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Review Article

Climate Crises and Developing Vector-Borne Diseases: A Narrative Review

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Abstract

Background: Climate change based on temperature, humidity and wind can improve many characteristics of the arthropod carrier life cycle, including survival, arthropod population, pathogen communication, and the spread of infectious agents from vectors. This study aimed to find association between content of disease followed climate change we demonstrate in humans.

Methods: All the articles from 2016 to 2021 associated with global climate change and the effect of vector-borne disease were selected form databases including PubMed and the Global Biodiversity information facility database. All the articles selected for this short review were English.

Results: Due to the high burden of infectious diseases and the growing evidence of the possible effects of climate change on the incidence of these diseases, these climate changes can potentially be involved with the COVID-19 epidemic. We highlighted the evidence of vector-borne diseases and the possible effects of climate change on these communicable diseases.

Conclusion: Climate change, specifically in rising temperature system is one of the world's greatest concerns already affected pathogen-vector and host relation. Lice parasitic, fleas, mites, ticks, and mosquitos are the prime public health importance in the transmission of virus to human hosts.

Keywords: Climate change; Rising temperature; Vector-borne diseases; Parasitic insects; COVID-19

Introduction

Rapid climate change has weighted long-term effects on humans and natural ecosystems and are overwhelming vector-borne diseases. Rising temperatures favor agricultural pests, diseases and disease vectors (1). Therefore, climate change has already made conditions more conducive to the spread of certain infectious diseases, including Lyme disease, water-borne diseases, and mosquito-borne diseases such as malaria and dengue fever (2, 3).

As a medical condition, both fleas and ticks are more common during the warmer months, and malaria is again endemic almost everywhere throughout the year. It is expected that the increase in the number of ticks is due to the fact that winters are generally much warmer than pre-

vious years. Climate change most likely determines how and where pathogens appear, including patterns of temperature and precipitation, however, the impending risks are not easy to predict. To help limit the risk of infectious diseases, we should do everything possible to significantly reduce greenhouse gas emissions and limit global warming (4).

In this narrative review, we summarize the type of arthropod-borne diseases face to humans with focusing on the influence of climate change on vector-borne diseases. Moreover, evidence demonstrating the high burden of COVID-19 disease due to potential impacts of climate change are mentioned.

Therefore, we aimed to find the association between content of disease followed climate change we demonstrate in humans.

Methods

All the studies from 2016 to 2021 associated with global climate change and the effect of vector-borne disease were extracted. This short review was conducted through searching databases including PubMed, GBIF and Google scholar. Our last search took place in Nov 2021. In order to include related studies, we used following terms: " Global Climate Change", "Vector-borne Diseases"," Leishmaniasis", "Mosquitos", "Ticks", "Fleas", " Global Warming", "Lice", "Mites", "Covid-19" as keywords for titiles or abstracts.

Selection of Studies and Data Extraction: All articles were separately reviewed by authors, and all evaluated the relevance of each article to the short-review. Fig. 1 shows the information flow of our short-review.

