complex coordination among many diverse stakeholders, and global advances in communication technology are reshaping the relationships and organizational structures in environmental governance. To explore the role of communication technologies in environmental institutions, we conducted semi-structured interviews with 22 staff members from organizations in Uganda, India, and the USA. Participants highlighted how their organizations' activities are fundamentally enabled and constrained by the technologies available in the communities where they work, enabling different forms of coordination, data collection, and community engagement. They also noted the mixed impact of technology on social aspects of their work; sometimes fostering trust and collaboration, while at other times chilling relationships, reinforcing top-down formalization, and having lukewarm effects on equity and inclusion efforts. These findings offer insights for environmental organizations to better leverage communication technologies for community engagement, and adapt to varying stages of technological adoption.

CCS Concepts

• **Information systems** → **Collaborative and social computing systems and tools**; Multimedia information systems; Texting; Social networks; *Trust*; • **Human-centered computing** → *Field studies*; *Empirical studies in HCI*; • **Applied computing** → *Business process management*; **Environmental sciences**.

Keywords

Environmental organizations, environmental communication, ICT for Sustainability, ICT4D

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1 Introduction

Environmental problems call for intensely social and collaborative solutions, requiring interactions among many diverse, intertwined stakeholders like governments, communities, businesses, and Non-Governmental Organizations (NGOs). For example, national governments work in diplomatic arenas to negotiate fishing rights in shared waters [4, 21], city governments combat water scarcity with campaigns encouraging citizens to replace lawns and conserve water [8, 31], and citizen groups lobby governments to regulate environmental harms from industry [41, 43].

These relationships are being reshaped by the rapid expansion of Information and Communication Technologies (ICTs), influencing the structures of institutions, shifting power dynamics among actors, and impacting social elements such as relationship-building, trust, and inclusion. The landscape of ICTs is evolving rapidly, with smartphones and basic mobile phones spreading into rural and remote areas, even those with limited electricity. Between 2015 and 2021, global mobile phone usage rose from 35% to 55%. In urban areas, new media-rich apps continue to transform communication, with tools like video chat playing a key role in reshaping organizations during the COVID-19 pandemic. However despite their foundational role, research on ICTs in environmental governance structures remains scarce. There is a large body of research on environmental institutions [2, 9, 12, 16–19, 22, 24, 30, 33, 46], but it largely neglects the structural role of ICTs. The adjacent field of *environmental communication* examines strategies for organizations using social media towards pro-environmental mobilization [11, 25, 29, 45, 49], and a handful of individual case studies describe various aspects of ICT use by environmental organizations for coordination and outreach [7, 13, 23, 27, 36, 37, 42, 47, 50].

The impetus for this study arose from firsthand observations of ICTs' foundational role within Ol Pejeta Conservancy's Community Development Program (CDP) [50]. The CDP, with a dozen full-time staff, worked on various initiatives with surrounding communities, such as environmental education, water management, and human-wildlife conflict mitigation. However, these communities were spread across vast distances, making travel between them challenging. As a result, CDP staff relied heavily on ICTs, each spending hours daily on the phone coordinating projects and fielding calls. Despite limited ICT infrastructure—marked by patchy network connectivity, unreliable electricity, and low internet penetration at the time—ICTs played a crucial role in shaping the CDP's projects, operations, and relationships.

To characterize this problem more broadly and find common themes and challenges across different institutions, we interviewed

a cross-section of 22 community-facing staff at environmental organizations (Table 1) about their work, community and public interactions, technology use in these interactions, and technology's effects on social factors like trust and inclusion. They represented a wide range of environmental institutions, including conservation parks, government agencies, academia, and NGOs; from 3 countries (India, n=14; Uganda, n=6; and the USA, n=2).

Our participants all explained how the availability of ICTs in the communities where they worked was a key factor enabling and constraining their organizations' activities and operational structures. We describe common themes that arose, such as ICTs effects on relationship building, equity and inclusion, and staff burdens. These results can suggest directions for new technology developments to help environmental organizations engage communities in various stages of technology adoption; and can help environmental organizations think more strategically about their use of ICTs in community engagement, while planning for future technology changes in communities where they work. Additionally, this work stakes out research questions on this understudied topic, and demonstrates its importance for additional research by environmental social scientists and social computing researchers.

2 Methods

Recruitment. We recruited participants from diverse organizations, environmental contexts, and locations using snowball sampling through personal networks, forums, and mailing lists; including WildLabs [1], the American Sociological Society [5], and Twitter. Two inclusion criteria were required for participation:

- (1) Participants must work (or have recently worked) at an environmental institution, such as a government agency, NGO, or conservation park.
- (2) They must have a people-facing role, working with the general public or local communities.

