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PERSPECTIVE PAPER

Climate change and health in Africa: perspectives on effect on malaria and dengue fever

IMAN M. SHAMMAT[1*], AHMED G. ABDOUN[2], VALINDAWO VALILE M DWAYI[3], PATRICIA NKWETEYIM[4], ALAA MOHAMED OSMAN[5], AJIBOLA F. OLADEJO[6], ANAS SALIH A. OMER7, NISSREEN MOHAMEDELHASSEN OSMAN[8], ALIA ABDALLAH FADLALLAH[9], SARAH A. MOHAMMED[10], ELSHARIF A BAZIE[11]

AFFILIATIONS:
[1]Department of Basic Medical Sciences, Faculty of Medical Laboratory Sciences, Omdurman Islamic University, Sudan.
[2]Omdurman Islamic University, Sudan.
[3]Central University of Technology, Bloemfontein, South Africa.
[4]Department of Performing and Visual Arts, University of Buea, Cameroon.
[5] Khartoum, Sudan.
[6]African Science Frontiers Initiatives/Covenant University, Nigeria.
[7]International University of Africa, Sudan
[8]Ministry of Health, CDC, Oman
[9]Kassala Teaching Hospital, Kassala, Sudan.
[10]Ministry of Health, Sudan
[11]Pediatric Department, Elimam Elmahdi University, Sudan.

CORRESPONDENCE:
Iman M. Shammat
imanish04@gmail.com

ABSTRACT

This paper explores the intersection of climate change and African public health, focusing on its impact on vector-borne diseases like malaria and dengue fever. While climate change is increasingly recognized as a critical issue for sustainable development, its effects on health, mainly through the spread of these diseases, remain under-explored. As climate conditions shift, so do disease transmission patterns, creating new challenges for already strained healthcare systems. This paper advocates a more integrated approach to understanding the relationship between climate, society, and health in Africa by reviewing existing literature and databases. It highlights the urgent need for policies that strengthen disease surveillance, improve vector control, build climate-resilient health systems, and support community engagement and research. Addressing these interconnected issues is essential for mitigating the health impacts of climate change, particularly concerning malaria and dengue fever.

KEYWORDS:
Africa, Climate Change, Dengue Fever, Health, Malaria

INTRODUCTION

Climate change is no longer a distant concern but an immediate threat, particularly in Africa, where its impacts are intensifying. While much attention has been given to the environmental consequences of climate change, the intersection between these changes and public health, especially vector-borne diseases such as malaria and dengue fever-remains an under-explored, yet critical, area of concern. As climate conditions fluctuate, so too do the conditions conducive to the proliferation of disease vectors, creating new challenges for healthcare systems that are already stretched thin[1].

In Africa, where the burden of malaria and dengue fever is disproportionately high, these diseases are not only the result of ecological factors but also deeply embedded in socio-economic, political, and infrastructural contexts [2,3]. Here lies the need for a fresh perspective on the problem-one that transcends traditional approaches that often isolate environmental or social determinants as separate issues. The current discourse, which typically oscillates between the positivist/structural approach, focusing on measurable climate variables and disease rates, and the socially constructive view, emphasizing local knowledge and socio-political factors, is incomplete. Neither approach fully captures the complexities of the issue.

Drawing from the critical realist perspective, this paper argues for a more nuanced and integrated framework to understand how climate change intersects with health in Africa [4,5]. Critical realism, which acknowledges the importance of both structural and social contexts, posits that the realities of climate change and disease are shaped by both observable phenomena and the underlying mechanisms that govern them. These mechanisms are not always immediately visible but must be considered to develop effective interventions. This perspective allows us to understand better how malaria and dengue fever are not only a consequence of changing weather patterns but are also deeply linked to human actions, governance, and infrastructural weaknesses that exacerbate vulnerability[6].

By exploring the complex interplay between climate, society, and health, this paper aims to provide a more comprehensive understanding of Africa's challenges and propose interventions that are sensitive to both the ecological realities and the socio-political dynamics at play. The time has come for a broader, more inclusive perspective that can guide the formulation of health policies and climate adaptation strategies, one that bridges the gap between the environment and the people it affects.

METHODS

Social and economic impacts of climate-sensitive diseases

The impacts of climate-sensitive diseases, especially malaria and dengue fever, threaten the social-economic development of the African continent, which, according to WHO, continues to carry the heaviest burden, accounting for an estimated 94% of malaria cases worldwide in 2023.

