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EDITED BY

Lingye Yao,
The Chinese University of Hong Kong,
China

REVIEWED BY

Tatiana Marrufo,
Instituto Nacional de Saúde,
Mozambique
Prihandoko Prihandoko,
Gunadarma University, Indonesia

*CORRESPONDENCE

Lawrencia D. Mushi
✉ ldmushi@mzumbe.ac.tz

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Governing climate change adaptation in urban Tanzania: health system capacity gaps and implications for resilience

Lawrencia D. Mushi*, Noel O. Ogweyo and Faraja U. Cosmas

Department of Health Systems Management, School of Public Administration and Management, Mzumbe University, Morogoro, Tanzania

Climate change is one of the greatest global health threats of the twenty-first century, with profound implications for health systems and progress toward universal health coverage. In Tanzania, urban areas such as Dar es Salaam are increasingly experiencing climate-related health challenges, including flooding, heat stress, and outbreaks of climate-sensitive diseases such as cholera, malaria, and respiratory infections, placing growing pressure on already constrained urban health systems. Although urban health systems in low- and middle-income countries are increasingly exposed to these risks, evidence on their capacity to govern and implement climate change adaptation actions remains limited. This study aimed to explore the governance capacity of the urban health system for climate change adaptation in Dar es Salaam, Tanzania. An exploratory qualitative study was conducted using in-depth interviews (IDIs) and focus group discussions (FGDs) with key stakeholders involved in health governance, policy development, and health service delivery. A total of 68 participants were purposively selected from municipal health management teams, public health facilities, and academic institutions across four municipal councils in Dar es Salaam. Data were analysed thematically and organised using ATLAS.ti software. The findings revealed strengths and gaps across three key areas of climate change adaptation governance. *First*, early warning and preparedness mechanisms existed but were constrained by fragmented disease surveillance systems, weak emergency response team functionality, and inadequate climate–health data for decision-making. *Second*, human resource capacity was supported by available training and research institutions; however, staffing shortages, limited training coverage, and irregular refresher training reduced preparedness for climate-related health emergencies. *Third*, institutional and material capacity remained inadequate, characterized by limited operational climate change guidelines at the facility level, infrastructure gaps, and insufficient financial and material resources to support effective adaptation. Although municipal health systems in urban Tanzania have initiated climate change adaptation efforts, the governance of these actions remains constrained by uneven and inadequate institutional capacity. Persistent shortages in human resources, infrastructure, and sustainable financing undermine the effectiveness of early warning systems and preparedness mechanisms. Consequently, urban health systems remain insufficiently resilient to complex climate-related health risks. Therefore, strengthening climate-resilient health governance will require targeted investments in workforce capacity, infrastructure, integrated climate-health information systems, sustained financing, and clearer institutional guidelines to support proactive and coordinated adaptation across governance levels.

KEYWORDS

adaptation, climate, governance, health systems, resilience, urban health

Introduction

Climate change is widely recognized as a public health emergency and one of the greatest global health threats of the twenty-first century (Ansah et al., 2024; Lugten and Hariharan, 2022; Schnitter et al., 2019; IPCC, 2023; WHO, 2023). Anthropogenic climate change poses significant risks to nearly every aspect of human life, including food security, sanitation, livelihoods, and essential service delivery (Kitole et al., 2024). These shifts also drive biodiversity loss and environmental degradation, creating complex pathways that further impact human health, especially in the low- and middle-income countries (Kitole et al., 2024). The World Health Organization (WHO) has warned that climate change will fundamentally affect health systems and undermine efforts to protect and sustain population health, threatening progress toward universal health coverage and broader development goals (WHO, 2023; Olu, 2017).

The health impacts of climate change are already evident and are expected to intensify in the coming decades (Ansah et al., 2024; Lugten and Hariharan, 2022; Romanello et al., 2021). Changing climate conditions are altering disease burdens by increasing heat-related illnesses, shifting patterns of infectious disease transmission, and amplifying the frequency and severity of disease outbreaks and pandemics (Ansah et al., 2024; Lugten and Hariharan, 2022; Romanello et al., 2021; Watts et al., 2021). These impacts disproportionately affect vulnerable populations, including women, children, older adults, people with underlying health conditions, and socially marginalized groups, who often have limited access to quality healthcare and weaker adaptive capacity (Lugten and Hariharan, 2022; Singh et al., 2020). Globally, climate change is projected to cause approximately 250,000 additional deaths annually between 2030 and 2050 due to malnutrition, malaria, diarrhoeal diseases, and heat stress, while imposing excess health-related costs of at least US\$21 trillion in low- and middle-income countries by 2050 (Lugten and Hariharan, 2022; WHO, 2023). These pressures significantly strain health systems by increasing service demand while simultaneously undermining system functionality and equity (IPCC, 2023; WHO, 2023).

Although climate change is a global phenomenon, its health impacts are highly localized, with urban areas increasingly emerging as hotspots of climate vulnerability (Liu, 2021; Boyd and Juhola, 2015). Urban populations are more vulnerable because densely populated settlements, inadequate drainage systems, poor waste management, and limited access to basic services increase the risk of climate-sensitive illnesses such as diarrhoeal diseases, malaria, respiratory infections, and heat-related conditions (Lugten and Hariharan, 2022; IPCC, 2023; Singh et al., 2020; Liu, 2021; Boyd and Juhola, 2015; Manyele and Anicetus, 2025). In many low- and middle-income countries (LMICs), urban flooding frequently disrupts health services, damages infrastructure, contaminates water sources, and increases the spread of vector- and water-borne diseases, thereby placing additional pressure on already fragile health systems (Lugten and Hariharan, 2022; IPCC, 2023; Singh et al., 2020; Manyele and Anicetus, 2025). In Tanzania, urbanisation is estimated at 5.22% annually, with nearly one-third of the population residing

in urban areas and a substantial proportion concentrated in Dar es Salaam (Shemdoo et al., 2016; The United Republic of Tanzania, 2022). Dar es Salaam is already experiencing rising temperatures, recurrent flooding, and climate-sensitive disease outbreaks, including cholera, malaria, and respiratory illnesses, which place increasing pressure on the urban health system (Kitole et al., 2024; MoH, 2025; Manyele and Anicetus, 2025). Seasonal flooding in informal urban settlements has repeatedly disrupted access to healthcare facilities, displaced vulnerable populations, and increased the burden of sanitation-related diseases, demonstrating the compounding effects of climate change and urban vulnerability (Kitole et al., 2024; Singh et al., 2020; Manyele and Anicetus, 2025). Notably, reported diarrhoeal cases in Tanzania increased from approximately 157,000 in 2011 to over 300,000 in 2022, with flood-prone urban regions such as Dar es Salaam among the most affected (Kitole et al., 2024).

