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One health perspective on Barriers to interventions for climate change related water associated diseases in Ethiopia and South Africa

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Abstract

Background: Climate change is exacerbating water- and vector-borne diseases, particularly in low-resource settings such as Ethiopia and South Africa, where infrastructural and health system constraints intensify vulnerability. Addressing these complex problems requires a One-Health approach that integrates human, animal, and environmental interfaces. However, limited evidence exists on how the stakeholders such as communities, local leaders, and decision-makers understand and operationalize such approaches. This study explored the one health perspective of local stakeholders on climate change and water-associated disease intervention barriers in Ethiopia and South Africa.

Methods. The study employed a cross-sectional stud design with qualitative method of data collection in Ethiopia and South Africa from January 2025 to March 2025. Data were collected through focus group discussions among community members, official key informant interviews, and participatory workshops with professionals from the health, environmental, and animal sectors. Thematic analysis, guided by the Drivers, Pressures, State, Impact, Response framework, was employed to examine climate-related risks and response gaps.

Result: Diarrhea, Cholera, Malaria, Chikungunya, and Dengue are the major health concerns mentioned by participants in Ethiopia, while Diarrhea and skin irritation dominate water-related health risks in South African cities. Climate variability, rapid urbanization and population growth drive informal settlements and infrastructure gaps, leading to poor waste management and unregulated human-animal contact that increase disease risk. In Ethiopia, limited understanding of climate-environment-animal-human linkages weakens response, which remain largely reactive and fragmented, underscoring the urgency of integrated one health approaches. In contrast, residents in South African informal settlements already recognize these interconnections, suggesting greater readiness for one health strategies.

Conclusion: The finding highlights despite the location variations, climate-related diseases are common, highlighting the need to strengthen community-centered and multi-sectoral One Health implementation, improve risk communication on transmission pathways, and enhance cross-sector collaboration.

Introduction

Water-associated diseases, particularly diarrhea and vector-borne diseases, like malaria and dengue, have rapidly increased globally; driven by changing climate conditions, particularly altered rainfall, rising temperatures, and frequent flooding [1, 2]. Africa and Asia, are disproportionately impacted due to limited finance capacity, inadequate infrastructure, and constrained health systems [3–5].

The complex interactions within the transmission pathways of these diseases require comprehensive detection and prevention strategies that explicitly take account of the human-animal-environmental interface [6, 7]. The one-health approach is widely viewed as an effective framework for addressing these interconnected challenges at this critical interface [8]. The approach focuses on enhancing human well-being, addressing ecosystem threats, ensuring access to essential services, and supporting

sustainable development by integrating multiple sectors, disciplines, and communities [9]. In practice, a One Health approach enables multi-sectoral, multilevel, and multi-group interventions for disease prevention and preparedness, thereby supporting decision-makers and key stakeholders to deal with emerging issues across human, animal and environmental health systems [10].

Building on this One Health framing, the current study explores stakeholders' insight including citizen perspectives, insights from local leaders and decision makers on water-associated diseases in Ethiopia and South Africa. Ethiopia has adopted a one-health approach as a fundamental strategy for disease detection and response [11]; yet the implementation is hindered by weak political commitment, insufficient community participation, limited technical expertise, institutional siloes, and insufficient involvement of professions, including environmental health professionals [3–5, 12, 13]. South Africa has likewise efforts to embrace a one health approach through collaborative approaches among the National Department of Health, National Institute of Communicable Diseases, National Health Laboratory Service and the other partners such as the University of Pretoria and the South African chapter of the World Health Organization [14].

Understanding the view of community along with insights from local leader and decision makers, regarding the water-associated disease burdens, and transmission dynamics is crucial for framing appropriate, context specific policy and intervention strategies within a one-health framework [15]. In Ethiopia, where the disease burdens are increasing, there is a pressing need to explore community-level perceptions and practices, along with the existing implementation landscape. In South Africa, residents, mostly living in informal/unplanned settlements face daily exposures to standing water, climate driven flooding, solid waste accumulation, increasing vulnerability to diarrhea, malaria and cholera [16–19].

Despite the recognition of these risks, evidence remains limited on how local stakeholders particularly community members and decision-makers understand the climate-disease linkages across the human-animal-environment interface, and on the barriers to effective one health actions. This study therefore applies the Driver-Pressure-State-Impact-Response (DPSIR) framework to map drivers, pressures, environmental and health states, impacts and existing responses, identifying critical gaps for integrated intervention in both settings.

Methods

Study Settings

The current study was conducted in Dire Dawa city (eastern Ethiopia) and City of Cape Town and KwaZulu-Natal, South Africa (Fig. 1).

Ethiopia

The study was conducted in Dire Dawa city administration, located in the eastern part of Ethiopia, 515 km from Addis Ababa. The city has a semi-arid climate with average annual temperature of around 24°C

(75°F); rainfall 500-600mm, mainly June-September, and long dry season (October-May) with high temperature. The 2017 project population was 466,000, with urban population of 293,000. The city is prone vector-borne and water-associated diseases, including Dengue Fever with 76% IgG seroprevalence, Chikungunya (44%), diarrhea, typhoid and cholera. Moreover; WHO have flagged Dire Dawa as vulnerable to cholera outbreaks when water sources are contaminated due to flooding [20].

South Africa: The South African study cities were in Cape Town (Western Cape; metro population of 5 million) with some participants from KwaZulu-Natal (KZN). Cape Town has a Mediterranean climate (warm dry summers, wet winters; 500 mm annual rainfall) and generally high formal access to water and sanitation, although informal settlements experience uneven supply. KZN, particularly eThekwini metro (4.2 million people), has a subtropical climate with higher rainfall (1000 mm, mainly in summer) [21]. Both areas face climate-related water vulnerability: Cape Town experienced the 2017–2018 “Day Zero” drought risk, while KZN suffered severe flooding in 2022 (~ 300 mm in 24 hours) that damaged critical water infrastructure [22].

Study period, design, and data sources

This study employed a qualitative design to explore climate change–related water-associated diseases and their drivers, impacts, and responses performed through a One Health perspective. Data were collected between January 2024 and March 2025 using focus group discussions (FGDs), key informant interviews (KIIs), and participatory workshops across Ethiopia and South Africa. The study targeted multiple stakeholder groups, including community members, local leaders, and professionals from the health, environmental, and animal sectors. This multi-level engagement enabled the examination of disease dynamics across the human-animal-environment interface.

