Mobile Phones in the Drylands: How Technology Supports Community Information Sharing in Rural Kenya

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Abstract

Mobile phone usage is widespread in rural Kenya, and digital services delivering livelihood-specific information can potentially aid development and mitigate climate impacts. However, to be embraced by individuals and communities, information should be delivered in ways that integrate with current community practices. We present an interview study with 24 community "information sharers", investigating information sharing practices and technology use within rural dryland pastoralist communities in Isiolo county. This region experiences frequent droughts exacerbated by climate change, and information regarding weather, water and climate is especially relevant. We found diverse ways in which information is obtained and shared to support dryland lives and livelihoods, with smartphones playing a prominent role. Notably, WhatsApp is widely used and integrates well with existing practices. However, inconsistency in the access and provision of information can lead to inequalities within and between communities. We offer several design recommendations for information provision systems in these settings.

CCS Concepts

• **Human-centered computing → Human computer interaction (HCI)**.

Keywords

Climate change, climate adaptation, ICTD, ICT4D, HCID, HCI4D, rural computing, development, East Africa.

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1 Introduction

Digital technologies can play a significant role in improving quality of life in rural communities in the Global South [39, 106], and creation and support of such services is one aspect of the ICT for Development (ICTD/ICT4D) and HCI for development (HCID/HCI4D) agenda. One way in which technology can contribute is by providing communities with information and advice which is relevant and timely, to support decision making and improve community livelihoods and wellbeing. (e.g. for agricultural advice [29], weather and climate information [19, 92], early warning of natural disasters [7] and health information [102]).

Rural communities in Sub-Saharan Africa are acutely affected by climate impacts, which disrupt traditional livelihoods such as pastoralism (herding animals on rangelands) and agriculture [18, 40]. This can be directly, such as through droughts and floods, or indirectly, such as through displaced communities and conflict over resources [40, 60]. Timely and relevant information and advice about expected climatic conditions can help mitigate disruption [27]; hence regional, national, and subnational organisations are investing in the development of digital services to provide such information and advice to communities, such as the Africa-led *Africa*

Adaptation Acceleration Program (AAAP)[1] and regional climate services supported by the World Meteorological Organisation and its local partners[2].

Historically, Short Messaging Service (SMS) and Interactive Voice Response (IVR) technologies have been implemented to provide information in ICTD services, leveraging the widespread uptake of basic mobile phones in the Global South [46, 52, 95, 115]. However, rapid uptake of smartphones in many regions [31] presents new alternatives — the capabilities of newer devices, coupled with increasing access to high-speed internet connections, means that designers can look beyond simple text or voice services. Given this increasing availability of smartphones, questions arise surrounding best practice in designing for these users, as despite this availability, communities often fail to adopt new technologies [94], and the information they provide is often unsuitable. For such information to be valuable to communities, and in line with good design practice that is sensitive to the context of use [55], it should be disseminated in a way which integrates into current sharing and decision-making practices, rather than requiring a change of practice. This necessitates a deep understanding of such practices and how smartphones are being appropriated by communities within this existing framework, which is often unfamiliar to designers without direct experience. However, there is limited research into understanding how smartphones are used in this way within rural pastoralist communities in East Africa, with most existing research focusing on the narrow application of mobile technology to animal herding [10, 16, 72].

This paper examines how information is gathered and shared in rural pastoralist communities in Isiolo county, Kenya, and how technology is incorporated into this information ecosystem. In contrast with previous work examining technology use by pastoralists, we examine information flow among the entire community focusing on how information enters the community and moves within it. Our new data provide insights into many of the unique challenges faced in the dryland regions of northern Kenya which may not be present in other regions, which are also influenced by the different cultures and groups living there and the local politics. Furthermore, we provide up-to-date perspectives in a fast-moving technology landscape, and focus on key "information sharers" who have community roles (formal or informal) that involve gathering and/or disseminating information. As such, these participants could also tell us about how information reaches their communities from a variety of formal and informal sources rather than only information shared within them. We achieved this through a collaboration between UK and Kenyan universities and local research assistants embedded in the communities of interest, where we performed an interview study with 24 participants. The results provide useful contextual information to help better understand these users and their communities, and reveals several implications for the design of new systems to serve them. While we are wary of generalising beyond these communities, there are commonalities of culture and practice among different pastoralist communities in East Africa, who are often more strongly linked by livelihood and kinship groups than by comparatively recent geopolitical borders [25] (e.g. ethnic Somalis in northern Kenya may identify more strongly with with Somalis nearby in Somalia, than with other groups in Kenya). As such, our study provides pointers to what might emerge in other communities as smartphones become more widespread. It also demonstrates the need for taking a strongly user-centred approach and performing significant groundwork to understand the everyday lives and challenges of potential users in the Global South, instead of making assumptions based on Global North norms that may not be practically or appropriate in such settings.

[1]https://www.afdb.org/en/topics-and-sectors/initiatives-partnerships/africa-adaptation-acceleration-program (last accessed 15th January 2025)
[2]https://www.icpac.net (last accessed 15th January 2025)

2 Background and related work

2.1 Rurality in HCI

Rural technology use often differs from in urban settings due to different lifestyles and technological constraints (e.g. poor infrastructure) [36]. However, despite around 42% of the world's population living in rural areas at the time of writing [23], rural use is often not considered during design — this can exclude rural users, e.g. when functionalities require network bandwidth that is abundant in cities but limited in rural areas [36].

Hardy et al. [37] explored a framework of rurality in HCI research that defines it across different dimensions: *descriptive* definitions are concerned with population density, proximity to urban areas, economic indicators, and are often the basis for official government definitions; *sociocultural* definitions focus on a distinct "rural culture" or "rural values" that are shared among rural residents; and *symbolic* definitions refer to how symbolism is used to connect people to rural settings, such as through linguistic terms such as "traditional" and "idyllic". In their scoping review, they found that HCI research overwhelmingly used descriptive definitions of rurality or did not define the notion of rurality at all. However, their study only targetted developed or high-income countries which excludes Africa by definition, despite it being a popular geographical focus of HCI research.

2.2 Rural information sharing in HCI

HCI research has explored information sharing in a number of contexts, such as workplaces [61], medical settings [62], sporting contexts [30], and on social media [84]. Here we examine some of the previous work in rural contexts.

Maye et al. [57] explored radio use in rural European communities, finding that it is important for sharing information both within the community and to the diaspora. Specifically, local radio was seen as a way to share information about natural emergencies and health issues. It was also important for communicating and discussing local issues and empowering people to make decisions, who felt they lacked autonomy due to the distance from government decision making centres.

Researchers have also examined information sharing in different regions of Africa. In South Africa, Bidwell et al. [9] explored information sharing among rural communities via prototype social media systems for low-end, Java-enabled feature phones. They found that co-present, oral communication was important, and that there were generational differences between users. Iraba and Venter [43] also developed a prototype information sharing system for farmers for then-current Java-enabled phones, after finding a

need for them to access and share information about their livelihoods. However, the system was not directly tested with users. In Kenya, Oduor et al. [77] explored the use of technology for family communication through the use of a prototype mobile web app for photo sharing. Participants used the *TumaPicha* system to communicate between rural family members and those living in urban areas, which was used to share information about farming and livelihood activities, village happenings, and health and wellbeing. Acknowledging the many barriers to technology in rural Kenya at the time, the system was lightweight and easy to use for people without much technological experience. Furthermore, due to limited internet connectivity, the system interfaced with motorbike taxis to physically transport phones containing photos to internet cafes to facilitate data transfer.

We note that studies often focus on the development of new systems, rather than examining how information sharing occurs organically through pre-existing, widely available systems. Furthermore, the technology landscape has changed significantly since these studies were conducted (2014–18) — uptake of mobile internet and smartphones is growing in developing regions and spreading to rural areas (albeit more slowly than in urban areas) [32] , and communication is often conducted through a small number of high-penetration platforms (e.g. WhatsApp, Facebook). Furthermore, while there are still barriers to technology use, some are less of an issue than they used to be in some areas (e.g. improved mobile network access).