Despite these escalating risks, the health impacts of climate change are largely preventable if health systems are sufficiently resilient and governed through effective climate change adaptation mechanisms (Ansah et al., 2024; Ebi et al., 2019). Health systems play a central role in protecting populations from climate-related health risks and must therefore integrate climate adaptation into planning, service delivery, and emergency preparedness (Schnitter et al., 2019; WHO, 2023). Experiences from the COVID-19 pandemic have further underscored the importance of strong, well-governed, and resilient health systems capable of absorbing shocks while maintaining essential services (Singh et al., 2020). As climate-related shocks and stressors intensify, health systems must strengthen governance arrangements that enable coordinated, anticipatory, and adaptive responses across multiple levels of the system (Ansah et al., 2024; WHO, 2023; Singh et al., 2020). Well-governed climate adaptation actions are essential to ensure continuity of routine health services while protecting vulnerable populations during climate-related emergencies (Ansah et al., 2024; WHO, 2023; Olu, 2017).

However, evidence on how health systems in LMICs to govern climate change adaptation, especially within rapidly urbanizing contexts, remains limited. Previous studies in LMICs have highlighted the importance of climate-resilient health systems, emphasizing the need for stronger infrastructure, improved emergency preparedness, and integration of climate risks into health planning and service delivery (Ansah et al., 2024; Olu, 2017; Manyele and Anicetus, 2025; Mboera et al., 2011). Other studies in Tanzania have examined climate change adaptation largely from environmental governance and community resilience perspectives, documenting challenges such as inadequate institutional coordination, weak implementation capacity, and limited local adaptation planning (Kitole et al., 2024; Shemdoo et al., 2016; Shemdoo et al., 2015; Ampaire et al., 2016). However, these studies provide limited evidence on the capacity of urban health systems, specifically in governing climate change adaptation, particularly in relation to institutional preparedness, workforce capacity, and governance arrangements within health service delivery systems. Dar es Salaam, despite being highly vulnerable to climate-related health risks, lacks comprehensive empirical evidence on the capacity of its urban health

system to effectively govern climate change adaptation. Addressing this gap is critical for informing policy implementation, strengthening institutional capacity, and enhancing health system resilience. This study, therefore, explores the capacity of the urban health system in Dar es Salaam to govern climate change adaptation.

Materials and methods

Research design

This study employed a qualitative exploratory research design to understand the governance of climate change adaptation within the urban health system of Dar es Salaam, Tanzania. A qualitative approach was appropriate as it enables in-depth exploration of complex governance processes, institutional arrangements, and stakeholder interactions that cannot be adequately captured through quantitative methods (Cresswell, 2007; Yin, 2016; Savenye and Robinson, 2005). Climate change adaptation governance involves multiple actors, policy frameworks, and contextual dynamics, requiring flexible and interpretive inquiry to understand how decisions are made and implemented in practice (Savenye and Robinson, 2005; Dawadi et al., 2021; Ryan et al., 2007). The exploratory design was particularly suitable given the limited empirical evidence on climate change adaptation governance within urban health systems in low- and middle-income countries (Yin, 2016; Savenye and Robinson, 2005), and it facilitated the identification of institutional capacities, coordination mechanisms, and contextual constraints shaping adaptation efforts within the health sector.

Study area

This study was conducted in Dar es Salaam, Tanzania's largest city and primary commercial centre, which is experiencing rapid urbanization and increasing vulnerability to climate change-related health risks (Manyele and Anicetus, 2025; Shemdoe et al., 2015; Mboera et al., 2011). As one of Africa's fastest-growing cities, Dar es Salaam is exposed to rising temperatures, recurrent flooding, and the growing burden of climate-sensitive diseases such as malaria, cholera, and respiratory illnesses (MoH, 2025; Manyele and Anicetus, 2025; Salukele et al., 2025). These climate pressures are compounded by high population density, informal settlements, and increasing demand for urban health services, placing additional strain on health system governance and service delivery (Pasquini et al., 2020). Dar es Salaam was selected due to frequent exposure to extreme weather events, its strategic importance within the national health system, and the complexity of its health governance structures (Salukele et al., 2025; Pasquini et al., 2020). These characteristics make the city a relevant and informative setting for examining climate change adaptation governance within urban health systems in low- and middle-income country contexts.

Participants and selection strategy

A total of 68 participants were purposively selected for the study. Of these, 38 participants took part in in-depth interviews (IDIs), including 10 Council Health Management Team (CHMT) members, 25 healthcare providers, and 3 public university lecturers. On the

other side, 30 healthcare providers participated in 5 focus group discussions (FGDs), each comprising 5–8 participants. Participants were selected based on their professional roles and experience in health system governance, climate change response, climate-related policy, and emergency preparedness. The sample was drawn from one public health university, four hospitals, six health centres, and eight dispensaries across four municipal councils in Dar es Salaam (Kinondoni, Ilala, Temeke, and Ubungu). These councils were selected due to their high exposure to climate-related health risks, diversity in governance structures, and prior engagement in climate adaptation initiatives.

The final sample size was determined according to the principle of data saturation recommended for qualitative inquiry (Guest et al., 2006), whereby data collection continued until no new themes or substantive insights emerged. Saturation was achieved when participants consistently reported similar governance experiences and challenges. This indicated that the information collected was sufficient to support a comprehensive qualitative analysis of climate change adaptation governance within the urban health system.

Data collection

Data were collected through IDIs and FGDs using an interview guide developed following a comprehensive literature review. The use of multiple qualitative methods enabled methodological triangulation and enhanced the credibility and rigour of the findings (Carter et al., 2014; Meydan and Akkaş, 2024). The interview guide comprised open-ended questions structured around three main domains of climate change adaptation governance: early warning and preparedness mechanisms, human resource capacity and training, and institutional infrastructure and material resources. These domains informed data collection and guided exploration of governance capacities and challenges within the urban health system. Before data collection, the tool was pretested to assess clarity, relevance, and logical flow, and minor revisions were made accordingly (Shakir and Rahman ur, 2022). All interviews and discussions were conducted in Kiswahili, audio-recorded with participants' consent, and supported by a trained moderator and note-taker who documented non-verbal cues and group dynamics. Data collection was carried out between October and November 2025.