Data collection tools and procedure

The data collection tool was designed to systematically investigate various factors that influence climate induced water-associated diseases with a one health perspective. The tools were developed by the research team from the two universities through repeated online meetings. The data collection in Ethiopia includes four focus group discussions, three key informant interviews, and one participatory workshop. The FGD participants were selected from household heads who lived in the city for a minimum of six months and community representative or leaders (influential community members). The minimum number of participants per the FGD was eight individuals per group. Based on this, 32 individuals (Female = 17, Male = 15) participated in the FGD. To ensure a diversity of ideas on the topic, the recruitment of the discussion participants was done through support of local health workers; particularly the Health Extension Workers. Considering local cultural contexts, and because of non-sensitive nature of the intended discussion, both male and female discussion participants were invited to participate in FGDs together. The Key-informants were drawn from the water supply and sewerage authority, the health bureau, and sanitation and beautification offices. Finally, a half day workshop was

conducted with nine experts selected from stakeholders working in the human health, agriculture, animal health, and environmental protection authority.

In South Africa, three focus groups were conducted. Two in-person focus groups of three hours each and one focus group online lasting for two hours. The first focus group, held virtually, consisted of 15 members including four team members from our research team. The online forum provided the opportunity for input from a wider range of participants, including those from KZN province, specifically those living in Durban (seven participants) and one participant from Gauteng province. Of the eleven participants not otherwise involved in the research four were men and seven were women. Attendees ranged from those involved in non-profits advocating for climate related interventions, to those working for government research organizations, and for government offices. The second focus group conducted was in person at the University of Cape Town. It included community health workers, whose attendance was facilitated through our pilot funding, as well as some researchers from other UCT institutions (ACDI-male) and one student from campus (female). The fifteen community health workers who joined the conversation reside in an informal/unplanned settlement called Khayelitsha (majority female, with about four male participants) - in addition one postdoctoral researcher from ACDI joined this discussion as well (male) and one undergraduate student (female); this focus group lasted two and a half hours and the conversation could have continued much longer as there was extensive interest in the topics raised. The final focus group involved five individuals, one student (the same female student who joined on the previous day), two employees of the City of Cape Town, one in climate change planning (female) and another in health sciences (male), and two University researchers (females).

Data Processing and Analysis

All the interviews and discussions were audio-recorded, transcribed verbatim, and anonymized to ensure confidentiality. The data organized by country and method (FGD, KIIs, workshops). Analysis was conducted in two stages: deductive coding and thematic analysis. First, deductive coding was undertaken by categorizing according the DPSIR components (Drivers, Pressure, Stata, Impacts, and Responses) to explore the causal link between components. The framework helped to indicate how drivers lead to pressure, pressure leads to state of water and environmental conditions, resulting in health impacts (outcomes) on human and animal health, and finally helps to investigate possible interventions or responses implemented leading to promote multi-sectoral responses [23, 24]. It also enables the team to investigate the web of interconnection between various factors influencing climate induced water-associated health outcomes which cannot be understood in isolation. Moreover; this framework supports efforts to integrate the link between human, animal and environmental health to develop targeted and holistic interventions to address the entire chain of causation [25].

Second, thematic analysis was conducted within each DPSIR category, by identifying repeated patterns and themes to capture interconnections across human, animal, and environmental domains. A code book was developed iteratively through repeated reading of transcripts and discussions. Coding was refined and grouped into higher order themes aligned with the DPSIR structure. This approach enabled a

systems-level understanding of how climate change interacts with social, environmental, and institutional factors to shape disease transmission and response within a one health framework.

Results

The main findings mapped using the Drivers-Pressures-State-Impacts-Response (DPSIR) framework as depicted in Table 1 show the local understanding of climate change-related water-associated diseases, their transmission pathways, response gaps from a One-Health perspective in specific locations in two study settings. The findings are systematically presented across human, animal, and environmental domains, highlighting the interconnected vulnerabilities and cascading effects across the three domains.

Table 1
Climate-related Water-Associated Diseases in study areas from one Health perspective using DIPSIR Analysis in Dire Dawa and Cape Town, 2025.

Drivers	Human Domain	Animal Domain	Environmental Domain
	• Population growth (Ethiopia and RSA) • Rapid urban expansion (Ethiopia and RSA) • Illegal (Ethiopia)/Informal unplanned (RSA) settlement and infrastructure constraints (Ethiopia and RSA) • Socioeconomic constraints (Ethiopia and RSA) • Rural-urban migration (Ethiopia and RSA) • Lack of resource and budget allocation (Ethiopia and RSA)	• Poor (Ethiopia)/limited (RSA) animal health surveillance in informal contexts • Stray dog proliferation (Ethiopia and RSA) • Unregulated livestock slaughter (Ethiopia and RSA) • Close human-animal cohabitation (cattle markets – Ethiopia; food processing - RSA)	• Climate variability/climate shifts (Erratic rainfall, temperature extremes, long term dry season, flash flooding). • Drainage challenges, especially in illegal/informal housing sectors – no planned drainage • Environmental degradation due to unplanned settlements, uncontrolled factory/industrial expansion, and deforestation • Settlements in wetlands, floodplains or unsuitable spaces for housing

Pressures	Human Domain	Animal Domain	Environmental Domain
	• Poor solid waste handling (Ethiopia and RSA) • Using untreated and turbid) water (Ethiopia and RSA) • Rainwater storage practices using open container (Ethiopia) • Misuse of insecticide Treated Mosquito Net (ITNs) and water guard (Ethiopia).	• Stray dogs scavenging waste • Unvaccinated stray dogs • Slaughter of sick animals ("Azurit" in goats) (Ethiopia) • Disposal of animal carcasses • Food slaughter in open/communal spaces	• Stagnant water accumulation • Drainage clogging • Groundwater contamination • Air pollution (industrial/burning)

State	Human Domain	Animal Domain	Environmental Domain
	• Open defecation practices • High disease susceptibility	• Rabies risk from stray dogs • Unexplained livestock deaths	• Turbid municipal water (E. coli contamination - Ethiopia) • Multiple mosquito breeding sites (tires/caps) • Methane and leachate emissions from landfills (Ethiopia) • Soil, water, and air pollution • Limited tap access (RSA) • Limited budgets to respond to emergency (RSA – esp KZN)

Impact	Human Domain	Animal Domain	Environmental Domain
	• Disease burden such as; dengue/Chikungunya endemicity, Malaria, frequent Cholera outbreaks, (Ethiopia) • Acute watery diharrea (AWD), Respiratory diseases (TB, asthma, Child pneumonia), Kidney disease suspicions and other comorbid diseases. • **Psychosocial and economic**: Work/school absenteeism due to illness, Emotional trauma and deaths, High health expenditures,	• Livestock death from unknown causes • Zoonotic disease transmission risk (eg. rabies) • Slaughter risks, consuming sick animal.	• Persistent (flash – Ethiopia) flood • Water source depletion • Increased vector breeding capacity

