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"It Will Be a Desert": Extreme Weather and the Effects of Climate Catastrophe on Vulnerable Riparian Spaces in Nairobi, Kenya

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Abstract: Urban riparian spaces are notoriously vulnerable, and pressure on water resources is growing. In the context of a fast-growing urban population and a lack of state-level structures and services to deal with water and sanitation, these spaces—including both land and water—are rapidly being degraded. Ongata Rongai, a satellite town in the Nairobi Metropolitan Area, is one of these spaces. Traditional livelihoods exist cheek-by-jowl with modern life; livestock are watered at the rivers, lions frequent the riverbanks, large commercial farms extract water for crops, industrial factories release heavy metal contaminants into the rivers, and rapidly constructed poor-quality apartment blocks with no provision for human waste release untreated sewage and dump trash into the rivers. Compounding these anthropogenic impacts is that of climate change. Riparian spaces have become sites where humans and animals fight for access to water and riparian space, and rain becomes less reliable or frequent, yet at other times, these spaces experience flash flooding and catastrophic water levels leading to the destruction of land. This study explores the dynamics of a rapidly changing riparian environment which finds itself dominated by urbanity, under the increasing pressure of anthropogenic climate change using a One Health perspective. This study contributes much needed human voices to a growing body of literature led by indigenous Kenyan scholars, calling for urgent structural level action to conserve urban riparian zones for the benefit of human and non-human actors.

Keywords: climate change; climate impact; urban; riparian; Kenya; landscape; water; One Health

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1. Introduction

Urban riparian spaces are being threatened globally due to climate change [1,2].

In Africa, it has been documented that riparian spaces are decreasing while agriculture increases, intensifying pressure on these fragile ecosystems [3]. The increase in urban settlement and decrease in vegetation cover in riparian spaces creates a situation where flash floods are a significant risk to urban dwellers [4,5].

Kenyans have reported increased pressure on water resources, especially in contexts in which population growth and development have been rapid. The planting of blue gum trees, known to diminish water resources, and the depletion of riparian land due to increased residential development has further intensified pressure on riparian spaces [6]. In Kenya, often there are no provisions made for reliable access to clean water in urban spaces, and water sources are used by human and non-human animals concurrently as well as for residential and industrial use, creating potential for adverse health and social outcomes for all users [7].

In Kenya, climate change, combined with increased human settlement, creates a context in which more extreme weather events can have a severe effect on human populations

living within riparian zones [8]. This includes a lack of access to clean, safe water, and increase in flash floods, [9,10] and a significant difference between water quality during wet and dry seasons (which are becoming more extreme) can have important implications for river-users, both human and animal [11].

Residents along Nairobi River in the Kenyan capital cited corruption and a lack of law enforcement as the major reasons for riparian encroachment leading to severe degradation of the riparian land and water [12]. In May 2024, the Kenyan government demolished informal dwellings alongside the Nairobi River in Mukuru after flash flooding and ongoing heavy rain caused the deaths of a number of residents [9,13]. Marginalised people occupy marginal spaces, which are often riparian, leading to the overpopulation of riparian land in informal housing [8].

Policy around riparian zoning exists: The Physical Planning Act legal notice 140 rule 15 (c) and (d) of 1998 defines riparian reserves as being any watercourse not less than 10 m in width on each bank except in areas with established flooding, and The Physical Planning Handbook of 2007 defines the riparian zone as the land on both sides of a watercourse from a minimum of 2 m up to a maximum of 30 m [14]. Building is not permitted within these spaces. Despite these policies, buildings were constructed within this demarcation contrary to these laws [14]. The penalties for this remain unclear, perhaps contributing to the increase in building and encroachment in these areas.

In recent years, much has been written of the potential benefits and importance of healthy riparian spaces for urban areas in a context of climate change and climate disaster [15,16], but less is known of the current state of urban riparian spaces. Indeed, human voices are often missing from this literature, with few representations of local realities, although some work has been performed to present a range of stakeholder opinions [14]. Human voices and experiences of climate change are important in understanding the impact that climate change has on daily life. Kenyan scholars have overwhelmingly led the body of literature regarding urban riparian spaces in Nairobi [7,14,17–19], but the translation of this research to policy has been frustratingly slow despite lobbyists and researchers flagging clear policy implications [18]. For some, a healthy riparian environment is unattainable because climate related issues feature low on the governments' list of priorities [7].

In this paper, I describe urban riparian spaces in Ongata Rongai, a satellite town in the Nairobi Metropolitan Area, Kenya, and present the narratives of the people who live and work there. The objective of this study was to shed light on urban riparian spaces and their users, both human and animal, and to understand the role of these spaces in daily life. The physical rivers were the starting point for all research activities, and we allowed the emergent narratives to guide the study thematically. This inductive approach is typical in ethnographically informed research studies [20].

The two rivers in Ongata Rongai, the Mbagathi and Kiserian/Kandisi, are under increasing pressure due to a number of factors including rapid population growth, which I discuss in detail elsewhere [21]. Here, I will present the specific challenges faced by river-users precipitated by what participants believe to be climate change in an environment under multiple urgent pressures, including prolonged drought and flash flooding [22].

In this research, I use a One Health theoretical lens. One Health is the interaction between humans, animals, and the environment, and in the context of this research, One Health helps to understand the roles played by each of these aspects and how they work together as a whole, each having an effect on the other [15]. It is especially useful in understanding this riparian zone, in which humans and animals (wild, domestic, and livestock) are present in and actors within and upon this environment. These interactions are key in understanding urban riparian environmental degradation in the context of climate change.

The paper is highly original; there is no research that we could find into the rapidly changing urban riparian environments in Ongata Rongai: this area has been ignored in favour of the more commonly researched Nairobi River, yet arguably, the Rongai Rivers

are more representative of the diversity of locations and populations both country-wide and across the continent. This research is highly significant as it is of interest to local groups, actors, and government and non-governmental agencies. It reflects recent trends on social media, including Instagram and TikTok [22,23] where local residents document the destruction caused to riparian spaces and beyond by flooding as a result of climate disaster. It is also of interest to national and international groups interested in riparian areas, climate change, urban impact on climate and the environment. It is relevant to lay people, government, and academic audiences because of its originality, and there is an urgent need for in-depth understanding of riparian dwellers and users in the context of ongoing catastrophic flooding in Nairobi and southern Kenya: this will be the first paper of its kind addressing the April and May 2024 flooding in the Nairobi Metropolitan Area.

The uses and users of riparian land are under threat from extreme weather events: 36,344 acres of agricultural land has been damaged during these recent floods, close to 200,000 people have been displaced, with hundreds killed and injured [24]. This research contributes in-depth community- and human-level understandings of the urgent problem of riparian land use and local realities in the context of climate disaster in the global south and has clear implications for urgent urban policy reform.