Interviews lasted 90 minutes, with USD \$10 compensation. Recruitment proved challenging,¹ with most respondents coming from the YETI mailing list [48] and a private email list of conservation professionals working in Uganda, maintained by Dr. Robert Ddamulira [14]. Our sample likely is biased towards individuals with a strong interest in ICTs and community engagement, so it is difficult to gauge how representative it is of all environmental organizations.

Interviews. Interviews were conducted remotely and recorded, with participants briefed on the protocol and consent form before starting. Each semi-structured interview, capped at 90 minutes, followed an interview guide (Appendix A) while allowing for open-ended discussion. Topics included the participant's work, interactions with the public and local communities, the role of mobile phones, communication challenges, and ideas for improving technology in community engagement. Some participants had held multiple recent job positions that fit the study's inclusion criteria, and in these cases we discussed each of the jobs separately and sometimes in comparison.

¹We hypothesize a few reasons for the difficulty recruiting participants: some people probably balked at the 90-minute length of the interview, and we hypothesize that community-facing staff are not as well-networked into professional organizations (compared to management or ecology-focused staff) and were thus harder to reach.

Analysis. Interview recordings were transcribed and analyzed inductively using AtlasTI software. In the first pass, quotations were coded with topic tags, followed by a second pass to refine and ensure consistency. Our goal is to describe participants' beliefs and experiences with technology, not to make direct causal attributions. Participants could choose to be named or remain anonymous. To protect confidentiality, encouraging more uninhibited and critical discussion, quotations are not attributed to specific participants. Gender pronouns (he/she/they) are used interchangeably. Participants were sent the manuscript for comments, corrections, and redactions. This study was reviewed and approved by an IRB.

3 Results

Our participants stressed the importance of strong community relationships for a variety of reasons. Some focused on building rapport to support research, learning about communities' environmental perspectives and practices. Others cultivated relationships to co-design and implement projects, and develop local capacity to sustain the projects when the participants were off-site. Many participants worked to energize communities to take environmental actions, such as supporting public policies, adopting eco-friendly agricultural practices, or protecting wildlife on public lands.

Participants highlighted various ways technology shaped their interactions with communities, sometimes in unexpected ways. The communities' varying levels of access to technology fundamentally influenced and constrained the outreach strategies of environmental organizations. This, in turn, shaped the organizations' structures and activities while impacting social dynamics like trust, relationship-building, and inclusivity.

3.1 Rapid Technology Change

Participants from every geographic cluster described seeing communities' technology access rapidly improve over the past years. They had seen more people get basic phones and smartphones in many remote areas with major improvements in network connectivity, with more community members using mobile apps, WhatsApp, pictures and video. Especially in urban areas, many thought that aspects of the pandemic-induced technology shift would stay, like more use of video calls. Many welcomed this change because it would allow their organizations to do more mobile engagement while also reducing the need for training as the communities' technology literacy grew.

Participants were excited about the new possibilities opening up for their organizations amidst this technology expansion. For example, one was hopeful that auto-translation was recently becoming good enough to use in her fieldwork, and was excited about the improved language support she had recently started to see in many apps. Several were keen to make more use of picture messaging and WhatsApp groups in communities as Internet access expanded. In another example, one participant was thinking about how to engage community members with mobile videos after they'd observed more people watching shows on their phones following cheaper data costs. They excitedly remarked that the connectivity improvements were "...a game changer in this field. I definitely believe that."