Responses	Human Domain	Animal Domain	Environmental Domain
	• House-to-house education by the Health Extension Workers (HEWs) in Ethiopia. • Point-of-use water treatment (Water Guard distribution) (Ethiopia) • "One-to-five" community teaching • Herbal remedies (eucalyptus, papaya leaf)(Ethiopia) • Use of contraband drug named "Relief" as anti-pain. (Ethiopia) • Coffee ceremony awareness sessions (Ethiopia) • Reliance on traditional medicine • Delayed healthcare seeking behavior	• Emergency slaughter of sick animals • Rabies vaccination demands • Avoidance of visibly sick animals • Reporting animal deaths to authorities • Livestock relocation during floods • Dedicated slaughter sites	• 20m/50m sanitation rule (poorly enforced) • Residual chemical spraying (Ethiopia) • Tree planting initiatives • Drain cleaning campaigns • River barrier construction

Theme 1: Drivers (D)

Participants in Ethiopia frequently reported climate variability, urbanization, rapid population growth, and socioeconomic factors were the fundamental drivers contributing to the climate-induced vector and water associated disease in Dire Dawa. Rapid urbanization coupled with rural-to-urban migration increased illegal settlements. Some participants mentioned that the number of city residents are increasing over time leading to overcrowding and the development of informal areas not defined for settlement.

"The number of residents increased over time. Now it has become dense, and *we are living in a very crowded environment mainly in illegal locations, without access to basic sanitation"* [FGD3, Dechatu, P7].

"Intermittent dry seasons push pastoralist community into the city, creating informal settlements with no waste management in the area" [FGD3, Dechatu, P4]

In South Africa, focus-group respondents in Cape Town and KwaZulu-Natal (Durban) linked rapid urban expansion to the growth of informal and unplanned settlements. These settlements typically lack proper drainage planning; high density worsens standing water, limited water and sanitation access, and flood impacts. After heavy rainfall, unmanaged run-off damages homes and leaves standing water in low-lying areas where informal housing has expanded. Respondents particularly noted construction sites that become open-water pits, posing ongoing health risks to residents and children.

Correspondingly, in Ethiopia climate change characterized by rising daily temperatures and erratic rainfall patterns were identified as main drivers in the environmental domains leading to favourable conditions for vector breading and stagnant water; as notes by FGD participants; *"Increasing temperatures in Dire Dawa...and erratic rainfall...create favourable conditions for vector breeding and water stagnation"* [FGD3, Dechatu, P8].

However, the community's understanding on climate change is based on weather patterns:

"Comparing the today's weather with the past; I would say; the rains don't come when they should, or the sun feels hotter now than before."[FGD3, Dechatu, P2]

South African focus groups, especially in KwaZulu-Natal, described cascading extreme weather events that left little recovery time: "we just don't get a break. Just as people are getting to their feet from one flood, another storm or flooded river comes" (CPT FG 1). Repeated shocks particularly affected marginalized neighborhoods, where limited budgets slowed rebuilding; better-resourced areas recovered faster. This mirrors Ethiopian findings that socioeconomic constraints restrict housing choices, pushing people into poorly serviced settlements where flooding and other hazards have more severe impacts.

Theme 2: Pressure (P)

This study suggests that the driving forces exert a significant pressure on human-animal-environment interface. The expansion of unplanned settlements and limited land use management have led to uncontrolled growth in unplanned settlements in flood-prone or low-lying areas with limited sanitation, drainage, water supply, and waste disposal services leading to potential environmental contamination and deterioration of human and animal health.

In Ethiopia, the improper use and overflow of temporary solid waste collection containers led to prolonged exposure to waste in the communities as stated by one key informant.

"Solid waste stayed longer causing high risk the community through disease transmission" [KII, health office]".

It was also noted that, even though new systems of collecting solid waste, at the household level, on a daily basis were initiated, implementation encountered challenges due to logistic constraints.

"The second challenge is that solid waste stays over two or three days in temporary collection places; this condition also causes disease transmission. Initially we have planned to collect every day, but failed to implement due of lack of vehicle." [KII, Sanitation and Beautification agency].

In the city, despite the availability of a landfill as a municipal solid waste disposal site, poor management such as lack of solid waste segregation, and shredding, means that the city is overwhelmed by piles of mixed wastes. The landfill site also produces leachate and sometimes the methane gas build-up, which risks causing fire and is generally associated with a bad odour in the area.

"*The landfill site has no capacity to collect methane gas properly; due to this, sometimes we see fires on the site."* [KII, Sanitation and beautification agency]

In both Ethiopia and South Africa, waste management, including its impact on clogged drainage systems, accumulation of stagnant waters surrounding residential areas, ground water pollution, and deterioration of air quality were common pressures mentioned multiple times. More importantly, water insecurity amplifies risk behaviour, for example, due to improper water storage at the household level in Ethiopia, or questionable recreation practices, for example, in South Africa:

"Flooding carry and collect waste in the same place and clog ditches. This created mosquito breeding sites in many parts of the village." [Ethiopia FGD2, Number One, P5].

"We store rainwater using plastic containers. The plastic containers are usually left open, we also add water repeatedly without cleaning it, which lead to mosquito proliferation and diarrheal illnesses" [Ethiopia, FGD1, Ganda Garada, P1].

"Sewage is an issue. Drains and pipes get blocked which then end up flooding the streets. The water is green and contaminated and so children play in the water and get diarrhea and rash." [Cape Town, FGD2, P2]

"In the informal settlement, there are big issues with sewage drainage and blockages of the pipes. This causes overflow into the street where children are playing. Children are then getting diarrhoea due to playing in and drinking the water. They also struggling with skin rashes." [Cape Town, FGD2, P5]

Land use change and environmental degradation was another important pressure highlighted by Ethiopian participants. Deforestation *("environmental mismanagement, like deforestation" - FGD3, Dechatu, P2*), relocation of cattle markets into residential areas *("cattle market... now part of our residency... produces waste, odour" (FGD2, lumber-One, P5*), and industrial pollution were discussed; *"dust and air pollutants released from factories"* [FGD3, Dechatu, P3] exacerbate risks by altering the state in the surrounding environment, human, and animal.