2. Materials and Methods

2.1. Context

2.1.1. Study Site

Ongata Rongai, or Rongai, is a peri-urban settlement to the south of Nairobi, part of the Nairobi Metropolitan administrative district. It has experienced significant population growth in the last ten years. Ongata Rongai is bounded by the two rivers, which formed the study sites for this research. I have documented elsewhere a more complete picture of these two rivers and the impact which they have on daily life in Ongata Rongai [21]. The two rivers are the Mbagathi or Empakasi—pronunciation depending on tribe—and the Kiserian, which further down becomes the Kandisi and eventually meets the Mbagathi River near the Athi Plains, where the river becomes the Athi River.

As I have said elsewhere [21], Rongai is not special. In fact, I chose this as the study site because it seems a fair representation of urban Kenya generally. Most if not all demographics are represented here, and challenges of daily urban life are applicable here as in other locations. Rongai is a dynamic, fast paced town, home to commuters, business owners, informal housing dwellers, wealthy expats, politicians, farmers and livestock herders.

I was a resident of Rongai for a number of years in a typical working-class neighbourhood, allowing me the opportunity to see and experience the challenges of the rivers firsthand, to hear the stories of friends and neighbours, and to witness the seasonal changes of these urban riparian spaces. This is deeply embedded participant observation, one of the foundations of ethnographic methodology [25].

Historically, Ongata Rongai was Maasai land where nomadic Maasai herders would bring livestock to graze seasonally. It was a narrow plain (Ongata Rongai being a Maa name meaning a narrow plain) bounded by the two rivers. It had few permanent inhabitants and few if any permanent structures.

The population of Ongata Rongai has exploded in the last ten to fifteen years (Figure 1). Historically, Rongai was a sparsely populated savannah grassland with patches of riparian forest and permanent rivers. The Maasai herders built temporary dwellings in the area when grazing livestock. Up until the 1950s and 1960s, aerial photographs (Figures 2–4) showed few permanent structures until the area began to be quarried for stone.

From a 1986 report by the Ministry of Planning and National Development and the Institute of African Studies at the University of Nairobi, which we accessed at the British Institute library in Nairobi, we were able to ascertain that Kajiado County was very sparsely populated in the preceding years. The report stated that in the "1979 population

census, Kajiado District had a total population of 149,005 inhabitants", and the only urban settlements were the towns of Loitokitok, Ngong, and Kajiado. The average population of each was just 2819. These were the only census data we could find prior to the 1999 census.

During the 1990s, the area began to be split into much smaller plots with permanent residential buildings on them. By the 2000s, much of Ongata Rongai was subdivided, and by 2019, the density of population was high: the annual growth rate of Rongai's population from 2009–2019 was 16% (Figure 1).

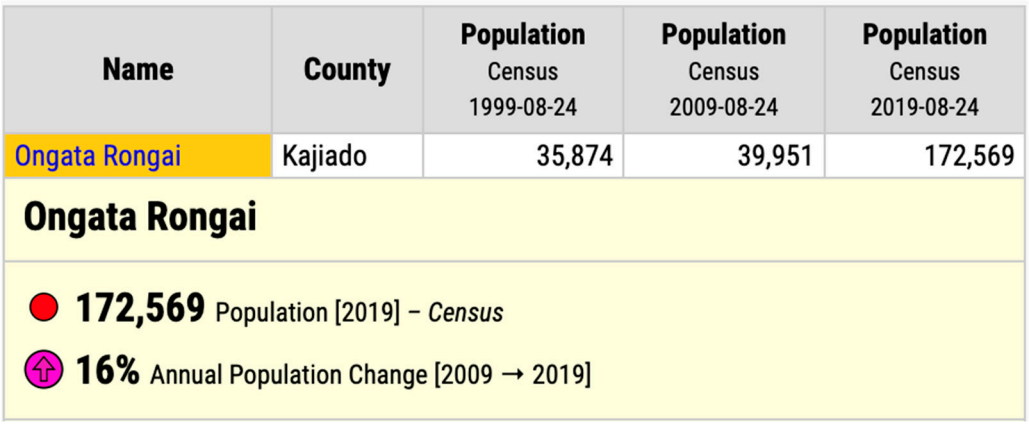

Figure 1. Dramatic growth in the population of Ongata Rongai, 1999–2019. Source: Kenya National Bureau of Statistics.

2.1.2. Access to the Field

In addition to the national level permissions, as with any study in Kenya a visit to the area chief's office is essential prior to fieldwork activities beginning. We sensitized the chief and her assistants on the purpose of the study and the project activities as well as the expected outputs. I have since sent her the first paper from this study as well as the link to my article in The Conversation [26] to ensure that she is kept informed and that she has access to data coming from her administrative area. In order to facilitate the study and to ensure our safety, she provided us with a letter which we carried at all times in case anyone asked us if we had permission to be there. Furthermore, the chief provided us with one of her outreach workers to go around the site with us and to assist in facilitating links to individuals and the wider community.

The study took place between the end of 2021 and the beginning of 2022. As a resident of Ongata Rongai at the time, I had various useful networks which I could draw upon to gain access and to find stakeholders including WhatsApp neighbourhood groups, friends and neighbours. Artist and curator James Muriuki accompanied much of the fieldwork and is a fellow resident of Ongata Rongai. As a native Gikuyu speaker, he was able to conduct interviews in Gikuyu if necessary, at the same time as documenting the research process through photographic medium.

2.1.3. Consent and Participant Information

Oral recorded consent was gained from participants prior to the start of interviews. We did not ask for written consent as many adults struggle with literacy and we did not want to cause anyone embarrassment.

We created and printed postcards with a photograph of the Kandisi Dam on one side and information about the study on the other. The information was written in Kiswahili and English and detailed the research activities, the importance of the study, and how we planned to use the data. This was translated by me as a bilingual Kiswahili and English speaker, with small edits by James Muriuki. Finally, there was a phone number for the project phone in case of any questions, or in case people wanted their data removed from the data set, as well as the email address and a contact for ILRI, Nairobi.

Interviews were transcribed by a professional transcriber and translated into English, and some interviews were conducted in Gikuyu so had to be translated later by our transcriber.

We never wrote down names of participants. We only used locations, approximate age and gender which allowed for anonymity but also meant that we would be able to identify and situate the data set as necessary.

2.1.4. Ethical Approval

We gained ethical approval for our study via the ILRI institutional ethical review committee on 22/3/21 (approval number ILRI-IREC2021-09), and this was later granted a short extension due to the complications of COVID-19, which meant that fieldwork did not taking place for some time. The University of Liverpool also granted ethical approval to the study in May 2021 (ref 9949), and a NACOSTI permit was sought and granted (NACOSTI/P/21/11430).

2.1.5. Data Storage and Protection

Data were stored on a Google Drive which was password-protected and accessible only to me as PI and to our transcriber. Data were further backed up and stored on a 1 TB secure external hard drive to which only I had access. These data files included the original recorded audio files, transcripts, translations and images. Original data are available upon reasonable request.

2.2. Methods

I employed a mixed methods ethnographically informed approach to this study **[**25**]**. I wanted to create an historical context (including archival materials) to better understand the evolution of these riparian spaces over time, changes in climate, as well as shedding light on contemporary uses and practices surrounding the rivers through traditional ethnographic methods of in-depth interviews and observation. We then incorporated more creative methods like walking and photography in order to triangulate other data points, allowing us to see what people do, not only to hear what they do.

