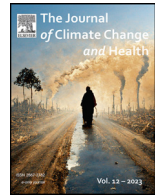




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## Research article

## ‘Q-Storming’ to identify challenges and opportunities for integrating health and climate adaptation measures in Africa

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## ABSTRACT

**Introduction:** Climate factors influence the state of human health and wellbeing. Climate-related threats are particularly being experienced by vulnerable populations in Africa. A Question (Q)-Storming session was convened at an international climate adaptation conference. It promoted dialog among a diverse spectrum of researchers, climate and medical scientists, health professionals, national government officials, civil society, business, and international governing organizations. The session identified approaches for the effective integration of health within African national climate adaptation policies.

**Materials and methods:** Two organizations partnered to convene the session at the Adaptations Futures 2018 Conference in Cape Town. Q-storming (which is an inverse approach to brainstorming) was applied to extract ideas from all participants. Four topics were presented during the session: (i) adaptive capacities related to climate change and infectious diseases; (ii) adaptive capacity of African governments in relation to health and climate change; (iii) making climate science work to protect the health of vulnerable populations; and (iv) making climate-health research usable.

**Results:** Nine cross-cutting adaptation themes were generated (i.e. key definitions, adaptive capacity, health sector priorities, resources, operational capacities and procedures, contextual conditions, information pathways, and information utility). The Q-Storming approach was a valuable tool for improving the understanding of the complexities of climate-health research collaborations, and priority identification for improved adaptation and service delivery.

**Conclusion:** Concerted recognition regarding difficulties in linking climate science and health vulnerability at the interface of practitioners and decision-makers is required, for better integration and use of climate-health research in climate adaptation in Africa. This can be achieved by innovations offered through Q-Storming.

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## 1. Introduction

Evidence of links between climate change and human health is growing – despite sparse research on low-and-middle-income countries (LMICs) [1,2]. Extreme weather events cause injury, loss of life

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and livelihoods. Simultaneously, increasing temperatures and infectious diseases put populations at risk [1]. Research and evidence generation from multi-disciplinary approaches are needed to support under-resourced and information-poor health systems. This promotes resilience to climate-induced health risks, and addresses misinformation and knowledge gaps [2–10]. Disconnections between key national sectors (i.e. ministries, departments, and research institutions) hinder effective planning and implementation of responses to emerging and exacerbated health risks [11,12]. Interdisciplinary efforts regarding policy, planning and research are essential to impact climate change on health and wellbeing particularly in LMICs [13–15]. Integration of climate information in medium- to long-term development and national agendas is significant to health system strategies [6,9,16], playing a key role in improving health services. This also limits the health burden and human costs of climate change [17].

With few multi-sectoral studies commissioned and most funded internationally, priority health burdens remain under-researched. National research capacities struggle to compete [6,18,19]. In Africa, key technical and analytical capacities, such as field epidemiology, data collection/management and laboratory infrastructure, are often inadequate, resulting in health systems unable to adequately respond to major public health disasters at many levels [11,15,20–22]. Moreover, unified strategies for integrating multi-sectoral approaches, resource mobilization and logistics support for public health climate emergencies must be fully defined [18,23,24]. Therefore, innovative approaches are needed to clearly identify these health challenges and how African country adaptation strategies can address them.

Comprehensive, systemic integration of seasonal variability and climate change information and related health implications is needed to prepare fragmented health systems against climate risks for improved service delivery and population health [24–26]. Without effective institutional integration, climate services such as health early warning systems or risk products (e.g., infectious disease surveillance, established climate-health risk metrics, advanced predictive capabilities for seasonal variability modeling, multi-sectoral knowledge dissemination tools and strategies) may be unable to inform varied decision-makers at the correct scales and levels [27,28]. Improved recognition of climate-induced (e.g., heat stress) or climate-amplified (e.g., non-communicable/vector-borne diseases) health risks is essential for effective integration and use of climate information. This is essential within African health systems and under-funded research programs, and for under-informed public officials [2,22,29–32]. This includes research into health risks as well as government's capacity to adapt and respond and enact appropriate policies to protect vulnerable groups.

Integration of climate and health research requires wider adoption of new approaches to all educational aspects and enhancement of skills in knowledge synthesis, across sectors and disciplines. This requires identification of new and emerging threats, particularly in under-funded or under-recognized areas. Appropriate mechanisms to leverage existing information and evidence; integrated with information from different sectors to improve responses from various stakeholders, is also required. In line with the World Health Organization's (WHO) "health in all policies" and "climate change and health adaptation and vulnerability" approaches, the authors advocate for health to be integrated into all climate-related policies and disciplines [33,34]. The challenge that remains is its effective implementation.