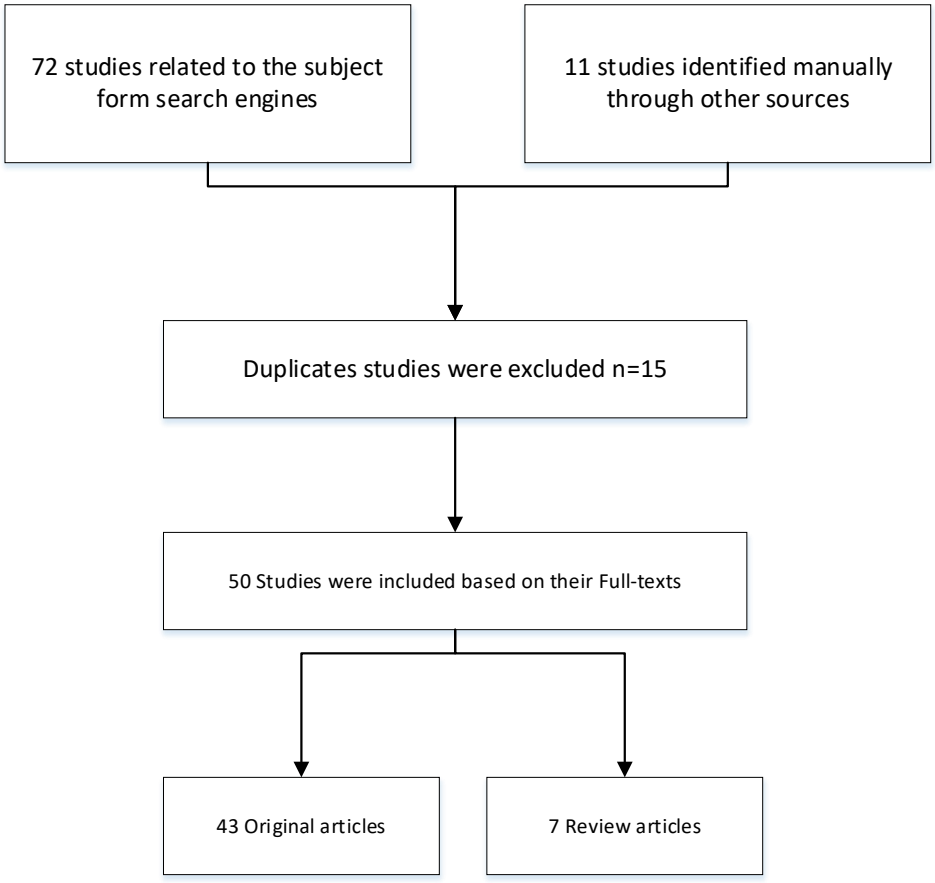

Fig. 1: The information flow through the phase of short review. Our search was done by using keywords in English. 50 related studies were used between 2016-2021

Results

A growing number of studies confirm that climate change due to air pollutants in particular affects human mortality and the spread of vector-borne diseases (4, 5). Fig. 2 shows the effect of climate change and its negative impact on environmental factors. The accumulation of greenhouse gases such as carbon dioxide, mainly caused by the combustion of fossil fuels, leads to air pollution and heat waves that is disrupting habitual territories and ecosystems. Climate is an important environmental factor for influencing of vector-borne diseases epidemic. Many articles have explored the potential consequences of global climate change, particularly the impact of global warming, on vector-borne diseases (6). Higher average of temperatures as a result of greenhouse gas emissions will increase more severe storms and droughts. Odorless and colorless gas, ozone, carbon monoxide (CO) is mainly produced from automotive exhaust gases, as well as from the production of tools, engines and industrial developments. On the other hand, the increase in water vapor and the formation of ozone on the earth's surface due to heat waves are linked to a number of health threats. Ozone (O3) is made up of three oxygen atoms in the atmosphere that could have harmful properties if produced in the Earth's lower atmosphere (7, 8). Along with increasing social sensitivity to mental health complications, global warming, with its impact on the environment, exposes individual health to an increase in communicable diseases, respiratory and allergic disorders (9, 10).

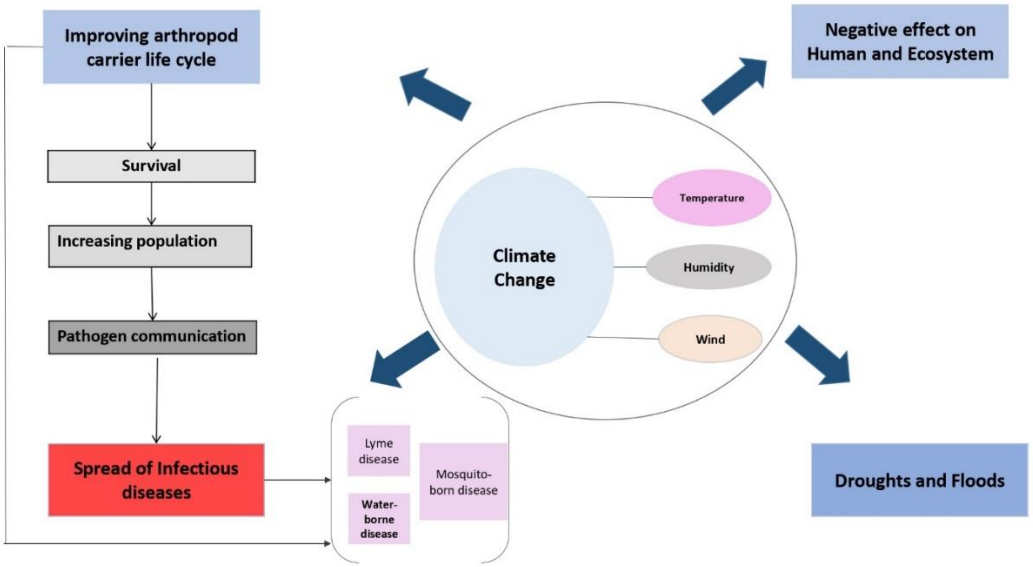

Fig. 2: The conceivable association of climate change on vector-borne diseases and spread of infectious diseases alongside with other negative impacts on human's health and environment