2.3 Information sharing in rural Kenya

Rural dryland communities in East Africa rely on the land for their livelihoods, practising a combination of pastoralism and crop farming and are adapted to seasonal patterns in the region: rainy seasons in March–May (the "long rains") and October–December (the "short rains") traditionally provided a predictable decision-making framework [83]. Though interannual variability in rainfall and temperature is normal, climate change is disrupting the seasonal climate. Declining trends in the long rains and increases in drought frequency and intensity over recent decades [1, 33, 54] have resulted in food and water insecurity, as crops and pasture do not grow and water stores are not recharged. Furthermore, shorter, more intense and localised rainfall results in increased flooding [6]. These issues can lead to further consequences in terms of conflict over limited resources and displacement of communities [40, 60].

Accessing and sharing timely and relevant information is necessary to respond to everyday challenges in countries in the Global South, which is achieved by a combination of traditional (e.g. word of mouth) and technological means (e.g. radio, mobile phones) [59]. Information sharing is an important part of community life in rural Kenya, and information relevant to the concerns and livelihoods of communities is shared and discussed through formal and informal networks [10, 59, 65]. Among pastoralist communities, herders often meet to informally exchange information about predators, animal health, and the location of pasture and water [10, 65].

Chiefs (community-level representatives of the government [82]) and other community leaders (e.g. elders) convene community meetings (a *baraza* in Swahili) to discuss issues and disseminate information to communities [69, 82], e.g. about weather conditions [51, 80], security issues [66], or health information [69]. Elders and other respected people are seen as trusted sources of information and play an important role in disseminating information within their communities [67, 74], and support collective decision making processes [93]. They may also practice traditional forecasting [89] (e.g. by observing environmental signs or reading animal entrails) for their communities. There are also grassroots and civil society groups that enable information exchange, such as managing access to water and grazing resources [21, 85], or to mobilise particular community groups such as women or young people [45, 107].

2.4 The role of technology in information access and sharing

Mobile phone usage across Sub-Saharan Africa is well established [96] and is seen as important for the development of the region [2]. Recent figures from the Communications Authority of Kenya [78] show that there are 33.48 million feature phones (66.2% penetration) and 29.49 million smartphones (58.3% penetration) in Kenya. However, this does not necessarily map directly to user numbers, as sharing devices is common [2, 110] and many people own multiple devices or SIM cards [97]. Furthermore, previous studies have reported lower levels of phone ownership in rural areas (e.g. [49, 110]) and barriers to uptake and use, such as lack of technology access, poor charging infrastructure, and lack of network signal or limited data and airtime [97, 114].

Technology access varies by gender, with Kenyan women having less access to phones than men [35, 111], who may have to share their husbands' or receive outdated hand-me-downs. Furthermore, women may have less technical literacy, driven by unequal demands on women's time (used to complete domestic work, caring duties, and run smallholder farms) which leaves little time to engage with technology [111]. Women also face fundamental challenges with technology, such as difficulty in adding airtime — if such essential tasks be completed easily then they cannot access many of the benefits that mobile phones and the internet can offer, which further reinforces existing gender inequalities [112].

Widespread mobile phone uptake in Kenya has seen prior research examine their possible use to disseminate important information. This tends to focus on particular information of potential value to communities and the technologies that underpin them, such as agricultural information and advisories (e.g. advice on crop varieties and market prices of produce [113]), health (e.g. disease alerts [98]), early warnings about extreme events (e.g. floods [42] and drought [56]), and security [4].

Due to persistent climate-related challenges affecting East Africa, research commonly focuses on *climate services* — systems that provide information about climate, weather, and related variables to support decision making [41] (typically referred to as *climate information*, despite not always being strictly about climate). These services are used throughout Africa by many users at different levels [92, 103], and dissemination to communities is typically top-down through official channels such as local governments. Despite the potential for climate services to support adaptation, there are well-recognised shortcomings in understanding user needs that mean information is often not relevant or actionable [11, 86, 108]. Thus, while such information could be of great use to pastoralists

in Kenya, understanding the needs of these communities and delivering useful information to them in an actionable way is non-trivial. Furthermore, very little HCI work has addressed climate services, despite being well within the discipline's remit [90].

Pastoralism is worth approximately $1.038 billion to the Kenyan economy, contributes significantly to the national food system, and provides direct employment to around 2.2 million people (and many more indirectly) [76]. It provides around 90% of employment in arid and semi-arid areas [75]. Therefore, pastoralists communities are important both economically and in terms of national food security. Though ICTs could help improve their livelihoods as well as their national economic and food resource contributions, pastoralist communities are often left behind with technological advancements [68]. However, a small number of services aimed at East African pastoralists have been developed to supply users with livelihood-relevant climate information. Global Communities created the *Afriscout* mobile app[3] to deliver satellite vegetation maps to pastoralists, paper versions of which having been found useful [53]. However, their design process was not documented and the system does not appear to have been formally evaluated, making it difficult to assess its impact. Indeed, the system has been criticised for not fully addressing the needs and capacities of the target users, and assuming that they do not already possess the information provided [24]. The *MyAnga* smartphone app was also developed to provide localised weather and forage information [26] which some pastoralist communities said they would find useful [91], but is no longer available at the time of writing.

2.5 Mobile phone use by East African pastoralists

Previous studies have explored mobile phone usage among pastoralist communities in East Africa. Butt [16] examined mobile phone use by pastoralists in Southern Kenya, finding that 97% of participants had access to a phone, which played a key role in their herding practices. Phones were used to inquire about locations of forage and water, predators, and lost animals, and calls were used almost exclusively over text messages (note: this study was published in 2015, before widespread smartphone uptake). However, the author also highlights that while phones were extremely useful, competition for limited natural resources meant that there was a high potential for misinformation and disinformation misleading competitors.

An ethnographic study by Nilsson and Salazar [72] on Maasai pastoralists in Kenya and Tanzania also found that phones were widely used in information exchange regarding animal herding. Participants expressed both positive and negative attitudes to mobile phones, but despite this they were a key part of everyday life. They also said that using mobile phones to access information and media from outside can erode their culture, and threaten the traditional social structures that favour male elders while marginalising women.

Boas [10] also found that phones were widely used among pastoral communities in Laikipia county, Kenya. Herders shared pictures of animals using WhatsApp, as well as information about potential security issues (e.g. the presence of soldiers or cattle thieves). The authors also describe "virtual herding", whereby people who cannot engage in pastoralism full-time due to other commitments (typically having moved to urban areas for work) can be in regular communication with herders looking after their animals on their behalf. In this way, mobile phones are used to enhance and augment traditional pastoralist practices.

An HCI study by Rigby et al. [91] examined current and potential future ways that pastoralist communities in Somaliland use mobile phones. They found that phones were widely used to assist in the access and sharing of livelihood-relevant information — mostly concerning weather, climate, and access to water and pasture. Feature phones were used by 70% of participants, but smartphones were much less common with only 27% having access. The study also suggests that designers need to be especially aware of the social and cultural context when designing new systems to service pastoral communities, as technology use cases can differ greatly from those in the Global North. This was also discussed by Dourish and Mainwaring [28], who advocate for designing systems that embrace local solutions and pluralism as part of a postcolonial ethos.

2.6 Summary

This section gives an overview of the information sharing practices employed by rural communities in East Africa, and how technology is used to facilitate this. We find there is limited prior research exploring pastoralist communities' use of technology, which typically focuses on how phones are used to facilitate herding practices rather than the broader community that they are part of. Furthermore, the speed at which technology is improving means that older research may no longer be accurate (e.g. before smartphones or widespread high-speed internet). We also see that, although climate services have the potential to provide information that pastoralists need, there is generally little understanding of user needs.