The IDIs were conducted with participants involved in climate governance, policy formulation, health system management, and healthcare delivery to capture in-depth perspectives on health system capacity for climate change adaptation governance. Interviews explored existing policies, enforcement mechanisms, achievements, and governance challenges, with durations ranging from 28 to 59 min. 36 interviews were conducted in person at the participants' offices, while 2 were conducted virtually. The FGDs were conducted with healthcare providers to examine shared experiences and perceptions of climate change adaptation practices and governance structures. FGDs facilitated collective reflection on barriers and facilitators to adaptation and generated practice-informed policy insights from frontline providers. All FGDs were conducted at health facilities and lasted between 57 and 86 min. These methods were appropriate as they enabled both detailed individual insights and interactive exploration of common governance challenges within urban health systems (McIlwain et al., 2024).

Data management

All interviews and discussions were conducted in quiet and conducive environments to ensure high-quality audio recordings, and participants were encouraged to speak clearly throughout the sessions. Audio recordings were transcribed verbatim within 24 h of data collection and spot-checked by both the interviewer and note-taker to verify accuracy and completeness (Savenye and Robinson, 2005; Ryan et al., 2007). Transcripts produced in Kiswahili were subsequently translated into English and cross-checked against the original audio files by the research team to ensure semantic accuracy and consistency, and to enhance the trustworthiness of the data (Ryan et al., 2007). All study materials, including audio recordings and transcripts, were securely stored on password-protected computers accessible only to the research team, ensuring confidentiality, data integrity, and compliance with ethical research standards.

Data analysis

The IDI and FGD transcripts were analysed using thematic analysis in Atlas. TI version 9 software for qualitative analysis. The Atlas.ti software was used to systematically organize the analysis process to increase the rigour of the study. The iterative thematic analysis was done using the framework suggested by Braun and Clarke (2006) involving six steps: (1) Data familiarization which began at the field during data collection, during transcription of audios and through repeated reading of transcripts. Next step (2) involved generating initial codes systematically across the dataset. At this stage, the transcripts were loaded into the ATLAS.ti software that helped to systematically organize the coding and entire analysis process. Coding was inductive, with meaningful sections of the dataset highlighted and labelled using the ‘*apply code*’ tab in the Atlas.ti home menu. Coding was undertaken alongside memo writing and analytical comments to capture emerging insights and reflections.

Next, step (3) involved grouping codes into potential themes. This was achieved by creating code groups in ATLAS.ti and organizing codes with similar meanings into them. Through this process, three broad themes were generated. Next step (4), themes were reviewed and refined by checking their coherence against coded extracts and the entire dataset. At this stage, themes were assessed for internal homogeneity and external heterogeneity to confirm that they captured meaningful patterns. The next step (5) involved defining and naming themes to capture their essence and core meaning. The final step (6) produces the final results, which include the actual participants’ quotes to reflect participant perspectives. At this stage, the ‘*code report*’ from the ATLAS. The TI software, which included the code groups or themes, memos, comments, codes and respective quotations, was downloaded in a Word document. The study’s result section was then written based on the downloaded output.

Trustworthiness

The trustworthiness of this qualitative study was ensured using the criteria of credibility, transferability, dependability, and confirmability, as proposed by Lincoln and Guba (1985). Credibility was enhanced through methodological triangulation, drawing on data from in-depth interviews, focus group discussions, and relevant literature. Member checking was also conducted, whereby selected participants reviewed preliminary interpretations of the findings to verify the accuracy and

authenticity of their perspectives, thereby strengthening the credibility of the results.

Transferability was supported by rich descriptions of the study context, setting, and participant characteristics, enabling readers to assess the applicability of the findings to comparable urban health systems. Dependability was ensured through transparent documentation of data collection and analysis procedures, including a systematic, iterative thematic analysis. Confirmability was reinforced through the maintenance of an audit trail comprising coded transcripts, analytical memos, and documented analytic decisions. Collectively, these strategies enhanced the methodological rigour of the study and strengthened confidence in the validity and trustworthiness of the findings (Savenye and Robinson, 2005; Ryan et al., 2007; Lincoln and Guba, 1985).

Results

Characteristics of participants

A total of 68 participants took part in the study, comprising 32 females and 36 males. In terms of educational attainment, 7 participants held postgraduate qualifications, 40 completed undergraduate degrees, and 21 had diploma- or certificate-level training. Most participants (56) had worked at their current institution for 3 years or more, while 12 had been there for approximately 2 years. Regarding professional experience, the majority (43) reported more than three years of work experience in their current position, whereas 25 had three years or less of experience. In terms of positions they served, 10 were CHMT members, 55 were health care providers, and 3 were University lecturers (Table 1).

Thematic findings

Analysis of the interview transcripts generated three broad themes describing climate change adaptation within urban health systems in Dar es Salaam. Participants reported ongoing adaptation efforts alongside persistent challenges in preparedness systems, workforce capacity, and institutional resources. The three broad themes were: (i) early warning and monitoring mechanisms; (ii) human resource capacity and training; and (iii) infrastructure and material resources for climate

TABLE 1 Distribution of study participants by category and role.

Participant category	Number	Role in study
CHMT members	10	Governance and policy oversight
Healthcare providers (IDIs)	25	Facility-level service delivery and emergency response
University lecturers	3	Academic and policy expertise
Healthcare providers (FGDs)	30	Shared frontline experiences
Total	68	

TABLE 2 Summary of major themes, key findings, and representative participant quotations.