To better understand and define the multidimensional and complex challenges for effective integration and use of climate and health information, the "Question-Storming" approach (Q-Storming) was applied with key stakeholders. It identified complex challenges in Africa for improved awareness of climate and health links and ways to integrate this information across/between sectors.

## 2. Materials and methods

### 2.1. Q-Storming conference session and approach

Q-Storming is an innovative way to extract information while breaking down barriers between diverse groups. Q-Storming discussions occurred during an interactive session at the *Adaptations Futures 2018 Conference* entitled: *Integrating health and climate adaptation measures in Africa*. A joint session was also led by the Public Health Association of South Africa Special Interest Group on Climate, Energy and Health (PHASA SIG CEH) [35] and Clim-HEALTH Africa [36], an international network for climate and health for Africa, coordinated by the WHO. Its objective was to promote dialog among a diverse group of stakeholders and identify effective approaches for integrating health within African national climate adaptation policies.

Initially conceived as a brainstorming technique in the 1950s, 'Q-Storming' has become the inverse of brainstorming. It solicits well-stated questions in an area of interest [37]. Q-storming has been applied in various scenarios [e.g., dental clinical practice, web-based injury learning; 37,38,39]. This technique has not, however, been applied in public health. Benefits of 'Q-Storming' include an independent process of question-thinking from the moderator and freedom of participants to pose any question without criticism. All questions raised during 'Q-Storming' are captured and analyzed to understand the flow of questions and key discussion topics/sub-topics generated. Specific questions are interrogated to reach a consensus on actionable activities and tasks to address the question and elicit problem-solving. 'Q-Storming' also helps establish the 'meta-question' associated with a problem. It asks, 'what are the best questions we should currently be asking about the issue?'

Prior to the Q-Storming session, an in-depth scoping review of the climate- and health-related scientific literature was conducted by the Organizing Committee, identifying multi-disciplinary challenges and adaptation needs across African climate and health domains. Key discussion topics and overall development took place over 10 months. It included iterative planning and development phases (September 2017 - June 2018). The protracted planning process demonstrated the complexities of integrating climate and health, alongside the multitude of varied approaches to defining risk, understanding vulnerabilities, and multiple actors. Pre-session work defined specific topics and a logical approach to managing the diverse interests and expertise of session participants. Key selected topics presented the pressing needs and reflected the multi-disciplinarity required to appropriately define, understand, and develop climate change and health adaptation strategies.

The final four key 'climate and health' topics impacting adaptation within Africa were identified for the Q-Storming session as: 1) Adaptive capacities related to climate change and infectious diseases; 2) Adaptive capacity of African governments – health and climate change; 3) Making climate science work to protect health of vulnerable populations; and 4) Making climate-health research usable.

### 2.2. Participants

Flyers, developed by the WHO's Climate Change and Health Team, were circulated via the conference secretariat, social media, organizing committee networks, and distributed during the conference. This Q-Storming session involved 47 participants from mid-twenties to mid-sixties (25 females, 22 males), including the organizing committee. In addition to varied expertise (e.g., climate specialists, public and environmental health specialists, development specialists, communication specialists) and disciplines (e.g., epidemiology, social science, public health, medicine, climate/earth science, communication), the session benefited from participants representing different countries (e.g., Benin, Kenya, Ethiopia, India, South Africa, Peru) and regions (e.g., North America, Asia, and Europe).

### 2.3. Q-Storming session process

**Phase 1:** The two-hour session included interdisciplinary presentations from four sectoral experts followed by interactive Q-Storming exercises. It was combined with another conference session because of the similarity in context and a lack of program space. The presentations from the other session provided case studies for participants to engage with before addressing issues in their groups related to climate change and health in Africa. The presentations included:

- Climate health and early warning systems for Rift Valley Fever in Kenya and implication for the broader health system (DG, Biometeorologist).
- A systems-based approach to climate and health in Africa - Promoting health, nutrition and wellbeing in the face of climate change (CP [climate science and livelihoods analyst] and RC [meteorologist]).
- Adaptive capacity of governments in East & West Africa to understand and respond to heat (CMD, climate scientist).

