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Impacts of Climatic Changes on Vector Borne Diseases - A Recent Perspective

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Abstract

The relationship between infections, vectors, and hosts influences vector-borne diseases (VBDs), which are increasingly linked to climate change. The physiological and ecological dynamics of vectors, particularly mosquitoes and ticks, are changed by rising global temperatures, which promotes the spread of these organisms into new geographical areas. As tropical species move into temperate zones and higher elevations, where they establish populations in formerly non-endemic locations, this expansion is especially visible. For example, the elevation range of malaria vectors has increased significantly, and diseases such as dengue and West Nile virus are spreading throughout Europe and North America as a result of favorable climate circumstances. The association between climate factors and the transmission of VBD is complicated; higher temperatures can increase the rates at which vectors bite, leading to an increase in the incidence of the disease. Furthermore, variations in precipitation patterns add to the amount of standing water that is available, which provides mosquitoes with the perfect environment for breeding. However, because of the interaction of several factors including changes in land use and human migration, it is still difficult to precisely attribute specific outbreaks to climate change. There are grave consequences for public health. If current trends continue, projections suggest that by 2070, an additional 4.7 billion people may be vulnerable to illnesses like dengue and malaria5. To reduce these risks, we urgently need effective intervention techniques such as improved surveillance systems, vector control measures, and public health preparation programs. Inaction will probably cause the burden of VBDs to increase, worsening global health inequities and placing a strain on healthcare systems all over the world. The continual adaptation of vectors to climate change emphasizes the need for adaptive management approaches to protect public health from this impending threat.

Keywords: *Climate, Disease, Host, Vector.*

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Introduction

A vector borne disease is a sickness transmitted via vectors, disease causing pathogens are transmitted via vectors by mosquitos, ticks, fleas & blood feeding anthropods [1].These vector borne diseases are mainly found in the tropical & sub-tropical regions in the world more than half of the world population is suffering from vector borne diseases like dengue, malaria and etc.19% of world infectious diseases are accounted by vector borne diseases [2]. Dengue is considered as one of the rapidly growing diseases in the world. Vector borne diseases are classified in two types they are emerging& re-emerging [3]. An emerging vector borne disease is a newly discovered disease which doesn't have any standard treatment& starts to spread very rapidly on the other side a re-emerging vector borne diseases already occurred disease which spreads many times even after identifying a treatment for it. They produce the immune to protect from the vaccines [4]. They undergo many evolutions to adopt with the host factors like ecological, geographical & more helps the pathogens to adopt to the host. They need a favourable condition for rapid growth & express. These factors help them to gain resistance for drugs & merges with different pathogens to produce different variants, as a result it starts to spread rapidly. The emergence of vector borne diseases is slightly associated with the climatic factors. Due to globalization, the ordinary climatic condition started to change these changes in climatic condition gives a favourable condition for many disease-causing organisms. with this favourable condition they start to reproduce, and new varieties of pathogens were identified [5]. For ex a healthy mosquito gets pathogens from birds after biting it, it starts to spread the pathogens by laying many infected mosquito eggs, with changes in climatic condition they will get a favourable condition to grow. Climatic changes played a main role in VBDs in this century, due to globalization and fluctuation in temperature results increase in different types of VBDs. Due to this climatic changes, water management started to occur, constructing water reservoirs at different places increased the growth of VBDs. Constructing these things at different geographical regions results in reoccurrence of old VBDs.