Theme	Main message	Sample quotation
Early warning and preparedness mechanisms	Early warning and surveillance systems are available, but limited local specificity and poor integration of climate-health data constrain preparedness.	<i>"We usually receive weather information in advance... This gives us a signal on how to prepare and what medicines we should stock."</i> (IDI – Health facility in charge 2)
	Emergency response teams exist, but they operate mainly in response to emergencies and lack regular preparedness meetings.	<i>"Most of the time they do not meet often... it is once in a while."</i> (IDI – Health facility secretary 2).
Human resource and capacity building for climate change adaptation	Training opportunities for climate-related emergencies exist, but coverage is selective and refresher trainings are inconsistent.	<i>"Capacity building is provided, although not everyone can attend..."</i> (IDI – Health facility in charge 2)
	Staffing shortages and limited expertise reduce the ability of facilities to respond effectively during climate-sensitive emergencies.	<i>"Human resources are limited, and when an outbreak occurs, staff are split..."</i> (IDI – Municipal nutrition officer).
Infrastructure, institutional capacity and resources for adaptation	Policy frameworks for climate adaptation exist at municipal level, but they are not consistently translated into facility-level operational guidance.	<i>"Guidelines exist only when such incidents occur, but... there are none."</i> (IDI – Health facility OPD in charge)
	Limited infrastructure, inadequate emergency space, and constrained financial resources weaken adaptation capacity.	<i>"Our facilities... do not have designated emergency or isolation areas."</i> (IDI – Municipal nutrition officer)

change adaptation governance. Table 2 summarizes the key themes, key messages and illustrative participant quotations.

Early warning and monitoring mechanisms

Participants described how climate change adaptation and preparedness are organized within the urban health system. They emphasized the roles of multiple actors and the structures that guide coordination and response. These included formal governance arrangements, emergency and disaster committees, response teams,

surveillance systems, and communication channels linking national, municipal, facility, and community levels.

Existence of early warning mechanisms

Participants consistently reported the existence of early warning mechanisms that integrate climate and health information to anticipate risks and support preparedness before the occurrence of climate-related events. These mechanisms were described as relying on meteorological data, health surveillance information, and inter-sectoral coordination to inform timely response actions.

Several participants indicated that climate information generated by meteorological services is shared with the health sector and other authorities to guide preparedness and response planning. This integration was described as part of a broader disaster risk management system involving multiple national and sub-national institutions.

"There is disaster response integration. In the health sector, climate information is integrated so that when meteorological services predict rainfall patterns, health systems prepare accordingly. There is an integrated disaster risk management system involving the health sector, meteorological services, disaster response authorities, the Prime Minister's Office, and local government authorities. They receive real-time information, do modelling, and predict possible health impacts such as increases in communicable diseases or heat stress so they can prepare responses." (IDI – Lecturer 3)

Another health care worker added that weather information is used for planning and purchasing important emergency items, such as medicines.

"We usually receive weather information in advance. For example, we are informed if there will be heavy rains. This gives us a signal on how to prepare and which medicines to stock to cope with the situation. We plan so that when patient numbers increase, resources, medicines, and supplies remain sufficient. At the same time, there is an emergency team in place" (IDI – Health facility in charge 2)

While the presence of such early warning information was acknowledged, participants also noted limitations in the level of detail and localization of meteorological forecasts. Some respondents reported that forecasts are often broad and region-wide, which may reduce their usefulness for localized preparedness and response.

"Forecasts are situation-based. They may predict strong winds affecting certain regions. However, sometimes rainfall is localized - one area gets heavy rain while another does not. If forecasts could be more specific at local levels, it would help." (IDI – Health facility in charge 2)

Participants further explained that when forecasts lack local specificity, communities and health actors may find it difficult to interpret or act upon the information.

"For example, if people are told there will be heavy rain in Dar es Salaam, but in reality it rains heavily only in one area like Kigamboni, others may not understand or believe it. More

localized forecasting would be helpful.” (IDI – Health facility in charge 2)

Climate change-related disease and outbreak monitoring mechanisms

Participants described the existence of monitoring systems that track disease trends and climate-sensitive health outcomes, supporting early detection and response to emerging health threats. The most frequently cited mechanism was the Integrated Disease Surveillance and Response (IDSR) system, which was reported to function as a routine reporting platform for notifiable diseases. Participants explained that health facilities submit disease data regularly, and the information is reviewed at higher administrative levels to identify abnormal patterns or alerts that may signal potential outbreaks. One interview participant expressed:

“There is a system called IDSR – Integrated Disease Surveillance and Response. IDSR is a reporting system for notifiable diseases, such as diarrhoea, vomiting, and dog bites. These diseases are reported weekly. People at higher levels collect the data, and when they see alerts... they investigate the nature of those cases and give us cautionary guidance.” (FGD – Health facility in charge 1)

The monitoring process was also described as supported by designated personnel at the facility level, responsible for reporting outbreak-related information.

“There is a person responsible for reporting information, especially when there is a disease outbreak.” (IDI – Health facility RCH in charge)

However, some participants reported limitations in the depth and consistency of monitoring practices, noting that attention is often directed toward managing health outcomes after they occur rather than proactively tracking climate trends or early warning indicators.

“Not sufficiently. Many are not actively monitoring climate change trends. They tend to focus on outcomes rather than ongoing monitoring and early warning signs.” (IDI – Health facility laboratory in charge)

Lack of data on climate change

Participants consistently reported significant challenges related to the availability, accessibility, and organization of climate change-related data, especially data linking climate trends with health outcomes. A recurring concern was the absence of a centralized and accessible data platform to support analysis of historical and real-time information for planning and decision-making. Participants described situations where data were reported to exist but were difficult to locate or access in practice.

“Sometimes you are told that data exists in a certain place, but when you go there, it is not available... We lack a central, accessible, transparent data platform. Research findings are scattered,

and access depends on personal networks rather than systems.” (IDI – Lecturer one)

Although the health sector was described as having relatively stronger surveillance and early warning mechanisms compared to other sectors, participants emphasized that integrated climate–health data remains limited, affecting planning and evaluation processes.

“Although the health sector performs relatively well... climate-related data linked to health is still limited. This affects national adaptation planning and our ability to understand where we are and why certain impacts are occurring.” (IDI – Lecturer one)

Participants further highlighted gaps in vulnerability assessments, noting that effective climate change adaptation requires localized data at the council, city, and national levels. The absence of comprehensive, context-specific assessments linking meteorological trends, population dynamics, and health impacts was reported as a key challenge.

“Another thing is vulnerability assessment, you may have heard of it, vulnerability assessment in climate change, you need databases at the council, city and national level. Challenges in Dar es Salaam differ from Iringa or Mwanza. Have they done an assessment in Dar es Salaam? Linked it with TMA, trends, impacts, population growth and health impacts, if not, that is a challenge.” (IDI – Lecturer two).