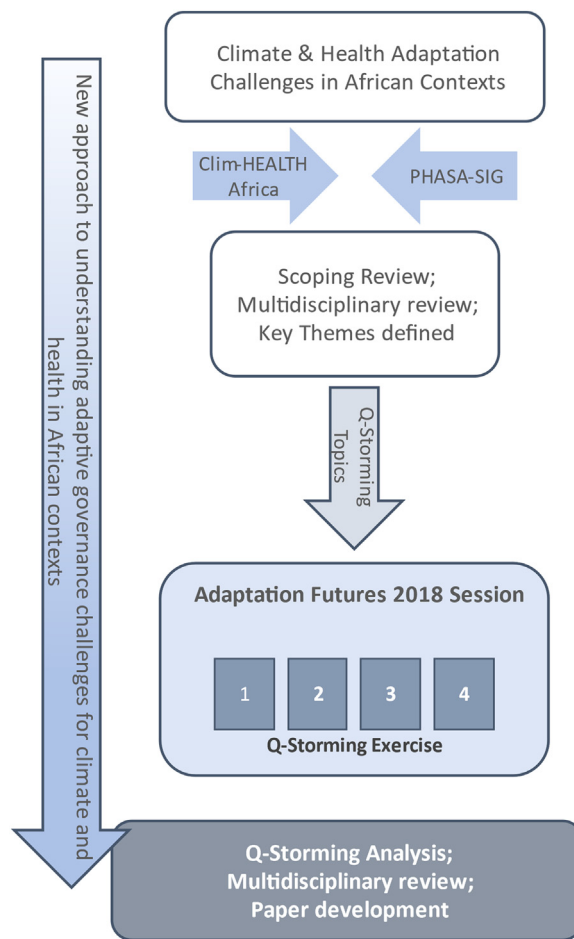
**Phase 2:** Participants were randomly assigned to four tables representing four key topics (listed in 2.1), ensuring that a range of ideas/experiences were reflected. Tables were given 10 min to generate as many questions as possible. Table facilitators, two per table, from the Organizing Committee, chose the topic of interest to moderate based on their interests and/or expertise. They described the topic and encouraged participants to raise questions. Each table topic was 'Q-Stormed' for its relevance to the wider problem/challenging situation and ideas for action were considered: who to address the question to, research, governance, policy, and practice perspectives, etc. Statements or ideas raised by participants needed to be rephrased as a question.

**Phase 3:** Next, table participants identified one prioritized question from their generated list of primary questions. These were then brainstormed by means of table discussion for 15 min. The brainstorming focused on solutions, adaptive capacity, stakeholders, and possible case studies. One person from each table presented the questions from the Q-storming process, and the suggestions to the session plenary for further discussion. Given time constraints, participants could not assess all questions generated.

### 2.4. Session data analysis

Findings from the scoping review informed a multi-disciplinary debate focused on four key topics (Fig. 1). Following Q-Storming, the questions, key discussion themes, and outputs of each topic were collated. Q-Storming questions, question flows, and the prioritized questions were reviewed, including perspectives from epidemiology, environmental sociology, public health, environmental management, and geography – identifying emergent and cross-cutting themes. Emergent themes were compared to the scoping review. This assessed outcomes and critical challenges (Fig. 2). Thematic debates informed how priorities, existing challenges, and opportunities for new approaches for adaptive governance of the climate health domain can be best addressed, thus improving research and service delivery. Reported outcomes were evaluated by the Organizing Committee and participants and stakeholders completed an inclusive and multidisciplinary review process.

A multi-staged approach was used to select questions for the Q-storming session, entailing multiple discussions and engaging with key stakeholders, prior to the session. Questions generated from the four group topics were categorized by the Organizing Committee according to nine adaptation themes cross-cutting all group discussions (Fig. 2). These themes were: key definitions, adaptive capacity, health sector priorities, resources, operational capacities and operational processes, contextual conditions, information pathways and



**Fig. 1.** Process of Identifying and analyzing key Q-storming topics. Clim-Health Africa and PHASA-SIG were the organizers of the session at the Adaptation Futures 2018 conference.

utility of information. Each group's list of primary questions was categorized accordingly. Following the Q-Storming brainstorm question session, each group assessed all available questions and prioritized the following questions as most 'emblematic' of the perceived challenges for African governments' effective adaptive capacities to health and climate change.