	ID	Country	Organization type	Project types summary
Remote rural	Ro1	Uganda	NGO	Wildlife rescue, poaching enforcement, poacher rehabilitation
	Ro2	Uganda	NGO	Forest outreach, alternative livelihoods, civic education
	Ro3*	India	Govt. Park	People’s Biodiversity Register implementation
	Ro4	India	NGO	Wildlife conservation, alternative livelihoods, civic education
	Ro5	India	Academia	Wildlife research, studying community perspectives
	Ro6	India	NGO Park	Wildlife conservation, human-wildlife conflict
	Ro7	India	NGO	Wildlife conservation, community outreach
Peri-rural	Ru1	Uganda	NGO	Implementing various environmental projects for donors
	Ru2	Uganda	Park	Wildlife park with community-relations department
	Ru3*	Uganda	NGO	Community forestry, REDD+ implementation
	Ru4	Uganda	NGO	Volunteer-run community forestry organization
	Ru5	USA	Government	Conservation district, grant-funded project implementation
	Ru6*	India	Govt. Park	Wildlife conservation, outreach, ecology
	Ru7	India	NGO	Wildfire reduction, forest products, grazing management
	Ru8*	India	Academia NGO	Wildlife rescue organization, human-wildlife conflict research
	Ru9*	India	NGO	Sustainable agriculture extension with demonstration farms
	Ru10	India	NGO	PBR implementation, environmental education, forest outreach
	Ru11	India	NGO	Participatory action research, riverbank restoration
	Ru12	India	Academia NGO	Research: protected area impacts on Indigenous communities
	Ru13	India	Govt. Park	Poaching investigation and enforcement
Urban	U1*	Uganda	NGO	Policy research, government transparency, civic education
	U2	USA	Government	Urban waterfront restoration with private landowners
	U3	India	Government	Large city forest department, handling tree and wildlife issues
	U4	India	NGO	Environmental education in many schools
	U5*	India	Academia	Urban wildlife research, human-wildlife conflict
	U6*	India	School	Teacher, environmental education

Table 1: List of participants, with brief summaries of organization and project types. (*Some participants discussed multiple jobs that fell into multiple categories, and their interview transcripts were split and assigned multiple participant codes for this analysis. Each of these pairs denote the same individual: Ro3 & Ru6, U1 & Ru3, U5 & Ru8, U6 & Ru9.)

3.2 Technology Shaping Operational Structures and Activities

Participants described the varying types of ICTs that were available in the communities where they worked, and described how technology fundamentally enabled and constrained their organization’s activities and operational structures (Figure 1). To summarize some of these experiences, we grouped participants into three groups with roughly similar technology access: remote rural communities, peri-rural communities, and urban communities.²

Remote rural organizations. Several participants worked in very remote areas that were difficult to access by road: deep in forest reserves, high up in mountain ranges, or spread across vast deserts. These communities were very isolated, often lacking government services like schools, but environmental organizations were active there because conservation areas tend to be located in remote places. They lacked electricity infrastructure and cellular reception,

yet mobile phones still percolated into some of these regions. Organizations often passed messages through relay chains, calling someone in a village with cellular reception, and then passing the message to other villages on foot or via two-way radios.³ Many of the organizations acted as liaisons to help these communities interact with the outside world,⁴ petitioning the government on their

³A participant described: “Most of the time they’re loose [tenuous] communications, or there’s no telephone signals for that area, so they pass the message to the nearest village or [person who works or volunteers for the organization], and that local person provides the message to another village or another community... Sometimes it’s a direct message to the community, sometime it’s like step by step... It’s like a message for their problems, or whatever [the organization] has done to get the problems from the community and try to pass it. They work as a postman to take their problem to the government, administrative bodies or local authorities.... So [the organization] tries to provide good news for the local communities: that they solved their problems; that the local authorities heard them... Sometimes it’s for some resources, like [the organization] provides them some things, and provides the message ‘we have purchased this for you; we will reach you so try to not go anywhere; meet at this place for our person at this time.’ So lots of these kinds of messages are deployed by a step-by-step process.”

⁴“Every kind of community, every landscape of communities has different needs... So when we talk, we only say ‘what’s your problem now? How do you think, how does your community think of what should the authorities do for you? And what do you want back from authorities? And what are your kind of thoughts?’ We give them a window to what authorities can do for you, what authorities want with you, how can you incorporate with them, how is it possible, how is it profitable or sustainable to you, especially for conservation. So it’s a very delicate thing to communicate with them or to try to understand their problems. Because we don’t know; we’ve never suffered these kinds of harsh conditions. Because if you want medical service, we just call an ambulance within 2 or 5 minutes. But in the community areas it’s very harsh. They don’t even know what an ambulance is, still.”

²These differences were largely shaped by geographic and economic factors: for example, fewer people had mobile phones in the most remote rural communities in part because they had sparse and unreliable electricity infrastructure and poor cellular network connectivity. These groupings arose inductively from our data, but we cannot claim that these organizational differences are caused directly by geographical variables because of other possible confounding factors. For example, the urban organizations represented in our sample may have just worked with more affluent communities.

behalf, or helping them navigate complex bureaucratic processes like compensation schemes. These tenuous mobile phone and radio connections were critical for relaying messages and updates, and keeping personal relationships alive. They tended only to have ICT-based interactions with local leaders or few key individuals, but word often spread quickly around communities because they tended to be small and close-knit.