Enhanced morbidity and mortality: The majority of people affected by climate-sensitive illnesses reside in low-income, remote areas with difficulties in accessing medical facilities and services, or affording medical care and materials. Untreated ailments cause long-term health issues and ultimately death, hence depopulation and manpower loss[8]. Malaria continues to be a major public health concern, with an estimated 95% of global deaths occurring in Africa. In 2023, dengue fever outbreaks were documented in 15 African nations, resulting in 57 fatalities[9].

Decreased productivity: Sick or dead people do not work, to the detriment of any nation's GDP. According to WHO, malaria significantly affects people and communities living in poverty and situations of vulnerability. It impoverishes families and households, reduces productivity, discourages investment and weakens national economies[7].

The Strain on the brittle and insufficient healthcare system increases as more individuals become ill. This leads to funds intended for other sectors to be diverted to health. For instance, domestic spending in nations where malaria is endemic increased from 33% in 2017 to 37% in 20237. This will definitely lead to the overall underdevelopment of the other industries and the region.

A critical realist perspective of climate change

By this submission, we draw from the social realist understanding [10,11,12], which is anchored on the critical realist perspective [13,14]. For critical realists [13,15,16,17,18,] a depth ontology, in comparison to a 'flat' ontology, entails an account of 'absence' (that is, which mechanisms are not working) and is an ontological framing that helps one to delve deeper, beyond the surface and the empirical, to the historical and the underlying powers that generate events and the experiences associated with them. As applied in this paper, such a perspective posits that the study of the social world entails understanding and explanation of both the social and economic dimensions as dialectically related.

Despite what can always play out in the social world as the interplays of the power dynamics and materialist conditions, the ideal results ought to be transformative, about the impactful and sustainable change and for human flourishing.

Figures 1 and 2, which represent Archer's theory of morphogenesis/stasis, illustrate the social world (social and economic impact) as emergent and over time. The focus on the social and economic impact ought to entail the study of the interplays of the structural systems (SS), the cultural systems (CS) and the agentic/human systems. By a structural system it means the roles, functions and responsibilities in the structural domain. Such structures are always in the interplays with the cultural system, as the collection of beliefs, norms, standards and values about the subject of inquiry. A credible and powerful study that draws on the social realist perspective therefore tries to analyse and explain the nature of these interplays in the open and complex social systems.