### 3. Results

The Q-Storming outcomes are presented in a composite table (Table 1) as the primary questions generated per group topic, categorized by the nine cross-cutting adaptation themes (Fig. 2). Not every group topic discussion covered all thematic elements. All group discussions generated questions from participants representing different sectors including the challenge of risk, operational capacities, resource allocation and competing health demands within non-aligned health risk timelines. The following 'prioritized questions' emerged:

#### Group 1 – Adaptive Capacity – Infectious Diseases

*How is the prevalence of infectious diseases affected by climate change? What adaptive strategies are needed to cope?*

#### Group 2 – Adaptive Capacity – African Governments

*How do we (health 'actors') prioritize immediate health needs with 'longer-term' impacts from climate change, and still meet pressing,*

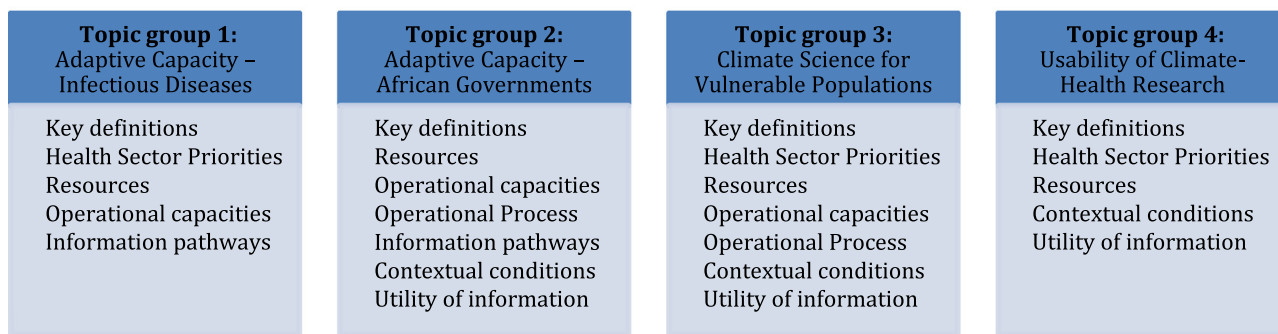


Fig. 2. Thematic Elements of Questions Generated for each Topic Group.

Table 1  
Q-Storming Example Questions Generated by Topic Groups (N = 4).

THEMES	EXAMPLE QUESTIONS
<b>Key Definitions</b>	<ul style="list-style-type: none"> <li>• What do we mean by adaptive capacity?</li> <li>• What is attribution, in our understanding?</li> <li>• Is attribution essential in talking about climate change and health?</li> <li>• Are there alternative systems of governance?</li> <li>• How do stakeholders define usability of climate change and health research?</li> </ul>
<b>Adaptive Capacity</b>	<ul style="list-style-type: none"> <li>• How does burden of disease impact someone's adaptive capacity to climate change?</li> <li>• How do we develop adaptive capacity?</li> <li>• Why are adaptation and development funded separately?</li> </ul>
<b>Health Sector Priorities</b>	<ul style="list-style-type: none"> <li>• What are the most relevant areas of health care related to climate science?</li> <li>• How do we introduce climate change and health into the health professional curriculum?</li> <li>• What are the most relevant areas of health care related to climate science?</li> </ul>
<b>Resources</b> (access, need, management)	<ul style="list-style-type: none"> <li>• How do we break through the 'silo' thinking in health and climate change in African governments?</li> <li>• Do we have enough data for policy makers to make decisions?</li> <li>• Where is the funding for this work?</li> </ul>
<b>Operational Capacities</b> (training people, access to data, archive systems)	<ul style="list-style-type: none"> <li>• How do we drive local climate change – health research to influence policy?</li> <li>• How do we manage governance versus governments? Is adaptive capacity influencing governments or governance?</li> </ul>
<b>Operational Process</b> (between different government departments supporting exchange of information and information flow)	<ul style="list-style-type: none"> <li>• What is needed to operationalize adaptive capacities?</li> <li>• How can climate science be internalized and acted on in a way that helps vulnerable people?</li> </ul>
<b>Information Pathways</b> (distribution of information outside of a single sector)	<ul style="list-style-type: none"> <li>• How are information pathways informing adaptation processes?</li> <li>• How do we grow the knowledge base of health – climate change connections?</li> </ul>
<b>Contextual Conditions</b> (culture, economics, politics, social)	<ul style="list-style-type: none"> <li>• What are the cultural understandings of adaptation and climate and health intersections?</li> <li>• Who provides the leadership to drive the addressing of the attribution barrier?</li> <li>• Is there a place for culture and tradition in planning health adaptation in Africa?</li> </ul>
<b>Utility of Information</b>	<ul style="list-style-type: none"> <li>• How do we make climate science more universally applicable?</li> <li>• How are local information and data informing adaptation processes?</li> <li>• Do we have enough data for decision making and for stakeholders?</li> </ul>

# The use of “We” refers to ‘climate and health’ actors (i.e., climate and health researchers, practitioners, policymakers, etc.).

immediate health issues (i.e., primary health care, maternal health, malnutrition)?