In South Africa, pressures centered on unplanned settlements built in low-lying areas with inadequate drainage. Clogged storm-water drains and open construction holes create standing water that poses vector, exposure and drowning risks. Parents and community health workers described children playing in stagnant "green waters" at construction sites, raising concerns about both physical injury and infection. During hot, water-scarce periods, the lack of safe places to cool off or play further increases exposure. Healthcare workers reported that walking through these waters commonly causes skin rashes and contact with mixed pollutants flowing past homes. Such contaminated surface water also contributes to diarrhea, a recurring concern linking water, environment and health in these informal settings. One focus group participant reflected on the diarrhoea statistics, noting how focus group discussions highlighted it as an ongoing problem:

“[For example, in 2016 statistics, look at] diarrhoea in South African statistics and children under five years of age, in South Africa [this] accounts for almost 20% of deaths, and in the African region, on the African continent it's 46% of deaths. If that is still the same, it is an urgent public health issue, then what should happen is that it should be elevated as such; it should be one of our priority areas. I think it's totally unacceptable that, one in five deaths is from diarrhoea in under-fives. It doesn't make sense to me, especially for a country like South Africa.”

Theme 3: State (S)

In the Ethiopian context, we found that these pressures have changed the state of environmental condition, human, and animal health. Concerning the environmental conditions, the reality is that waterways are congested due to damaged and clogged, or totally absent, drainage systems (see urban stream syndrome[26]. Decomposing organic matter serves as a conducive breeding site for proliferation of existing and new strains of biological vectors. Poor drainage was raised by respondents across both countries and highlights the contamination of water, soil, and air with the potential to exacerbate respiratory illness, diarrhea, and vector borne diseases. Respondents had concerns of emerging kidney disease associated with poor quality drinking water in Ethiopia, whereas in South Africa, the state of waterways was associated with a range of illnesses from diarrhoea to some respondents suggesting associations between the untidy, disorganized local environments and TB transmission.

In Ethiopia, some mentioned that the municipal water supply is often unsafe; as stated by FGD participants, associated with the perception that there was inconsistent implementation of treatment of the water supply. There was also confirmed faecal coliform contamination through laboratory investigation.

"The drinking water distributed through the municipality is not safe for drinking, and is sometimes described as "turbid, red colored, salty, dirt in colour." (FGD3, Dechatu, P8)

When focusing on the animal domain, the findings highlighted how animal considerations for One Health in the context of water-related, climate sensitive concern, lacked a structured inclusion. This was evidenced through the location of livestock markets within residential areas and weak animal health intervention. The prevalence of unvaccinated stray dogs in the City were often identified as a unique interface between animal-human-environment as these dogs sometimes bite while scavenging on improperly disposed leftover foods.

"the previous cattle market was damaged by extensive flooding and it is now relocated at the center of the village, which is not safe" [Ethiopia, FGD2, Number One, P5]

"stray dogs simply walk around and eat leftover food. They sometimes bite people, We have been asking concerned bodies for a possible solution; however, they said the vaccination for these dogs is very expensive" [Ethiopia, FGD3, Dechatu, P5]

"You can see stray dogs in areas where there are disposed leftover foods; they are looking for leftovers. They are not vaccinated, no owner" [Ethiopia, KII3, Sanitation and Beautification agency]

In the Cape Town context - although not addressed in as much details as in Ethiopian focus groups, due largely to time constraints, CHW suggested that animals and human's 'just mix' in the townships and unplanned neighbourhoods. One focus group participant, who works in the public health sector suggested:

"Informal settlements have a lot of animals being kept. Animals and zoonotic diseases related to water is not often a focus. There is a high degree of water contamination by animals in our informal settlements. There is a high possibility of disease cross-over." [Cape Town, FG3, P4]

This mixing was seen as a potential source of illness. Respondents mentioned chickens and cattle more often than dogs, but repeatedly highlighted the lack of planning around informal livestock markets and open slaughter. Community health workers noted that slaughtering and cooking in neighbourhoods with little or no drainage release blood, waste and by-products into the environment. These residues clog drains or decay in high-traffic areas, creating breeding sites for vectors and pathways for pathogen spread.

Theme 4: Impact (I)

The study indicates the cascading animal and human health impacts originating from climatic and socioeconomic drivers that results in multiple burdens of communicable disease, social, and economic impacts. The findings from Ethiopia show that the recurrent outbreaks of water and vector borne communicable diseases, including malaria, dengue, Chikungunya, acute watery diarrhoea (AWD), and cholera were predominantly reported to have serious impact on human health. Some of these diseases, especially dengue, Chikungunya, acute watery diarrhoea (AWD), and cholera were reported to happen as often as once or twice a year and sometimes overlapping outbreaks.

"*we have experienced a lots of health problems such as*, coughing, *flu, and sneezing; everyone is infected just like an outbreak"* [Ethiopia, FGD4, Addis Ketema, P3];

"bad odor from decomposed waste, open burning of solid waste... cause of respiratory diseases" [Ethiopia, FGD2, Number One, P1].

In the South African contexts, the most discussed direct human health impacts ranged from injury/drowning to diarrheal disease, to skin irritations and added burdens to people already living with compromised immune systems. Indirect concerns involved changes in access to care and/or chronic medicines, for example, after flooding events, or serious climate event. Mental health impacts related to added burdens, fears of flooding (PTSD from past events), and concerns for childrens' wellbeing were repeated topics in the South African focus groups.

In Ethiopia, alongside communicable diseases, non-communicable diseases such as diabetes and hypertension were also mentioned. The psycho-social and economic impacts including persistent absenteeism from work and school, emotional distress, health expenditure, loss of income, and, in some cases, deaths, were repeatedly raised:

"Absenteeism from school, missing work, high hospital expenditure, and losing income," and "Dengue is a fatal disease. Many people die due to this disease." [FGD1, Ganda Garada, P7]

"high costs for treatment, high cost of transportation, financial strain or debt became big burden to this community" – [FGD3, Dechatu, P4],

*Conditions are unliveable due to contamination. Many issues include rashes on skin, TB, breathing issues, brittle or sore bones, malnourished children even though they are eating well, other health problems impact on nutrition [*Cape Town, FG2, P5]

The animal domain was inundated by fear of zoonotic spill over (mainly rabies), livestock morbidity, and stray dog bites. Though its link with the human health was not systematically indicated, participants reported death of animals due to unknown causes. *"Sometimes, chicken, sheep, or goats may die, but people slaughter them before, when they notice signs of illness"*

Impacts – concerns around the close intersections around animal and human life – esp in the post-covid limited clean water for washing context of some informal neighborhoods

Theme 5: Responses (R)

Health Sector:

In Ethiopia, dedicated key informant interviews explored the health sector responses to topics raised in focus groups. This study revealed that the health sector responses were mainly reactive which is predominated by case identification and management; similarly the community often perceive it was inadequate and inefficient.