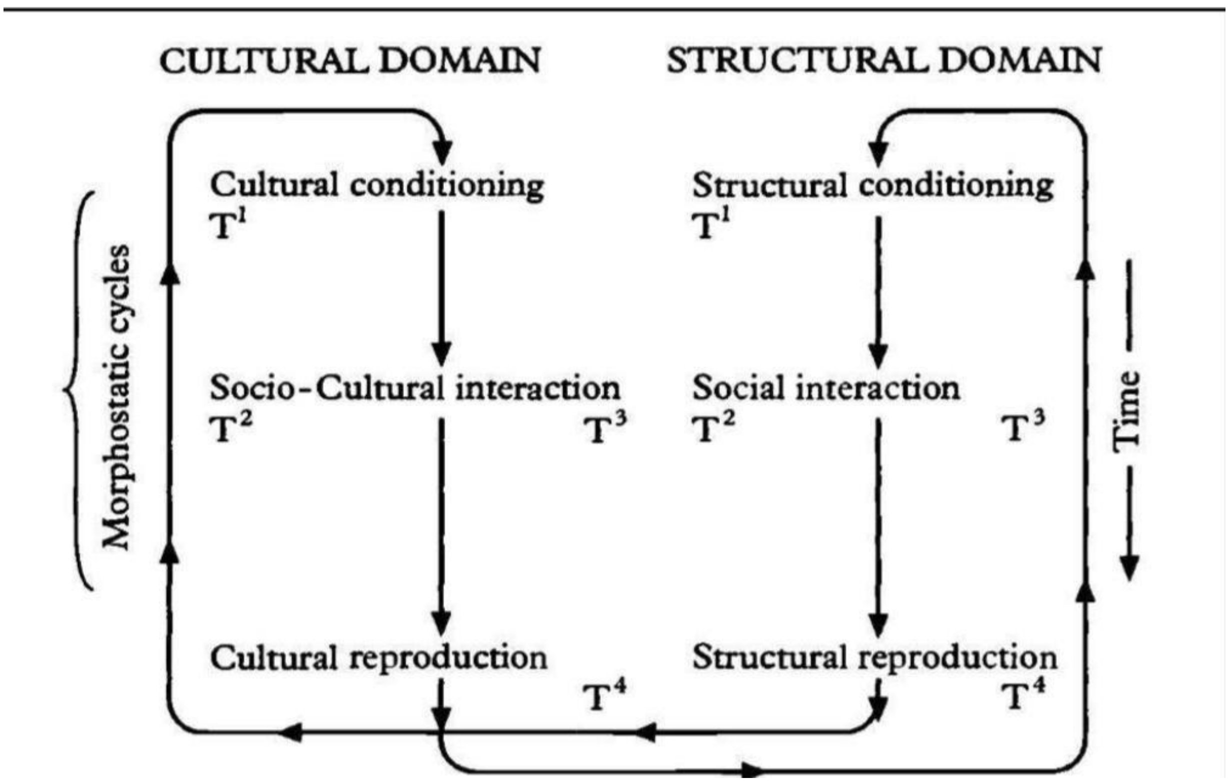

Figure 1. Structural and cultural configuration reproducing morphostatic cycles in society (Archer, 1995:309).

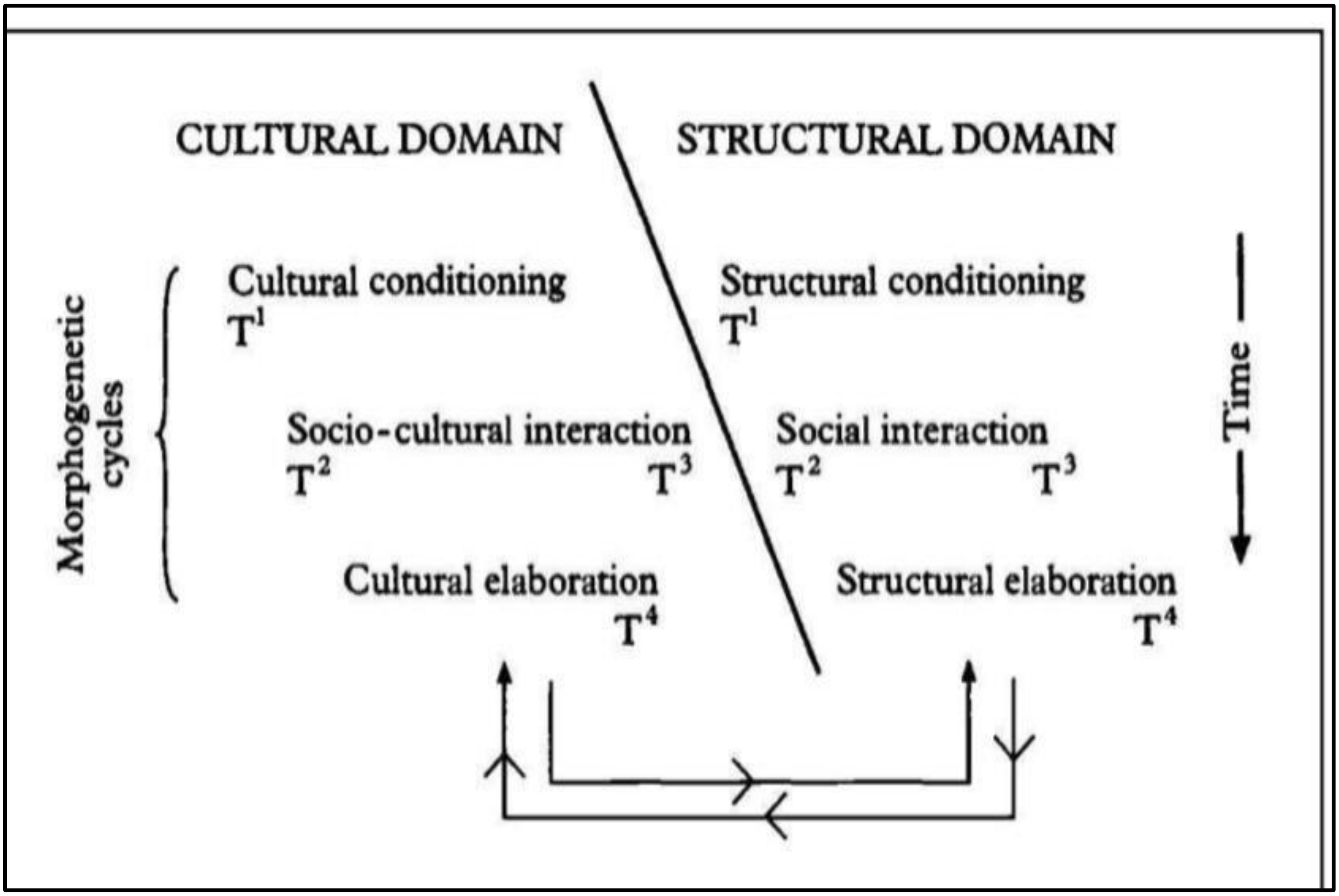

Figure 2. Structural and cultural configuration reproducing morphostatic cycles in society (Archer, 1995:323).