Peri-rural organizations. The largest group of participants worked in rural regions that were more easily accessible by road. Mobile phones were common in all of these communities, albeit with varying levels of cellular reception and smartphone/Internet access. These organizations tended towards more interventionist projects like tree-planting campaigns, encouraging sustainable agriculture techniques, or developing alternative livelihoods that are less dependent on natural resources. The availability of ICTs allowed them to coordinate projects across many sites, sharing information, implementing accountability mechanisms, monitoring project statuses, and collecting data using technologies like voice calls, SMS, WhatsApp groups, photo messages, and sometimes custom apps. Many utilized hub-and-spoke management structures, using phones to stay in touch with key people in each community who implemented projects on the ground.

Most of these organizations found it prohibitively difficult to use ICTs for mass community engagement—for challenges like handling complex social dynamics, energizing communities to take action, and building consensus—finding the available technologies (like SMS and voice calls) too limiting⁵ and instead relying on large in-person meetings or door-to-door campaigns. Some used broadcast media like radio advertisements, posters and fliers, and vehicle-mounted public address systems, but noted these had many disadvantages.⁶

Urban organizations. Urban organizations operated in highly-connected environments. The widespread availability of social media and rich multimedia interfaces via apps and websites gave them opportunities to broadly engage mass audiences; for purposes like advertising to new audiences, raising their name recognition, promoting events, and boosting public awareness of causes. Many of them made heavy use of visual multimedia like videos and infographics to catch audiences' attention and communicate complex

ideas.⁷ Several reported struggling to manage large volumes of incoming messages, though.⁸ Some organizations were able to have complex, lively group discussions over social media;⁹ but others worried that their mass-communication efforts only led to superficial interactions, having to compete for attention on media-saturated platforms, and questioning whether they led to any meaningful action. For example, one described his biggest challenge as energizing busy stakeholders to take action, and this was much easier in person.

3.3 Equity and Inclusion

Environmental problems frequently affect communities differently along lines of income, social status, gender, race, ethnicity and caste. For example, rural people experiencing poverty are often more dependent on natural resources because they lack alternative livelihoods. Accounting for this, most participants voiced that equity and inclusion were important for their organization's mission. Several organizations had specific programs targeting marginalized groups. For instance, some held women-only meetings to discuss their issues without being drowned out by men, or had female field staff engage with women in cases where communities frowned upon women interacting with unrelated men.

Most participants felt that technology did not significantly affect their organizations' inclusion efforts, either in a positive or negative way: *"For diversity and inclusion, the mobile phone has not made any impact, from what I have seen."* Another echoed: *"Honestly I haven't seen any of it. I haven't seen any impact of [technology] on gender diversity things."*

Participants described many cases where uneven technology access only echoed the societal inequities that already existed. Projects relying on ICTs often failed to benefit the most marginalized groups because these groups had the lowest access to ICTs, further perpetuating their marginalization. Many participants worried about this *"digital divide"*—*"a certain section of the society will be left out."* A main driver of this discrepancy was income: many described poorer community members having less device ownership and worse network access. Gender norms also played a role; some participants worked in communities where people believed *"women should not hold phones."* Some described that their organizations rarely got

⁵There were a couple exceptions: one regularly sent bulk SMS messages to community members, manually sending them on his personal phone to 50-100 people at a time; with messages reminding members to plant food and trees before the rainy season, or asking how many people raised the tree saplings they received, for example. He felt it was a highly effective way to interact with communities and was eager to try technologies to automate these messages and make them easier to send. Another had begun conducting farmer interviews over the phone during the COVID-19 pandemic and found them more cost-effective than in-person interviews. He had gotten their phone numbers from local leaders, and felt that the farmers agreed to participate because of the local leaders' support. A small number had successfully used WhatsApp groups for purposes like coordinating field visits, coordinating compensation for plant diseases and wildlife kills, and exchanging project ideas and opportunities among volunteers. Some noted problems moderating spam on WhatsApp groups, however, and many communities lacked enough smartphones to use them.

⁶Radio advertisements were prohibitively expensive for many organizations, community radio stations were unavailable in many places, and the wide geographical ranges of radio stations' broadcasts often carried far beyond the specific communities they sought to target. Posters and fliers were common, but many expressed skepticism of their effectiveness, sometimes noting the spammy over-abundance of posters in many areas.

⁷One described pulling up GIS mapping tools during Zoom calls, finding them helpful to excite people and spur discussions. Another used video calls to go on a virtual field trip, with photos and videos showing them starting at the school, getting on a bus, and exploring sites. One also had asked landowners to send videos and photos on their phones to show aspects of their properties, noting that it was helpful to visually see the extent of flooding, for example.

