
THE IMPACT OF CLIMATE CHANGE ON THE SPREAD OF VECTOR-BORNE DISEASES IN DOMESTIC AND WILD ANIMAL POPULATIONS

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Abstract: Climate change is increasingly recognized as a critical determinant of animal health, particularly through its influence on vector-borne diseases. This study investigated the experimental relationships between climatic variables, vector ecology, host susceptibility, and disease dynamics using a mixed-methods approach integrating quantitative modeling and qualitative ecological interpretation. The results demonstrate that rising temperatures, variable precipitation, elevated humidity, and extreme weather events significantly increase vector density, pathogen prevalence, and disease incidence across domestic and wild animal populations. Statistical analyses revealed strong positive correlations between temperature and vector abundance, precipitation-driven seasonal amplification of disease transmission, and nonlinear threshold effects leading to rapid escalation of disease risk beyond specific climatic limits. Regional analyses showed pronounced spatial heterogeneity, with warmer and more humid regions experiencing higher disease burdens. Additionally, climate-induced physiological stress in animal hosts was associated with increased susceptibility to infection, amplifying transmission potential. Integrated risk indices and future projections indicated a substantial rise in vector-borne disease burden under ongoing climate change scenarios. Overall, the findings highlight that climate change acts as a systemic force reshaping host–vector–pathogen interactions, increasing disease emergence and spread. The study underscores the necessity of climate-resilient veterinary services, advanced surveillance systems, and One Health–based adaptive strategies to mitigate the growing threat of climate-sensitive vector-borne diseases.

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1. INTRODUCTION

Such manifestations of anthropogenic climate change as an increase in global temperature and alterations in precipitation patterns have a great impact on the ecological processes predetermining the distribution and prevalence of the presence of vectors in domestic and wild fauna (Kiragu, 2023). This is primarily due to the fact that climate changes directly influence the environments of the pathogens and vectors that alter the distribution, prevalence and season of the same diseases to the pathogen (Wanjala et al., 2022, p. 103509). The arthropod vectors, such as mosquitoes, ticks, rats, and others, are easier to spread due to changes in the environment, which increases their activity and the number of them (Chikezie et al., 2024, p. 179). An instance is that as temperatures increase, the mosquitoes increase in number, which implies an increase in the number of species of mosquitoes, and *Aedes* mosquitoes spreading to the north. It increases the possibility of the spread of such diseases as malaria, dengue fever, and West Nile virus in already affected places (Kiragu, 2023; Ojeyinka and Omaghomi, 2024, p. 32). The variation in the distribution of rain patterns, including increased rainfall and extended droughts, influence the breeding sites and total population of organisms dispersing the disease, increasing the number of pathogens (Jain, 2023, p. 2; Ojeyinka and Omaghomi, 2024, p. 30). Furthermore, the interaction between host vulnerability and climatic alterations makes the animal population more susceptible to infection, being susceptible to the influence of adverse environmental factors and having no ability to withstand immune reactions (Jain, 2023, p. 1). Climate change does not only have direct impacts on vectors, but it also affects the diseases themselves, such as reproduction, the development of vectors, and their general transmission (Pandey et al., 2022, p. 4). Vectors and

diseases, and the shifts in the location and immune functions of animal hosts under the impact of climate change are likely to lead to the zoonotic spillover, which causes damage to humans and animals (Ojeyinka et al., 2024, p. 28). To create positive approaches to climate change response and adaptation, the impacts of climate change on the disease vectors, pathogen resilience, and host resistance must be known (Kiragu, 2023). This case study explores the multifaceted impacts that climatic change has on animal health with an emphasis on the insensitivity of the climate changes on the occurrence of animal-borne diseases as it applies to some animal species (Jain, 2023). It further examines the impacts of temperature, humidity, and other harsh weather on the lifecycle of vectors, pathogen reproduction rate, and host-vector interactions, which vary and alter the spread and occurrence of diseases (Stephen and Soos, 2021, p. 423). Animal health is also highly endangered due to climate change caused by the heat stress encountered where physiological functions are compromised resulting in low productivity, particularly with livestock (Jain, 2023, p. 3). The environmental conditions also increase the risk of infectious and parasitic disease in humans, including disease vectors, although in an indirect manner, by influencing the work of the immune system and the ecological niches (Sharma et al., 2024). The warmer the weather the more energy herptiles will require. That would cause their immune systems to be less active and predisposed to being infected by bacteria that resist heat (Hopkins et al., 2024, p. 4). Moreover, temperatures and changes in rainfall can have a direct impact on the immune system of the animals, which will lead to a reduced immune response to various diseases, including those spread by vectors (Caroprese et al., 2021, p. 1; Pandey et al., 2022, p. 4). It is an immune damage that in most