We aimed to address these shortcomings in the current study, seeking to understand how information is obtained and shared in pastoralist communities in Isiolo, Kenya, focusing on the sharing of information in the wider community rather than only by herders. We also examine the information ecosystem through key "information sharers", respected community members that play a role in the gathering and dissemination of information at a local level and could be target users for future information sharing platforms [91]. This forms part of a user-centred approach to assess user needs for designing technologies to support information provision and decision making in these communities.

3 Current study

3.1 Location and context

Isiolo county is located in central-northern Kenya (see Fig. 1), approximately 300 kilometres northeast of the capital Nairobi. Situated in a dryland region, the entire county is classified as arid or semi-arid [64] and suffers frequent droughts. An example of the landscape can be seen in Fig. 2. It covers 25,700 square kilometres and is home to 268,000 people [79], mainly from the Borana, Somali, Samburu, Turkana and Meru ethnic groups [63]. As is common in East Africa, much of the rural population rely on pastoralism for their livelihoods, which involves driving herds of animals often long distances for water and vegetation. This may be combined

[3] https://globalcommunities.org/afriscout/ (last accessed 7th December 2024)

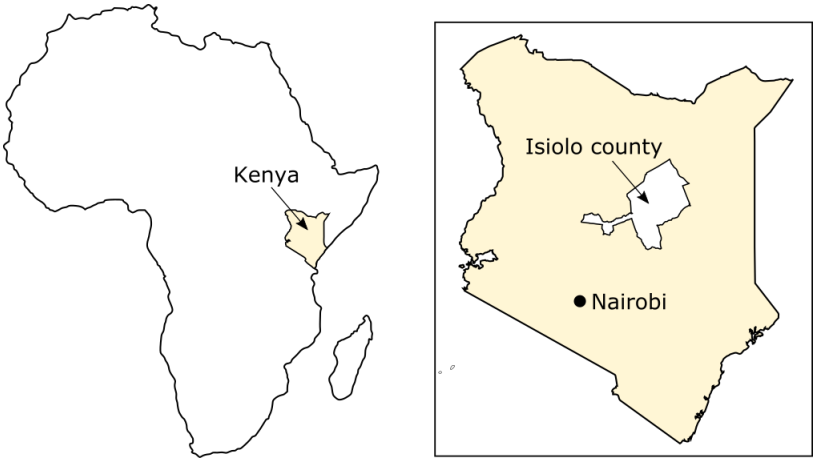

Figure 1: The location of Isiolo county within Kenya.

Figure 2: Camels browsing in a typical landscape in Isiolo county.

with crop farming (referred to as *agropastoralism*) where possible [64].

Reflecting on Hardy et al. [37]'s classifications of rurality, the areas and communities sampled in this study are defined as rural along *descriptive* and *sociocultural* lines: descriptively, they are located outside of urban centres and isolated due to poor roads, and internet connectivity is patchy; some areas have 4G connections, whereas others may have little or no connectivity. Socioculturally, the pastoralist culture that is shared by the communities is inherently rural — pastoralism is by default a rural activity that typically requires large rangelands, and forms a large part of the economy in Isiolo that involves many people directly or indirectly.

3.2 Aims and method

Access to reliable information is crucial to the livelihoods and well-being of rural Kenyan communities, and as described above, information entering communities is often reliant on particular community members who play a role in information gathering and sharing (we refer to these as "information sharers"). This may be through a salaried position (e.g. a chief), through volunteer roles (e.g. leader of a local committee), or more informally. We sought to better understand information sharing practices and associated phenomena to inform the design of possible future systems for disseminating information to communities. We addressed the following research questions:

(1) What are the different ways in which information is gathered and shared within communities?
(2) How is technology used in the information sharing process?

To answer these, we conducted an interview study with community information sharers, who were identified as key informants by the Kenyan co-authors of this paper as they possess important knowledge about how information is exchanged (though we acknowledge it may not be the "full picture"). To facilitate the data collection, we worked with local research assistants (RAs) who either lived in, or were known to, the communities of interest. They were therefore not seen as outsiders and spoke the local languages used by the participants. Our study took place in October 2022, during a period of severe drought that was affecting East Africa.

3.3 Positionality and ethical considerations

Due to potential ethical issues involved in conducting research in the international development space (e.g. power imbalances and lack of recognition of contributions) we would like to acknowledge the positionality and contributions of those involved in this research. As part of an international project focusing on the provision of climate services across East Africa, our study is a collaboration between UK and Kenyan universities. The research aims were conceived by two of the UK researchers who are HCI specialists, and were developed with the broader interdisciplinary team. Notably, particular guidance was given by Kenyan co-authors with extensive experience performing research with Kenyan pastoralist communities. Our aim was to understand information sharing within these communities without judgement, though we are aware that biases may still exist with regard to how the research is conducted and how the results are interpreted. A close partnership between the institutions mitigated this.

Data collection was performed by RAs from communities participating in the research. They had previously received research training in data collection and note taking from an international NGO, and were further trained on location by the authors (Kenyan and British) based on the study aims and requirements. They were paid for their time and services commensurate with local norms. The coordinating researchers were present for two data collection sessions (one in each of the two wards studied; see below), which allowed them to contextualise the research within the setting that it took place. Due to possible power imbalances that exist with research teams comprising Europeans and academics in rural Africa, they observed from afar and did not participate. This research was reviewed and approved by the School of Geographical Sciences Research Ethics Committee at the University of Bristol, UK (project 12109).

The involvement of Kenyan researchers in the development and execution of this work was instrumental to its success, and they are equal partners in this project. Their local knowledge guided the research protocol to suit communities of interest and ensured it was practical and culturally appropriate. Furthermore, they lead the planning of logistics and other practicalities in the field.

3.4 Participants

Twenty-four participants were recruited from Burat and Kinna wards in Isiolo county (See Fig. 3). All participants played some role in information sharing in their communities — these include both formal roles (e.g. a government-appointed chief) and informal ones (e.g. youth leader). Participants were required to own a smartphone. Seventeen were male and seven were female, and aged between 26 to 69 years (mean = 44, median = 46, SD = 13.35). Full participant details can be seen in Table 1. Each participant received 500 Kenyan shillings (~3.50 USD) for participating (recommended as appropriate by the local partners).

Figure 3: The location of Burat and Kinna wards within Isiolo county.

3.5 Procedure

As local knowledge and trust is critical in community-based research, local RAs performed the recruitment and data collection. This also mitigated language barriers and other practicalities (e.g. gaining entry to communities and recruiting participants). They received training in the interview methods and data collection specifics relevant to the study objectives. The RAs had prior experience in performing research data collection, but as they were not HCI experts and did not have in-depth knowledge of our research aims, we used a structured interview protocol to ensure consistency. This was also the preference of the RAs based on their experience and training.

The RAs used their local contacts to approach potential participants based on our requirements. The study was explained, and if they showed interest in participating, they were given an information sheet to read and a consent form to sign. If they were unable to read it themselves the RAs read it to them (due to the diversity of possible language requirements, materials were prepared in English and translated by the RAs when necessary following guidance by local partners). After gaining informed consent, the RAs collected demographic information (see Table 1). They then began the interview, following the interview protocol which covered questions on how participants share information in their communities, the giving of advice, the use of mobile phones specifically in information sharing, and general attitudes towards mobile phones (see Table 2 for a full list). The RAs took detailed field notes which were written up fully after the interview. Interviews took around 20-30 minutes, and when complete the participants were paid.