⁸One offered this story illustrating the difficulty making sense of so many communications coming in: they had to coordinate government agencies and NGOs responding to a dangerous animal spotted in the city, fielding information from emails, calls, and WhatsApp messages. They tried to locate the animal based on videos and pictures circulating around WhatsApp, and it was impossible to know which information was current which was old. He remarked that it was very hard to know what was happening in real time when the volume of information was so high.

⁹*"We had a lot of people sometimes who would post on the [WhatsApp] group telling us [about other events], or they would be requesting a different kind of workshop: can we try focusing on gardening this month, or can we try having a tree walk? ... We would share infographics or fun facts or something. So we would also post them to our WhatsApp group, based on that also they would react to it; they would interact; they would have conversations. And sometimes it would lead to a full-blown conversation about 'what is happening, what should we do, how should we help, what do you think about the pollution?'"*

Figure 1: Environmental organizations’ activities enabled and constrained by community technology access, summarized as 3 roughly-similar clusters.



phone calls from women, in places where women were not supposed to talk to strangers and were expected to handle issues via male relatives instead. Some community members with disabilities were negatively affected by the shift to ICTs; one environmental educator described how her students with special learning needs were acutely disadvantaged by the shift to online learning. More marginalized communities also faced higher literacy and language barriers for using technology, which further kept them from benefiting from these environmental projects.

In addition to presenting inequitable access barriers, technology also sometimes led to discrimination when organizations brought groups together for virtual interactions. For example, one participant described a case where her organization made urban ecology WhatsApp groups mixed with people of different languages and socioeconomic statuses, and found that English quickly became the groups' main language, and lower-status people (who spoke the local language) stopped participating. Another described needing to make different groups for different castes, as members from one refused to interact with the other. These groups required careful moderation from the organizations.

While participants felt lukewarm about improving environmental equity through technology, they identified some reasons to be hopeful. Similarly to their offline efforts, organizations could use ICTs to target specific demographics, such as women-focused WhatsApp groups or youth outreach via social media. One participant noted that mobile phones offered discretion when working with communities in conflict. Improving ICT outreach to marginalized groups will require focused efforts and resources from environmental organizations.

3.4 Building Trust and Relationships

Every participant enthusiastically agreed, without exception, that building trust and relationships with communities was crucial for their work. Communities needed to have trust that the organization was competent, genuinely had the community's interests in mind, and could deliver strong-enough results for it to be worth the time, effort, and risk inherent in working together. In addition, personal relationships kept things working smoothly when systems faltered, and allowed the institutions and communities to work together when difficulties and disputes arose.

However, communities often distrusted environmental organizations due to past negative experiences, broken promises, or threats of regulation and resource extraction. Many viewed them as outsiders with cultural and language barriers, and hesitated to share information: *“each of these communities have assumptions towards city people. And there will be people who know that we're working for wildlife, and we are basically not working for communities. So you know, they start lying about stuff and there is usually no trust. The trust comes only after you [work together] for a particular time, and then there is a bit of trust. And then there is truth in whatever they speak. But until that time, through that gradual process, you really cannot believe any of these people.”* Participants agreed building trust with communities required time, consistency, and repeated positive interactions, often through *“small wins”*. Trust grew as community members observed the organization's actions, with personal connections and a sustained presence playing key roles.

Many participants voiced that it was very difficult or even impossible to build initial trust over phones or the Internet. Technology-mediated communication crucially lacked the warmth of in-person human interactions, and could not convey the same social and cultural cues needed to convey mutual respect: *“This is an area where a lot of stuff gets done on handshakes... when I don't shake their hand, or if I don't come in to have coffee with them, that is a barrier now to continue working. That human contact is no longer there, or it's just kind of dampened... It's harder to make a connection with people if you're not looking them in the eye, being in close contact, shaking hands, that sort of thing makes it very difficult.”* Several also noted that social immersion was missing in virtual interactions: it took a long time, getting to know a person and seeing them behave in a social context before communities could begin to trust them.

These problems may be mitigated somewhat by richer interactions from social media, video calls, and digital multimedia (while being more pronounced with basic ICTs like SMS). As a couple potential exceptions, some urban organizations used online advertising and social media to reach out to new audiences. However, some voiced doubts that these interactions ever actually led to meaningful in-person interactions or trusting relationships.