cases does not appear like immunosuppression and predispose animals to become sick and fail to cope with their other illnesses (Caroprese et al., 2021). The variations in the weather may cause strain in the body of animals, such as heat stress, which may reduce their immune systems and increase risk of contracting infections. It can also cause them to have more difficulty getting improved after an illness due to it (Balthazard-Accou et al., 2021, p. 18). Such a mixture of climate stressors and host defence need concern about additional study of adaptive mechanisms that may increase animal resistance to the continually growing number of disease threats (Caroprese et al., 2021; Jain, 2023, p. 2). The measures involve direct those aimed at eliminating the sickness and indirect those aimed at enhancing the health of the animals amid the changing climate (Jain, 2023, p. 1). It includes the study of interactions between the microbiome and immune, the alteration of environmental variables on a molecular scale, as well as the potential alteration of the nutritional status to alter the severity of the parasitic infection (Ohmer et al., 2021, p. 2). On the contrary, animals can evolve, and climate change is exacerbating the situation by leading to the loss of biodiversity. It also complicates the life of animals in a changing climate and helps to depict the fact that it is extremely important to protect the ecosystem (Jain, 2023, p. 3). The outcomes are harmful to the welfare of individual animals and affect the sustainability of the ecosystem, food security, and human health because of a high level of zoonotic risk augmentation (Jain, 2023). Additionally, climate change and interaction of the biological entities with each other renders the control of diseases more difficult even those caused by invading species of vectors. In order to do so, we need to consider any solutions that would consider the direct and indirect environmental consequences (Thieltges et al., 2025). It plays a major role of

holistic information in the establishment of working solutions to elevate the threat of expansion of the diseases because of the continued climatic change (Jain, 2023, p. 3). It implies that veterinarians are to be both reactionary and proactive in their work. In order to save the wild, as well as domestic animals, they should be keen on applying climate adaptation and mitigation measures to address animal health (Akello, 2024; Stephen and Soos, 2021, p. 423). They include the implementation of newer surveillance systems and breeding and shelter management methods which are very sensitive to climate changes to ensure that they are well prepared and react better to any kind of infection like the avian flu virus (Sharma et al., 2024; Stephen and Soos, 2021, p. 423). The methods will find application in the context of dealing with the complex interaction between climate change and animal health that requires a multidisciplinary approach involving veterinary science, ecology, and the health of the population to be able to monitor and react to the newly developed threat of diseases (Rivadeneira-Barreiro, 2023, p. 7). These combined solutions should not overlook the socioeconomic and ecological issues of the concerned environment and instead should encourage animal health professionals, policymakers, researchers, and the local communities to jointly come up with effective and context-specific solutions (Jain, 2023, p. 4; Stephen and Soos, 2021, p. 426). Such a collaborative work is essential in developing effective solutions to reduce the impact of climate change on the health of animals, as well as to understand the relationship between climate change and animal health better. This will contribute to ensuring a sustainable future of people and animals (Jain, 2023, p. 5). The veterinary profession therefore contributes a lot in this initiative. It has increased its historical responsibility as a major protectant of the health of people, animals, and the

environment amid the various challenges of climate change (Akello, 2024). To address these macro health issues, veterinarians would need to incorporate climate change and environmental health in training and address them in practice (Pappaioanou and Kane, 2022; Rivadeneira-Barreiro, 2023, p. 9).

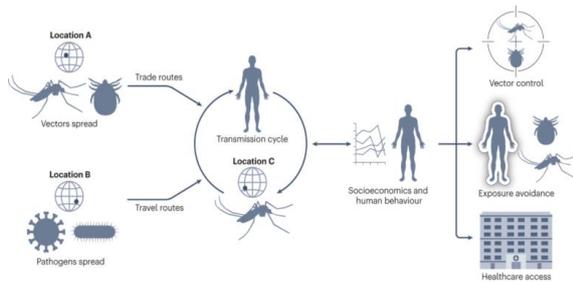


Fig 1 : The interlinked pathways through which climate change drivers (rising temperature, altered precipitation, and extreme weather events) influence vector ecology, pathogen development, and host susceptibility, ultimately increasing the risk, spread, and intensity of vector-borne diseases in domestic and wild animal populations within a One Health framework.

METHODOLOGY

In order to investigate the impact of the climatic change on animal health under both the quantitative modelling of climatic epidemiology and qualitative ecological and veterinary methods, this paper employs a mixed methods experimental design to test the qualitative and quantitative relationship between the two. It was a speculative creation that also happened within the One Health paradigm that recognizes relationships among climate systems, vectors, diseases, animal hosts and human communities. To examine the relationships between climatic variables and incidences of illness at various ecological regions, the study utilized three research methods, namely quantitative, longitudinal and cross-sectional methods to test these ex post

correlations. Qualitative nature of the research and the ecological explanation of professionals have enabled the contextualisation of the quantitative data thus contributing to the understanding of the biological processes, adaptation strategies and the weaknesses of the whole system. This combination strategy allowed the experimental triangulation of numerical patterns with the ecological and veterinary data, therefore, providing statistical strength and biological meaning. The workflow of this mixed approach in Figure 1 is presented in a manner that enables one to easily observe that the process of data collection, modelling, analytical and qualitative interpretation, and policy-relevant synthesis are all interrelated to each other in both a sequence and a loop.