Existence of emergency response teams in the urban health system

Participants reported the presence of emergency response teams operating within the urban health system, especially at municipal and facility levels. Established to manage health-related emergencies associated with climate-sensitive events. These teams were described as formally designated and multi-disciplinary, with responsibilities covering preparedness and response to a range of emergencies. Several participants explained that emergency teams exist in all health facilities and are supported through orientation and capacity-building activities provided by the Ministry of Health. Team membership was described as flexible, with replacements made when staff are transferred, and periodic training conducted to maintain readiness. One participant said that:

“Every facility has an emergency team that handles all emergencies. They also receive orientation from the Ministry and, based on outcomes, continue to build their capacity. If a staff member is transferred, another is assigned, and every year there must be various capacity-building trainings. The facilities themselves also have internal units for emergency activities, and they implement them whenever emergencies occur.” (IDI – Municipal health secretary 1)

However, participants noted that these teams are generally structured to respond to emergencies in general, rather than being specifically dedicated to climate change. Climate-related health events were addressed when they manifested as emergencies, such as outbreaks or disasters, rather than as part of a standalone climate change response structure.

“The team we have is the emergency team – not specifically for climate change. It is just for when disasters occur. For example, cholera, mpox, or dengue. But for climate change itself, there isn’t one – unless an emergency happens.” (IDI – Health facility in charge 3)

In addition, participants indicated that although emergency response teams are established and expected to remain prepared, they do not meet regularly. Meetings were described as occurring occasionally, often in response to specific events rather than through routine scheduling.

“Most of the time they do not meet often. There is no regular meeting schedule. It is a team that remains ready for whatever may happen, but if you ask whether they meet, it is once in a while.” (IDI – Health facility secretary 2).

Overall, participants reported that while early warning systems, disease surveillance mechanisms, and emergency response structures were present within the urban health system, challenges remained in the availability of localized forecasts, integration of climate-health data, routine monitoring of climate trends, and the regular functioning of emergency response teams.

Human resource and capacity building for climate change adaptation within the urban health system

Participants described the human resource capacity for climate change adaptation in terms of staff availability, skills, training opportunities, and preparedness for climate-sensitive health emergencies. Across interviews, respondents highlighted both the presence of training and research institutions and the persistence of gaps between required and existing human resource capacity at the facility and municipal levels.

Availability of health and climate change training institutions

Participants reported the existence of academic and professional institutions engaged in education and research at the intersection of climate change, environment, and health. These institutions were described as contributing to climate change adaptation both directly and indirectly through research, training, and policy-oriented work.

“.....we also have a College of Health and Allied Sciences, with researchers focusing on health policy, environment, and climate change. So, implementation of climate change actions is both direct and indirect.” (IDI – Lecturer 3)

Staff training and capacity building on climate change adaptation

Participants indicated that training programs are a key mechanism for building staff capacity in managing climate-related health emergencies. Trainings were reported to focus primarily on outbreak preparedness, personal protective equipment for health workers, and patient education, often initiated by ministries or higher authorities following the identification of emerging health threats.

“The main actions that we usually take are training first, for our staff, to train them in case an outbreak occurs and so on. For

example, when ministries have already detected something, they instruct the provision of various trainings to ensure that staff first protect themselves, and also educate patients at our health facilities.” (IDI – Health facility secretary 2).

However, participants also noted limitations in the reach and continuity of these training efforts. Training opportunities were described as selective, with only a small number of staff able to attend sessions at regional or district levels, after which information is shared with colleagues upon return. One participant reported that:

“Capacity building is provided, although not everyone can attend... usually two or three staff attend, and when they return, they give feedback to the rest of the team.” (IDI – Health facility in charge 2)

In addition, refresher training was reported to be irregular, with capacity-building activities often conducted after outbreaks rather than during periods of preparedness.

“Members are trained to respond to various emergencies... the challenge is that during calm periods, refresher trainings are not conducted. Training often happens only after an outbreak occurs.” (FGD – Health facility nursing in charge)

Inadequate human resource capacity at health facility and municipal levels

Participants consistently reported staffing shortages and a lack of specialized expertise at both the health facility and municipal council levels. Emergency response was described as requiring multiple inputs, including skilled personnel, equipment, and supplies, which were reported to be insufficient in many settings.

“Institutional capacity at the hospital level is very low... we lack a lot. Sometimes patients come, and we can only partially manage them. Staff who respond to outbreaks may not be adequately compensated, and protective equipment is insufficient.” (FGD – Health facility in charge 1).

Staff shortages were also reported to affect service organization during outbreaks, with available personnel divided between emergency response and routine service provision.

“Human resources are limited, and when an outbreak occurs, staff are split; some handle outbreaks, others continue routine services. That creates challenges because outbreak response becomes weak and routine services also become weak.” (IDI – Municipal nutrition officer).

Participants further described how limited staffing leads to extended working hours during emergencies. One health care worker observed that, “...you were supposed to leave at 3 p.m., but you are told to stay until 8:30 p.m. You work extra hours.” (IDI – Health facility in charge 3).

Infrastructure and material resources for adaptation

Participants described infrastructure, institutional capacity, and resources as key foundations for climate change adaptation within the urban health system. Their accounts focused on the availability of

physical infrastructure, adaptation frameworks, equipment, supplies, and financial resources, as well as the constraints that influence preparedness and response to climate-sensitive health events. Respondents highlighted that adaptation capacity is shaped by both material resources and institutional arrangements for mobilizing and allocating funds.

Existence of institutional climate change policies and guidelines in the urban health system

Participants reported mixed experiences regarding the presence of institutional policies, guidelines, or standard operating procedures related to climate change within the urban health system. These experiences varied notably between municipal-level actors and frontline health facility staff. At the municipal level, participants described the presence of formal policy frameworks that guide climate change adaptation within the health sector. These frameworks were reported to be aligned with national policy instruments and were described as key reference documents for mainstreaming climate change considerations into health system planning and response.

“Yes, we have legal frameworks where the council established key policies and frameworks to guide climate change adaptation in health systems. The primary document is the Health National Adaptation Plan (HNAP) for 2025–2050, which mainstreams adaptation into health policies to build resilience against climate impacts.” (Municipal medical officer)

In contrast, participants at the health facility level frequently reported limited access to, or absence of, written institutional guidelines specifically addressing climate change adaptation. Several respondents explained that guidance is typically provided reactively, once an outbreak or emergency has already occurred, rather than through standing protocols. One participant observed that:

“If an outbreak happens, they tell us what to do – for example, to prepare a room. If a patient comes with malaria or suspected mpox, we put them in a holding room and report the case. Guidelines exist only when such incidents occur, but to say there are standing guidelines – there are none.” (IDI – Health facility OPD in charge)

Other participants noted that facility-level actions are often guided by routine operational practices rather than formalized climate-related policies or written procedures.