2.2.1. Archival Research

Historical ethnography is the practice of regarding "the archive itself…as a locus of research" [27] and by using archival materials in ethnographic work, we can uncover tensions between the present and the past which might otherwise have remained hidden [27]. Initially we hoped to access the Kenyan National Archives to locate maps, images and reports from the colonial era to provide historical context. However, we rapidly discovered that much of the material was either not digitized or not in a format to which we could have access. Instead, we found the NCAP—the National Collection of Aerial Photography in the UK. Through them, I was able to access digitized images from as early as the 1940s which allowed us to see the changes over time in land use and population of Ongata Rongai and the riparian zones. Through the British Institute in East Africa (BIEA) we accessed archival maps of Ongata Rongai which proved useful in Focus Group Discussions (FGDs) in prompting discussion and reflexive thinking. We also found reports from colonial officers dating to the 1950s discussing some of the uses of the riparian zones in Rongai which allowed for triangulation with oral histories and interview data.

In the two images below from 1948, Ongata Rongai does not exist as a town but as an empty space bounded by the two rivers, as I have labeled in Figure 2. In the top-right-hand corner of Figure 3, above the Mbagathi River, is what is now the Nairobi National Park. There are no permanent structures that we can see, and there are patches of forest. The rest of the space appears to be savannah grassland.

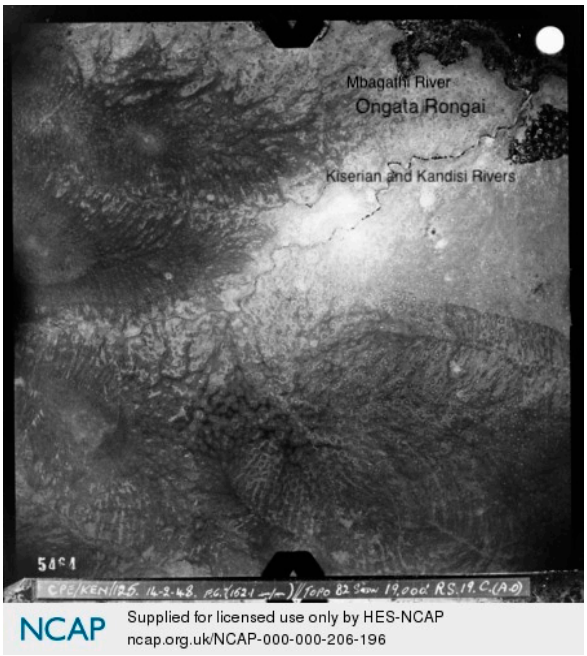

Figure 2. Courtesy of NCAP, Ongata Rongai, in 1948.

Figure 3. Courtesy of NCAP, Ongata Rongai in 1948. Note the convergence of the two rivers. Above is now the Nairobi National Park.

Further images allowed us to see the changes over time in the settlement, population and expansion of Rongai. In Figure 4 it is possible to see the beginnings of the quarries close to where I have labelled Ongata Rongai (small white circular patterns). The paths and tracks across the area are becoming more permanent and more visible, and a dirt road which will later become the gridlocked Magadi Road is also visible under the "Ongata Rongai" label.

Figure 4. Courtesy of NCAP, Ongata Rongai in 1963.

In Figure 5, we can see the quarries marked (Kandis Quarries, now "Kware", a phonetic spelling of quarry) as well as Magadi Road, the rivers, and a small group of shops labelled Langata Rongai—a possible misspelling, or an earlier iteration of Ongata Rongai.

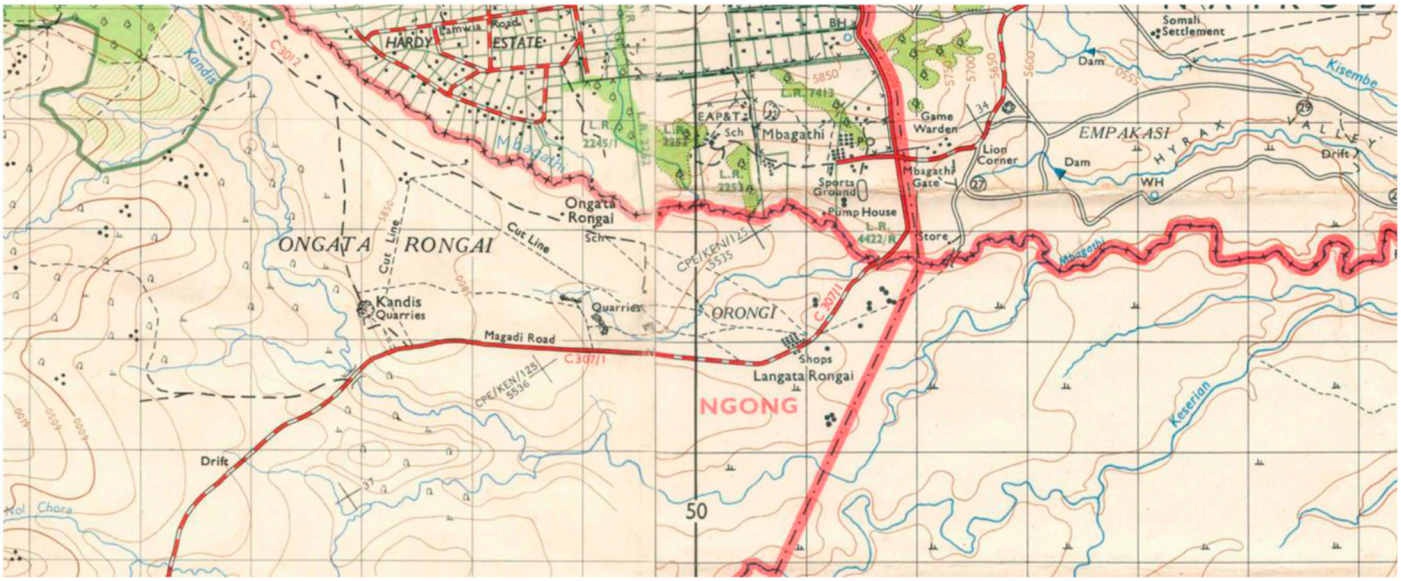

Figure 5. 1964 map of Ongata Rongai published by the Survey of Kenya courtesy of BIEA.

In Figure 6 we see further evidence of population, with greater enclosure of land both within and on the peripheries of Rongai, including to the north of Mbagathi River in what is now the Karen and Hardy areas. In Rongai, the quarries are now becoming more established in what will become the Kware area. Today, Kware is densely populated with a lot of informal housing and *ghorofas*—high-rise housing.