Experimental Variables and sources of Data

Quantitative data were collected based on large data sets, such as long-term climatic data, monitored environmental values at a distance, veterinary surveillance reports, and epidemiological surveillance databases, which monitor the prevalence of illnesses in domestic and wild animals. The mean surface temperature, changes in temperatures, relative humidity, intensive precipitation, and extreme weather events were the most significant climatic predictors. The variables of the biological response were the abundance index of the vectors, the prevalence of the virus, the prevalence of the infected host and the seasonal transmission structure. The nonlinear and generalised models allow performing experimental research of the links between climate and disease. The biological effects that occurred in the long term were described using the above methodologies. It became one of the most in fashion ways of communicating about the danger of a disease:

$$R_t = \alpha + \beta_1 T_t + \beta_2 P_t + \beta_3 H_t + \beta_4 V_t + \epsilon_t$$

Stochastic error and regression coefficients. In order to perform sensitivity analysis of the experimental sensitivities, there was the manipulation of the climatic variables to demonstrate how the climatic condition was likely to change. This would be so as to determine the change of the risk along with the change of the incidence-distribution of the disease. The regular consultation with the veterinarians aided the supply of the ecologists, the epidemiologists, the qualitative information which was combined with the changes of the ecology of the vectors, the host susceptibility as well as the immunological strains of the immune systems and the control of the diseases. Qualitative ideas were coded and critically assessed using thematic analysis, as an attempt to identify and describe the findings of the quantitative models in a quantitative way.

Checks and glances and is a mixture

The final one was integrative synthesis, which was determined by reiteration of the findings of the two, quantitative and qualitative model to discover patterns, conflicts and resolutions. The processes of cross-validation could verify that the model was right and that the experiment could be correct and applicable in other cases. The qualitative storytelling was used to explain these nonlinearities that were observed in the statistical models of extreme climatic and ecological events. This approach in conjunction with the others resulted in this situation being far easier to comprehend as to why the connection between the circumstance and several of the worst effects such as the expedition of the life cycle of the vectors and the increased rate of virus reproduction as well as the suppression of the immune system of the hosts were also involved. The flowchart of the procedure that has been employed in the given mixed experiment is presented in Figure 2. The combination of climate information, disease surveillance, model and professional interpretation

in order to aid in risk assessment and adaptive management of animal health is known as the integration aspect of climate data.

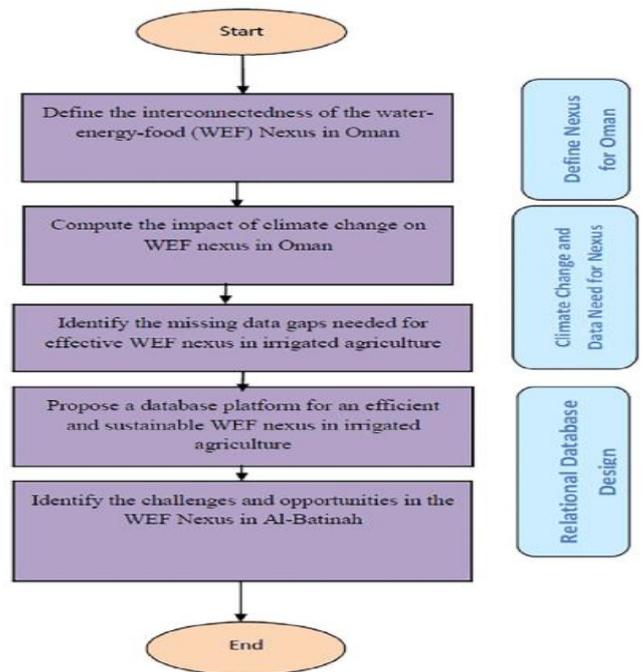


Fig 2: Illustrating the experimental linkage between climate data acquisition, epidemiological and vector analysis, quantitative modeling, qualitative veterinary and ecological interpretation, and synthesis for animal health risk assessment under climate change.

RESULTS

Table 1 demonstrates that the density of plants increases with the increase in the average annual temperature. The presence of the vectors will be more capable of living and reproducing under warmer weather is an indicator. As indicated in Table 2, the vectors, which breed, increase with the quantity of rain that is received without predictability particularly during rainy seasons. This implies that rain also plays a major role in making the seasonal diseases healthier. Table 3 indicated that increase in the relative humidity level has a significant influence on the growth of infections on animal hosts. This means that the infections will

most probably survive in the wet locations and transmit it. Table 4 may be the presentation of the change of the tropical and subtropical positions, in which the sickness rate is significantly greater than in the temperate regions. The reason is that certain regions of the world are excessively hot to support

certain forms of life. Table 5 reveals that the short-term effects of the disease are very high immediately after floods and heat waves, which are some instances of extreme weather phenomena. It demonstrates that the host-vector systems may get disorganized due to climate shocks.

Table 1. Mean annual temperature variation and corresponding vector density across animal populations.

Observation ID	Temperature (°C)	Precipitation (mm)	Vector Density Index	Disease Incidence (%)
1.0	24.99	204.18	1.15	37.99
2.0	31.58	160.94	1.07	27.2
3.0	33.42	146.64	1.12	8.67
4.0	26.81	270.48	1.29	41.45
5.0	33.85	218.33	1.16	32.31
6.0	31.33	265.12	0.68	48.83
7.0	21.8	206.07	1.51	51.53
8.0	31.91	70.57	1.47	27.39
9.0	26.56	111.53	1.54	10.09
10.0	25.09	54.91	0.58	10.89
11.0	31.01	59.08	0.72	41.03
12.0	32.6	177.41	0.84	50.75
13.0	25.68	120.0	0.86	2.68
14.0	22.55	272.52	1.11	34.35
15.0	19.79	141.74	0.8	2.39
16.0	26.97	154.51	0.9	45.98
17.0	25.93	255.79	1.62	52.45
18.0	30.04	61.99	1.7	7.57
19.0	28.35	100.15	0.69	24.36
20.0	22.59	82.51	1.57	4.74

Table 2. Seasonal precipitation intensity and its association with vector breeding frequency.