However, some participants reported that ICTs could help keep relationships open, friendly, and warm after they had already been established in person. Many environmental staff relied on mobile phones to keep in touch with community members when they were away, and they felt that this helped them to build trust by being consistently available to community members when they couldn't be physically present.¹⁰

3.5 Top-Down Formalization

In many cases, ICTs led to more top-down structures and formality. This was sometimes intentional: organizations used ICT-based accountability mechanisms to meet donors' requirements and ensure consistency.¹¹ Some introduced structures to simplify management, like reporting information using pre-determined Open Data Kit forms. One set up WhatsApp groups for coordinating meetings, and instructed members not to post other things to avoid clutter.

However, several participants expressed concern that ICTs had made their interactions more superficial, limiting deeper engagement and understanding. Personal warmth and nuanced conversations were crucial for addressing serious community issues, but were difficult through digital communication.¹² Some people felt less comfortable speaking freely and expressing their true opinions over ICTs: *“I think they just kept putting things that they thought*

¹⁰One participant who had made close friends in the communities explained *“...if they asked for my number, just to stay in touch and all that, I was totally cool with it... ‘Whenever you visit, give me a call, and I'll definitely help you out with anything you need...’ I had already gained their trust.”*

¹¹For example, one organization required community point-people to send pictures of themselves to prove when they went to the field; another asked them to take a photo showing the number of participants who came to community meetings. Sometimes this evidence was shared directly with donors to demonstrate that work was carried out. (One participant argued that these mechanisms were ineffective though, and that people always found ways to evade them.)

¹²One participant offered: *“For serious issues it's very difficult to go over the phone and talk about it. For stuff like... ‘these materials are coming tomorrow and you have to come get it,’ these [types of issues] are fine on the phone. But when you have to talk about something—a serious matter—like a thing that might affect the community, or something the community is going through but no one knows about, I don't think that talking over the phone can do much.”*

*you wanted to see, rather than thinking out of the box, and rather than just being uninhibited and saying what they wanted to say.*¹³

Furthermore, many participants worried that reliance on ICTs had reduced community input in project design and diminished their decision-making power. This led to more projects designed “*through your organizations’ needs and wants,*” as ICTs enabled organizations to arrive with more pre-established structures and objectives. This reliance on top-down systems, driven by upper-level management and donors, made it harder to adapt projects to specific community needs, leading to project failures and poor outcomes. Several participants worried that ICTs reinforced this problem: “*That’s the thing, right? We think that we’re the ones telling them what to do, but actually it’s the other way around. We hardly ever listen to them, and I guess that’s where I feel the problems lie.*”

3.6 Misinformation and Rumors

Several participants reported problems with online misinformation and exaggerated rumors, such as people claiming the organization was trying to take their land. One participant discussed an extreme example where staff were threatened because of WhatsApp rumors and they had to stop work in some communities, but could keep working in areas where WhatsApp wasn’t available.¹⁴ These participants relayed that the most effective way to handle misinformation was to build trusting relationships with communities, so they could speak openly and clear up misconceptions.

3.7 Staff Burden

ICT interactions with communities was a major resource investment for organizations; several of the participants reported spending hours every day on calls with community members. Many described being stressed and annoyed from being bombarded with calls: one described “*one of the drawbacks occasionally is I get [community members] that really like to text me, and that is not always great, but at the same time I think it builds trust.*” Another complained “*they expect you to be on standby all the time.*” One switched off their phone on weekends because of this.

Additionally, some participants had to field frequent calls from community members asking for personal favors or money. By allowing community members to contact them at any time, it created personal stresses for some and they had to determine and enforce their personal boundaries.¹⁵

¹³They continued: “*...When you go to the field certain stories come out which you won’t be able to capture through technology. It’s personal things which come out, and you’re able to build relationships better when you’re face-to-face. Technology is a good substitute during tough times, but I don’t think it would be able to replace the kind of intimacy and relationships you build while you’re working with communities in the field.*”

¹⁴“*Somebody said on a WhatsApp group that we are working to relocate the villages from that area. So all of a sudden, we had to stop our [service projects] and everything. Some people even came to our offices and threatened our staff. All these things did happen because we have a human tendency that the good news will travel slower, but the bad news will always travel faster! ... We have left that particular area because of that... We have some areas that we have left, where we are not working. But one good thing we did was that we continued to work where people did not say anything. So again, non-penetration of mobiles is also an advantage in this case! We were able to go and do this [service project] where the mobile penetration was very, very less—only one or two percent there—and they were not bothered: [saying] ‘Okay you want to [do this good thing for us.] okay you can go.’... And because we were able to continue those [projects], later on some other villages who had objected to our presence also became friendly because they were seeing that we are still constantly continuing with our work.*”

¹⁵One had stopped giving out her phone number because she received too many calls asking for favors: “*They have actually called and asked for, you know, like they are*

3.8 Technology Investments: Training and Providing Devices

Some urban and rural environmental organizations made investments to improve technology capacity in the communities where they worked. They sometimes provided mobile phones or tablets to community members, often conducted technology training, paid for airtime/data, and sometimes even set up network infrastructure.¹⁶ Participants described that these investments were often expensive and resource-intensive, forming a significant constraint for many organizations but also underscoring their strong beliefs about ICTs importance for their missions.