3.6 Analysis

The field notes (produced in the RAs' language of choice) were developed into full English language write-ups, and contained both

Table 1: Details of participants. **The dehda is an elder committee that manages grazing rights.*

#	Age	Gender	Location	Self-described community role	Self-described livelihood	Smartphone make/model (if known)
1	26	M	Kinna	Community leader	Businessman	Oppo A15
2	54	M	Kinna	*Not stated*	Businessman	*Not stated*
3	31	F	Burat	Akadeli chairwoman	Business lady	Tecno Pop 5
4	53	M	Burat	Sub-area community leader	Pastoralist	Samsung
5	39	M	Burat	Chief	Pastoralist	Samsung
6	48	F	Burat	Cluster head	Pastoralist	Tecno
7	35	M	Kinna	Community Health Unit leader	Pastoralist	Tecno
8	61	M	Kinna	Chairman, conservancy	Pastoralist	Nokia
9	64	M	Kinna	Dehda* chairman	Pastoralist	ITEL
10	50	M	Kinna	Chief, Kinna South	Pastoralist	Samsung Galaxy
11	38	M	Burat	Water and land committee chairwoman	Pastoralist	*Not stated*
12	48	F	Burat	Community health volunteer, alternative dispute resolution, area manager, group chairwoman	Agropastoralist	Nokia
13	48	M	Burat	Assistant area manager	Pastoralist	Tecno
14	27	M	Burat	Church youth leader, water committee secretary, village secretary	Pastoralist	Oppo
15	51	F	Kinna	Elder, women's group chairwoman	Pastoralist	Samsung
16	*Not stated*	M	Kinna	Malka cultural village leader (chairwoman)	Farmer and pastoralist	Tecno Spark 8
17	64	M	Kinna	Elder, member land committee	Pastoralist	Samsung
18	42	F	Kinna	Malka cultural village leader (chairwoman)	Farmer and pastoralist	Oppo
19	26	M	Burat	Climate monitor	Pastoralist	Tecno Spark 7
20	39	F	Burat	Sub-area local community leader	Pastoralist	Oppo
21	26	M	Burat	Community volunteer	Pastoralist	Infinix Hot 8
22	27	F	Kinna	Youth leader	Housewife	Tecno
23	69	M	Kinna	Community elder	Pastoralist	Tecno Pop
24	39	M	Burat	Chief	Pastoralist	Samsung A12, Samsung Duos

direct quotes and generalised observations. We used reflexive thematic analysis [12, 13] to analyse these write-ups, and followed the established six-phase process [17]: 1. Write-ups were read to familiarise ourselves with the data. 2. Write-ups were inductively coded by the lead author. At least two passes were performed, resulting in 314 codes, which were mainly semantic. 3. Two authors used digital sticky notes to independently group codes into potential themes. 4. Potential themes were discussed and developed into a single set of agreed themes. 5. Themes were named to reflect their subject matter (see Section 4.2). 6. Results were written up (this paper).

4 Results

4.1 Overview

Participants told us about both their own information sharing practices and wider practices observed in their communities. Overall, we found an extremely varied landscape of both general technology use and information gathering and sharing. Both feature phones and smartphones were in use by participants and their communities, but there are some without access to either. Participants and phone users from the wider community used phones to differing extents, from those who were very comfortable with technology to those who only used basic features. We discuss these varied practices in the following sections.

Though some questions focused on information directly related to livelihood concerns, i.e. weather, climate, and access to water resources (referred to as "water, weather, and the seasons" in interviews), the results yielded broader insights. Due to the cross-cutting nature of these issues, participants spoke about related issues that are affected by drought and climate such as insecurity related to conflict over resources.

4.2 Thematic analysis results

The reflexive thematic analysis yielded four themes: 1. *Informal and heterogeneous approaches to information gathering and sharing*, 2. *Technology supporting life in the drylands*, 3. *Interaction between technology and traditional roles, structures, and practices*, and 4. *Screening and curating information and the importance of trust*. We describe these in the following sections.

4.2.1 Informal and heterogeneous approaches to information gathering and sharing. Unsurprisingly, informal verbal information sharing through one-to-one and small group conversations continues to be important. Participants spoke of sharing information, with P10 (M, chief) sharing with *"elders, women, and livestock owners at water points"* and P3 (F, local chairwoman) at *"local markets"*, among others. Meetings involving particular groups are also used, and chiefs and elders may call whole-village meetings to convey and discuss information, for example P10 (M, chief): *"I [..] hold barazas where I give information [about] weather and also security matters"*.

Table 2: Interview questions. Sub-questions denoted by a, b, c, etc. were used as additional probes if they were not covered in the participants' initial answers.

Num.	Question
1	First we would like to consider how you assist in sharing information about water, weather and the seasons in the community. Please can you describe how you do this?
1a	What kinds of information exactly do you share?
1b	Where or who does the information you share come from?
1c	Do you seek this information yourself, or does it come to you?
1d	Who do you share this information with?
1e	How do you use smartphones or feature phones to do this?
1f	What languages are the information sources you use?
2	Do you make a choice about which information you share with other people in the community?
2a	How do you choose which information to share?
2b	Which information sources do you trust, and why?
2c	Which do you not trust, and why?
3	When you share information, do you also give advice about what actions to take?
3a	In what ways do you do this?
4	Why do people look to you for information and/or advice?
5	We have spoken in detail about how you share information in the community. In general, how are phones and smartphones used to share information about water, weather, and the seasons?
6	Do you think smartphones could be used to further improve information sharing and decision making about water, weather, and the seasons in the community in the future? If so, how?

However, this is supplemented and integrated with technology usage. WhatsApp is used particularly widely by most of the participants and their communities, and valued for its speed:

> *"Digital technologies are the fastest method of sharing information [...]. We usually get an alert through WhatsApp messages that there will be prolonged drought."* —P6 (F, cluster head)

Furthermore, WhatsApp's broad installed base makes it effective in reaching many people, P12 (F, area manager and group chairwoman) remarked that it is *"the most used app to share information [...] because WhatsApp is common in the villages, even for people with low education"*.

Many community WhatsApp groups have emerged, and can support formal committees and groupings. For example, P21 (M, community volunteer) speaks of passing information and evidence about soil erosion to the *"grazing land [committee] responsible for sharing information in WhatsApp groups."*. They are also created by less formal subcommunities and interest groups, such as a *"group we formed for the youth from our area, [called] Activista"* (P23, M, elder).

Sharing content using WhatsApp groups is common, and this happens both within and between groups. Furthermore, people may then share WhatsApp group content privately to other contacts. This combination of dedicated groups about specific subjects, and the sharing of content from these groups to personal connections, means that *"the community are educated through WhatsApp groups"* (P20, F, sub-area local community leader).

WhatsApp was also favoured due to the ability to share multimedia, which can easily convey messages without text. In particular, participants talked about its effectiveness in showing the condition of natural resources:

> *"Through WhatsApp groups I am able to share pictures and videos. [...] For example, pictures of dams filled with water."* —P18 (F, village leader)

A lot of activity takes place within such groups, including information sharing. P24 (M, chief) explains: *"we have a lot of heated discussion through the WhatsApp"*. However, they are not considered a substitute for non-technological approaches and effort is made to include those without access to smartphones, particularly when information is urgent:

> *"The moment I receive message from the office of water that there is shortage of water in the borehole, I call the meeting and inform the community."* —P6 (F, cluster head)

And information from digital sources spreads through the network of face-to-face conversations:

> *"When I get information from my smartphone, I share the information in meetings like church meetings, village savings and loan association groups, seminars."* —P11 (M, committee chairwoman)

WhatsApp also does not fully replace phone calls or SMS messaging. Urgent information, such as security threats, can be passed on through calls to ensure they are received. Calls and SMS messages are also used to convey urgent or important information arriving via WhatsApp to herders currently away from the community who (for reasons discussed in Section 4.2.2) favour feature phones over smartphones. Hence, our data suggest the development of a relatively effective hybrid approach across the community, where traditional informal and formal information sharing practices have been augmented through the appropriation of technology — most notably WhatsApp, but also SMS and calls. Facebook, and to a lesser extent Twitter/X, were also mentioned by participants, though to a significantly smaller extent and primarily as sources of incoming information rather than sharing within communities.