“We follow routine procedures rather than formal guidelines. When it rains, certain actions are automatically taken as part of daily operations, inspections, and evaluations. These are standard practices, but they are not written guidelines.” (IDI – Health facility environmental health officer)

Health facility buildings and physical space for emergency response

Participants reported challenges related to the physical design and layout of health facility buildings, particularly in relation to managing climate-sensitive and infectious disease emergencies. It was noted that

many facilities were not originally designed with designated emergency or isolation spaces, which affects how services are delivered during outbreaks. One participant explained that, depending on the nature of the disease, transferring patients may not be appropriate due to the risk of further transmission. In such situations, facilities are required to repurpose existing rooms to serve as isolation areas, resulting in the separation of routine and emergency services within the same physical infrastructure.

“Sometimes we should not transfer patients because that will spread the disease more. As they are built, our facilities do not have designated emergency or isolation areas. So challenges arise. If a doctor is told, ‘Do not enter this room again, this is now an isolation room,’ and others are redirected, that is when you start distinguishing routine services from emergency services. So it affects the health system.” (IDI – Municipal nutrition officer)

In addition to the absence of designated emergency spaces, participants emphasized the need for adequate physical infrastructure, particularly sufficient buildings and properly designed isolation units within health facilities. It was reported that limited space in buildings makes it difficult to separate infectious patients from those seeking routine care, especially during outbreaks such as cholera. One participant noted that isolation is often constrained by the small number of buildings available at lower-level facilities, which complicates emergency response and increases operational challenges. While higher-level facilities may have designated isolation units and receive targeted equipment, similar arrangements were reported to be limited at primary and facility levels.

“There should be enough buildings. Second, there should be proper isolation areas, because you cannot mix a cholera patient with other regular patients. But often our hospitals have few buildings, so isolation becomes difficult. At higher levels, they usually designate specific units for isolation at the district level and send equipment there. But at our level, if we had such arrangements, it would also help, even though some support does come.” (IDI – Health facility RCH in charge)

Another participant highlighted that, in the absence of standard isolation units, facilities sometimes rely on temporary or inappropriate spaces, such as detention rooms, which do not meet required standards. It was also reported that isolation camps are occasionally established after outbreaks have already begun, resulting in delayed responses.

“Many health facilities lack standard isolation areas, and patients are often placed in inadequate detention rooms. Sometimes, isolation camps are established only after outbreaks occur, which takes time and allows further transmission. Proper facilities should be built to meet isolation standards.” (FGD – Health facility in charge)

Planning and budgeting for climate change adaptation activities

Participants consistently described planning and budgeting for climate change adaptation as largely guided by national frameworks and budgetary guidelines rather than by explicit local-level climate

vulnerability assessments. Across interviews, respondents indicated that health facilities and councils follow standardized budget structures that specify expenditure proportions for different cost items, with limited flexibility.

Planning processes were reported to be guided by municipal budget ceilings, institutional revenue collection, and prior experience with emergencies. After accounting for mandatory expenditures such as medicines and staff entitlements, the remaining funds are assessed and allocated to address anticipated emergency needs, including staff overtime, short-term training, and the procurement of emergency-related equipment. A CHMT member reported the following:

“We have a budget guideline that guides us in preparing facility budgets. In that guideline, it is directed that certain percentages go to medicines and others to other items. When we review, we also consider guidance from our senior management and the ceiling set by the municipality. Because as a health facility, we are given a ceiling, maybe one billion, let's say, based on our collections. From that one billion, after deducting medicine revenues and staff entitlements, we assess emergency needs. We must allocate funds for short-term training, staff overtime for service provision, and emergency equipment purchases. So we plan based on the ceiling allocated by the municipality and the magnitude of problems we have previously experienced”. (IDI – Health facility secretary 1).

Inadequate capacity and resources for climate change adaptation

Participants reported multiple constraints across infrastructure, financial resources, human resources, and equipment, which they described as limiting the health system's ability to respond effectively to climate-related emergencies. While some level of preparedness was acknowledged, participants emphasized that the scale and unpredictability of emergencies often exceed existing capacity. Several participants explained that although emergency budgets exist, they are insufficient when large-scale or prolonged events occur. Experiences from previous emergencies, such as the COVID-19 pandemic, were cited as examples of situations in which financial and institutional capacity were stretched beyond planned limits.

“As a department, we prepare for emergencies, but you cannot predict how much an emergency will cost. We do have a direct budget, but if the problem is big, costs increase. For example, during COVID-19, challenges were many, and facilities and departments struggled to fulfil daily responsibilities” (IDI – Municipal health secretary 1)

Participants also described how the magnitude of disasters determines the level of strain on available resources, including finances, staff, and equipment. Some events were reported as unprecedented, creating additional challenges for governing the preparedness and response.

“Challenges occur when a disaster happens. I mean, you can prepare, but it depends on the magnitude of the disaster when it occurs. There may be challenges related to resources, including financial resources, staff, and equipment. And here we have even witnessed disasters that we had never experienced before, like last

year when those buildings collapsed in Kariakoo”. (IDI – Health facility secretary 1)

Participants further highlighted limitations in diagnostic infrastructure and working tools, noting delays associated with sample referral and procurement processes when diagnostic capacity is not available on-site.

“When we get samples, they have to be sent elsewhere for diagnosis... if we had our own infrastructure for diagnosis, it would simplify things greatly.” (Municipal nutrition officer)

Financial constraints were also linked to staff motivation and compensation, most especially during outbreaks that require additional duties and extended working hours. One of the participants observed that:

“During outbreaks people must be paid since it is extra work, they are doing additional duties.” (IDI – Health facility in charge 5)

Challenges with power supply and temperature control were reported to affect equipment performance, especially under high-temperature conditions.