The impacts of climate change are likely to be worsen by developing vector-borne viral diseases alongside diseases such as malaria in the tropics and even temperate zones, thus generating extra infectious bites each year. Speaking of the current global warming crisis, coupled with the direct influence of rising temperatures on numerous human health problems such as heat stress and vector-borne diseases (8).

Vector-borne diseases will continue to evolve in a changing world, as they have done throughout history, to continue to plague world health. Among the most climate related diseases, mosquito-borne viral and parasitic diseases are the

most worrying. These diseases profoundly limit socioeconomic status and development in countries with the highest infection rates as many of found in the tropics and subtropics area (11). The unequal increase in average nighttime compared to daytime temperatures makes available the ideal temperature for the growth of vector insects and the spread of related diseases (10, 12).
Here, the profound health problem related to the influence of climate change in the onset of arthropod-borne diseases are elucidated.

Vector-borne diseases that put the population at risk in global warming

Vectors are the transmitters of disease-causing organisms; that is, they carry pathogens from one host to another. They are typically species of mosquitoes and ticks capable of transmitting viruses, bacteria or parasites to humans and other warm-blooded hosts, but may also include rodents, which carry the infectious agent from a reservoir to a susceptible host (9, 10). A reservoir, included humans, animals or insects, is the principal habitat in which a pathogen lives and flourishes. Vector-borne diseases such as malaria, dengue fever, Chagas disease, leishmaniasis, trypanosomiasis, schistosomiasis and yellow fever are the infections that are most transmitted by the bite of infected arthropod and cause a significant fraction of the global burden of infectious disease (13-15). Although human leishmaniasis have a variety of clinical range, is the ignored tropical disease, which have a large variety of parasite species, reservoirs and vectors associated in transmission.
The responsible agent the Protoza *Leishemania*, which has more than 20 species can infect humans and animals via bite of particular species of female sand flies (14). Vector-borne disease cycles are complex systems due to the requisite interactions between arthropod vectors, animal hosts and pathogens that are under the influence of environmental factors that contribute to the variation of disease transmission in complex ways. Arthropod vectors are cold-blooded (ectothermic) and therefore are particularly sensitive to climatic and other environmental factors. Weather effects on vector survival and reproduction rates, vector distribution and abundance; and also influences habitat suitability in addition to year-round biting rates and the reproduction of pathogens within vectors (16-18).
However, climate is only one of many factors influencing vector distribution, such as habitat destruction, land use, pesticide application, and host density. Vector-borne diseases are widespread and transmitted by lice, fleas and hard **ticks** (ticks and mites), mosquitoes and other vectors that put humans at enormous risk of death (19). Vector borne diseases and their main disease born kinds of them are illustrated in Fig. 3.