"The health care workers prescribe only paracetamol and ORS for dengue and chikungunya" (FGD1, Ganda Garada, P1).

During an outbreak the health system focus on community health education, spraying vector control chemicals, distribution of drinking water treatment tablets (WaterGuard), and distribution of Insecticide-Treated Nets (ITNs). However it unsustainable,

"free distribution of Insecticide-Treated Nets (ITNs) *has been stopped, after it was distributed one time at the health facility"* [FGD1, Ganda Garada, P6) FGD2 P2].

In the Cape Town context, where some health and other CoCT officials took part in focus groups, it appears as though the City is trying to shift its response from reactive to pro-active. Organizationally a

directorate dedicated to climate in the City, with close communications with health sector officials has been developed.

My department is the risk and resilience department and their role is to find the gaps that arise in intersectoral work. They have only been around for a year and so can't say it is a success yet. They have taken on the risk of heat as a main action as there was no department that had heat fall underneath it. So, they do heat planning. . .[Cape Town, FGD3, P1]

Planning to address a less reactive approach to both heat and flooding are underway in the City, we learned from our focus groups.

Environmental Management:

Environmental management that included sanitation campaigns, drainage cleaning, solid waste collection by micro-enterprises, and implementation of environmental regulations were discussed a practices already in place in Ethiopia. However, solid waste management which was the highest burden was severely challenged by resource constraints, poor community participation, and lack of law enforcement for open dumping, limited staff capacity, shortage of man power, and relevant machines and vehicles..

"Community participation has decreased over time, they. People need motivation to sustain their engagement" [FGD2, Number One, P1]

"We are responsible to manage this but we have limited staff capacity, shortages of manpower, vehicles, and important machines" [KII2, Sanitation and beautification agency].

"The government gave direction that the households must clear their surroundings within a 20-meter radius, while business enterprises must clear their surroundings within 50 meter radius; however; it was not properly implemented" [KII2, Sanitation and beautification agency]

Similar concerns in environmental management topics were highlighted in Cape Town. As outlined throughout this paper and the comments offered from focus group participants, key areas of concern were drainage, and relatedly surface water runoff. In the context of unplanned settlements, the challenge of solid waste further complicating urban runoff issues was repeatedly raised by participants. City officials highlighted how the changing climate contexts are challenging well-placed intentions for planning:

Looking at the last two winters there has been a shift in patterns that is important to observe. There has been a year where it was constant rain for 6 months which caused low-level flooding that needed to be sorted out. Then there was a year where there were storms in spring which was unexpected and not normal. Therefore, it makes planning extremely challenging for local government to plan appropriately for what is coming.

Community response and coping mechanisms:

To overcome the consequences of diseases such as dengue and chikungunya, people in Ethiopia use traditional remedies such as eucalyptus, smokes of different leaves, garlic, ginger, and ‘Mech Medhanit’ ;evidenced by multiple FGD participants from Ethiopia(FGD1 P5, FGD4 P4, FGD4 P6). Interview participants also described many people using the illegal/contraband drugs named "Relief" as remedial solution as they perceive the drug gives quick relief from pain associated with the illness (FGD3, Dechatu, P8).

To overcome water supply constraints; residents have been harvesting rainwater; which was a pressure (P), collecting water from surface water, ponds, and vehicle.

As in Ethiopia, a water scarcity pressure (P) in South Africa exists. To this end, focus group participants highlighted how this impacted their lives, and the health profiles in the city. Some examples follow:

Drought related issues. Water-borne diseases will arise when there is no water to run through a system. Water is what drives things like sewage to where it needs to go and so if there is no water to do this, then health issues like water-borne diseases will arise. (Cape Town, FG3, P4)

Government is further exacerbating problems that already exist through interventions. Day zero drought they were told to use minimal water and so all that happened was they shut down people’s car washes. Then in day zero drought they were being told to use less than 50L water a day but they were using 1 kettle to wash but people in Constantia were watering gardens, filling pools etc… Government was also telling them to wash their hands every 15 minutes to keep healthy and hygienic but they switch off their water every weekend. So Government tells them to do things but then causes further problems. [Cape Town, FG2, P5]

Policy & Institutional Gaps:

There appears to be a clear one health intervention shortfall. In Ethiopia, key informant interview participants often elaborated that the existence of policies and strategic documents such as Climate Resilient Green Economy (CRGE), Health National Adaptation Plan (HNAP), and Malaria Elimination program, showed to have significant implementation gaps due to fragmented and under-resourced approaches. Similar challenges were noted on waste management, as the system is outdated.

"we have various national guidelines and documents; however, cascading mechanisms, and proper local implementation have serious gaps.It lacks funding, resource, and follow up" [KII1, Health Office].

“*We only get 10% of the total budget allocation of the city administration. The agency pay* 1000 Ethiopian birr per person per month for the waste collectors organized through microfinance” [KII2, Sanitation and Beautification agency].

One of the key gaps we have identified was absence of integrated One Health approaches (human-animal-environment interface) across key sectors or actors as mentioned by key informant from the City Administration Health office *"We do not have such a strong system that integrates human and*

environmental health" (KII1, health office); *"Proper integration and cooperation are lacking between institutions and different sectors.* Coordination and collaboration is often limited to emergency task forces.*"* (KII2/3, sanitation and beautification Agency). The animal health interventions such as vaccination, market management, and carcase management was inadequately integrated with human health and environmental management.

In Cape Town the question of responsive/reactive policy and practice versus, planning ahead was discussed at length. Key to this discussion was how prepared the City is. One participant suggested:

We are already not adapted to our current climate so it is not about being ready for what is to come, it is about being resilient to what is happening now and the long-term impacts of what could come. [FG3, P1]

While the discussion in Cape Town focus groups did not address human-animal interactions as much as planned, the overall message of a need for better integrated planning and systems across departments was discussed. A snippet of one of the conversations from FG3 is provided below:

P3: The concept of interventions that need to be put into place are intersectoral in nature. The way the government is set up makes intersectoral activities difficult to execute. Who takes responsibility for what and whose budget must pay for what? There are some intersectoral initiatives such as the approach to drowning by the WC Department of Disaster Risk Reduction but things are being put on hold because there are budget and expense disputes. When doing intersectoral work sometimes it is easier to get fewer departments together first to work with. It becomes almost impossible to do intersectoral work and interventions when you need to include so many different parties. Tiers of government present a bigger challenge with intersectoral work. Example of the drought and how the local government could make calls on the dam but then they weren't allowed to touch the drains and pipes as that fell under a different department that was nationally run. So, tiers in government get in the way too.