Though WhatsApp seemed to dominate technological information sharing *within* communities, there was more heterogeneity of approaches and sources when it came to information arriving into communities. Specifically with regard to weather and climate information, some spoke of the value of official information from Kenya Meteorological Department (KMD) and the National Drought Management Authority (NDMA) — however, they accessed it in different ways. Some had information "pushed" to them, including through a specific regional WhatsApp group for community administrators:

> *"We have a special WhatsApp group that we use to receive information and send information with. I receive information from NDMA on weather and the climate of impending seasons that I'm required to send to the members of the community."* —P10 (M, chief)

In addition, agencies send text messages containing alerts and advice concerning droughts. Recipients spoke of passing these on

both by forwarding the message (typically via SMS or WhatsApp), and also word of mouth:

> *"The [KMD] forecasters pass information through SMS that the rainy season will delay. The moment I receive the message I share with the community members through the word of mouth. I read while translating to them."* —P6 (F, cluster head)

Others accessed similar information through a "pull" approach, including phoning contacts in these organisations, or accessing the organisation's website such as P2 (M), who gets *"weather information from the KMD website"*. Information from these organisations can also reach the community through being shared on regional WhatsApp groups which include community members, and then reshared on community WhatsApp groups:

> *"I get [weather information] from WhatsApp groups like Kinna times, Kinna Professionals and Southern Voice. On getting this information I share to Whatsapp Groups like Activista."* — P22 (F, youth leader)

Notably, some participants in official roles (e.g. chiefs) who would be expected to receive and disseminate such information did *not* have information sent to them by regional representatives of the agencies, while others did. E.g. P1 (M, community leader) said he received information from KMD, but P24 (M, chief) said he did not).

Participants also spoke of using search engines to find weather information (though not necessarily from the more reliable official sources discussed above). Other sources of information mentioned include YouTube and Facebook.

Prior research has discussed indigenous knowledge sources (e.g. [3]), including reading natural signs (animal behaviour, clouds, etc.) [89] and this was discussed by some of our participants. P9 (M, dehda chairman) mentioned that they provided this information:

> *"I frequently provide information [...] on timing of the rain. I am good at observing the clouds, and there are various changes happening in our surrounding that help in predicting the onset of drought or rain, like the observation of stars, wind and clouds."*

However, participants' uptake of this information appears limited, and typically combined with other sources. Opinions were mixed; P17 (M, elder and land committee member) said *"I trust and rely on information from my fellow elders, leaders, and also the traditional forecasters."*, but others questioned its accuracy:

> *"I do not trust traditional sources completely because the source lacks modernised tools and credible skills to predict weather." — P16 (M, village leader)*

4.2.2 Technology supporting life in the drylands. Participants described many instances of how mobile phones are used to assist with everyday challenges specific to the drylands, which for many have become an important part of life:

> *"Most of our activities nowadays revolve around phones. Without them then everything will be at a standstill."* —P18 (F, village leader)

As pastoralism is the dominant livelihood in Isiolo, access to water and pasture is an important consideration. Many participants spoke of sharing information about water availability with others in their communities:

> *"Smartphones and phones are used to send photos and videos of water levels in earth pans, [and the] availability of streams and rivers."* —P10 (M, chief)

Information received from authorities such as the NDMA often includes advice on how the community should respond. However, the advice is not always followed. P1 (M, community leader) spoke about drought warnings and advisories from the NDMA, saying that *"some followed the advice and some didn't"*.

Participants also spoke about the effectiveness of images and videos for showing the seriousness of drought and other extreme events affecting their communities. P19 (M, climate monitor) said: *"I share pictures of animals like goats which died due to hunger, and alert the community to take proper measures."* This approach is also used for communicating with authorities above community level:

> *"This year all sources of water have dried up completely. [...] So I took a photo of dirty water and sent it to the chief through WhatsApp, and the chief shared to the minister of water. Now they have already built a borehole in our village."* —P6 (F, cluster head).

Security issues are a frequent concern in the rural drylands — due to frequent droughts, conflict over resources is common and theft of animals by bandits is an ever-present threat. Participants told us how they mitigate this by sharing information about crime and security:

> *"Sometimes we get intelligence that there are [intruders] [...]. We immediately communicate to the pastoralists and also give calls and also send people to that area."* —P24 (M, chief)

In addition to avoiding possible security issues, participants also described how multimedia capabilities of smartphones meant that they could be used to collect and share photo and video evidence of crimes and help resolve community issues.

Though inter-group conflict and violence was a serious concern, the misuse of limited resources exacerbated by the droughts — mainly water and pasture — is also an issue that mobile phones are used to assist with. During the interview with P24 (M), a chief, he was actively taking phone calls from his the police county commissioner and sending messages to try and find the owner of roaming camels illegally grazing:

> *"He wanted me to share the information and identify the owners. He has sent me the pictures of the camels so that I can assist. [...] It was found grazing on private property. Currently we have a lot of problems... there's no pasture due to the prolonged drought, so the camels are not getting their pasture at the grazing area."*

P24 also recounted similar evidence collection and sharing with regard to shared water usage, which is strictly controlled:

> *"We also have some spies — informants — at all levels. So in a certain area, they will tell us somebody's pumping water at the wrong time. Then the assistant chief will move to the place and also confirm, and if he [confirms] it, the person will be arrested. [...] If you have any*

> *incidents you have to document. So you take the photo, then we send to our WhatsApp group for security."*

Due to the nature of pastoralist life, some community members may be away from settlements for long periods in search of water and pasture and face extreme conditions. Despite the additional functionalities that smartphones provide, some participants told us that many herders prefer to use feature phones over smartphones as they are seen as more robust and have longer battery life (though this can limit communication options to voice calls only):

> *"The pastoralists have this one* (points to feature phone)*, yeah, and this* (points to smartphone) *is fragile. We have to be very careful with this one. If you go to the pastoral grazing area, the area is very harsh."* — P24 (M, chief)

4.2.3 Interaction between technology and traditional roles, structures, and practices. Despite the growth of technology, traditional community structures and practices are still important. Pastoralist communities have a strong culture of information sharing, especially regarding locating water and pasture, and many participants spoke of its importance and the privilege of having such a role. E.g. P2 (M) said that "*sharing of information is one way of caring for your community*".

Community hierarchies are well established and respected. Notably, community elders play an important role in decision making and information sharing, and are therefore often trusted. P20 (F, sub-area local community leader) said that the information they provide *"is true and can be relied on"*, and this trust means that elders are a useful entry point to communities for information sharing, and also keep abreast of the happenings in their area. As such, they are important conduits of information. P24 (M, chief) told us about the importance of elders to him as a chief:

> *"It's good to have some trusted elders that you can give information to from different communities, because in my area, it's vast. And I also have different communities. [...] I need elders from those communities who I can trust with information."*

To communicate between each other to discuss community issues such as community security and grazing, participants said that elders favour a combination of speaking in person and voice calls:

> *"Elders including myself normally call each other through phones to know of what is happening in our areas and the neighbouring regions. Those who communicate through the phone also most times meet to have a word-of-mouth meeting with each other. So both models of communication are used unanimously, especially on weather and climate, water, and pasture availability."* — P17 (M, elder and land committee member)

P24 (M, chief) suggested that they may favour voice calls over other methods due to a lack of technological and basic literacy skills:

> *"They are not technological, because most of them are older. [...] It's not easy for them because of the literacy level [required]."*

A direct example of this is P13 (M, assistant area manager), who described his own lack of experience with a smartphone:

> *"I only call my fellow leaders to have a meeting [...]. Even though I have a smartphone, I only use it for betting with the help of my son since I know nothing about the Internet."*