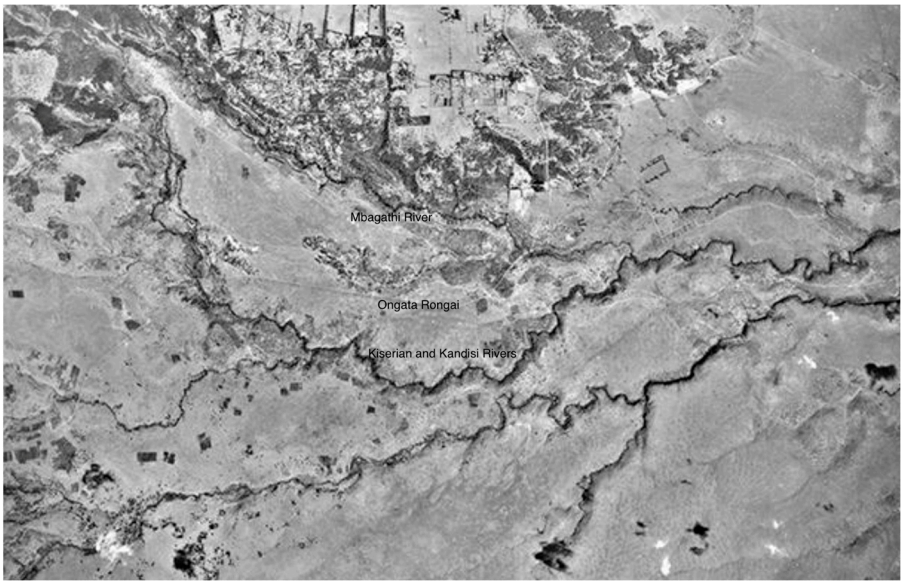

Figure 6. Courtesy of NCAP, Ongata Rongai in 1969.

Despite the poor-quality image, by 1985, it is possible to see permanent structures and an increase in the subdivision of land (Figure 7), and by 2021, the pressure on the environment is clear (Figure 8).

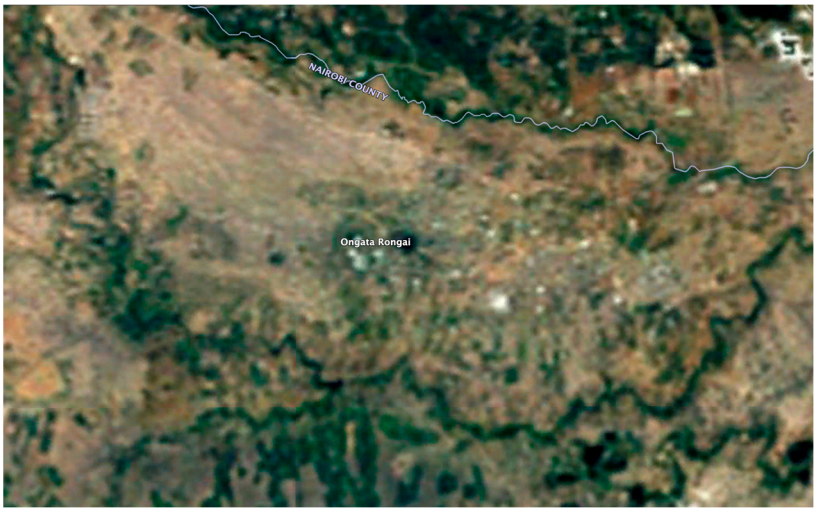

Figure 7. Courtesy of Google Maps, Ongata Rongai in 1985.

Figure 8. Courtesy of Google Earth, Ongata Rongai in 2021.

These images were vital in gaining a longitudinal understanding of the impacts of climate change and anthropogenic impact on the environment in Ongata Rongai. It is within this context that we can now situate stories of environmental change and climate emergency.

2.2.2. Interviews and Sampling

We used in-depth interviews and a combination of purposive, convenience and snowball sampling to gather the majority of narrative data for this study. We chose these sampling methods for a number of reasons, and these sampling methods are common in social science and ethnographically informed research.

Purposive sampling involves the matching of sample and participants to the study aims and objectives. This, it has been argued, can improve the rigour of the study and the quality of data and findings [28]. This was key in our study since many urban dwellers have little knowledge of the rivers, with some middle-class community members being shocked to find from our photographs that the riparian spaces are so green and beautiful. For this study, we needed to capture the stories of individuals with in-depth knowledge of these spaces over time. Therefore, we requested an employee of the chief's office to assist in locating individuals who live or work in riparian spaces, or those who have lived in Ongata Rongai for many years. We did this because the representative has greater longitudinal knowledge as well as in-depth knowledge of the local population and could identify individuals with the required experiences of living or working close to riparian spaces.

Convenience sampling, although lacking in generalizability, allows the researcher to go to a location—or a number of locations—to find participants who fit the study aims and objectives [29]. We needed to be sure that the people we spoke to were river-users, and therefore, we used convenience sampling by situating ourselves on bridges, crossings, and dams and speaking to passers-by. Although by doing this, it could be argued that we sacrifice generalizability, we gain a sample which has specific, specialist knowledge of the rivers, and since in the general population, individuals with such knowledge are likely few, this was the most effective sampling approach for this study.

In snowball sampling, "Researchers…use their social networks to establish initial links, with sampling momentum developing from these, capturing an increasing chain of participants. Sampling usually finishes once either a target sample size or saturation point has been reached." [30] Again, given the relatively few regular river-users or dwellers when compared to the large population of Ongata Rongai, we utilized our own existing networks to identify individuals with specialist knowledge and experiences of the rivers,

and allowed those individuals to then identify others, until we reached thematic saturation.

Thematic saturation refers to the point at which no new themes, codes, ideas or data are being collected, meaning that there are sufficient data to illustrate a theory and that no "new" information is being generated. Saturation is commonly thought of as key to academic rigour in qualitative research and is an accepted means of ensuring rigour in ethnographically informed research [31,32].

In total, we spoke to 30 individuals as interviewees who were located either in situ as we walked the rivers, or who were identified by our assistant from the chief's office or through our personal networks as people with longitudinal understandings of the rivers, as is the well-documented standard for snowball, convenience, and purposive sampling [28–30,33]. Interview questions were explorative in nature, using the physical rivers as the starting point and allowing participants' themes to guide discussions. We interviewed 30 people because this was the point at which thematic saturation was achieved.

Interviews took place in various locations depending on interviewees preferences. Sometimes this was on the riverbank, other times in a room at the chiefs' compound, or at their own homes. Other times, we travelled to meet people who had been longtime residents of Ongata Rongai but who had now moved away. We felt that these people had important, often reflexive insights to add to our narrative data.

In this way, we collected relevant narrative data, but this can only be seen as a partial understanding due to the sampling methods: although thematic saturation was reached by 30 interviews, we cannot claim to have conducted sufficient numbers of interviews to shed light on every experience of river-users and dwellers in Ongata Rongai. Our narratives did, however, come from a broad range of demographics, and we did our best to include all backgrounds, genders, ages, and ethnicities in our sample.

All interviews were in English, Kiswahili or Gikuyu depending on the interviewee's preference, and were audio recorded, and occasionally I took notes at the same time. The recordings were later transcribed and translated by a professional transcriber who speaks Gikuyu, Kiswahili and English. These transcriptions were then analysed using a thematic analysis: I read transcripts and notes multiple times to identify themes and subthemes and I created the analysis using word and an Excel table. This allowed for identification of recurring themes and ideas from the narratives.