Figures 1 and 2 represent Archer's theory of morphogenesis/stasis. Margaret Archer's social realist explanatory program 10 allows for how to develop deep insights in our understanding of the social phenomenon/world. For Archer, the social world is constitutive of the dynamic interplay of structure, culture, and agency over time. Archer propagates the understanding of these three elements (structure, culture, and agency) as systems. To Archer this means that, while both the structure, as the roles, functions and responsibilities can be represented by the policies and strategies, and the culture, as the ideas, beliefs, values and norms thereof, all predate Agency by operating at macro level. Agency, as the range of choices and actions at the micro level, reacts to both the structural and cultural elements! With time, that is, from the state of socio-cultural conditioning (T1), the interplays then allow for possible change by means of emergent powers and properties of each element with the other in causally efficacious ways (T2-T3). That then can result in either transformative (morphogenetic state) or reproductive (morphogenetic state) (T4).

RESULTS

The possible result of analyzing these interplays is the realization that the structural system, while necessary, is not always a proxy for the actual results. At the same time, as the cultural system is always dialectically related to the structural system, such cultural positions always remain contested in privileged and not so privileged ways of thinking-making-doing. In both cases, the main factor is the role of Agency, the human factor, as action or no action, in both the SS and CS. Therefore, while impact generally refers to the assumed quality of life, with the adverse results from the Climate-Sensitive Diseases/Public Health Systems and Society, the credible explanation, as the subject of inquiry, is that one that ought to be able to account for absence, that is, the negative or positive impact or the variations of these. While the general view in systems thinking is about the outputs-results-outcomes elements in the complexity and open systems, the impact refers to something beyond the outcomes, that is, to sustainable value creation. Therefore, the impact measure ought to account for the root causes about the negative cases that must be ameliorated, and completely abolished, at best, as emergent ways and over time, in terms of agency as the individual abilities, group capacity and institutional capabilities.

The science behind climate sensitive disease transmission

The rapid climate change affects humans and ecosystems in various dimensions including epidemiology, pathology, and molecular biology. It is projected that between 2030 and 2050, about 250,000 people will die annually due to climate change related causes like infectious diseases, undernutrition, and heat-stress, with the majority of these deaths occurring in low-income countries, particularly in Africa19. Data on the expected rise in disease burden due to climate change are sourced from global health reports, including the World Health Organization's (WHO) and regional studies, which highlight the projected impacts of climate change on health in vulnerable regions like Africa.

The pathogenic microorganisms (e.g. bacteria, viruses, parasites or fungi) are the causes of infectious diseases, which are transmitted by direct contact, air/water or vector-borne transmission. Several vector-borne pathogens are climate-sensitive and, therefore, affected by climate change through changes in transmission risk factors or shifts in vector distribution and behavior[20]. The data on the transmission dynamics of vector-borne diseases (VBDs) were sourced from a combination of global health reports and modelling studies, particularly the work by Mordecai et al.21, which explores the physiological relationship between temperature and malaria transmission. This model is validated by 40 years of field data collected across various African regions.

As climate change raises the temperatures, the optimal temperature range for vector-borne diseases (VBDs) may expand their transmission in some regions and contract in others. Also, the climate may become more suitable for some diseases and less suitable for others[22]. As climate change raises temperatures, the optimal temperature range for VBDs may expand in some regions while contracting in others. This shift may make certain regions more suitable for disease transmission while rendering others less favourable. Projections regarding the effects of climate change on VBD transmission are based on climate scenario models and regional studies, including those from the Intergovernmental Panel on Climate Change (IPCC), which predict rising temperatures and their impact on mosquito populations and disease spread across Africa.

Mosquitoes, unable to regulate their body temperature, actively seek favourable microclimate conditions. Temperature thus plays a critical role in their survival and development. For example, a temperature range of 22-23°C is optimal for mosquito reproduction and the extrinsic incubation period (EIP) of pathogens such as Plasmodium falciparum. The EIP can be shortened from 26 to 13 days as temperatures rise from 20°C to 25°C, accelerating the transmission cycle. However, excessive heat can also increase pathogen mortality rates[23]. This relationship between temperature and mosquito life-cycle development is supported by laboratory and field [24].