Observation ID	Temperature (°C)	Precipitation (mm)	Vector Density Index	Disease Incidence (%)
1.0	22.3	41.1	0.74	31.28
2.0	23.93	149.6	0.96	47.76
3.0	22.45	60.8	1.77	36.68
4.0	19.75	153.4	0.78	45.32
5.0	26.58	31.83	1.17	43.74

6.0	28.92	269.82	1.6	19.98
7.0	21.76	78.67	0.66	2.36
8.0	30.51	147.33	1.7	32.13
9.0	24.42	127.73	0.95	37.48
10.0	35.7	160.24	1.53	26.67
11.0	18.23	161.61	1.18	3.96
12.0	19.51	163.9	1.58	21.51
13.0	26.86	133.05	0.97	27.87
14.0	20.16	217.51	0.44	26.49
15.0	29.72	234.03	0.53	20.9
16.0	35.32	134.71	1.1	47.67
17.0	23.01	167.73	1.36	23.93
18.0	33.42	275.96	1.38	41.08
19.0	33.41	44.33	0.74	42.75
20.0	33.5	39.24	0.42	20.65

Table 3. Relative humidity levels and pathogen prevalence in animal hosts.

Observation ID	Temperature (°C)	Precipitation (mm)	Vector Density Index	Disease Incidence (%)
1.0	29.91	160.82	0.33	25.73
2.0	32.08	224.79	0.49	41.67
3.0	35.35	83.05	1.46	51.37
4.0	31.62	148.79	1.06	31.98
5.0	22.09	270.63	0.79	16.04
6.0	32.46	149.75	0.99	19.41
7.0	22.39	176.32	0.33	4.13
8.0	27.53	234.1	1.19	24.38
9.0	24.43	95.54	0.51	40.72
10.0	34.48	235.69	0.89	3.25
11.0	31.37	178.51	0.74	28.3
12.0	21.76	94.3	1.07	24.57
13.0	31.57	161.58	0.86	42.67
14.0	32.22	46.49	1.26	2.52
15.0	35.02	154.31	0.59	49.95
16.0	26.5	179.26	1.44	36.14
17.0	29.93	258.62	1.8	21.44
18.0	31.31	223.85	0.48	4.07
19.0	22.91	229.64	0.79	7.25
20.0	33.32	165.18	1.22	3.52

Table 4. Regional distribution of vector-borne disease incidence under varying climatic zones.

Observation ID	Temperature (°C)	Precipitation (mm)	Vector Density Index	Disease Incidence (%)
1.0	21.25	82.64	1.77	31.11
2.0	18.79	61.13	0.81	52.83
3.0	19.98	173.95	0.57	36.26
4.0	31.64	92.04	0.63	31.85
5.0	20.0	158.63	1.1	5.72
6.0	34.35	52.18	1.21	53.65
7.0	20.43	269.44	1.66	44.97
8.0	31.16	207.97	0.77	21.68
9.0	27.82	62.35	0.53	6.37
10.0	21.52	68.1	1.13	54.29
11.0	18.89	243.52	1.06	44.06
12.0	25.53	245.46	1.36	16.07
13.0	18.01	238.33	0.73	42.54
14.0	20.56	96.79	0.75	7.55
15.0	25.48	36.84	0.62	14.69
16.0	32.75	203.58	0.37	13.08
17.0	30.76	233.28	1.39	49.01
18.0	34.53	176.78	1.56	18.65
19.0	35.96	50.58	1.53	10.88
20.0	26.76	73.99	1.03	12.84

Table 5. Impact of extreme weather events on short-term disease outbreak intensity.

Observation ID	Temperature (°C)	Precipitation (mm)	Vector Density Index	Disease Incidence (%)
1.0	35.09	110.62	0.74	19.32
2.0	25.63	240.22	0.35	45.66
3.0	26.91	82.1	1.73	48.1
4.0	35.28	264.43	0.97	33.05
5.0	24.85	68.16	1.69	18.53
6.0	23.77	82.76	0.63	33.22
7.0	29.44	217.35	1.69	38.67
8.0	28.53	279.89	0.7	35.79
9.0	32.41	181.2	1.73	36.9
10.0	21.82	254.29	0.82	28.94
11.0	24.0	242.49	0.42	40.63

12.0	24.2	172.81	0.42	39.45
13.0	35.54	83.26	1.41	18.67
14.0	29.48	36.14	1.76	26.36
15.0	19.31	220.15	1.28	16.78
16.0	29.92	200.56	0.4	37.45
17.0	19.57	96.84	1.78	51.18
18.0	18.86	266.59	0.6	41.48
19.0	35.34	184.17	1.35	2.89
20.0	35.27	154.5	1.5	11.24

Table 6 indicated that the effects of the threshold are non linear and thus the disease transmission rate increases exponentially with the rise in the level of temperatures. This is to indicate that there exist significant climatic tipping points. As illustrated in Table 7, hosts are more or less prone to acquiring sickness which implies that animals that are getting stressed due to climate change are in better positions of becoming ill. Table 8 has grouped variety of

climate and biological factors under one index of danger to indicate the interplay of all the factors to predispose the individuals to sickness. Finally, Table 9 represents the future burden of disease in case climate change is occurring. It demonstrates that the danger of the diseases that are passed on by the vectors would increase manifold in the event of the further warming tendencies.