**Group 3 – Climate Science for Vulnerable Populations**

Why is it so difficult to make the institutional link between climate science and vulnerability?

**Group 4 – Usability of Climate-Health Research**

How do we define “usability” of climate change and health research?

Results of the prioritized questions' discussion highlighted gaps in knowledge that require research to answer these prioritized questions. Table 2 presents examples of brainstorming ideas generated.

**Table 2**  
Example results from group discussions of prioritized questions.

Group and Prioritized Question	Further Questions Identified (Challenges)	Example Solutions Identified (Opportunities)
<p><b>Group 1 – Adaptive Capacity – Infectious Diseases</b> How is the prevalence of infectious diseases affected by climate change? What adaptive strategies are needed to cope?</p>	<ul style="list-style-type: none"> <li>• How do governments administer data collected from different sectors and utilize the information to come to an informed decision?</li> <li>• How do governments cooperate worldwide and exchange shared information which can benefit local levels?</li> <li>• What do we mean by adaptive capacity?</li> <li>• How do we develop adaptive capacity?</li> <li>• Livelihood changes – how are those being pushed to limits (e.g. migrants)?</li> </ul>	<ul style="list-style-type: none"> <li>• Those responsible for budgets and ministers of <b>finance</b> need to conceptualize preventative health budgets as adaptation.</li> <li>• Translate the research – weather patterns, extreme events</li> <li>• Health department needs to <b>collaborate</b> with the environmental department</li> <li>• Shifting ecosystems of the vectors of water-borne diseases – need to <b>monitor</b></li> <li>• Research on indirect impacts (e.g., sanitation)</li> <li>• Adaptive strategies – <b>policy</b> (looking at human nutritional impacts)</li> <li>• <b>Stakeholder engagement</b></li> </ul>
<p><b>Group 2 – Adaptive Capacity – African Governments</b> How do we (health ‘actors’) prioritize immediate health needs with ‘longer-term’ impacts from climate change, and still meet pressing, immediate health issues (i.e., primary health care, maternal health, malnutrition)?</p>	<p><b>How do we prioritize health (immediate) and climate change (longer term issue) when other pressing issues are immediate (e.g., food insecurity)?</b></p> <ul style="list-style-type: none"> <li>• How define space for action, what is needed?</li> <li>• Is community led/ patient led action to determine immediate impacts around participation and decision, actually recommendable?             <ul style="list-style-type: none"> <li>- Where do ‘experts’ fit in?</li> </ul> </li> </ul> <p><b>Do we think the solutions are essentially political and institutional or knowledge and leadership based?</b></p> <ul style="list-style-type: none"> <li>• Which comes first?</li> <li>• How do we manage?</li> </ul> <p><b>Where is the leadership within governance of climate change/ health integration?</b></p> <ul style="list-style-type: none"> <li>- How do we reconcile with individualism and individualistic tendencies (e.g., lack of recognition, “what is in it for me?”)?</li> </ul> <p><b>Are we ready to use all this information at individual, community and institutional scales? Where are tipping points . . . . Will they exist only once we are too far gone?</b></p>	<p>Prioritize health and climate change within understanding as a ‘wicked problem’.</p> <ul style="list-style-type: none"> <li>• Highlighting successes (savings vs. costs) vs. need</li> <li>• Need for shift from ‘management’</li> <li>• Resource management, emphasizing savings vs costs</li> <li>• Get corporations/private sector on board</li> </ul> <p><b>Leadership involves:</b></p> <ul style="list-style-type: none"> <li>• Knowledge</li> <li>• Transparency</li> <li>• Benefit co-sharing</li> <li>• Recognition of interdependencies</li> </ul> <p>You must <b>start somewhere:</b></p> <ul style="list-style-type: none"> <li>• Need to join up agendas of national champions of climate and health to use existing evidence base and drive action</li> </ul> <p><b>Solutions</b></p> <ul style="list-style-type: none"> <li>• Identify and channel the knowledge gaps</li> <li>• Champions to create leadership</li> <li>• Illustrate business case savings vs costs – i.e. map resource management and adaptation with regard to savings</li> </ul> <p><b>Governance</b></p> <ul style="list-style-type: none"> <li>• Involve communities &amp; decision-makers as active key players</li> <li>• Share info openly, be willing and open to discussions</li> <li>• Show-case success stories</li> <li>• Prioritize active learning – an iterative process of learning</li> </ul>
<p><b>Group 3 – Climate Science for Vulnerable Populations</b> Why is it so difficult to make the institutional link between climate science and vulnerability?</p>	<ul style="list-style-type: none"> <li>• Why is it so difficult to institutionalize links around climate change and health care?</li> <li>• What are the key areas of health related to climate science? (Group used air pollution as an example – single biggest environmental contributor to burden of disease)</li> </ul> <p><b>Who should address this issue?</b></p> <ul style="list-style-type: none"> <li>• Leadership – Who provides the leadership to drive this?</li> <li>• Point of contact – What are the priority areas of health related to climate science?</li> <li>• Why is it so hard to institutionalize the links between climate change and health?</li> <li>• Is attribution absolutely necessary for talking about climate change and health?</li> </ul> <p><b>How should this issue be addressed?</b></p> <ul style="list-style-type: none"> <li>• In thinking about decision making influencing climate health, how do decisions get made?</li> <li>• Food security as a threat linked to climate change (especially those with HIV/AIDS)</li> </ul> <p><b>The group felt that to answer this question, the following questions should be addressed.</b></p> <ul style="list-style-type: none"> <li>• Is direct attribution essential in talking about climate change and health?</li> <li>• What are most relevant areas of health care related to climate science?</li> </ul>	<p><b>Solutions need to address:</b></p> <ul style="list-style-type: none"> <li>• <b>Institutional policies</b> around climate change are not linked to health- (e.g., generating electricity in South Africa and no consideration for environmental footprint)</li> <li>• <b>Governance</b> – not a good facilitator between climate science and those who protect vulnerable populations</li> <li>• <b>Departments of Health</b> are not on top of environmental issues – disparity between sectors in government</li> </ul> <p>Systems in place should connect with people and health, especially vulnerable populations (e.g. food security).</p>