2.2.3. Focus Group Discussions

We undertook two FGDs—one with women and one with men—and had approximately eight people attending in each group. People came and went as is typical in other FGDs I have conducted in East Africa. The women's FGD took place on a riverbank farm under a tree, and the men's FGD took place in a vacant room at the chief's compound. This allowed for a more general understanding of environmental issues and longitudinal change, as well as reflexive discussion around the old photographs and maps.

Participants were identified by the chief and her assistants as people who either live or work in the vicinity of the rivers or people who had lived for a long time on or near to the rivers. The FGDs were undertaken about halfway through interviews so that we had some understanding and context for issues around the rivers but were still able to gain new ideas and information. FGDs were important for triangulation of other data points.

2.2.4. Walking, Observing, and Photography

Walking is an integral part of ethnography but is rarely identified as a method in and of itself. Purposeful walking has gained traction in recent years as a research method [34–37] and allowed for triangulation of narrative data to understand if what people say is happening can be seen to be happening. Walking, especially in liminal [1] spaces, is an important way to understand the uses of that space and any important contextual factors which might be missed in narrative interviews. I believe that walking with purpose as a research methodology is a different type of engagement with the landscape, allowing for

firsthand understandings of how humans and animals traverse riparian spaces, how they interact, and how spaces are treated—sometimes with reverence, sometimes with revulsion, and other times with disregard.

Walking was one way in which we collected observational data, and we often walked as we talked to people, who would then point out particular issues to illustrate their narratives. We also used walking as an opportunity to take photographs and to illustrate our findings, as well as triangulation of narrative data.

3. Results

Having conducted a thematic analysis of our data, a number of key themes or ideas emerged. These are discussed more broadly elsewhere [21], but here, I will specifically discuss findings around the theme of climate change. Climate change was one of the most often cited reasons for the changes seen and experienced by those who live near to or use the riparian spaces.

The results section is presented as follows:

Section 3.1 gives the reader much-needed historical context in narrative form, describing participants' experiences and recollections of the environment and climate in the past.

Section 3.2 gives an overview, through narratives, of the rivers and riparian landscapes today.

Section 3.3, Climate related themes, is divided into Sections 3.3.1 through 3.3.5 and these address the most commonly discussed themes from participants as relating to climate and the environment. These subthemes are as follows:

3.3.1 Climate change and unpredictability

3.3.2 Water scarcity and pressure on water resources

3.3.3 Change of land use and soil health

3.3.4 Uses of water

3.3.5 Climate futures and the riparian zone

In this way, the findings lead the reader from the past, through to the present, and into the possible future of the Ongata Rongai riparian land and environment with photographs of the areas in order to triangulate the narrative data with visual cues, illustrating many of the challenges faced by river-users and dwellers.

3.1. Historical Context, Environment, and Climate

Our interviewees had varied and rich recollections of Ongata Rongai in the past. They recalled that the area was mostly open plains with patches of forest:

> [in those days] we would come here [where we now sit] to graze our cattle. There were none of these quarries, those deep holes…in those days you'd see bomas but quite spread out…and this area was called *Ngaivoronya*, meaning the place of trees because it had many *Oleimurunyei* trees. And in this area, many wilderbeest would come to give birth [wilderbeest are grassland animals] and when that happened usually we would move the cattle to the other side. Because the place where a wilderbeest gives birth, if a cow eats that grass it will die…all the way up to Kerarapon, there was just one tree up that side and we used to fight over it's shade with the wild animals…it was an *oltepesi* tree…here was just an open area, with many zebra, and no people, just animals, all the way to Kileleshwa. There was nothing, nothing, just cattle and wild animals.
>
> (Older man, Ongata Rongai resident, 2022)

Land use was mostly as grazing, and this was predominantly by Maasai herders with their livestock. However, there was some agriculture as well:

> This area was really agricultural land but people didn't like it much because it was like a desert.

(Older man, Ongata Rongai resident, 2022)

One major problem for people settling in Ongata Rongai, which continues to be a problem today, is that of wildlife. Many interviewees and longtime residents reported animal attacks in the past:

> …we used to commute up and down. And like yeah, this was really wild, when we even moved, we had a lot of attacks by animals. Two of my dogs were taken by leopards outside.
>
> (Younger male business owner, Ongata Rongai, 2022)

> Even today there is a significant problem of human-animal conflict in Rongai. In February 2024, two students were attacked by a hyena at 6pm, and a child was killed near a dam: "[local resident's] eldest son who had been collecting firewood. He was dragged towards Saitoti's bridge but clothing and some body parts were found along the way…" [2]

People began to move to Ongata Rongai and to settle there in greater numbers when the quarries began. From narratives, and from aerial photographs, we suspect that this was sometime around the 1950s. Even in those days, people would fish in the rivers and the water was very clear:

> The water was crystal clear…there were fish everywhere and many kinds of fish.
>
> (Older male and female siblings, Ongata Rongai residents, 2022)

Ongata Rongai's riparian environment looks very different today, and in the next section, I will detail broadly what interviewees reported were the main problems of the rivers and riparian land before discussing in detail the role which interviewees believe climate change has played in this transition.

3.2. Ongata Rongai's Rivers Today

Today, the river water is visibly filthy. Traditional uses of the rivers, such as watering livestock, irrigating crops, collecting water, washing clothes, and people washing themselves do not look like they used to. The water often smells of sewage, which makes the riparian environment unusable for humans and animals:

> These days, the livestock get sick from drinking the water. Because the water is very little [in the river] and the sewage is a lot. So that has brought many changes. Because before we would bring our cattle here to drink, and even us we would drink it…but now it is mostly sewage, this water.
>
> (Older man, Ongata Rongai resident, 2022)

Some areas of the river where people traditionally fished are now potentially disastrous for health:

> …there is a Luo guy near here and he wanted to fish [the Luo are traditionally fishers]. So he goes down to the river and…before he did anything he sees soap, excrement, the sewage that people dump in it at night…even the fish could never survive there.
>
> (Older men, Ongata Rongai residents, 2022)

Farmers complained that they can no longer use the river water to irrigate their crops:

> -Does the river have any meaning or use for you today?
>
> -No, because when you come to the farm you have to carry your own water from home. And if you try and pour it on your vegetables in the farm, they shrivel up. You water them today and you find tomorrow they have all dried up. It is because of that sewage.
>
> (Female farmers, Ongata Rongai residents, 2022)

The rivers and riparian land had uses beyond the practical: this land was sacred to the Maasai, but the old beliefs which protected the riparian land and forest have been supplanted by Christianity:

> Long ago, when the riparian forest was here, let's say there had been no rain. The elders would come and slaughter a goat, pray to our god there, for him to bring rain. And you know we have the river here and big trees, people would not go there, they were afraid and would never cut a tree because that is where the elders pray…but something came and changed that…Christianity…so we no longer care about the environment.
>
> (Older men, Ongata Rongai residents, 2022)