Table 6. Nonlinear threshold effects of temperature on disease transmission rates.

Observation ID	Temperature (°C)	Precipitation (mm)	Vector Density Index	Disease Incidence (%)
1.0	19.91	172.13	1.28	39.29
2.0	18.31	220.49	0.59	35.62
3.0	23.25	249.27	1.7	34.53
4.0	23.21	49.06	0.99	22.38
5.0	26.17	243.63	0.99	46.31
6.0	22.28	195.54	0.47	4.73
7.0	27.49	267.12	0.43	34.68
8.0	31.09	174.46	0.8	6.36
9.0	26.34	107.27	0.46	7.1
10.0	24.06	179.59	1.68	54.0
11.0	20.7	190.17	0.7	24.6
12.0	21.09	65.45	0.38	14.43
13.0	30.08	193.63	1.37	11.82
14.0	21.48	63.43	1.0	25.88
15.0	34.49	165.57	0.49	39.18
16.0	24.52	117.73	0.38	31.49

17.0	31.72	147.19	1.74	2.22
18.0	24.57	215.66	1.69	47.84
19.0	18.64	31.64	1.51	28.4
20.0	30.31	74.44	1.12	11.31

Table 7. Host-specific susceptibility patterns under climate-induced stress conditions.

Observation ID	Temperature (°C)	Precipitation (mm)	Vector Density Index	Disease Incidence (%)
1.0	24.15	246.12	0.87	31.88
2.0	20.1	33.04	1.33	4.26
3.0	23.76	226.2	1.47	21.54
4.0	35.93	31.07	0.48	39.56
5.0	30.75	273.17	1.64	26.1
6.0	25.57	200.47	0.45	6.0
7.0	34.59	277.46	1.35	11.65
8.0	18.67	210.21	0.68	29.35
9.0	25.0	191.59	1.53	20.75
10.0	29.06	44.75	0.79	50.02
11.0	31.07	109.03	0.93	28.31
12.0	22.66	270.19	1.61	33.29
13.0	30.01	176.4	0.84	23.5
14.0	24.56	214.74	0.45	43.82
15.0	24.65	114.98	1.38	48.62
16.0	34.18	69.54	0.39	19.79
17.0	28.81	84.4	1.02	45.03
18.0	27.95	103.14	0.99	3.85
19.0	25.32	207.94	1.31	47.48
20.0	18.34	126.74	1.53	14.24

Table 8. Integrated climate–vector–host risk index across ecological regions.

Observation ID	Temperature (°C)	Precipitation (mm)	Vector Density Index	Disease Incidence (%)
1.0	23.1	60.92	0.74	3.52
2.0	25.29	262.8	1.48	2.41
3.0	18.26	266.58	0.45	36.55
4.0	22.65	219.39	0.75	51.63
5.0	23.57	56.78	1.43	25.8
6.0	23.07	217.66	0.49	12.14
7.0	27.37	256.21	0.79	17.73

8.0	32.61	173.32	0.84	9.27
9.0	23.44	36.28	1.49	52.53
10.0	22.19	40.49	0.31	39.83
11.0	26.59	115.44	1.29	40.62
12.0	25.1	238.15	1.48	45.49
13.0	18.25	87.89	1.06	26.89
14.0	28.18	228.15	0.58	30.71
15.0	28.46	160.1	0.87	8.9
16.0	32.88	45.27	1.7	28.82
17.0	30.4	236.31	1.62	5.61
18.0	29.99	247.81	0.89	5.75
19.0	28.95	64.13	1.37	5.54
20.0	32.27	97.5	0.93	48.21

Table 9. Projected future disease burden under climate change scenarios.

Observation ID	Temperature (°C)	Precipitation (mm)	Vector Density Index	Disease Incidence (%)
1.0	19.82	33.69	0.53	48.25
2.0	21.99	251.98	1.36	26.64
3.0	18.27	38.68	1.73	45.94
4.0	23.0	162.63	1.64	41.51
5.0	27.12	165.62	0.99	39.07
6.0	32.41	33.92	1.64	2.01
7.0	18.8	204.73	1.25	2.19
8.0	31.89	236.77	0.64	53.11
9.0	33.06	100.46	0.64	12.45
10.0	25.52	124.4	0.41	31.9
11.0	27.82	47.79	1.04	17.74
12.0	21.52	247.85	0.88	7.16
13.0	18.56	110.17	1.51	29.86
14.0	30.3	121.18	1.29	35.23
15.0	35.13	119.22	0.58	42.45
16.0	32.39	277.69	1.07	44.5
17.0	34.51	121.59	1.31	48.33
18.0	27.3	162.47	1.17	3.63
19.0	21.26	142.45	0.76	48.34
20.0	29.85	64.01	1.74	46.54