Many of the organizations in every geographic category invested in technology skills training for community members. In some cases organizations taught people certain specialized skills required for project tasks, like how to take a GPS reading or use a data-collection app. Oftentimes though, organizations spent considerable time teaching basic technology literacy and skills to community members, like taking pictures and sending messages. One urban participant described: “*When we have Zoom calls, like... I was just tech support last night for a community meeting we had in [location] and it was like, helping an old lady with how to connect and that kind of thing.*” Some of the organizations had built considerable institutional infrastructure for large-scale training operations, “*training people as trainers,*” and some even regularly provided technology training to government agency staff who they worked with.

4 Discussion and Conclusion

The past decade’s global, rapid expansion of ICTs has enabled a range of activities that were too difficult and expensive for environmental institutions beforehand. Furthermore, they saw social dynamics and community relationships change as their organization began to incorporate more technology in their community interactions. Many of these social changes were subtle, like formalization in relationships or barriers to trust, but still crucial for their projects’ successes and failures. This cross-section of experiences can suggest future technology developments to help environmental institutions work more effectively with communities, and help environmental organizations think more strategically about their technology use with communities as ICTs continue to proliferate in the future.

Study limitations. Our sample is biased by our use of snowball sampling through our personal networks, and from participant response biases. We cannot claim that our sample evenly represents all types of environmental organizations, and we cannot assess the prevalence of the themes we found within the general population

having some financial problems so they need this particular thing, medicine and the like... But when it comes to medicine, or you know, maybe some food kind of things, or any emergency in which you feel you can help, then you try to. But then what happens, once you do it once, now it becomes like a habit. Every day you get bombarded with a different call. And now, even the issue is very small like ‘we don’t have any electricity; it has gone for one hour.’ Now that has also come onto us. And you have to tell them, like, ‘we are working for conservation for wildlife; we are not here for this.’”

¹⁶Some participants had heard of other environmental organizations who had set up cellular networks to be able to communicate with remote communities where they worked; though none of them reported that their own organizations had done it themselves, often being too difficult, expensive, and beyond their capabilities. Some had looked into other connectivity options for remote areas like satellite phones (though none reported deploying them).

of environmental organizations. Our sample additionally has a self-selection bias, as participants who took interest in the study are likely to be more enthusiastic about this topic than what is typical among all environmental organizations. Our study probably also has a response bias whereby participants may have sought to portray themselves and their organizations in a positive light, perhaps withholding some negative information. (However, we sought to mitigate this with several steps, including ensuring confidentiality and promising a degree of anonymity, allowing them to review the manuscript and make redactions, and specifically soliciting critical perspectives and negative experiences.) This study is also limited by its focus only on perspectives of environmental organization staff. We have not collected input from the community members impacted by these projects; or from other organizational layers like upper management or donors.

Technology improvements. Our findings suggest several directions for new technology developments that could help environmental organizations engage communities more effectively. Many of these applications already exist in other sectors, and additional research can help determine how they can be adapted for environmental organizations' needs.¹⁷

Design patterns from ICTD research can be a source of inspiration towards some of these solutions, showing a variety of creative applications using widely-available basic technologies for complex, rich community engagements: i.e. partially automated SMS chatbots or interactive forums using voice calls [3, 32, 35, 40, 44].¹⁸ Auto-translation for under-resourced languages may also soon reach a stage where it is useful for many of our participants, allowing them to speak across language barriers when no translator is available, and giving access to more software in local languages.

Approaches from eCivics research could help many of the organizations who mediated between communities governments, like submitting data to officials or providing feedback on plans [10, 20, 38]. For example, interactive eCivics applications could be helpful for some of the problems our participants described like quickly reporting the locations of wildlife problems in a city, or consulting community members about urban river restoration plans [15, 26, 39, 42].¹⁹

As many organizations struggled to manage large volumes of messages, some might benefit from systems to simplify and coordinate these interactions, like Customer Relationship Management (CRM) systems [28];²⁰ or project management systems, some

¹⁷Off-the-shelf, commercially available software might be sufficient for many of these use cases. The fact that many organizations did not find these off-the-shelf solutions on their own underscores their lack of basic IT capacity; many complained that IT support was too difficult to fund. In the process of the interviews, there were several times when we connected participants with off-the-shelf software for problems they had discussed, like free phone-based GIS software or bulk SMS services that they didn't know about; we also answered their technical questions on several occasions.