P1: Silos won't disappear as no matter how many times you restructure there will eventually be silos.

P3: There will always be a reporting line at some point.

P1: So, we need to figure out how to work with silos and around them as they won't go away.

P3: Things don't happen unless there is a policy, or something written and agreed upon in government. And things don't happen unless there is someone championing the space. Department of the President or Department of the Premier is the one who needs to raise these cross-cutting issues and then call on the different departments and give them different responsibility within these issues. When these issues are raised and discussed, there are also not the right people in the room. Engineering is missing, or the people present are all policy makers that don't have an idea of what the actual ground problems are.

Community Knowledge & Awareness Gaps

despite the existence of community health education; the understanding of climate change causation is often explained by weather observations and divine/behavioral attributions. The misconceptions about disease transmission, causation, interconnection of animal-human-environment, and benefits and health intervention showed existence of response failure manly related to community awareness and knowledge.

"I think it is transmitted through sweating, contact with an infected person, and sharing different things food utensil and clothing in the same house." [FGD1, Ganda Garada, P7]

Response failure:

"Climate change is a deviation of the climate condition from the normal or usual experience. For instance, Dire Dawa is hot climate, this might become extreme hot or cold" [FGD 3, Ganda Garada, P1].

On the other hand; there was perception that the clash between hot and cold climate lead to illness called "Mich" which is manifested by fever and sweating. Response failure was also evidence on the miss use of ITN and water guard (drinking water treatment chemical).

"There was distribution of ITNs in the community; however, people use them for other purposes such as curtain for the outdoor kitchen. Additionally; I was using water treatment liquid to wash clothes, if is effective to remove dirt from cloth" [FGD 3, Dechatu, P2]

In Cape Town, while local residents, city officials and everyone in between was aware of many of the challenges, one discussant highlight how easy it is to forget one pressing problem, when faced with a range of other pressing problems:

FG3 P6: With all the work that different departments do, they are picking things up but when sharing that information to someone who is not in the same field are we able to communicate this in a way that is understandable and convincing and that there are no gaps. Example with flooding is that if someone is not experiencing flooding or not impacted by it in a big way then why they would focus on it.

In other words, while knowledge gaps are not what our focus groups looked for, we were able to highlight that if a pressing concern is not the one you are facing, you are less likely to be attuned to it. Cultural contexts here matter. In some cases in Cape Town we learned that some participants feel that the notion of climate change is a conspiracy aimed at limiting their potential, while other articulated some limits to climate change understandings a bit differently:

People don't know what climate change is and what it means. In the beginning people were being told that climate change means the climate is heating up but then were also being told that floods and burning of materials is also climate change. In isiXhosa, when the wind blows it means the rain is coming but with climate change that will change. But people are confused about what climate change means, it does not exist in their local language and so how do you explain this. People need to be educated about what [it means]. [FG2 P8]

In the context of cascading pressures, the ways in which people handle priorities rests on which challenges they have most recently faced – similar to how the City is forced to address challenges:

DISCUSSION

This study explored how climate change-related water-associated disease are understood and experienced across human, animal, and environmental domains, drawing on perspectives from local stakeholders such as citizens, local leaders, and decision-makers in Ethiopia and South Africa. Using the DPSIR framework, the findings reveal a clear chain of correlation from climate and socioeconomic drivers to health impacts, while exposing critical gaps in response planning, systems and one health implementation.

While communities in two settings consistently reported an increasing burden of water- and vector-borne disease over time, in Ethiopia, mainly dengue, chikungunya, cholera, and diarrhoea, and in Cape Town, diarrhoea and skin irritation, peoples' understanding of the underlying mechanisms linking climate change to disease transmission is varied and for some remains limited. Participants were able to recognize changes in climate patterns, such as increasing temperature, erratic rainfall and flooding, and associate these with worsening health outcomes. However, their explanations of disease causation were largely based on proximate and observable factors, such as poor sanitation or direct contact, rather than systematic linkage, involving environmental change, vector ecology, and transmission dynamics, which is consistent with prior studies [27, 28]. This gap between experiential knowledge and understanding represents a critical barrier to effective prevention, as it limits the adoption of appropriate risk-reduction behaviours [28]. Yet, this also highlights an opportunity space to develop co-learning interventions that engage local knowledge alongside climate science to better raise awareness about how climate shifts might be locally felt, and/or planned for.

The key drivers of the water-associated diseases are extreme events, particularly drought and flash flooding. Drought causes rural-to-urban migration which makes overpopulated city with poor housing condition [29, 30]; that creates pressure on water supply and waste management system and ultimately to system's failure. Similarly, the seasonal flash floods together with inadequate drainage and heavy rainfall, high temperature, and irregular precipitation strains the city's water supply systems. Insufficient sewerage coverage and poor solid waste management intensify the residents' exposure to associated health hazards [31, 32]. Poor drainage systems leads to flooding that mixes storm water with sewerage and solid waste then contaminating water bodies, and drainage channels[33, 34].

The study unpacked complicated transmission pathways of the diseases due to the interaction across human-animal and environment interface. Poorly sited cattle markets, located in the vicinity of residents, exposes households to animal waste, which is discarded in open areas in the absence of adequate waste removal. Waterways and children come into contact with animal waste, creating vulnerability to fecal-oral transmission routes of zoonotic enteric infections [35]. The market place would also be a conducive environment for mosquitoes to breed due to water stagnation [36]. Similarly, stray animals, a

repeated community concern in the Ethiopian context, contribute to environmental contamination and spread zoonotic disease cycles. Domestic animals in urban households frequently consume contaminated water, increasing risk of zoonotic diseases transmission to back to human.

Although the interconnection human-animal and environmental health in the disease transmission is well recognized, the practical implementation of one health approaches remains weak characterized with fragmented governance, sectoral siloes, and inadequate awareness [37, 38]. The engagement of health extension workers in Ethiopia, who have a mandate to promote hygiene, risk communication, vector control, and climate-related health literacy, in the disease prevention is very limited. Similarly, the health, environment, and agriculture sectors do not systematically operate joint surveillance and outbreak response. Therefore, response to the disease remains mostly reactive, with limited emphasis on prevention through environmental and animal management.