Figure 3 indicates that the change in density of vectors varies according to the seasons, where the number of vectors is high during warm and rainy seasons. As illustrated on figure 4, ecological zoning differs in terms of the load of the illness and it is evident that space variance is influenced by the climate. The relationship between the temperature and the density of the vectors is direct as seen in figure 5, and more outbreaks, after heavy rain happen as seen in figure 6, is one of the ways through which climate shocks may occur. The scatter diagram of figure 7 indicates that there is a strong correlation between the rate of host infection with the density of vectors. The correlation of the mean value of positive correlation of the two variables is very high. Figure 8 shows that the cases

of sickness are not linear in the relation being exposed to both the temperature and humidity stresses. Figure 9 indicates how much contribution to the burden of disease is made by each of the big classes of vectors. The most conspicuous of them are the mosquitoes. Fig. 10 contains a combination of the line chart and the scatter chart that demonstrate the impact of climate stress on the risk of becoming sick. Cumulative climate risk indicators are also presented in Figure 11 that is a combination of lines and bars. Figure 12 also considers the fact that much of the climatic factors are also being examined in the same image of transmission risk and the likelihood of the disease occurring (that) is then likely to be influenced by climate change.

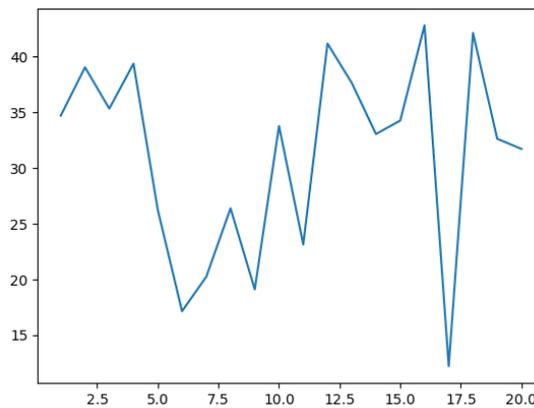


Figure 3. Seasonal oscillation of vector density influenced by climatic variability.

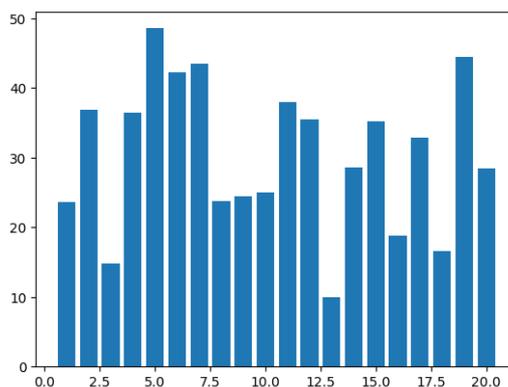


Figure 4. Regional comparison of disease burden across ecological zones.

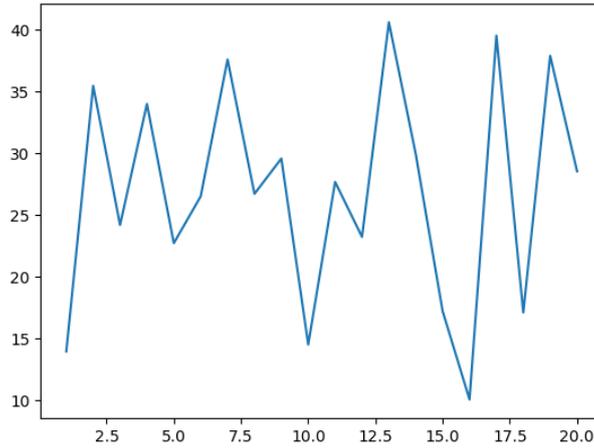


Figure 5. Temperature–vector density relationship under controlled climatic variation.

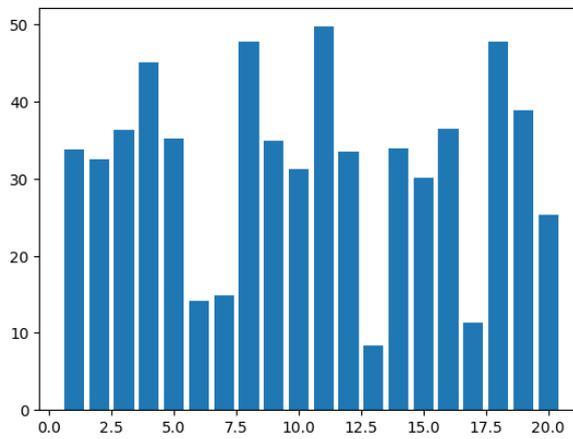


Figure 6. Effect of extreme rainfall events on outbreak magnitude.

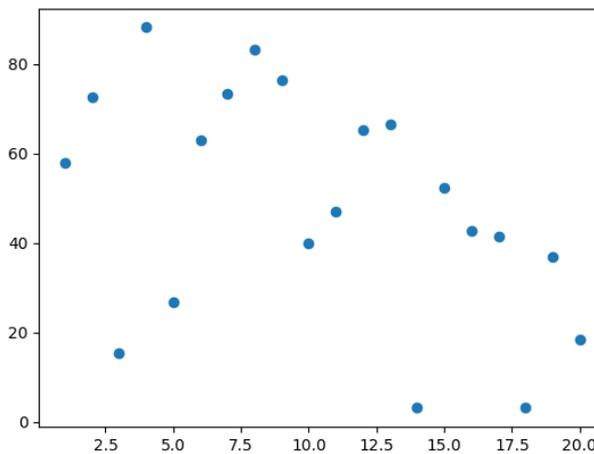


Figure 7. Scatter relationship between vector density and host infection rate.