Interviewees were aware of the potential health implications around eating crops which have been watered with dirty water:

> So for example, these vegetables, we would collect water in a bucket [from the river] and water the vegetables. But they refuse to grow!...If you water the vegetables with this filth, it goes direct into the leaves, you see? Even you, then, will be eating that filth…and it is ruining people and it is ruining animals.
>
> (Female farmers, Ongata Rongai residents, 2022)

> …then we hear people are farming, irrigating, with sewage, and we hear that that food can harm people, in their bodies. So with time you start to think that maybe farming isn't really reliable [income].
>
> (Older man, Ongata Rongai, 2022)

They also explained how "exhauster" trucks—sewage removal trucks—openly discharge untreated sewage into the rivers, and this has meant that people can no longer use the river water as they once did:

> Those guys are pouring the sewage directly into the river. Let them not pour it into the rivers. Let it not even reach the rivers! Because it's not even just us people who use the river, who are affected. Even animals use the river. And we asked them, "you guys pouring the sewage, why are you pouring it even in the places where we collect water for drinking?" And that water is even being pumped to residents in Kware. But they say that sewage doesn't reach that place, yet we see it.
>
> (Female farmers, Ongata Rongai residents, 2022)

The dirtiness of the river has totally changed the community's relationship with it. Much of the current state of the river and riparian environment has been caused by human action—as demonstrated by these narratives, the major issues are trash and sewage being dumped into the river as observed in Figure 9 below.

Figure 9. A drainage ditch for wastewater, sewage, and trash runs into the Kandisi River. Image: author's own.

There is, however, a third important aspect to the dramatic environmental degradation of the Rongai rivers: climate change. In the next section, I will present narrative data which describe what residents and river-users perceive to be issues either caused by or exacerbated by the climate crisis.

3.3. Climate Related Themes

3.3.1. Climate Change and Unpredictability

A common complaint from respondents was that climate and weather conditions are less predictable than they once were. This included timing and amount of rain and prolonged drought conditions:

> It rained the other day, just a little, but not like it should do at this time of year. Let's say it rained two weeks back, there is very little water remaining. So now there's nowhere to put out our nets, it's no longer deep here. Not like it should be for this time [of year].
>
> (Fishermen, Mbagathi River, January 2022)

Farmers rely on predictable seasons in order to plant at the correct time and to harvest their crops. For the small scale and subsistence farmers who make up the majority of farmers in the riparian zone of Ongata Rongai (see Figure 10), this is potentially disastrous.The unpredictability of the rain has an enormous impact on river and riparian land users including the fishermen (Figure 11).

> And in those times there was no irrigation of crops using the river water. No, no. No. Never. There was no pumping water to irrigate farms. Because like I said the rains were sufficient and reliable. There were no pumps.
>
> (Older men, Ongata Rongai residents, 2022)

Figure 10. Terraced riparian farmland ready for planting. Image: author's own.

Figure 11. Fisherman preparing his nets, Mbagathi River. Image: author's own.

> The rains are also less heavy than in previous years, as several farmers told us:
>
> …the rain, there is no rain, or it is very little rain not like it used to be. It never used to be like this, [the river] never used to dry up like this, so I can say there are many significant changes in the time I have lived here.

(Fishermen, Mbagathi River, 2022)

However, flash floods had occurred several times over the past few years, one killing seven people (11 missing) at Fatima Bridge (see Figure 12 where this is completely submerged, and Figure 13, the bridge on a more typical day) over the Kandisi River in 2018 [38], and a student was killed in Olekasasi at a river crossing in 2019 [39]. Flash floods caused school closures and general disruption and destruction in 2018 [40]. Other have died in previous years [41]. At the time of writing, May 2024, the rivers have once again flooded, causing ongoing destruction of farmland and property and loss of human and animal life. Flash floods also affected local businesses:

> But the first two times we were hit so badly it just ripped off the whole wall, 'coz the water, it is a seasonal river and the only time we get water is when it rains or when it rains in Ngong and they open the dam or something and we just get flash floods, and that lasts like for half an hour.
>
> (Male business owner, Ongata Rongai, 2022)

The lack of rain compared to the past, coupled with unpredictability of seasons and flash flooding, was a thread running through the majority of narratives, especially those for whom the riparian landscape provides their food.

Figure 12. Screenshot from a local resident's video shared on a community WhatsApp group,accessed on 7th May 2024. This should show Fatima Bridge, a Kandisi River crossing for cars and pedestrians. Instead, it is below the waterline.

Figure 13. Fatima Bridge over the Kandisi River on a dry day. Image: author's own.

3.3.2. Water Scarcity and Pressure on Water Resources

Another common theme in the narrative data was the scarcity of clean water, the problems of accessing it, and increased pressure on existing water resources. One major problem is individual ownership of riparian land. This has led to fencing and blocking public access to the river as well as uncontrolled extraction of water using pumps for irrigation of marginal land:

> There was a time that the river was so dry. The river was finished, the water level was so low. Then people were banned from using pumps for watering the farms. Because you know they are pumping water from the river? So there was a time it was stopped. But now those people using pumps have started up again. Because there's more water currently. People are really, really pumping a lot of water [to irrigate farms].
>
> (Older women farmers, Ongata Rongai, 2022)

It was recognised that the increase in human population and anthropogenic factors has led to greater pressure on the river and water resources, and the river has become seasonal:

> The Kiserian River, that one has always been seasonal but this one [the Mbagathi River] never used to finish. Ever. In the dry season it would reduce but never finish. Now it gets finished because many people have come in.
>
> (Older man, Ongata Rongai resident, 2022)

There is an understanding that climate change and water scarcity are anthropogenic, especially due to water abstraction for farming marginal land (Figure 14), where in the past, this land was not farmed:

> They farm with [the river water] and they will use a generator [for water abstraction] which is why it is getting finished.
>
> (Older man, Ongata Rongai resident, 2022)

Figure 14. A typical riparian farm. Image: author's own.

There was some debate over when the water scarcity began, and the cause, but several told us that between the 1980s and 1990s was when they began seeing or experiencing environmental changes—in particular, water scarcity and a lack of soil fertility:

> But from the 1980s, I would say, I have seen changes to the environment. In those days, the environment was good, the farms were good. If you go to the farm, you do not leave with nothing…compared to nowadays, where you just leave emptyhanded.
>
> (Older women farmers, Ongata Rongai, 2022)

In past decades, people explained that there was much stricter control of water abstraction from the river in order to prevent water scarcity, which they said was much

better than the uncontrolled access today (see Figure 15 for typical irrigation practices with river water):

> Even my father used to apply for that permit…we used to use our hands to water the crops but then he bought a pump and he was told, this permit is a requirement and there was an extension worker to explain what you are supposed to do. And the government wanted to control water because if people used it too much then people and even animals would lack water.
>
> (Older man, Ongata Rongai resident, 2022)

Today, there is confusion over the legality of water abstraction:

> As far as I know, if you live along the river, you are allowed to take water out of it, unless there is a subsequent agreement, most parts of Kenya they have water users associations, where it is metered, it is strict, but it doesn't really work because it is Kenya.
>
> (Older man, Ongata Rongai resident, 2022)

Figure 15. Typical pump irrigation on a smallholder farm, Mbagathi River. Image: author's own.