“One major challenge is the lack of generators capable of supporting all equipment, including air conditioners and fans. Sometimes equipment indicates it should operate within certain temperature ranges, but the actual room temperature exceeds those limits, reaching 32–36 degrees Celsius. This mismatch creates serious operational risks”. (IDI – Health facility laboratory in charge 1).

Despite these constraints, one participant reported a contrasting experience, indicating that some facilities have adequate resources for response. *“We are capable because, first, we have enough vehicles; second, we have enough staff.”* (IDI – Health facility in charge 5).

In general, participants reported that although some planning mechanisms, policy frameworks, and emergency resources were available, health facilities continued to face challenges related to inadequate infrastructure, limited physical space for emergency response, insufficient diagnostic capacity, and financial and material resource constraints.

Discussion

This study explored the capacity of urban health systems in Dar es Salaam to govern climate change adaptation actions. We found a complex reality in which foundational adaptation efforts are in place, including the implementation of early warning mechanisms, the establishment of emergency response teams, and the integration of emergency planning into facility budgets. However, these adaptive actions are critically undermined by systemic governance constraints. We identify persistent gaps in governance capacity, characterized by fragmented preparedness, significant shortages in human resources and skills, limited infrastructure, inadequate data systems, and funding deficits. These gaps limit the health system's ability to translate existing adaptation efforts into resilience against escalating climate-health risks as desired national and global goals for ensuring a

climate-resilient health system (WHO, 2023; MoH, 2025). Taken together, these findings indicate that while adaptation structures exist, weaknesses in their operationalization constrain the health system's overall readiness to respond effectively to climate-related health risks.

We found that early warning and preparedness mechanisms are present within the urban health system in Dar es Salaam and are embedded within broader disaster risk management arrangements that link meteorological services, health authorities, and other government institutions. The integration of climate and health information enables anticipatory actions, such as emergency planning, prepositioning of medicines, and activation of response teams, reflecting the growing recognition of climate-related health risks within the health system. Similar to global and national policy aspirations, including the Tanzania Health National Adaptation Plan (H-NAP) and WHO guidance (WHO, 2023; MoH, 2025), these mechanisms demonstrate an institutional foundation for climate-sensitive preparedness and coordinated response. Such integration is an essential prerequisite for building climate-resilient health systems, as it supports early detection of risks and timely mobilization of resources (Ansah et al., 2024; IPCC, 2023; Olu, 2017).

However, despite the existence of these mechanisms, our study reveals important limitations that constrain their effective governance. Participants consistently highlighted the lack of localized and actionable climate forecasts, which reduces the utility of early warning information for facility-level planning and community preparedness. Broad, region-wide forecasts were perceived as difficult to interpret and insufficient for guiding localized decision-making, particularly in highly heterogeneous urban settings. In addition, disease surveillance systems such as IDSR were largely oriented toward reporting health outcomes after they occur, rather than proactively linking climate trends with disease risk monitoring. These findings align with evidence from Ansah et al. (2024), who reported insufficient preparedness, weak surveillance of climate-sensitive vulnerabilities, and limited use of integrated assessment approaches across health systems in a scoping review of global evidence.

The observed gaps in early warning specificity, proactive surveillance, and climate-informed monitoring weaken the governance of climate change adaptation and limit the health system's ability to plan, budget, train personnel, and coordinate responses effectively. As emphasized in the literature, resilient health systems require robust early warning systems supported by quality diagnostics, innovative technologies such as remote sensing, and routine epidemiological surveillance that explicitly incorporate climate-sensitive diseases (Ansah et al., 2024; WHO, 2023; MoH, 2025). Without reliable localized climate-health intelligence, preparedness actions remain reactive, reducing the effectiveness of adaptation planning and weakening institutional responsiveness during climate-related events. Therefore, targeted investments are required to ensure localized climate forecasting, integrated climate-health surveillance, and modern data systems, for the urban health systems in Tanzania to achieve the national and global resilience benchmarks.

Our findings indicate that the emergency response teams established within the health systems are largely reactive and event-driven, with limited orientation toward anticipatory climate change adaptation. Teams were not specifically structured to address climate risks unless these manifested as acute emergencies, and the absence of routine meetings constrained preparedness, learning, and coordination. This reactive posture mirrors broader challenges identified in the literature, where climate-related stresses increasingly threaten primary

healthcare readiness, human resources, and supply chains (Singh et al., 2020). Strengthening resilience, therefore, requires a shift from general emergency response to climate-informed preparedness, including regular team engagement, integrating climate risk assessment into emergency planning, and stronger community participation (Ansah et al., 2024; Singh et al., 2020).

In the present study, we found that while institutions engaged in climate-health education and research exist and contribute to adaptation efforts, their potential is not fully translated into strengthened operational capacity within the urban health system. Training initiatives were largely oriented toward outbreak response and personal protection, often triggered after emerging threats are detected, rather than embedded within routine preparedness processes. The selective nature of training, limited staff coverage, and irregular refresher sessions constrained the diffusion and sustainability of climate-related competencies at the facility level. These observations are consistent with earlier studies in Tanzania and LMICs that documented weak institutional capacity, limited knowledge of climate change policies and vulnerability assessments, and inadequate skills among local government officials responsible for planning and implementation (Shemdoe et al., 2015; Ampaire et al., 2016; Nemer et al., 2025). From a resilience perspective, the absence of systematic, continuous, and inclusive capacity-building limits the health system's ability to anticipate climate risks and undermines proactive governance of adaptation actions (Ansah et al., 2024; Nemer et al., 2025).

In addition to training gaps, persistent shortages of human resources and specialised expertise further weakened preparedness and governance capacity at both municipal and facility levels. Participants described how limited staffing forced health workers to balance outbreak response with routine service delivery, resulting in compromised care and increased workload during climate-sensitive emergencies. This indicates that workforce shortages not only affect service delivery but also reduce the system's flexibility to absorb additional climate-related shocks, thereby undermining adaptive capacity. These challenges reflect broader pressures facing health systems, including rising burdens of communicable and noncommunicable diseases and constrained resources (Singh et al., 2020). In line with WHO recommendations on developing a climate-smart health workforce (WHO, 2023), strengthening urban health system resilience requires strategic investments in workforce expansion, retention, and climate-specific competencies (Ansah et al., 2024; Shemdoe et al., 2015). Embedding climate change into pre-service and in-service training, institutionalizing regular refresher courses, and ensuring adequate staffing levels would enhance adaptive capacity, protect frontline workers, and improve the continuity and quality of health services in the face of escalating climate-related health risks (WHO, 2023; Mash and Lokotola, 2025; Robinson et al., 2025).