Changes in the rainfall patterns in Africa also directly influence mosquitoes' reproduction. Increased rainfall can create stagnant water, which is a preferable breeding area for species like Anopheles and Aedes. Conversely, prolonged dry season often results in water shortage, forcing communities to store water in containers, which become new breeding sites. Data on rainfall patterns and their impact on mosquito breeding habitats were obtained from regional studies on climate variability, with sources such as the WHO and the Global Health journal providing up-to-date statistics on how shifting rainfall patterns influence mosquito population dynamics.

These shifts in mosquito breeding habitats are critical in the geographic expansion of VBDs, increasing the risk of outbreaks in previously non-endemic areas [25]. Additionally, the alteration of disease dynamics, due to the persistence of optimal conditions year-round instead of being confined to specific seasons, further complicates the situation. However, the overall effects of climate change may also increase population vulnerability to these diseases irrespective of the direct effects on transmission[26]. Studies focusing on the geographic spread of vector-borne diseases, including reports from the WHO and regional research on malaria and dengue fever, emphasize the expanding transmission areas as climate change alters optimal conditions.

Malaria in Africa: climate change and rising risks

Health-related risks from climate change exist and are under study[27], but the direct effect of health outcomes on human influence on the climate remains challenging[28]. Despite the ongoing global eradication efforts, malaria persists as the most lethal climate-sensitive infectious disease. Its transmission is intricately linked to temperature, a factor that influences the life cycle of the mosquito vectors (Anopheles spp.) and the thermal sensitivity of the parasites (Plasmodium spp.) themselves. This urgent issue demands our immediate attention[29].

Malaria causes about 435,000 deaths per year, with most cases occurring in Africa, and affecting children under five disproportionately[30]. The World Health Organization reported in 2017 and over the prior year, that malaria increased by 3.7 million cases in Africa in the ten high-burden African countries[31]. Mordecai et al. introduced a mechanistic nonlinear physiological temperature-driven malaria transmission suitability model in 2013, a significant contribution to our understanding of malaria transmission. This model, based on laboratory data, demonstrated that the transmissibility of malaria is constrained between 17 and 34 ℃, which will, therefore, limit the spatial distribution of malaria on the landscape. In addition, this model updated the optimum temperature for malaria transmission from 31 ℃ to 25 ℃, and the model was well-validated using 40 years of field observation data matched to specific locations, months and temperatures[21]. Malaria transmission is not only influenced by climatic factors but also by human activity. As we look to the future, the escalating greenhouse gas emissions will further exacerbate climate change. This, in turn, will expand the habitat index for the reproduction of malaria vectors, leading to a surge in vector breeding. The impact of climate change on malaria transmission cannot be overstated [32,33,34.] In experimental studies, P. falciparum transmission by An. gambiae peaks around 25°C, stopping below ~16°C or above ~34°C[35]. Many studies in Africa suggest that climate change will reduce or eventually preclude transmission of malaria[36.] The malaria season usually occurs between September and November, with a clear peak in October. Malaria transmission occurs toward the end of the rainy season in West Africa, following heavy and frequent monsoon rains[37].

Dengue fever: a growing threat in Africa

For over half of the world's population, Dengue fever is the biggest public health concern. Mostly in endemic locations, the disease is the leading cause of illness and death[38]. According to recent research, an estimated 3.9 billion people are susceptible to dengue fever, with an estimated 390 million infections annually, over 100 million asymptomatic cases, and 10,000 fatalities [39, 40, 41]. Over the previous 50 years, the burden of sickness has increased 30 times. [42,43], and the number of endemic countries for the disease has increased from 9 to 125 over the last four decades40. The geographic distribution of dengue fever incidence is predicted to expand in the future due to climate change [44,45]. By the end of the 21st century, the mean global temperature is predicted to increase between 1.8°C (low scenario) and 4°C (high scenario)[46]. Africa is highly vulnerable to climate change. Overall, in Africa the temperature has increased by 0.7°C, over the 20th century and is predicted to increase further with 0.2°C (low scenario) to 0.5°C (high scenario) per decade [46,47]. Precipitation patterns are also uneven in Africa. Thus, knowing the relationships between climate change and climate-sensitive infectious diseases such as dengue fever in Africa, where disease prevention measures are minimal, is crucial for improving public health and for early preparedness.