(continued)

Table 2 (Continued)

Group and Prioritized Question	Further Questions Identified (Challenges)	Example Solutions Identified (Opportunities)
<p><b>Group 4 – Usability of Climate-Health Research</b> How do we translate climate-health research findings into policy and action for society aimed at different stakeholders? Focusing on user-centric applications.</p>	<ul style="list-style-type: none"> <li>• How do we drive local climate change – health research to influence policy?</li> <li>• Have we resolved the contestation over climate change effects on health?</li> </ul> <p>If research is inconclusive, can it be used</p> <ul style="list-style-type: none"> <li>• Can we distinguish between the impact of climate change vs the impact of climate variability on health?</li> <li>• Is climate change- health research in a format that is unusable by policy makers?</li> <li>• How do decisions over climate change –health get made?</li> </ul>	<p><b>First point:</b> Building adaptive capacity requires understanding of how climate and health research is currently put into action and the factors that support success.<b>Second point:</b> Legislative policy is needed to support climate health research and shape investment cases for informative adaptive strategies for the health system.<b>Third point:</b> Integrated governance systems are needed that connect climate change drivers with health impacts and agencies tasked with climate change adaptation and resilience.<b>Solutions:</b></p> <ul style="list-style-type: none"> <li>- Train policy makers on climate change and health</li> <li>- Set evidence thresholds</li> <li>- Involve stakeholders in setting priorities</li> <li>- Minimum set of indicators (Monitoring)</li> <li>- Do basic research (set basic research questions)</li> <li>- Identify local needs</li> <li>- Measure infrastructure for adaptation</li> <li>- Simplify conclusions</li> </ul> <p><b>Who?</b></p> <ul style="list-style-type: none"> <li>• Policy makers, officials and professionals</li> </ul> <p><b>How?</b></p> <ul style="list-style-type: none"> <li>• (Defining how to make it usable): Actionable, understandable, smart, accurate, available and accessible.</li> </ul>

## 4. Discussion

### 4.1. Adaptive capacity – infectious diseases

Clearly defined and identified adaptive capacities for climate change and infectious diseases are necessary to identify areas for collaboration and exchange, developing supportive guidelines and strategies. This recognizes the burden of disease and related coping capacities (i.e. financial/technical/data/human resources) and prioritization of related policies/planning strategies. Considering adaptive capacities of African governments to scale integration and use of climate information within health systems, these session findings reveal a fundamental disconnect between the ability of health systems and service providers to juggle competing needs of immediate to longer-term risks (Table 1; Supplementary File S1). This is underpinned by a limited evidence base or inappropriate information flow of defined risks. Therefore, governments or departments are underprepared and have limited adaptive capacity to respond to longer-term climate change and health risks.