In some Borana communities, elders may form the *dehda*, a council formed to control and manage grazing areas. This customary practice is encouraged and supported by local governments as a way of managing natural resources and promoting cultural heritage [21]. Two participants mentioned that they were members, and described how they often disseminate this information through mobile phones:

> *"We have put in place social bylaws that govern the zoning of our region into wet season grazing zones and dry season grazing zones. [Community members] are discouraged from overgrazing in a particular area by the elders. This we do either through holding an elders' baraza or through use of phones."* — P9 (M, dehda chairman)

Though P9 and others use both barazas and phones to discuss issues, it is possible that the baraza tradition could be challenged through technology by democratising information, facilitated by the speed and ease with which information can be shared:

> *"Instead of calling barazas during the day or calling people in the group you just share it in the smartphone. It is the simplest form of sharing and accessing information from the people and to the people."* —P3 (F, local chairwoman)

Despite this, it seems that some young people are embracing the benefits and importance of group meetings but employing technology to conduct them:

> *"The community also has active youth who discuss the factors affecting the community, and most of the meetings are carried out through Zoom meetings and Google Meet."* —P21 (M, community volunteer)

As discussed in Section 2.4, traditional gender roles and other systemic inequalities mean that women often have reduced access to mobile phones. Though we did not collect quantitative data to confirm whether this was the case in the communities we studied, we heard how mobile phones are used to support and connect women. For example, P6 (F, cluster head) said:

> *"I seek information from the women's WhatsApp group, by getting online and using data to receive other information from other women's group in different locations".*

We also heard that both male and female participants did discuss the sharing of information with women. P5, a male chief, said:

> *I share information to the youth in the community, elders, and the women — older Women and young ladies.[...] I also share information to the chairladies of several groups to distribute information to the other women in the group.*

4.2.4 Screening and curating information and the importance of trust. Upon receiving information, most of the information sharers we interviewed performed some kind of screening before sharing

it more widely. For instance, P16 (M, village leader) said: *"I only share information that I have confirmed or information that originates from credible sources"*. An important part of this is assessing the trustworthiness of the source and the information received, and this was again not consistent between participants — some sources were trusted by some participants, but not others. For instance, P18 (F, village leader) stated:

> *"I share information that I believe comes from a true source. And for me, radio, KMD, and NDMA are truthful sources."*

Conversely, P8 (M, conservancy chairman) stated:

> *"The information by the KMD is mostly false, and we are starting to think that the persons employed are not qualified and skilled to work as weather forecasters."*

Thus we observed very different ideas of who was a trustworthy source and who was not. Trust or distrust of particular sources appeared to be based on previous experiences of how accurate information was. Bad experiences led to a lack of trust in a source, which meant future information would not be shared or used.

We also found that participants sometimes conflated the source of information with the method by which it was obtained. This meant that incorrect information received by particular method could affect the trust placed in all future information from that method, regardless of source:

> *"There were times when we received information through phones of impending rain, only to experience severe drought. This in essence means that most information sourced through phone calls are not trustable."* —P9 (M, dehda chairman)

Similarly, P7 (M, Community Health Unit leader) expressed greater trust for a particular web browser app, even though it does not necessarily affect the source of information.

> *"I trust information from Phoenix [web browser]. Phoenix gives real updates and I trust it more than [other browsers] like Opera Mini. "*

Once information has been deemed credible, the information sharers then typically decide who to share it with and by what method. Participants said that translation is often necessary to facilitate this. Information from government sources or other sources outside of the community (e.g. the Internet) is often received in English and then translated to suit the intended audience — this lack of African-language content from internet sources has also been highlighted by [71], who note that it presents significant barriers for users of these languages who wish to interact with technology. P4 (M), a community leader in a diverse area, explained how he translates for different communities:

> *"The languages mostly used are Swahili and English, and I translate to my local Turkana, Samburu, Ndorobo to [allow them to] understand the information better. In Burat, all communities are living here — it's a cosmopolitan location. "*

Swahili is the common *lingua franca* in Kenya, and many may also know English (especially younger people). Both are official languages and English is the language of government, but Swahili is more widely spoken. P14 (M, group and village secretary) said, *"for the young, I can use both Swahili and English"*. However, older people and more remote communities may not speak either. In these cases, participants spoke of efforts to keep these people informed, such as P12 (F, area manager and group chairwoman) who has to *"translate to the vernacular if I have to pass the information to the older people or the illiterate"*.

As well as curating and sharing information, some participants told us that they also give advice based on information they receive. P22 (F, youth leader) described how she advises based on the current conditions:

> *"In case there is scarcity of water, I advise people to fetch enough water to be used in the future. In the situation of weather, I advise to store the grasses and feed to the animals during tough times."*

5 Discussion

Our research demonstrates how technology, especially mobile phones, is appropriated by pastoralist communities and integrated into established information sharing approaches. Despite varying levels of engagement with technology, it was clear that phones have become part of everyday life, supporting and extending informal information sharing through voice calls and messaging. Technology also supports more formal dissemination processes, via virtual discussion by village committees on WhatsApp, and augments in-person community gatherings where those with smartphones share relevant information which they have received.

Prior work has examined the used of mobile phones among East African pastoralists (see Section 2). However, this focuses on phone use by herders themselves for activities directly related to herding, rather than general technology use by the wider communities who live against a backdrop of dryland pastoralism [10, 16, 72], or focuses on settings where the culture and context is vastly different (i.e., Somaliland [91]), or simply is no longer a representation of up-to-date mobile phone usage. In contrast, our work explores the wider information sharing ecosystem that incorporates the entire community as well as external bodies, and paints a rich picture of current technology use that supports communities and their livelihoods in the drylands. Our findings have important implications for designers looking to support information provision in these communities through technology, which can help to define how services should provide information and how they are accessed.

For any digital service providing information to support rural livelihoods there are a number of design questions to be answered, including *what* information should be disseminated? *How* should it reach users? *Who* should receive it? *When* should they receive it? It is important to note that this paper mainly addresses *how* information should reach users, and therefore designers need to perform additional user research to answer other important questions before implementing a new service. This should be performed in collaboration with the communities, employing user-centred and participatory methods to ensure bottom-up solutions that effectively address user needs and are sensitive to the local and cultural context.

5.1 How technology does and does not integrate effectively with community practice

Our findings show that mobile technologies enable frequent and active discussions and information sharing in many ways, and between diverse audiences who form networks based on their livelihoods and community lives. We find that many of the phenomena reported by our participants effectively mirror or extend common community practices that happen 'offline', many of which existed prior to mobile phones and the internet. For example, community-wide WhatsApp groups are analogous to holding community meetings, but extend beyond a single event and allow discussion to continue outside of it. We suggest that this is why these practices have been readily embraced by communities, and are quickly integrated with everyday life without much issue or fanfare — such wide-ranging communal information exchange has a long tradition in these communities (see Section 2.3), and therefore develops quickly and organically over technology platforms.

In contrast with information sharing within communities which has a long cultural history, arrival of information into communities on a large scale (both in quantity and frequency) from many different sources is a newer phenomenon. Therefore, it is perhaps unsurprising that there is more heterogeneity of practice and experimentation among our participants. They adopt a variety of informal approaches to determine which information is useful and to be shared with their communities, typically based on their assessment of the source's trustworthiness. As we have seen, this can mean disregarding potentially useful information sources based on a bad experience (e.g. incorrect weather forecasts). Such a risk can be mitigated through encouragement of existing "communities of practice"[109] — informal peer groups who discuss a shared concern — to learn together what information sources are most reliable and useful. In Isiolo county, examples include Farmer Field Schools [101] supported by NGOs[4]. These are groups of farmers and pastoralists who meet regularly and communicate through WhatsApp, sharing best practice and learning from experienced practitioners. As part of this, participants can learn of useful and reliable information sources.