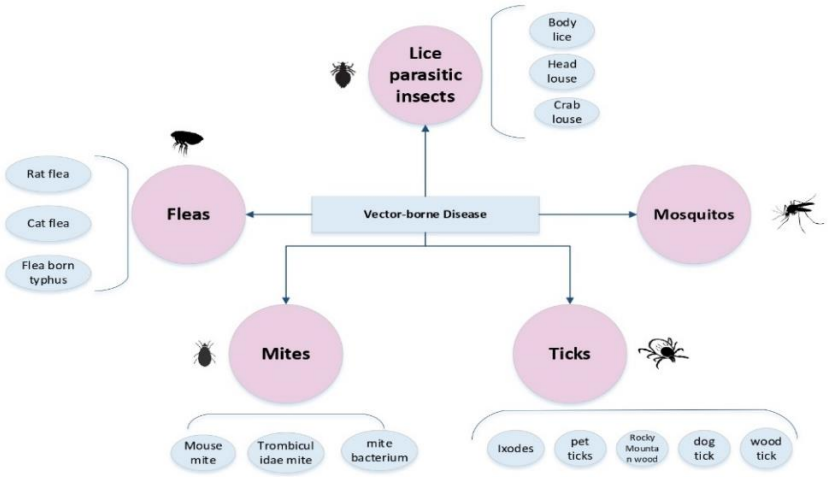

Fig. 3: Five main arthropod vectors with their predominant kinds

Lice parasitic insects

Adult body lice are hematophagous ectoparasites with a length of 2.3-3.6 mm that infest people of all races around the world. They lay eggs on clothing and do not live directly on the host, they only take care of them when they feed. Body lice are well known with the prevalence of lice-borne diseases, in which the body louse (*Pediculus humanus humanus*) infected with the bacterium *Rickettsia prowazekii* causes epidemic typhus. While endemic recurrent fever and trench fever are spread by human body lice infected with bacteria called *Borrelia recurrentis* and *Bartonella Quintana* respectively. Two other lice are the head louse and the crab louse or pubic louse. In the life cycle of body lice, eggs are the most resistant stage to changes in environmental temperatures (17, 20).

Fleas as common external parasites

Fleas are parasitic insects that impact public health through two species, the rat flea *Xenopsilla cheopis* as a vector of *Rickettsia typhi* and the cat flea *Ctenocephalides felis* as a crucial vector of *R. felis* and sometimes *R. typhi*. Endemic or flea-borne (murine) typhus caused by the bite of fleas infected with *R. typhi* . Fleas become infected as they bite reservoir animals such as rats and cats to feed on blood and then spread infections to people while interacting with flea dirt or inhaling infected flea dirt or wiping their eyes. However, flea-borne typhus is less well known and many often infected individuals are confused with viral infections. Fleas will threaten various pets and people as our planet's climate warms (19, 21).

Mites: insect-like organisms

Acari, a taxon of arachnids, encompasses mites and ticks that identified by the lack of wings and antennae but having four pairs of legs that is vary from the insects. Virtually there are a lot of dissimilar types of mites as much as exist insects that live and grow in various environments. Mites are thoroughly similar to ticks and therefore spread a wide range of infectious microbial diseases. Truthfully, the solitary infectious diseases transmitted by mites are some of which bite or cause irritation to humans as specifically related to asthma, rickettsialpox and scrub typhus. The human being most affected by mites for respiratory disease and the inspiration of asthma, which is the distinct character of the mites (22).

Self-limiting Rickettsia pox disease spread by the bite of an infected mouse mite *Liponyssoides sanguineus* and caused by the Rickettsia bacterium such as *R. akari* . One of mites-borne rickettsiosis family known as *Orientia tsutsugamushi* develops Scrub Typhus with a typhus figure and is transferred to humans from the Trombiculidae mite family (*Leptotrombidium deliense* and *L. akamushi*) while feeding on infected rodent hosts. However, cross-infection has sometimes been established between other rodents and humans (22-24).

Ticks as most important vector-borne disease

Ticks are considered to be the most important vector-borne disease that have an emotional impact on health and cause infections and types of disease in humans and other mammals briefly described here (25, 26). Lyme disease, also identified as Lyme borreliosis, is an infectious disease with the Borrelia bacterium spreading from the *Ixodes* genus of ticks. About a week after the tick bite spot, a red rash or erythema migrans appears as the most common sign of infection along with fever, headache, joint discomfort and neck stiffness, and partial absence of facial movement. (6)

The *Coxiella burnetii* bacterium is responsible for Q fever rarely transmitted to humans by pet tricks. It is commonly mild with signs such as the flu, but it can be a serious illness in people with heart valve complications or a failing immune system (27, 28).

Colorado tick fever, also known as "mountain fever", is an infectious disease of the *Coltivirus* that infects hematopoietic cells, mainly erythrocytes and transmitted by the bite of an infected Rocky Mountain wood tick known as *Dermacentor andersoni* (29).

Tularemia is a human disease known as "rabbit fever" elicited by the bite of the infected dog tick *Dermacentor variabilis* and the wood tick *D. andersoni* with *Francisella tularensis* bacterium. Indica-

tions of the disease may include fever, skin ulcers and swollen lymph nodes which also rarely occur pneumonia or throat infections (30). Relapsing fever is a bacterial infection caused by several species of *Borrelia spirochetes* transmitted to humans by lice or ticks (31). Babesiosis or piroplasmosis is a form of red blood cell infection with very few parasites known as *Babesia microti* and spread by the black-legged tick *I. scapularis* . It is thought to be the second largest mammalian shared blood parasite after malaria and often associated with other tick-borne infections such as Lyme disease (32). Ehrlichiosis is transmitted to humans by an infected tick *Ambylomma americanum* with bacteria from the family Anaplasmataceae, genera *Ehrlichia* and *Anaplasma* that infect and destroy white blood cells. Tick-borne encephalitis (TBE) frequently manifests as meningitis, encephalitis or meningoencephalitis and is caused by the TBE virus infected tick (32-34).