### 4.2. Adaptive capacity – African governments

From the questions generated by Group 2, discussions focused on how African governments must play an active role in the definition, design, resource allocation and implementation of national (and sub-national) research agendas (Table 1; Supplementary File S2). Scaling active health and climate change research should include cross-sector collaboration, communication, defined pathways for information exchange, dedicated resources, and a defined operational structure [40–43]. Lack of such structures impacts existing service delivery/preparedness. Operational challenges, along with existing limited evidence base and lack of information flow, often conflate the problem. The ability of national actors to define immediate to long-term climate and health risks/impacts is necessary for adaptation and resilience planning for health service providers and within wider health systems. Outcomes and discussion also demonstrated a structural challenge and barrier between ‘climate’ and ‘health’ domains. A disconnect was identified between valuation of different risks and

timescales considered ‘appropriate’ for action. For example, many African countries remain food insecure with limited resources to address pressing immediate issues of existing food insecurity and related problems of malnutrition. It remains a challenging task to address immediate health concerns, while also earmarking resources for future research and response.

### 4.3. Climate science for vulnerable populations

Climate science plays a valuable role in meeting current and future challenges of protecting the health of vulnerable populations [44,45]. In practice, however, climate science is rarely integrated into health system planning (Table 1; Supplementary File S3). Within a broad African context, key sectors such as health, environment, meteorological services, and disaster management agencies remain siloed, making operational integration difficult. Key structural and information challenges persist in ‘mainstreaming’ of climate information and in defining climate-linked health risks, specifically among vulnerable groups. Analysis of the Q-Storming discussion and related questions revealed the need for core understanding and interpretation of climate science showing the benefits of protecting the health of vulnerable groups, prior to adaptive strategies being designed/implemented to support them. Vulnerability to health impacts of climate change in Africa is experienced differentially across and within climatic regions etc. [44,45]. Given the intersectionality within vulnerable groups, climate and health interventions should be context-specific to reduce and avoid adverse climate change related-health risks.

Air pollution is the world’s largest single environmental health risk [46,47] but there is a problem of attribution. Unlike deaths caused by water contamination [48], no institutional responsibility exists for deaths caused by air pollution – and thus by climate change. The WHO attributes approximately a quarter of premature preventable deaths to modifiable environmental deaths [49]. Absence of an interface between poor air quality and the various groups it affects, means that their protection becomes the responsibility of other agencies. This causes a disconnect between the systems that govern the ‘causes’ of climate change and the systems that are meant

to protect vulnerable groups from potential health impacts. Improving information flow and its presentation could advance the systematic use of climate-linked health research within LMICs governments. Challenges were identified in the difficulty in linking climate science and health vulnerability across institutions to support improved use of climate science specifically towards protection of the health of vulnerable populations in Africa. Questions on climate science for vulnerable populations were not tailored to the health system and climate policy. Thus, viewpoints were not provided on key issues relating to long-term datasets determining how climate is changing and affecting health systems at local or regional levels. This highlights the lack of awareness of these issues, in any meaningful depth, among a broad stakeholder group.

#### 4.4. Usability of climate-health research

Group 4 identified questions that informed the prioritization question and resultant brainstorming (Table 1; Supplementary File S4). The concept of *usability* of research findings for policymaking and for impacting societal change was explored, acknowledging the need for African climate-health nexus data. The group's discussion highlighted the complexity of understanding what 'usability' of research findings referred to in practice. Evidence-based policy making was seen to be the responsibility of policymakers, officials, and professionals. The group felt that evidence-based policymaking should be achieved by ensuring that research is actionable, and that accurate data are available and accessible. Solutions identified for achieving these research outcomes to make them relevant for policy-making included:

- setting of evidence thresholds,
- involving stakeholders in setting research priorities,
- developing a minimum set of indicators for monitoring purposes,
- conducting basic research, including setting fundamental research questions,
- identifying local needs,
- measuring infrastructures as an indication of adaptation, and
- training policy makers on climate change and health.

The group's discussion and suggestions indicated a broader awareness need among relevant stakeholders. More progressive approaches to evidence-based policy making, promoting a "climate-health in all policies" (not just in health policies or adaptation strategies), is also needed [30,50,51]. The discussion also highlighted the need for researchers to move beyond stating key research findings. Including mechanisms and approaches to bridge the academic-policy divide in implementing and interpreting research findings in adaptation strategies is key. Notably, topics three and four on climate science and climate research, respectively, could have been combined for analysis; but were separated to highlight the questions' nuances specific to each topic and group relating to the original methodological approach. Future Q-storming could combine them to see if questions would be generated on how new or existing disease surveillance systems could be strengthened. Benefits of research and modeling as related to generation of data, and risk indicators (e.g., mosquito numbers) or health outcome (infectious disease outbreaks) should also be considered.