Climate factors drive dengue fever incidence as part of the different stages that the virus has to go through in the mosquito vector during the transmission of the disease [39,42,48]. Climate change, along with fluctuations in climate patterns, has a clear impact on the spread and future risks of malaria and dengue, two of the most prevalent vector-borne diseases around the world[49]. Climate change amplifies dengue and malaria in Africa by expanding mosquito ranges, extending transmission seasons, and causing unpredictable outbreaks. Effective responses require strengthened disease surveillance, targeted vector control, climate-resilient health systems, community engagement, and research. Crucial actions include integrating climate data, developing novel control methods, improving access to healthcare, and ensuring equity and sustainability, necessitating cross-sector collaboration and increased funding.

DISCUSSION

The pointers for the policy, solutions, & interventions

While Policy is the structural arrangement which must be explicit about the roles, functions and responsibilities, such arrangements do not always become the proxy for the actual results in the complexity of power relations and the politics of knowledge. The ability to implement the policy will always be dependent on the logical connections (the ideas, beliefs, norms and standards) that the implementers are able to draw on for making the policy implementable/successful. This therefore makes for the challenges of the policy-practice nexus, further to theory-practice, research-development, etc.

For the latter reasons, it is always advisable that the policy and procedures, the solutions and interventions on Climate-Sensitive Diseases/Public Health Systems and Society, consider the following factors.

1. Operations, the technicalities about Climate-Sensitive Diseases/Public Health Systems and Society. What kind of technical abilities to develop for those who are in the front line of Climate-Sensitive Diseases/Public Health Systems and Society?
2. Business, the issues about Climate-Sensitive Diseases/Public Health Systems and Society. What kind of business plans must respond to the concerns, issues and projects as capacity development about Climate-Sensitive Diseases/Public Health Systems and Society?
3. Strategy, the context about Climate-Sensitive Diseases/Public Health Systems and Society. What forms of medium to long term institutional strategies, as capabilities development; about Climate-Sensitive Diseases/Public Health Systems and Society?

Ideally, for any well-structured institution about Climate-Sensitive Diseases/Public Health Systems and Society to consider the ideal that, while the challenges/constraints are attenuated from the top down (from strategy to business and to operations), the enablers ought to be amplified from the bottom up and for optimal results/outcomes/impact!

Current policies, intervention and solutions for addressing climate change- sensitive diseases

Inadequate mitigation measures have been taken, and since any climate change would have detrimental effects on the health of people, animals, and plants, it is imperative that efforts be increased, and action be accelerated.[50]. Reducing carbon emissions, implementing the one health approach, increasing funding to address climate change, and changing the food system to a net zero strategy will all help reduce greenhouse gas emissions because they may have an impact on the risk of infectious transmission through the food chain and water resource management[51]. Malaria, dengue fever, and other climate-sensitive diseases are being treated with traditional medicine in many nations' resource-poor populations. There is some evidence that traditional medicine can help treat some infectious climatic disorders.[52]

To improve the health system's capacity to adapt to changing conditions and continue to operate under pressure, WHO created a conceptual framework for resilience. The following is a summary of this framework: i) lessen susceptibility by reducing exposure and sensitivity; ii) boost capacity; and iii) enhance possibilities and options, which ultimately translate into either a better outcome, a better state than before, or a recovery to avoid[53].

CONCLUSION

The significance of climate change as the subject of inquiry derives from the reality of the research thereof as this article has shown. Contemporary research ought to provide insights about how to possibly control dengue and malaria in Africa by reducing mosquito ranges and transmission seasons, and hence, prevent unpredictable outbreaks. This article has argued that the contemporary perspective towards such insights can ideally draw on the critical realist philosophy and their social realist explanatory program. From the point of view of structural systems (policies and strategies, for example), effective responses for climate change require strengthened disease surveillance, targeted vector control, climate-resilient health systems, community engagement, and research. From the point of a cultural system (the values, norms, ideas and beliefs), crucial actions ought to include integrating climate data, developing novel control methods, improving access to healthcare, and ensuring equity and sustainability, necessitating cross-sector collaboration and increased funding. The critical factor in both the structural and cultural systems would thus be the relevant and responsive actions, choices and projects for mediating the observed challenges as discussed in this paper than currently is the case. Future research about the subject ought to focus on the role of agency, especially on the nature of the contradictions, tensions, inconsistencies and lacks in the management of climate change for health and how the latter can be resolved by the exercise of agency.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interests.

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AUTHOR'S CONTRIBUTIONS

All authors contributed to the study conception and design, writing, revision and approved the final manuscript.

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