Inconsistent access and use of information pushed to communities from government and NGO sources was also noted in our results. Usability of information is one factor — how the information is presented and whether it is straightforwardly interpretable and actionable. This is commonly cited a shortcoming of information dissemination in the Global South, especially in the domain of climate services [50, 88], and prior research highlights the role that HCI can play in developing more suitable systems [90]. Notably, good solutions should involve better understanding user needs [73, 104] and user participation in the design and production of information [14, 105].

We also found examples of key community members not receiving some important official information that they should have. Anecdotal evidence collected outside the research interviews suggested that personal relationships and area politics play a role here: some community leaders are excluded from official communication simply because the local official chooses to do so. Because this happens at a "to community" rather than "within community" level, it can result in an informational divide between communities. If taken to an extreme, it could result in some communities being unprepared and "left behind" with regard to drought management [20], with potentially devastating consequences.

5.2 WhatsApp as a backbone of information sharing

A particular finding of our research is the prevalence of WhatsApp as the preferred method of communication for many. The benefits are clear — quick and easy communication, multimedia functionality, and a large installed base. Group chats are a particularly well-used feature according to our participants. WhatsApp groups fit very well with the discursive nature of traditional practice (e.g. village meetings), and hence are very widely used in our communities of study. McGregor et al. [58] found similar popularity of WhatsApp among professionals in Kenya for work purposes, including the proliferation of groups. The authors highlight how WhatsApp and other chat apps are effective in gathering and sharing information in the workplace, and our findings show that this is mirrored outside of this context. Gachago et al. [34] characterises such groups as virtual "third spaces", places in between work and home that support social cohesion and provide a link between individuals and society.

Despite the obvious benefits, over reliance on WhatsApp could also be problematic. In many ways, it has become critical infrastructure in the Global South, as demonstrated by a recent outage that caused widespread disruption[5]. This affected both personal users and the many businesses who rely on it for customer communication. A single company (Meta) having control over the world's communications could be cause for concern, especially when they have not been good custodians of users' private data in the past [44].

5.3 Possible negative consequences of information provision through technology

Providing access to information that can improve the lives and livelihoods of individuals is ostensibly a beneficial use of new technologies. However, there are potential downsides that must be considered. For instance, there is a risk that the provision of such information will marginalise and disadvantage those who cannot access it. This could result in a "digital divide", which women can be particularly affected by [35, 111]. In our communities of study, one could imagine a situation where those with smartphones have access to better information on the location of water and pasture, and information on drought-tolerant agricultural practices — this could perpetuate and increase inequities.

Prior research has noted how technology can amplify existing inequalities [99, 112], and in our context there is a danger that those who do not use technology, or cannot read or interpret the content it provides, could miss out on potential benefits. Although such a scenario is likely within a competitive individualist culture, a

[4]https://www.preventionweb.net/news/kenya-extreme-weather-drives-rustling-pastoralists-turn-farming (last accessed 23rd January 2025.)

[5]https://www.theguardian.com/technology/2021/oct/05/facebook-outage-highlights-global-over-reliance-on-its-services (last accessed 13th December 2024)

strong sense of community and a collectivist outlook in Kenya — encapsulated by the spirit of togetherness and self-help known as *harambee* ("all pull together") [22] — can mitigate this. Our research suggests that such inequalities are mitigated within our communities of study, as the culture of information sharing and collective decision making mediates the use of digital technology for information gathering, with information viewed as a community asset rather than an individual one. Furthermore, participants told us of efforts to ensure that those without access to technology are not excluded. In general, we found that community members feel a sense of civic duty and pride in sharing information, and receive respect from others for doing so. However, as our data collection focused only on these "information sharers", it means we are missing the perspectives of the wider community, and whether all members feel adequately informed and included. Further research is necessary to understand these.

Though technology is integrated into traditional processes (e.g. WhatsApp groups augmenting physical community groups), it inevitably results in changes to the informal community dynamics. Most notably, some elders who traditionally take a leading role in information sharing and coordinating decision making are less likely to be comfortable with such technology, and so may rely on younger members to source the information [10]. Technology also makes it easier for alternative discussion and sharing forums to develop which exclude these elders — most notably in our findings, women and youth groups. This has potential to disrupt the traditional power hierarchy, which was also discussed by Nilsson and Salazar [72] in Masaai communities in southern Kenya and Tanzania.

In the communities we studied, our evidence suggests this disruption is limited . This may in part be due to a sense of mutual respect between individuals, and a wider respect for the cultural traditions of the community which place value in elders' roles. It can be viewed more as an evolution of practice, perhaps allowing the voices of women and youth members to be more clearly articulated and heard, while maintaining the traditional community structures. However, we note that this requires the women and youth to have access to smartphones to participate, and so the poorest women and youth may remain marginalised (and possibly further excluded by these online-only discussion groups). Alternatively, it may be that these online communities also reach out and include the voices of these others through informal conversation and networking. Further research, particularly with those without smartphone access, is needed to resolve this question.

Though a technology-led rebalancing of power may seem appealing to some, it is important to acknowledge that there may be positives and unforeseen negatives. One possible negative is the erosion of cultural heritage — an HCI study by Kotut and McCrickard [48] found that online cultural arenas for Kenya's Kalenjin people had a distinct lack of elder presence, possibly due to their unfamiliarity with technology. This limited the exchange of culturally important indigenous knowledge, especially for those who now lived in urban areas. It is therefore important that technology does not entirely remove opportunities for this exchange to take place.

Finally, in a context where natural resources are often scarce and under contention [8, 100], broadcasting their location could lead to conflict. This presents complex ethical questions surrounding the disclosure or withholding of such information. Resolving these matters is out of the scope of this research, though the answer may lie in engaging with the communities themselves, who often have their own customary methods of dispute resolution and resource management [8, 21, 93]. This could encourage a community-driven response, rather than one imposed top-down.

5.4 Design recommendations

The majority of technology use by rural pastoralist communities has been through organic uptake of mobile phones and the services they provide, initially via basic handsets but more recently via smartphones through services like WhatsApp and Facebook. Conversely, the small number of services aimed specifically at this user group do not appear to have been especially successful (see Section 2.4). To help information technology designers to mitigate some of the issues we observed in our research, we have derived the following design recommendations for future systems designed to facilitate information gathering and sharing for pastoralist communities in Kenya.

5.4.1 Embrace informality. Participants described information sharing practices on a spectrum of formality (e.g. dissemination from national and local government being more formal, and word-of-mouth discussion among kin being less formal). The informal elements play an important role in ensuring information is propagated around communities to those who need it, including those without technology access. Therefore, it is important that designers recognise the importance and flexibility of such informality, and do not impose a formal system of dissemination unnecessarily. For example, delivering information to every individual in a community via technology is a difficult endeavour. It may be better to deliver information to specific individuals (such as the participants in this study) and then let the informal community networks fill in the gaps, as previously discussed in the context of pastoralist communities in Somaliland [91].

5.4.2 Integrate instant messaging services. Despite concerns about the near-monopoly that WhatsApp has over the instant messaging sector (see Section 5.2), it is undeniably an effective way of reaching many people. Therefore, When designing systems that revolve around information dissemination, integrating with WhatsApp and other chat services (e.g. Telegram) can encourage uptake due to the large installed base. Awori et al. [5] also discuss how WhatsApp's popularity presents opportunities for delivering agricultural information, noting that Kenyans often favour technologies with a social element over interacting with purely automated services (e.g. e-commerce platforms that facilitate direct communication between vendors and customers) — thus, building systems around chat interfaces that allow two-way communication may be preferred. Furthermore, WhatsApp is very familiar to these communities, and often the preferred method of communication, giving a high chance of new services being integrated into current community practice. They already "speak the language" of WhatsApp, removing friction associated with the uptake and acceptance of new services. Previous services have used proprietary smartphone apps for rural communities. However, these involve ongoing development and

maintenance, and users have to discover and download a new and unfamiliar application. The success of previous app-based services appears limited — Golbal Concern's Afriscout has only 10,000 downloads on the Google Play Store[6] despite serving three countries, and the MyAnga app is no longer available. De Bruijn et al. [24] writes that "*for many scholars studying the relations between technology, sustainability, and development, mobile apps have often been looked upon with a great degree of scepticism*", which also describes the position of the HCI researchers coordinating the current research.