#### 4.5. Considerations and limitations

We are only able to report on issues that were raised in the Topic Group discussions. We note that what did not come out in these discussions may be just as important as what did. Notable omissions included climate finance and health in relation to both loss and damage; prominent features of Conference of the Parties (CoP) negotiations [52]. Broader development issues that must be addressed to achieve

climate adaptation (e.g., poverty, water/sanitation services, agriculture, health systems, education/training, public awareness) should not be ignored. Additionally, exchanging information between health and development sectors (a precondition for an integrated approach to adaptive responses in health and livelihood security), was not mentioned by participants. This may in part be explained by time constraints. The Q-storming session was limited to a two-hour slot in a full agenda. Since the pre-pandemic Adaptation Futures conference took place, remote workshops and conferences have become the norm. Similar exercises could be conducted online, hence providing opportunities for wider reflection. Other rationales for these omissions could relate to sensitivity of broaching discussions about potential trade-offs. Tensions between limited financial resources and prioritization of seemingly divergent health adaptation and development goals, may also contribute. Challenges remain in identifying and understanding complexities of effective climate and health strategies. The 2018 Adaptation Futures Conference focused specifically on adaptation, but we recognize that effective resilience in health systems requires a broader awareness among relevant stakeholders. Preparation, adaptation, and mitigation strategies, complementing and contributing to broader development agendas and climate-health resilience planning is also needed.

## 5. Conclusions

Using the Q-Storming approach, the session collected experiences and ideas to identify multidisciplinary areas of critical need and opportunities. Study participants found Q-storming an effective approach for addressing key sector silos. Outcomes demonstrated that greater dialog and cross-sectoral knowledge exchange are needed between research, policy, and practitioners possibly by including relevant material in curricula and training [52]. Within adaptive governance strategies, improved structures can inform research agendas and improve service in public health delivery. Extending this approach to include participant-elicited solutions to adaptation issues could contribute to successful adaptation implementation. There is an opportunity for research funders to support knowledge development and for researchers to use evidence-based outcomes to lobby and advocate for policy changes. For African governments to adapt to climate change impacts on public health, targeted investment aimed at building strong and resilient health systems is needed [50]. Many African health systems require attention presenting an opportunity for improvements including climate and health considerations. Focusing on immediate or extreme weather event-related climate change impacts on health, is only part of preparedness. Effective and ethical climate-health responses are needed. Hence, usability of climate-health information and sustainable implementation of research results requires integration of endogenous concerns of vulnerable populations. The mobilization of diverse decision-making/stakeholder knowledge through direct and iterative collaboration should also not be neglected. □

## Author contributions

HAR and CYW conceived the conference abstract. HAR and CMD analyzed the session findings and drafted the initial paper. CYW provided input related to Q-Storming. All authors reviewed and edited the final draft. All authors have read and agreed to the published version of the manuscript.

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### Author agreement statement

We the undersigned declare that this manuscript is original, has not been published before and is not currently being considered for publication elsewhere.

We confirm that the manuscript has been read and approved by all named authors and that there are no other persons who satisfied the criteria for authorship but are not listed. We further confirm that the order of authors listed in the manuscript has been approved by all of us.

We understand that the Corresponding Author is the sole contact for the Editorial process. He/she is responsible for communicating with the other authors about progress, submissions of revisions and final approval of proofs

### Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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The **PHASA SIG CEH** is a network of Southern African practitioners, decision-makers, health professionals, researchers, lobbyists, students and academics, and civil society, working in the fields of public health, energy and fossil fuels, and climate vulnerability and change. The PHASA SIG CEH brings together relevant disciplines to understand the intersection of climate, energy, and health in southern Africa, and to provide evidence for informed policy development and decision-making across the region.

**Clim-HEALTH Africa** is the World Health Organization's international network for climate and health efforts in Africa, bringing together Pan-African technical institutes and international partners to guide and strengthen the public health resilience of African countries and communities. Comprised of African and international institutions focused on climate, environment and health, *Clim-HEALTH Africa* provides scientific leadership, capacity building, research, and policy support to help inform and support health sectors' transition from reactionary policy and action to proactive planning and preparedness.

### Supplementary materials

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