The river has many users, and given the pressure on water resources, this has led to the water being unsafe. Livestock, wildlife, and humans all use the river (Figure 16), and

this is especially true when there is no rain. This in turn means even less water, and what little water there is is unsafe for consumption, even by animals:

> It's not only humans who need clean water for health, it is animals too, don't you see? Water is life.
>
> (Older women farmers, Ongata Rongai, 2022)

Figure 16. Non-human river-users. Image: Authors own.

3.3.3. Change of Land Use and Soil Health

As I have documented, there have been changes in land use in Ongata Rongai over the past 50 years or so from savannah grassland and pastoralism to dense urban residential use and small-scale subsistence agriculture (generally speaking—there are a few exceptions in large commercial flower farms), and these changes in land use have led to environmental changes in the riparian zone:

> The river is shrinking, we say, because we were told there is somewhere up river where they are growing flowers and they use a lot of water to do that…but they demolished the dam and then the water started to trickle in the river again.
>
> (Older man, Ongata Rongai resident, 2022).

The population explosion has led not only to the pressure on water resources and water scarcity, which our interviewees repeatedly discussed, but also to pressure on marginal riparian land. This land is now used both for residential and agricultural purposes, but it is prone to flash flooding, erosion and silting, as well as being affected by the river water:

> There used to be rules for what you could plant by the river. Like for example you had to leave a certain distance from the water and then plant things like napier grass first. Because when it rained, when the river flooded, that would stop all your crops being carried away.
>
> (Older man, Ongata Rongai resident, 2022)

Your farm gets taken away…carried by the river…

(Older man, Ongata Rongai resident, 2022)

We spoke to farmers who complained that the soil is no longer fertile:

We have used the land up, its' strength is finished

(Female farmer, Ongata Rongai resident, 2022)

Many people spoke of the residential developments and construction on riparian land:

Ongata Rongai has expanded dramatically and there's so many more people that have bought land, you know, along that river…its all sold [laughter] Its gone. And mainly to sort of, wealthy white folk, unfortunately and I think there's sort of stark difference between Ongata Rongai and these fancy houses along the river, with these sort of bucolic, romantic spaces…

(Female, middle aged former resident of Ongata Rongai, 2022)

3.3.4. Uses of Water

Due to the significant degradation in water quality and quantity, as discussed by Rongai residents, the way in which people use the water has had to change:

These days, you cannot really use that water. It's basically just toilet water, sewage. It's not really water anymore…we are buying borehole water.

(Older woman, Ongata Rongai, 2022)

Some said that they would not even use the river water to do their laundry:

Interviewer: These days can you use the river water in the way you used to?

Interviewee: No, we are afraid. Because all of it is filthy. Even to wash your clothes you cannot. We have to use the piped water instead.

(Older man, Ongata Rongai resident, 2022)

For some, they must still use the rivers as they used to (including washing clothes in Figure 17), despite the risks:

Fishing is in our blood. We are Luos. So it doesn't matter where we live, where we move to, we must find water and fish. We cannot go for as much as a week without eating fish.

(Fishermen, Mbagathi River, 2022 – see Figure 18)

Figure 17. For some, using the river water to do laundry was their only option. Image: author's own.

Figure 18. Luo fisherman displays his catch, Mbagathi River. Image: author's own.

3.3.5. Climate Futures and the Riparian Zone

Participants had mixed feelings about the future of the rivers. Some were hopeful in spite of the context of climate change:

> There are young people who really love hanging out by the river, they say oh we love the environment, it is peaceful, there's the water, and whatnot. So there must be some hope there for the future.
>
> (Older man, Ongata Rongai, 2022)

> You know, there's a way I have thought of to fix this problem with the environment. You know churches, these days churches are everywhere…and church is the thing that people run to [it is popular]. So perhaps church can help to bring some kind of improvement to the riparian environment…but us alone, we cannot.
>
> (Older man, Ongata Rongai resident, 2022)

But others had a more dystopian view.

> What will this place be like in 20 years? It will be a desert. A desert.
>
> (Older female farmer, Ongata Rongai resident, 2022)

Some used their personal ontologies to explain this:

> These days the river is cursed. The river is ruined because people have cursed it. I was brought up on this river, not water from taps. But now it is cursed.
>
> (Older female farmer, Ongata Rongai resident, 2022)

Other interviewees had a more fatalistic approach to riparian spaces and climate change:

> Just by being people, I am afraid we compromise the Earth. Why? Because there are 6 billion of us. And it is -- there's just too many, we are all drinking water, producing waste water, sewage, consuming, messing up the thing. It is just inevitable. And the richer you are, the worse you are….[we need to] go back to nature.
>
> (Older man, Ongata Rongai resident, 2022)

4. Discussion

Our research demonstrates that the Ongata Rongai riparian land and rivers have undergone significant changes in the last 50 years, much of this due to anthropogenic factors. The area has transformed from a savannah grassland with riparian forests and pockets of human settlement to one of the most densely populated urban spaces in Kenya. This has led to severe environmental degradation [21]. However, this environmental degradation—coupled with unreliable rainy seasons and flash flooding, which proved fatal in Nairobi in April and May of 2024—and perceived overall reduced rainfall have created a climate disaster. The rivers and riparian land are under severe pressure and are becoming unusable, inaccessible, and dangerous for humans and animals due to severe pollution, water abstraction, flash flooding, and land enclosure.

Interviewees understood that much of this climate disaster is caused by human action. The lack of legislation or enforcement around water use and management has led to scarcity and increased pressure on the remaining water resources. This was found in research around other rivers in Nairobi [7]. This lack of structural-level environmental management is detrimental to both human and animal health and wellbeing and has led to fights and disagreements over access to water supplies. Indeed, in many cases, clean water has to be purchased now for humans, crops and animals, as the rivers are no longer safe to use. This is similar to findings from elsewhere globally, where it is widely acknowledged that urban green and riparian spaces are highly beneficial for a number of reasons: green spaces increase the price of urban real estate; they have mental and physical health benefits; they bring social benefits through social interactions; and they have numerous environmental benefits, including increasing biodiversity, noise reduction, air cleanliness, shade, and moisture [42].

The fatal and catastrophic flash flooding in Ongata Rongai and the wider Nairobi Metropolitan area in April and May 2024 [43] shows just how urgent the need is for structural-level controls and enforcement around riparian zoning. The need is urgent not just because of the destruction of property, homes, farms and other buildings located in riparian zones but also because of the loss of human life due to flash flood drownings and cholera outbreaks, other waterborne diseases, and malaria [43,44]. The flooding highlights the need for a combined One Health approach, understanding how humans, animals and the environment interact, leading to outbreaks of disease during such incidents, with involvement of stakeholders from local and national government, NGOs, healthcare providers, NEMA [3] and community leaders.