Mosquitoes are important vectors in the transmission of many diseases

Mosquitoes are of prime public health importance for malaria and mosquito-borne viruses greatly expanded their range of distribution (35, 36). Malaria is a life-threatening disease that occurs via the parasites *Plasmodium vivax*, *P.* falciparum and *P. ovale* of people through the bites of infected female Anopheles mosquitoes (26, 37). However, mosquitoes are widely believed to be emerging infectious such as arbovirus encephalitis and viral hemorrhagic fevers from four main virus groups *Flaviviridae*, *Bunyavirales*, *Reoviridae*, *Arboviruses* and *Togaviridae*. Viruses such as dengue virus, West Nile virus, Zika virus, yellow fever virus and mosquito-borne chikungunya virus are responsible for serious illness and even death in humans (Fig. 4) (38-41).

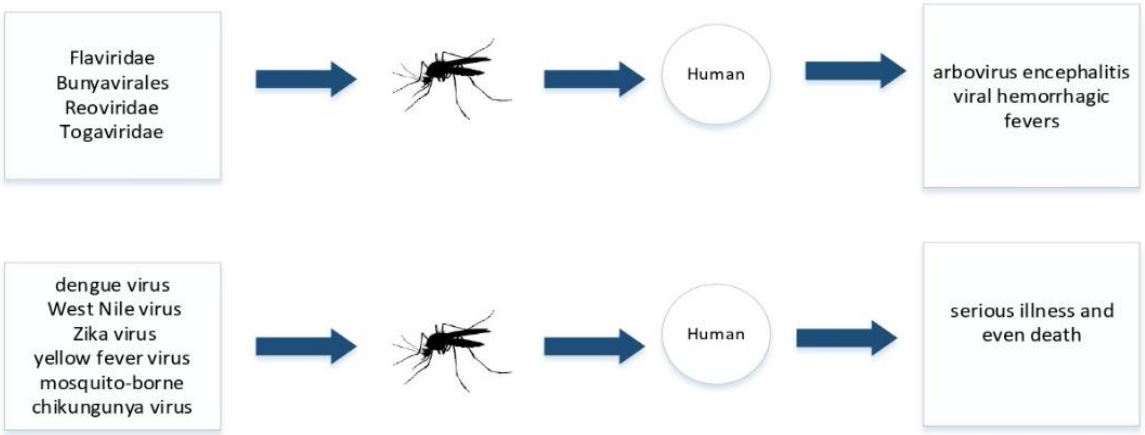

Fig. 4: Viral agents transmitted to humans through mosquito bites

New challenge of COVID-19 by Climate change

Recent public health problems in the SARS-CoV-2 area have been concentrating into vector-borne diseases for surveillance and prevention. Although there is no confirmation that COVID-19 is capable of spreading via mosquitoes, however, arthropod ectoparasites such as ticks and unnourished cat fleas could potentially play a role in transmitting the virus to their human hosts due to the sequence homology between ectoparasite ACE and human ACE2 protein and its interaction with the viral Spike (42). Furthermore, evolutionary and phylogenetic analyzes of ACE2 among 48 important mammals revealed a potential large array of rodents for SARS-CoV- 2. Understanding SARS-CoV-2 animal reservoirs is important for vector-borne COVID-19 community impacted by global climate change.

The role of environmental aspects such as temperature, humidity, and wind speed and air pollution is discussed in recent studies for the trans-

mission of COVID-19. Fig. 5 shows SARS-COV-19 transmission through environmental elements and reaching to the human host.

Air pollution possibly associated with an increased risk of severity and mortality from COVID-19 (43). Even the most recent studies have shown the risk of spreading SARS-COV-2 bioaerosol in the air, in which, infectious bioaerosols can pass up to 6 feet (44). Meteorological parameters such as temperature change and humidity are supposed to be the crucial factors that persuade infectious diseases such as severe acute respiratory syndrome (SARS) and influenza (45). However, further studies need to clarify that climate change or other environmental factors have arranged for the spread of infectious bioaerosols. In addition, active measures must be taken to control the source of the infection, block transmission and prevent further spread of COVID-19(46).