The health, environmental, and animal health experts have insufficient knowledge regarding One Health, and that challenges in fostering effective cross-sector collaboration and addressing complex health issues, affects its implementation in the study area. This is demonstrated in-depth interviews, which reveal little knowledge due to a lack of sufficient training on cross-sectoral collaboration and in understanding climate and disease dynamics. Broader institutional challenges, including limited One Health education, weak institutionalization, and the absence of dedicated budgets, sustain these siloes and restrict integrated policy making[39, 40]

Although community perceptions and engagement are equally critical, the current study is characterized by misconceptions about disease origins. It is often rooted in traditional beliefs rather than climate and environmental realities, which reduce the adoption of preventive measures. Active community participation in One Health programs, however, has proven effective. For instance, Rwanda's experience underlines how grassroots involvement enhances cultural relevance, builds trust, and fosters ownership of health initiatives [13]. In Ethiopia, participatory approach is already proven to align interventions with community knowledge and practices, increasing both acceptability and effectiveness [41]. Leveraging these approaches through a one health framework ensure broader impact by simultaneously addressing human, animal, and environmental health challenges.

In general, the highlights how the application of the DPSIR framework can be valuable in systematically linking drivers, pressures, states, impacts, and responses across the human-animal-environment interface. This framework can enable the identification of critical intervention points, particularly at the level of pressure, where targeted actions would disrupt disease transmission pathways. More importantly, the framework highlights failure in one domain cascades across others, reinforcing the need for integrated approach. Critical gap identified in this study was the limited understanding of disease transmission mechanisms from a one health perspective, particularly the interconnections between climate change, environmental conditions, animal health, and human health outcomes. This gap significantly affects the effectiveness of prevention and response strategies.

Conclusion

The study reveals, despite the location variations, climate-related diseases are common in Ethiopia and South Africa, and arise form interconnected human, animal and environmental factors. Although communities perceive increasing disease trends, limited understanding of underlying transmission mechanisms, particularly from a one health perspective, limits effective prevention of the diseases. Responses remain largely reactive and fragmented, with weak integration across sectors despite policy-level recognition of one health. Persistent challenges in water, sanitation, waste management, and human-animal integration continue to drive disease risks in the study settings. Strengthening one health implementation requires integrated, preventive approaches that combines cross-secotral coordination, improved infrastructure, and context specific community engagement. Bridging knowledge gaps and aligning institutional and community responses are critical to reducing disease burden and enhance resilience in both countries.

Declarations

Ethical approval and consent to participate

The study was conducted after obtaining ethical approval from the *Institutional Health Research Ethics Review Committee* (IHRERC) of Haramaya University, college of Health and Medical Science (Reference number IHRERC/013/2025), and Ethical Review Board of the University of Cape Town's Faculty of Engineering and the Built Environment (EBE). The inclusion and gathering of data from study participants were performed in accordance with the institutional guidelines and regulations. In Ethiopia an official letter was submitted to the City Health Bureau and Mayor's office to get permission and support. The objectives, purposes, risks, and benefits of the study was clearly explained to all respondents Moreover, the they were informed that their participation in the interview is on a voluntary basis and they have full right to withdraw at any point, including in the middle of the interview. Participants also had the right not to answer to any question if they were unwilling to respond. Finally informed consent was obtained from all study participants.

Consent for publication

Informed consent was obtained from all individual participants included in the study.

Competing interest

The authors declare that there is no competing interest.

Clinical Trial Number in the manuscript

Not applicable.

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Author Contribution

Conceptualization: JW, AA, MJ, GH, AN, AG & YM; Methodology: JW, AA, MJ, GH, AN, AG, YM; Investigation: YM, AG, DM, AA, AN, JW; Data Curation: YM, AG, DM, AA, AN, MJ; Formal analysis: YM, AG, DM, AA, MJ; Resources: JW; Original draft preparation: YM, AG, AA, MJ; Reviewing and editing: JW, AA, GH, AN. All authors read and approved the final manuscript.

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References

1. WHO. Burden of disease attributable to unsafe drinking-water, sanitation and hygiene, 2019 update. World Health Organization; 2023.
2. Obame-Nkoghe J, Agossou AE, Mboowa G, Kamgang B, Caminade C, Duke DC, Githeko AK, Ogega OM, Engone Elloué N, Sarr FB, et al. Climate-influenced vector-borne diseases in Africa: a call to empower the next generation of African researchers for sustainable solutions. Infect Dis Poverty. 2024;13(1):26.
3. Levy K, Smith SM, Carlton EJ. Climate Change Impacts on Waterborne Diseases: Moving Toward Designing Interventions. Curr Environ Health Rep. 2018;5(2):272–82.
4. Suhr F, Steinert JI. Epidemiology of floods in sub-Saharan Africa: a systematic review of health outcomes. BMC Public Health. 2022;22(1):268.
5. WHO. The state of health in the WHO African Region: an analysis of the status of health, health services and health systems in the context of the Sustainable Development Goals. In. Brazzaville: WHO Regional Office for Africa; 2018.
6. WHO. The Tripartite's Commitment Providing multisectoral, Collaborative Leadership in Addressing Health Challenges. In. Rome. Paris, Geneva: FAO, OIE; 2017.