¹⁸For example, many participants' organizations' made use of in-person surveys, and ICTD researchers have explored the strengths and weaknesses of SMS-based survey systems that could be helpful in some of these instances [3, 35]. As another example, most organizations needed to broadcast information out to communities, but remote and peri-rural organizations rarely attempted this with SMS or voice calls because of their difficulty and limitations. ICTD researchers, in contrast, have extensively studied various broadcasting strategies over ICTs and analyzed their cost-effectiveness; this work is immediately applicable to some of these participants' problems [32, 40, 44].

¹⁹ICTD projects like Gram Vaani [15, 39, 42] and Red Cross WhatFutures [26] show examples of systems that aggregate messages directly from community members into a presentation or petition to leaders.

²⁰Some urban participants did already did use CRM's; e.g. managing email campaigns with Salesforce.

of which are already specialized for low-connectivity environments [6, 34]. Future research could explore adapting them for environmental institutions and integrated into their contexts. We can also look to ICTD and social computing research for strategies towards building relationships amid increasingly-automated interactions.

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A Interview Guide

A.1 Preamble & housekeeping

- (1) Review process and consent form
 - (a) We will record this interview, but the recording will be kept confidential and will only be reviewed by me, as a reference while writing the report.
 - (b) We will report the results in a way that nothing you say can be traced back to you individually. This is important because I want participants to feel free to speak freely and honestly.
 - (c) We will send you a copy of the report at least 2 weeks before it is published, so you can request something to be redacted if it is too sensitive, or you can correct any errors.
 - (d) You may refuse to answer any question.
- (2) Would you like to have your name and organization listed in the publication, or remain anonymous? You can change your mind at any time, until the report is published.
- (3) The interview will go about 90 minutes.
- (4) Do you have any questions before we begin?
- (5) Do I have your permission to start recording?
- (6) The interview topics will be: about your work, interactions with the community, how you currently use mobile phones and technology, and your ideas for technology improvements.

A.2 About your work

- (1) Could you tell me a bit about your work?
- (2) What is your day-to-day workday like?
 - (a) How do you spend your time in a typical day?
 - (b) What proportion of your day do you spend interacting with local community members?

A.3 Community interaction

- (1) How do you interact with local people?
- (2) Who in the community do you tend to work with?
 - (a) Are there certain people who are more engaged than others?
 - (b) Certain people who are hard to reach?
- (3) What are the main issues in these communities?
- (4) Why do people contact you?
- (5) What is your experience with *trust*, in this?
- (6) What are all the ways that you communicate with local people? Meetings? Signs? Local people working at your organization?
- (7) Do you have any processes for knowing about what's going on in the communities, their needs, etc?

A.4 Experiences with phones

- (1) How much time do you spend interacting with communities over the phone?
- (2) Do you use these technologies? How/when do you use them?
 - (a) Phone calls
 - (b) SMS messages
 - (c) WhatsApp

- (d) Social media
- (e) Websites
- (f) Other things?
- (3) Do people send you photos?
- (4) What non-ICT ways do you engage communities? I.e. posters, radio, schools?
- (5) Could you tell me some examples of recent communications you've had? (The ones that you remember most, but also the ordinary day-to-day ones.)
- (6) What kinds of phones do community members have?
 - (a) How many have touchscreen phones?
 - (b) How many don't have a phone?
 - (c) Is network connectivity an issue?
 - (d) Is electricity an issue?
- (7) Are there certain community members who you deal with over the phone more?
- (8) Do you think mobile phones have helped create trust with the communities? Or led to more problems?
- (9) Have mobile phones impacted inclusivity in your work?
- (10) Has your organization done much technology training for community members?
- (11) How has COVID changed your organization's use of phones and technology?
- (12) Have you had any negative impacts from mobile phones?

A.5 Ideas & Brainstorming

- (1) What are your biggest challenges in communicating with the community?
- (2) What are some things you would like to do, but currently cannot?
- (3) What are some things that you have tried but haven't worked?
- (4) Do you have any technology ideas that you would like to try?
- (5) What is your post-COVID plan?
- (6) What types of findings would you hope to see from this study that would help you the most with your work? E.g. if you were going to interview 20-or-so community-facing staff from environmental organizations, what burning question would you ask them?
- (7) Any last thoughts?