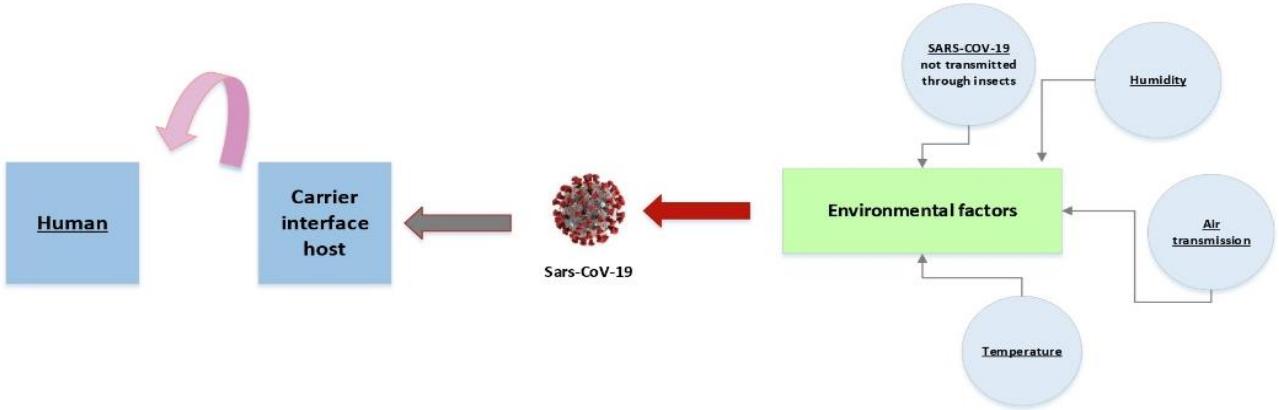

Fig. 5: Casual relations of Covid-19 and environmental factors

Discussion

Climate change poses many risks to human health and increases the threat of emerging diseases in subsequent years (32, 47). Healthcare professionals are increasingly addressing the negative health effects of global climate change and air pollution in their practices, so a rapid response from the government is needed to avoid environmentally damaging activities (48, 49). Current study has shown that climate change has directly generated a promising atmosphere for the boom of numerous bat species, enabling the development of novel coronaviruses and the SARS-CoV-2 strain (32). As a result of the widespread ups and downs of the countryside, the natural habitats of animals are compromised and subsequently increase their interaction with humans by harvesting them the infectious agent transmitted by an arthropod vector from infected reservoir hosts to human or accidental hosts that are primarily pets (41, 50). Therefore, viruses and bacteria along with other infectious agents that trigger the disease, spread more rapidly (31). The COVID-19 pandemic is a case in point to demonstrate how viruses and pathogens move faster r than before and to indicate changes in human behavior. Direct data has not been on climate change persuasion on the extent of COVID-19, however he has been aware that climate change changes the way we communicate to other species on Earth and that the complications to our health and our risk of infections (43). The current association with our nature must be reconsidered in the direction of the sustainable use of existing resources. Producing electricity by burning fossil fuels such as coal, oil and natural gas by increasing the long-term effects associated with air pollution such as chronic asthma, lung failure, stroke, obesity, diabetes and premature death. Reducing air pollution also protects us from the onset of respiratory infections such as coronavirus. To combat climate change, we need to significantly decrease greenhouse gas produc-

tion by using low-carbon energy bases like wind and solar that keep our lungs healthy. Furthermore, the social and economic challenges associated with water scarcity due to global climate change, especially in areas where the demand for anthropogenesis exceeds supply, must be addressed quickly.

Conclusion

Climate change, specifically in rising temperature system is one of the world's greatest concerns already affected pathogen-vector and host relation. Lice parasitic insects, Fleas, Ticks and Mosquitos are the principal public health prominence for vector-borne diseases. Therefore, checking, monitoring environmental, and climate changes can help us towards predicting increase of cases involved with vector-born disease. By preventing the vector-born disease's expansion under climate change conditions, there would be a lot of assistance to further human costs and financial costs of a possible epidemic.

Journalism Ethics considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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Conflict of interest

The authors declare that there is no conflict of interests.

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