Though designers could capitalise on WhatsApp's popularity, access to the necessary APIs appears complex and somewhat limited, offering only limited functionality and extensibility [87]. Alternative platforms such as Telegram offer a more open platform for developers, but suffer from a smaller installed base. However, functionality and use is very similar to WhatsApp, and it is at least somewhat familiar to the communities we studied as its use was mentioned by participants. Furthermore, using multiple services can mitigate the risks of relying on a single provider.

5.4.3 Support both push and pull of information. As we found individual differences in the extent to which participants actively seek information, services should support the automatic provision of content to registered recipients (push), and the access content of interest at the users' request (pull). Though exact preferences should be user-configurable, a combination of the two could be used effectively as a default — pushed information can ensure that particularly critical information is delivered, and could be combined with notifications or follow-ups with (possibly automated) voice calls. This mirrors a strategy used by some of our participants to ensure information is received. Less critical information that may be of interest to smaller audiences could be pulled on request. Designers should also ensure that information is archived for access at any time, even if previously pushed. As well as encouraging transparency and comparison over time, this guards against accidental deletion and users losing or replacing their devices.

5.4.4 Ensure platforms are open and inclusive. Through this research, we found that the consistency of information provision to and within communities was highly variable. Even from official government sources such as the NDMA and KMD, it appears that not everybody who should receive updates actually does (see Section 4.2.1). Anecdotal discussions outside of the data collection activities suggested that this could be due to the lack of formal systems to provide regular information, and a lack of formal lists of recipients (especially those without well-defined, official community roles). This means that people working for such agencies tended to rely on personal contacts, giving potential for exclusion of entire communities or preferential treatment for others. However, this reliance on personal contacts is highly valued and not uncommon in Kenya, where work contacts and personal contacts can frequently overlap [5].

To mitigate this exclusion risk, services should be designed in a way that is fair and open. Access to those who require it should be possible without the need to know specific people, and all users should be treated equitably. Services should also be easily discoverable so that access does not require recommendations that rely on personal social networks. Given the importance placed on personal relationships [5], this would obviously not preclude sharing of information with one's personal network, but offer an open alternative. As gender inequality is also a serious concern, this could allow female community representatives to also access these services without the need for permission or acceptance from male counterparts.

5.4.5 Assume information will be widely shared and used. Our results showed that once information is available, it is widely shared to different audiences and through different modes. Therefore, designers should assume that content will find its way to diverse audiences far beyond their original intention. To allow for the differing capacities of recipients, care should be be taken in the presentation of information. For example, text should be clear and simple, and in multiple languages where necessary (in Kenya, at least English and Swahili but possibly also local languages). To account for recipients with limited literacy skills, text should be accompanied by simple images that convey broadly the same message. The inclusion of audio may also be possible, and has successfully be used in other ICTD/HCID work [46, 95].

Trust in an information source is a very important factor when deciding which information to act on and which to ignore, but repeated sharing of information can mean that the original source is lost. Therefore, information sources should be clearly stated in all of the above media, e.g. if information about an upcoming drought is shared from the NDMA, their logo should be prominently displayed. If it is further endorsed by other trusted parties (e.g. local government), then this should also be stated. It is important that this information is "baked in" to the content and cannot easily be removed, such that it does not get lost with repeated sharing. Also, making communication consistent over time with clear branding — established layouts, fonts, colours, speakers, language, etc. — can make it easily identifiable as being from a particular trusted source.

6 Limitations

We acknowledge some limitations to this research. Firstly, the Kenyan research partners recommended selecting participants who had an information sharing role in their communities to allow us to develop an overview of the information sharing ecosystem, as these community members have a good understanding of where information comes from and how it moves through their communities. The participants themselves are often key points of contact for information and thus have first-hand experiences of how and when sharing occurs. Community members without such roles may not have such a good understanding of the information flow within their communities, making it difficult for us to build as clear a picture. However, due to the participants' community roles they may be speaking from a position of relative privilege or power. This could result in them being unaware of the concerns of less privileged community members (e.g., those without access to technology in this context). However, we generally felt that our participants were aware of such inequalities, and that communities took active steps to increase inclusion. Nonetheless, unconscious biases may still have an effect.

[6] https://play.google.com/store/apps/details?id=com.pci_afriscout (Last accessed 16th December 2024)

We also acknowledge that women were less represented in our sample than men (seven female participants versus 17 male). Despite our intentions for an even gender balance, the RAs conducting the recruitment found it difficult to achieve. This was likely for two reasons: firstly, participant availability during the data collection sessions — schedules are typically quite fluid in Kenya, meaning that recruitment arrangements were often made at short notice, or that participants were not available during data collection sessions despite previously expressing interest. Women tend to have less free time than men due to expectations that they will perform domestic and childcare duties [70, 81, 111], which may be deemed more important than research participation. Secondly, this imbalance also reflects how more men typically hold these community positions than women. However, the seven female participants show that some women are taking on important community roles and representing the issues that women may be facing, albeit in fewer numbers than men. However, it is possible that these roles allow them more privilege than other women in their communities.

Our research also focused on smartphone owners. Though this was a conscious choice, information sharers who own only feature phones will have different technology usage practices and would not have been able to use additional features provided by smartphones. However, some feature phones contain a version of WhatsApp which would allow for interaction with smartphone users via the platform. Furthermore, anecdotal conversations with the RAs revealed that people matching the profile of interest would likely own a smartphone anyway. Some owned both types of phone, and participants spoke widely about interacting with them and were aware of their limitations and functionalities regardless.

7 Reflections and future work

Though the fields of ICTD and HCID aim to improve lives in developing countries, some previous research has questioned the efficacy and appropriateness of this research [38]. Furthermore, dryland regions in East Africa are often a target for development by governments and NGOs [21], and pastoralist livelihoods have sometimes been seen as a barrier to such development by governments [47]. We were careful to approach this research in a sensitive manner that makes no such judgements on pastoralist life and culture, rather seeking to understand the current picture of technology use to better inform possible future services. Brown and Grant [15] note that there are two channels of ICTD research, research focusing on (new) technologies *for development*, and research focusing on technology *in* developing countries. We position our study as the latter, with the intention that our results can support the implementation of appropriately-designed future technologies. As our research mainly addresses the questions of *how* information could be disseminated to pastoralist communities in Kenya, future research should more closely examine *what* information is most relevant and its format. This should be conducted in partnership with local organisations who understand the local context, and with the communities themselves in a participatory and user-centred way.

8 Conclusions

Information gathering and sharing plays a key role in rural pastoralist communities in Kenya, allowing them to plan for the future, mitigate climate shocks, and keep aware of important local matters. This is driven by key community members who have formal and informal roles that facilitate information sharing to and among communities. Through our interview study with 24 of these information sharers, we found that the ways in which people gathered and shared information were highly variable, depending on the preferences, capacities, and practices of individuals and the wider community network. Mobile phones played a key role in this, with WhatsApp being especially well used for individual and group communication. Despite a high level of variability, there was a commonality in the way that mobile phones are used to augment well-established information sharing practices that are ingrained into Kenyan and pastoralist culture, such as the use of community meetings and groups that are formed around particular community concerns. However, we found that the frequent influx of information from diverse sources was less compatible with customary information sharing practices. When designing technology to improve information dissemination to these communities, designers should ensure they deliver technologies that will integrate with practices and community structures.

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