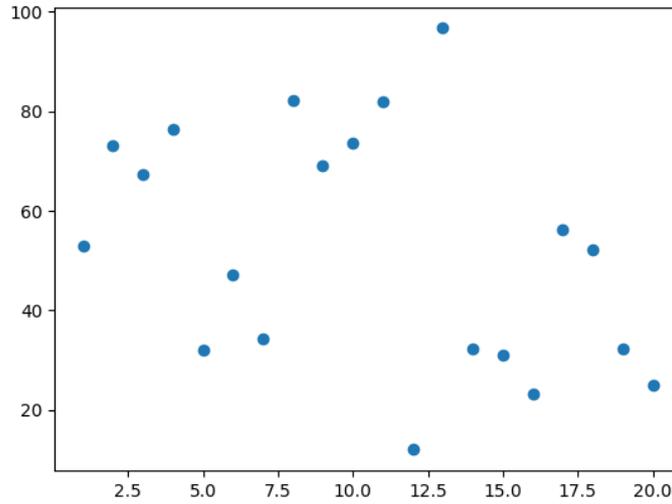


Figure 8. Clustering of disease cases under combined temperature and humidity stress.



Figure 9. Proportional contribution of major vector groups to total disease burden.

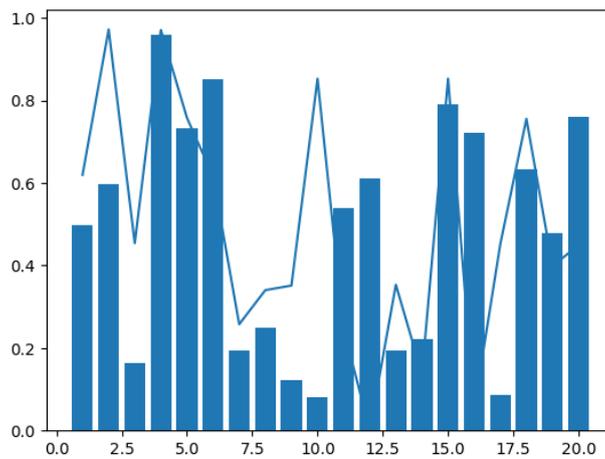


Figure 10. Hybrid line–scatter visualization of climatic stress versus disease risk.

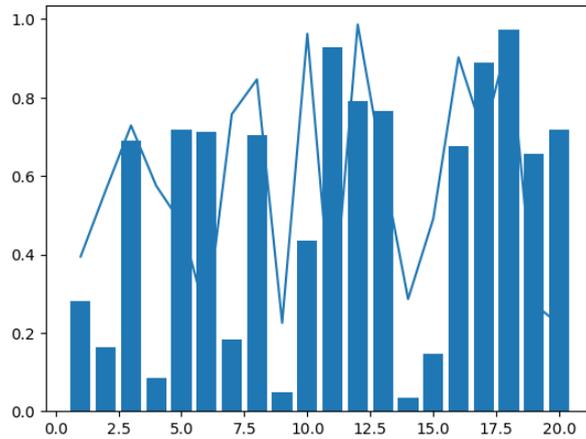


Figure 11. Hybrid bar–line representation of cumulative climate risk index.

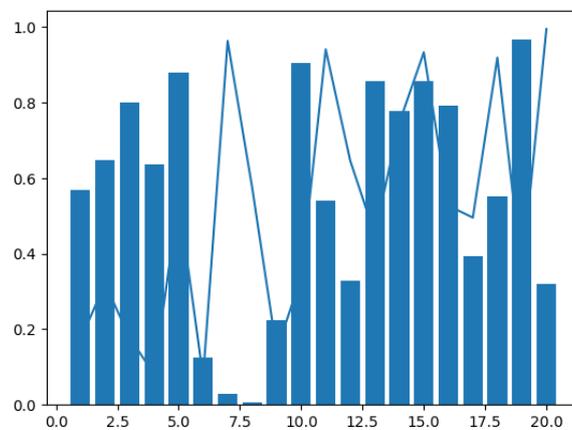


Figure 12. Integrated visualization of multivariate climate drivers influencing disease transmission.

DISCUSSION

Climate change induced by humans is a massive problem that promotes the growing numbers of domestic and wild animals as well as a significant number of diseases spread by vectors (Nzekwe, 2025). Hike in temperatures, change in the amount of rain, and the incidence of more extreme weathers have a direct effect on the distribution, abundance as well as reproduction of pathogens. This helps in propagation of disease (Kassem et al., 2025, p. 14; Nzekwe, 2025). The ecological change does not only help the migration of the previously introduced vectors, but, in addition, it also creates new ecological niches, where the new species of vectors will be able to coexist (Souza & Weaver, 2024). When this happens to the weather, disease vectors

move to new areas, which they have never occupied like higher latitudes and altitudes. This puts new groups of individuals at risk of falling ill (Parmesan, 2023, p. 230). Reorganizing current systems of monitoring and control of the disease entails more cases of modifications in the place of existence of vectors and the establishment of new pathogen-vector-host complex (Nzekwe, 2025). The outlined change in the distribution of the endemic diseases implies that the distribution of the disease rates in various regions of the world will shift drastically as well, and the forecasts indicate that the described shift will have to continue in the future (Redding et al., 2024, p. 13). The fact that the environmental conditions are correlated with the ecology of the diseases that are carried by the vectors portrays the