We found that institutional climate change policies and adaptation frameworks exist at the municipal level and are broadly aligned with national instruments such as the H-NAP, providing an overarching policy foundation for climate-resilient health system governance. However, this policy presence was not consistently translated into operational guidance at the health facility level, where frontline actors reported limited access to written climate-specific protocols. Instead, adaptation actions were largely guided by routine practices and reactive instructions issued during emergencies. This gap between higher-level policy frameworks and facility-level implementation reflects institutional fragmentation and mirrors observations by (Ansah et al., 2024), who noted that weak organizational frameworks undermine

the timely deployment of adaptive measures. The absence of standardized, facility-level climate adaptation guidelines constrains anticipatory planning and limits the institutionalization of climate-informed decision-making within everyday health system operations (Lador et al., 2025).

In terms of physical infrastructure, the study revealed substantial constraints affecting emergency preparedness and response, especially at primary and lower-level facilities. We found that many health facilities lacked designated isolation or emergency spaces, forcing staff to repurpose existing rooms or rely on temporary, substandard arrangements during outbreaks. Such practices complicate service delivery, increase the risk of disease transmission, and strain routine operations. These infrastructural limitations reduce health facilities' ability to respond rapidly and safely during emergencies, thereby weakening resilience to climate-sensitive disease outbreaks. These infrastructural gaps are consistent with evidence from the literature indicating that inadequate facilities and organizational arrangements hinder effective governance of climate adaptation within health systems (Ansah et al., 2024). The lack of climate-resilient infrastructure, such as properly designed isolation units, sufficient space for buildings, a reliable power supply, and temperature-controlled environments, undermines the health system's capacity to respond safely and efficiently to climate-sensitive health threats (Manyele and Anicetus, 2025).

Our findings revealed that inadequate capacity and resource constraints remain a central barrier to effective governance of climate change adaptation within Tanzania's urban health system. Although emergency preparedness mechanisms and contingency budgets exist, participants consistently reported that these provisions are insufficient when confronted with large-scale, prolonged, or unprecedented climate-related emergencies. Experiences from the COVID-19 pandemic and recent urban disasters illustrate how rapidly financial, human, and material resources can be overwhelmed, forcing health facilities and municipal departments to operate beyond planned limits. Similar constraints have been widely documented in the literature, where insufficient and unpredictable financing, limited long-term investment, and difficulties in mobilising resources have been shown to undermine health system adaptation to climate change (Ansah et al., 2024).

Globally, resource shortages for effective climate adaptation governance are evident and have been associated with widespread service disruptions, excess mortality, and significant indirect health impacts during climate crises (Singh et al., 2020). During the COVID-19 pandemic, for example, inadequate healthcare resources led to disruptions in more than 50% of essential health services across 129 countries, contributing to an estimated 14.91 million excess deaths within 24 months (Singh et al., 2020). Similarly, the 2020 Lancet Countdown report indicated that although approximately half of surveyed countries had developed national health and climate change strategies or plans, only 9% had secured sufficient financing for implementation (Watts et al., 2021; Singh et al., 2020). These global experiences demonstrate how resource shortages and low investments in the health system weaken the system's capacity to govern the climate adaptation actions for resilience.

Without sustained financing, climate-resilient infrastructure, and strong governance mechanisms to ensure efficient resource allocation and oversight, urban health systems remain vulnerable to service disruptions during climate emergencies. Strengthening the health system governance requires predictable and adequate financing for emergency health services, investments in diagnostic and energy

infrastructure, and workforce support mechanisms that maintain staff motivation and performance during crises (Olu, 2017; Manyele and Anicetus, 2025). These investments are essential for enabling the health system to move from reactive emergency response toward proactive climate adaptation planning and resilience building. Available evidence in the literature emphasizes that robust health governance combined with adequate financial and logistical resources is essential for coordinated disaster response and for safeguarding population health in an increasingly climate-stressed urban context (Olu, 2017).

Conclusion

While municipal health systems in urban Tanzania have initiated climate change adaptation actions, the governance of these efforts remains constrained by uneven and inadequate institutional capacity. Preparedness and response mechanisms are fragmented and undermined by persistent shortages in human resources, infrastructure, climate-health data, and sustainable financing. These limit the effectiveness of early warning systems and coordinated planning. As a result, urban health systems remain insufficiently resilient to the escalating and complex health risks posed by climate change. The findings demonstrate that the presence of adaptation structures alone is insufficient without the institutional capacity, operational coordination, and resources required to sustain effective implementation. Strengthening climate-resilient health governance will require coordinated investments in workforce development, infrastructure improvement, integrated climate-health information systems, sustainable financing, and clear operational guidance to enhance preparedness and build resilience within urban health systems.

Potential study limitation and mitigation

The study might have been exposed to potential response and social desirability bias. As the study relied on self-reported data from participants involved in health system governance and service delivery, responses may have been influenced by social desirability or institutional positioning, especially when discussing system weaknesses or governance performance. To mitigate this, data were triangulated across in-depth interviews, focus group discussions, and multiple stakeholder categories to validate emerging findings. Participants were assured of confidentiality and anonymity, which encouraged open and honest discussion of challenges and constraints.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

Ethical approval was obtained from the National Institute for Medical Research (NIMR) (Ref: NIMR/HQ/R.8a/Vol.IX/5102), in compliance with national and institutional ethical standards.

Voluntary informed consents were obtained from all participants. Confidentiality and anonymity were strictly maintained. No personal identifiers were recorded or disclosed in any reports, publications, or presentations arising from the study. Interview transcripts, focus group recordings, and related documents were securely stored and accessible only to the research team. Data were protected using password-secured digital files and locked storage for physical materials. Participants were also informed about how their data would be used and were assured that findings would be reported in aggregated form to prevent individual identification.

Author contributions

LM: Formal analysis, Project administration, Methodology, Funding acquisition, Conceptualization, Writing – review & editing, Writing – original draft. NO: Conceptualization, Writing – review & editing, Methodology, Funding acquisition, Writing – original draft, Formal analysis. FC: Writing – original draft, Formal analysis, Writing – review & editing, Conceptualization, Funding acquisition, Methodology.

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Conflict of interest

The author(s) declared that this work was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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