Understanding how humans and animals use riparian spaces in Nairobi is vital in planning for extreme environmental catastrophes, and indeed President Ruto has spoken in recent days of reinforcing the legislation against any building or dwelling within 40 m

of riparian land [13]. There has, however, not been any discussion of where or how people, often marginalized groups, living within this space will be rehoused, leading to criticism from political opponents and residents alike [8,9].

Throughout the narrative interviews and FGDs, there was a continuous understanding that the land and water, river and soil, were inextricably linked: if the water was poisoned, the land was poisoned. Furthermore, people clearly understood the link between land and climate interactions. Unreliable rain meant depletion of water supplies, which led to pressure on water sources and a lack of available water for irrigation of farmland. Flooding had a similar impact due to the pollution of safe water supplies and the destruction of land and crops. This in turn has a significant and detrimental effect on food security for the small-scale urban farmers who depend on marginal land for subsistence and sometimes a small income. Farmers require better access to water and more accurate climate and weather prediction in order to mitigate crop losses or low yields through adaptive management. These predictions can have a greater, positive impact on farmers resilience when combined with farmer's own indigenous knowledge and experience [45].

Environmental extremes, such as drought and floods, both have negative impacts on food security; grazing land; and human and animal health, safety, and wellbeing, a finding supported by earlier research on urban green spaces [42]. This continuous link between humans, animals, and the environment demonstrates that a One Health lens is essential here: human health is linked to the health of animals and the environment, and each of the three elements closely impact the others. If the health of the environment is compromised, then so is the health of humans and livestock. As of 3/5/24, it was thought that 8565 livestock had been drowned or lost in flash floods across Kenya [24]. Indeed, the meanings and uses of shared spaces change when impacted by climate change, and this negatively impacts health outcomes for the users of these spaces [46].

There is anecdotal evidence to suggest that watering crops with the river water might cause serious GI sickness as well as the withering of crops. Contaminated water not only affects human health but animal health as well [47], which was discussed by our interviewees, and this is supported by recent reports of waterborne disease risk following flash flooding in the Nairobi region [44]. Riparian health is a quintessentially One Health issue; these multispecies interactions between human, animal, and environmental health are inextricably linked.

As discussed in the methods section, this study cannot be used to generalize or to make statements about urban riparian spaces more generally due to the sample technique and size. However, like all ethnographically informed research, it takes an in-depth snapshot of a particular place and a particular time through an admittedly narrow lens. Further studies in this area should address land use and flooding in the context of Ruto's ongoing and apparently inequitable demolitions of riparian structures [48]. However, as mentioned, Rongai is fairly representative of other urban areas nationally and across the continent, so some issues may be generalizable.

Weak policy and institutional frameworks have been flagged by Kenyan scholars as contributing to the ongoing degradation of the riparian environment in Nairobi for many years [17]. Urban policy and planning need to be robust, especially so in terms of implementation—Muketha found that other rivers in the Nairobi River Basin experience similar issues to a lesser or greater degree, depending on the location, as the Kiserian, Kandisi, and Mbagathi which I present here [7]. He describes how the rivers in his study, perhaps more central to Nairobi whereas those in Rongai are more peripheral, experience significant contestations of land use. He argues that other, more peripheral rivers have less significant contestations. However, this study has demonstrated that these rivers, which are rapidly becoming central and not peripheral due to the massive population increase, also are characterized by various uses, including industrial, agricultural, residential, and quarries amongst many other vital uses for the local population.

Muketha determined that riparian zones are not sufficiently delineated to provide protection of the land and ecological character of these areas [7], yet in another study, he

describes how riparian zoning is properly demarcated in high-income areas [14]. Indeed, any legislation or urban planning policy does not at present seem to be capable of protecting either the riparian environment or its dwellers, with a huge number of residential structures present within just 10 m of the river [7]. Indeed, his written and photographic evidence is consistent with mine: riparian land use, as it currently stands in Nairobi, is causing significant risk to both humans and the environment. This study therefore feeds into the growing body of evidence relevant to policy makers and urban planners which tells us that urban policy must address these growing riparian challenges.

More research is required by microbiologists and environmental science to better understand issues such as heavy metal, viruses, parasites, and antimicrobial-resistant bacteria presence [49] in fish, water, and soil in urban riparian spaces. This will help to triangulate narrative data by providing an understanding of pathologies associated with riparian soil and water use. There are no data at a microbiological level on the rivers in Ongata Rongai—Mbagathi, Kandisi, and Kiserian Rivers—which limits academic and public understanding of the risks of using river water and riparian land and which would provide further understandings of One Health in riparian zones. Additionally, the human, animal and environmental impacts of the recent catastrophic flooding in Ongata Rongai need to be understood at the individual and community levels. With the increasingly dramatic impacts of anthropogenic climate change, it is likely that such flooding events will become more common, and so with a community-level understanding must come structural-level change to protect people, animals and the environment from further destruction, morbidity and mortality.

Going forward, studies like ours require priority funding to translate findings into community-friendly formats to engage local audiences. In other studies, we have successfully used art, animation, and comics to engage working-class, youth, and lower income audiences. Sharing academic work across journalistic and media forums is also important in gathering momentum for change.

Globally, studies of urban green spaces are becoming more common, yet studies such as ours located in the global south are still under-represented, and there is a special need for multi- or-trans-disciplinary qualitative-led studies of these marginal spaces shedding light on indigenous voices [42]. A multi-site approach is important too in order to gather information on upstream and downstream effects of climate change for urban riparian landscapes. A study focused specifically on farmers' experiences of climate change and flooding, and their methods of adaption would allow for national and global stakeholders to co-create workable adaption strategies and plan for climate catastrophes alongside local stakeholders [45]. These data are essential in creating a thorough understanding of riparian health and risk within a context of climate crisis, water scarcity, a rapidly growing urban population, and extreme weather events.

The enforcement and clarification of existing urban policy around riparian spaces must be a priority for devolved governments across Kenya. This has been called for by Kenyan scholars [12,17,18] but has yet to be implemented. Residents of informal settlements, many of which are located in riparian zones, make up 60% of all urban dwellers in Africa—policy change is urgent [50]. The enforcement of anti-encroachment laws must be carried out with immediate effect to prevent further loss of life and loss of property when flooding occurs. Local chiefs could be crucial in this undertaking given their in-depth situated knowledge of both individuals and property development in their wards.

Finally, a community participatory approach should be employed when undertaking riparian reclamation and conservation activities to ensure that not only low-income families are displaced, as it is unfair and unethical to only demolish informal housing yet preserve mansions, and that there is provision for their relocation. A community approach should include significant education and sensitization especially in low-income communities where delineation of the riparian zone is not present, as this is a challenging issue, and preventing any further encroachment is vital while communities and devolved government deal with existing encroachment.

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Notes

[1] Liminal: a place inbetween, neither one thing or another, a border-land.
[2] Quote from the local residents association WhatsApp group, of which we are members.
[3] National Environment Management Authority

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