7. WHO. One health joint plan of action (2022–2026): working together for the health of humans, animals. plants and the environment: World Health Organization; 2022.
8. Gibbs EP. The evolution of One Health: a decade of progress and challenges for the future. Vet Rec. 2014;174(4):85–91.
9. Prendergast AJ, Gharpure R, Mor S, Viney M, Dube K, Lello J, Berger C, Siwila J, Joyeux M, Hodobo T. Putting the A into WaSH: a call for integrated management of water, animals, sanitation, and hygiene. Lancet Planet Health. 2019;3(8):e336–7.
10. Robbiati C, Milano A, Declich S, Dente MG. One Health prevention and preparedness to vector-borne diseases: how should we deal with a multisectoral, multilevel and multigroup governance? One Health Outlook. 2024;6(1):21.
11. HEAL: ONE HEALTH POLICY CONTEXT OF ETHIOPIA. SOMALIA AND KENYA. In. Edited by Diana Onyango MF, Barbara Wieland, Davis Ikiror, Jason Sircely and Samuel Tefera: One Health Units for Humans, Environment, Animals and Livelihoods (HEAL) Project; 2019.
12. Osman Y, Zinsstag J, Abtidon R, Hattendorf J, Crump L, Wali H, Mo'alin A, Muhumed A, Tschopp R. Operationalizing a community-based One Health surveillance and response in Adadle district of Ethiopia. CABI One Health. 2023;2023:ohcs202300014.
13. Henley P, Igihozo G, Wotton L. One Health approaches require community engagement, education, and international collaborations—a lesson from Rwanda. Nat Med. 2021;27(6):947–8.
14. Mamabolo M, Machalaba C, Zantsi S, Rostal MK, Karesh WB, Thompson PN, Chaminuka P. One Health Economics approach to prevention and control of zoonotic and animal diseases-considerations for South Africa. One Health Outlook. 2025;7(1):30.
15. Spence CE, Jenkins SC, Osman M. Impact of disease characteristics and knowledge on public risk perception of zoonoses. Biol Lett. 2022;18(8):20220148.
16. Prüss-Ustün A, Wolf J, Bartram J, Clasen T, Cumming O, Freeman MC, Gordon B, Hunter PR, Medlicott K, Johnston R. Burden of disease from inadequate water, sanitation and hygiene for selected adverse health outcomes: An updated analysis with a focus on low- and middle-income countries. Int J Hyg Environ Health. 2019;222(5):765–77.
17. Weimann A, Oni T. A systematised review of the health impact of urban informal settlements and implications for upgrading interventions in South Africa, a rapidly urbanising middle-income country. Int J Environ Res Public Health. 2019;16(19):3608.
18. Christaki E, Dimitriou P, Pantavou K, Nikolopoulos GK. The impact of climate change on cholera: a review on the global status and future challenges. Atmosphere. 2020;11(5):449.
19. Hunter PR, MacDonald AM, Carter RC. Water supply and health. PLoS Med. 2010;7(11):e1000361.
20. Parker DM, Haileselassie W, Hailemariam TS, Workenh A, Workineh S, Wang X, Lee M-C, Yan G. High seroprevalence of antibodies to Dengue, Chikungunya, and Zika viruses in Dire Dawa, Ethiopia: A cross-sectional survey in 2024. PLoS Negl Trop Dis. 2025;19(7):e0013357.
21. Ndlovu M, Clulow AD, Savage MJ, Nhamo L, Magidi J, Mabhaudhi T. An assessment of the impacts of climate variability and change in KwaZulu-Natal Province, South Africa. Atmosphere.

2021;12(4):427.

22. Engelbrecht FA, Steinkopf J, Chang N, Biskop S, Malherbe J, Engelbrecht CJ, Grab S, le Roux A, Vogel C, Padavatan J, et al. Extreme event attribution using km-scale simulations reveals the pronounced role of climate change in the Durban floods. Commun Earth Environ. 2025;6(1):506.
23. Smeets E, Weterings R. Environmental indicators: Typology and overview. 1999.
24. Atkins JP, Gregory AJ, Burdon D, Elliott M. Managing the marine environment: is the DPSIR framework holistic enough? Syst Res Behav Sci. 2011;28(5):497–508.
25. Zinsstag J, Schelling E, Waltner-Toews D, Tanner M. From one medicine to one health and systemic approaches to health and well-being. Prev Vet Med. 2011;101(3–4):148–56.
26. Walsh CJ, Roy AH, Feminella JW, Cottingham PD, Groffman PM, Morgan RP. The urban stream syndrome: current knowledge and the search for a cure. J North Am Benthological Soc. 2005;24(3):706–23.
27. Nigatu AS, Asamoah BO, Kloos H. Knowledge and perceptions about the health impact of climate change among health sciences students in Ethiopia: a cross-sectional study. BMC Public Health. 2014;14(1):587.
28. Tamire M, Mor SM, Baylis M, Kaba M. Perceived impacts of climate change in pastoralist regions of Ethiopia: A qualitative study applying the concept of One Health. Int J Environ Res Public Health. 2025;22(2):257.
29. Moalin Hassan O. Impact of Water Security, Climate Change and Population Growth on Rural-Urban Migration in Sub-Saharan Africa. 2017.
30. Abeje A. Causes and effects of rural-urban migration in Ethiopia: A case study from Amhara Region. Afr Stud. 2021;80(1):77–94.
31. Ayele S, Workneh ZG, Meshesha BT. Water challenges of Dire Dawa city of Ethiopia: An assessment of urban growth and groundwater supply. Environ Challenges. 2023;12:100738.
32. Mekonnen DC, Legass HA. Urbanization and its Effects on Environment and Socio-economic Sustainability; Evidence from Dire Dawa, Ethiopia. Sharia Oikonomia Law J. 2024;2(4):292–319.
33. Semie AG, Diro GT, Demissie T, Yigezu YM, Hailu B. Towards Improved Flash Flood Forecasting over Dire Dawa, Ethiopia Using WRF-Hydro. Water. 2023;15(18):3262.
34. Ali Mude AS, Nageye YA, Bello KE. Current Epidemiological Status of Chikungunya Virus Infection in East Africa: A Systematic Review and Meta-Analysis. J Trop Med. 2024;2024(1):7357911.
35. Geremew G, Ambelu A, Dadi D, Haddis A. Relationship Between Domestic Animals, Environmental and Behavioral Factors, and Under-Five Diarrhea in Sidama Region, Ethiopia: A Matched Case-Control Study. J Epidemiol Glob Health. 2025;15(1):100.
36. Mattah PAD, Futagbi G, Amekudzi LK, Mattah MM, de Souza DK, Kartey-Attipoe WD, Bimi L, Wilson MD. Diversity in breeding sites and distribution of Anopheles mosquitoes in selected urban areas of southern Ghana. Parasites Vectors. 2017;10(1):25.

37. Nyokabi NS, Moore H, Berg S, Lindahl J, Phelan L, Gimechu G, Mihret A, Wood JLN. Implementing a one health approach to strengthen the management of zoonoses in Ethiopia. One Health. 2023;16:100521.
38. Gebru B, Elofsson K, Amuakwa-Mensah F, Marbuah G. Climate variability and its impact on sanitation facility choice in Ethiopia. Discover Water. 2025;5(1):43.
39. Alimi Y, Wabacha J. Strengthening coordination and collaboration of one health approach for zoonotic diseases in Africa. One Health Outlook. 2023;5(1):10.
40. Tadesse Y, Mor S, Knight-Jones T, Richards S, Kaba M. Capacitating One Health in eastern and southern Africa: Experiences and implications in Ethiopia. One Health Cases. 2024;2024:ohcs20240012.
41. Leulseged H, Bethencourt C, Igunza KA, Akelo V, Onyango D, Omore R, Ogbuanu IU, Ameh S, Moseray A, Kowuor D, et al. Clinicopathological discrepancies in the diagnoses of childhood causes of death in the CHAMPS network: An analysis of antemortem diagnostic inaccuracies. BMJ Paediatrics Open. 2024;8(1):e002654.