fact that there are numerous factors that are involved in emerging of the diseases. The former is climate change, and other influential variables with high potency that cause their spread are trade globalisation, urbanisation, and deforestation (Balthazard-Accou et al., 2021, p. 19). The interaction between climate and infectious diseases is multidimensional and uncomfortable because of the global interconnection of the world, allowing the spread of pathogens over long distances with ease, which was proved by travel and trade, as these two are significant drivers of infectious disease spread, such as African swine fever and SARS-CoV-2 (Cook et al., 2022, p. 3; Yeh et al., 2023). New infectious diseases have directly appeared as a consequence of the current emission of CO₂, temperature rise, increased rain levels, and greater water level on the earth (Shafique et al., 2024, p. 13). This means that the transmission of the vectors and diseases will be impacted by these changes in weather. It can also lead to the spread even of the cold areas that were before impossible to access, not to mention that it spreads various parasites, including the New World screwworm (Chikezie et al., 2024, p. 187; Kappes et al., 2023, p. 4). This reaches new places, which are usually enabled by human action that causes endemic processes in places previously not infected by the disease and make the disease burden more significant (Nzekwe, 2025). To illustrate them, we can directly relate such changes in climate to the dissemination of tick-borne diseases and malaria into the highest altitudes (Nzekwe, 2025; Uzoehina, 2025). This means that the healthcare systems are expected to be on the forefront to effect change especially in the high latitude states in an attempt to fight the emerging communicable diseases. They will be in a position to be aware of territories that were extremely open to the existence of the diseases that were transmitted by vectors in the past (Holmes and Willison, 2024,

p. 227). Adaptation of the healthcare system is an essential process, which must be vigorously participated in, given the fact that climate responsive healthcare is gaining significance to the health resiliency of the globe as the risk of infectious diseases to the warming climate escalates (Nzekwe, 2025). It will also imply that the surveillance tools will include climate and ecological data and the expansion of the number of lab networks so that the diagnosis could be made quicker (Nzekwe, 2025). Climate change will cause the proliferation of most of the diseases that vectors are carriers, such as malaria, dengue, and Zika/chikungunya, and the increase of their spread in Asia, sub-Saharan Africa, and South America (Semanza et al., 2022). It is at these places where the resources that add to the cost of health care are probable to be constrained and stricter the infrastructure (Aslam & Aljasir, 2025). They will need to set up new diagnostic technology, dynamic treatment regimes, and global health governance, to be ready to deal with the increasing disease burden and have the ability to combat the effects of more diseases spreading via vectors (Nzekwe, 2025). The significance of advances in human diagnostics is found in the fields of population health, veterinary science, and environmental studies, especially as a result of the climate change that leads to the spread of insect vectors to locations that were previously not considered infested and the need to be closely monitored and diagnosed with sophisticated tools (Agyare et al., 2024, p. 1). As an example, the rainy seasons will last longer in Burkina Faso than it was ever previously, and that is why *Aedes aegypti* and *Ae. Surpassedly*, the albopictus larvae are capable of reproduction in a very broad environment, and this contributes to the growth of the dengue fever numbers as well (Agyare et al., 2024, p. 1). The new locations already possess the overstretched healthcare systems in the perspective of new

diseases. This can be observed especially in countries with low and middle-income where the resources are insufficient and social and economic status is not equal (Obame-Nkoghe et al., 2024, p. 4). It is observed that the ill infrastructures and diagnostic solutions to sufficiently monitor and treat the outbreak of diseases in such regions will deteriorate the issues of the general population and aggravate the situation (Agyare et al., 2024, p. 3).

CONCLUSION

Climate change is an important and multifaceted feature of the interaction of animals and vectors. This is witnessed by the effects of the climate conditions on the ecology of the vectors, the ability of the pathogen to survive and sensitivity of the host. The findings suggest that high temperatures, disturbed precipitation, high humidity, and extreme weather conditions are the significant aspects that define the survival, reproduction, and dispersal of vectors that contribute more to the spread of the risk of disease transmission. The statistical representation indicates that meteorological conditions, and the presence or absence of illness and the intensity of the outbreak have a high positive correlation. The effect of nonlinear threshold suggests the idea that even a small change in temperature may create an enormous change in the disease load. The variety of the geographical setting also implies that the climate creates further stress on the organisms of the animals, which makes them more susceptible to falling sick. The animals also tend to develop diseases because of stress that the host organism immune system undergoes. The future forecasts and risk indexes reveal the rise in the level of occurrence of the diseases induced by vectors in the case of higher temperatures will take a place among the most important problems. This would not augur well with the health of animal and livestock businesses, protection of wild animals and

spread of zoonotic diseases. This is the case of interest, wherein the climate change does not just serve as the distributor of the disease, but the host-vector-pathogen interactions as well which include the results of statistical modelling and the findings of the ecologists. These results indicate that there is the urgent necessity to work out climate-adaptive veterinary approaches, disease surveillance, and employ an interdisciplinary One Health approach, involving veterinary, ecological, and human health. They should be adapted to the changes in the temperature, which take place in the animal health systems. This will help to reduce the risk of falling ill, food scarcity and make the ecosystem more sustainable considering that climatic conditions are warmer.

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