Climatic Condition and Non-Climatic Condition

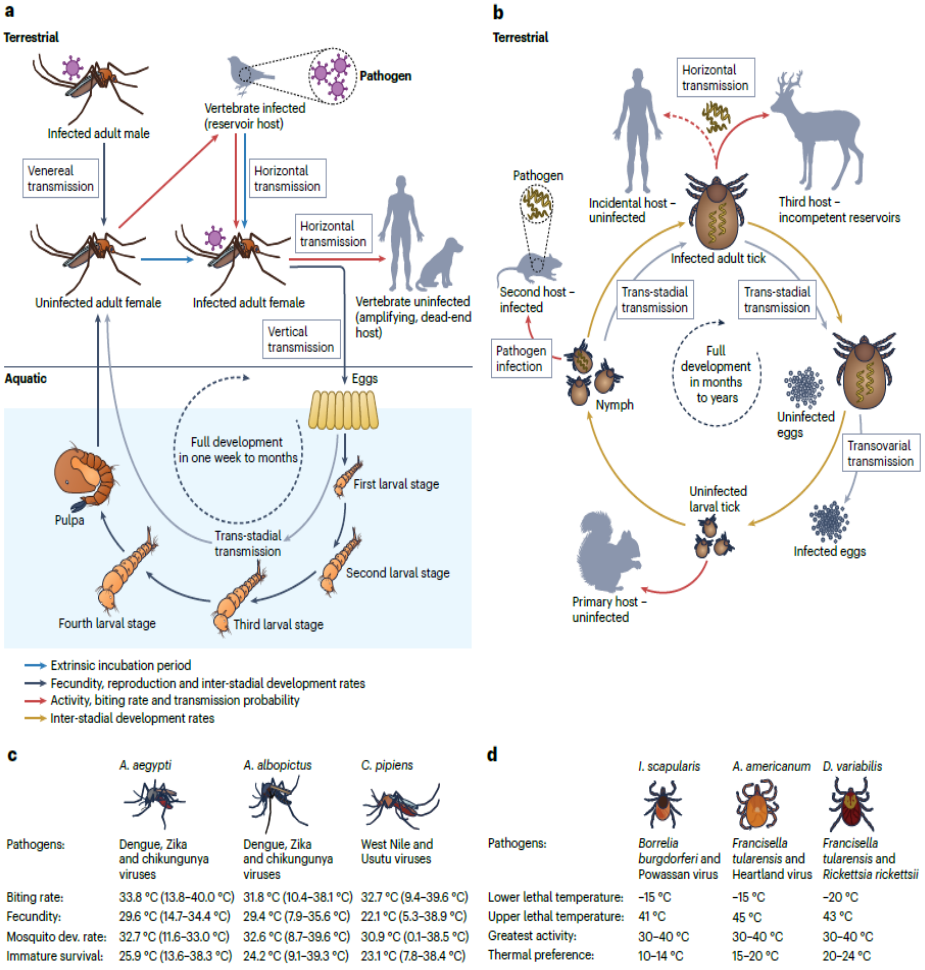
Climatic changes refer a sudden fluctuation in the weather for a long period of time. These climatic changes play a major role in VBDs. Things like deforestation, exploitation, urbanizations are Considered as a driving factors of Climatic changes can be classified in two types, they are Short-time weather changes & Long-time weather changes. In short-time weather changes dipteron vectors such as mosquitos were affected. Mosquitos have short period of life span. They evolve from Egg to an adult in days, on the other side ticks, They have longer period of life span .It takes months to years for its Development, In between the growth stages occurs in months, thus these short-period weather changes does not affect them, these climatic changes affects them by changes in rate of survival, biting, development, pathogens and more [6]. These Weather changes affect the Eco system For Ex: El Nino and La Nina, which is a natural Cyclical weather pattern, which affects the temperature in Pacific Ocean, This Events were affected by the Climatic Changes. El Nino is a condition in which the ocean will be very warmth, at that time they disrupt the temperature, rainfall and winds. Instead in La Nina, it stimulates a cooling phase which is contrast to El Nino. El Nino is connected with double impact in Vector Activity & Risk of VBDs. Predictions of El Nino activity helps to identify increased VBDs risks and development of Health Hazard. Ex. Rift valley fever follows El Nino pattern which affects in the African countries for every 5 to 15 Years.

This pattern gives a perfect Growth for Aedes Mosquitos Infected with RVFV. At the same time these climatic patterns reduce VBDs Sometimes. El nino activity reduced malaria in Tanzania by increased rainfall in 1997-1998 period [7-13]. Mosquitos have a maximum temperature of 22-23ºC for its perfect incubation period at the same time Japanese Encephalitius Virus (JEV) needs minimum of 25-26ºC for its perfect incubation period. Thus, climatic changes play an important role in the habitat of VBDs. VBDs can easily affect the society which was shown by some studies. Climatic changes directly impact on the occurrence and intensity at the same time control measures which was taken by humans to clear pathogens and vectors. The common factor for VBDs is considered to be unspecified but some international trades and commerce accounts 11 to 14% of VBDs, Climatic factor accounts 10% as a driving factor for VBDs. Some natural calamities like extreme Flood and droughts makes the changes the ideal conditions of vector borne diseases. thus, climatic changes play a major role in Vector borne diseases.

Non-Climatic Changes

As climatic changes determines the survival of vector borne diseases there are some non-climatic reasons which plays an important role in the survival of a vector borne diseases. There are many factors which is responsible for VBDs like Globalization, urbanization ,expansion of metro cites, Agricultural development and more. These environmental risk factors have shown some reoccurrence of some deadly vector borne disease. The main factor of the non-Climatic factors is Globalization. This factor occurs in both emerging and re-emerging vector borne diseases. globalization not only led the evolution of a person's life but also the evolution of pathogens. Factors like poverty, poor medical infrastructure, food habitat are considered as reason for the evolution of re-emerging and emerging vector borne diseases. peoples closed interaction with animals are considered to be a reason for spreading some harmful diseases [3]. many harmful vector borne diseases are evolving all over the world due to the expansions of terrestrial areas. Urbanization is another factor for the growth of VBDs, conversion of rural area to an urban place will give the ideal condition for the survival of VBDs the unorganized Urbanization may leads to formation of ideal condition for some harmful diseases. Unorganized urbanization may result in lack of medical infrastructure and have worst disease management. Due poor maintenance there might be formation of water, waste and many ideal conditions which is very helpful for the growth of VBDs. New pathogens and variants of pathogens were produced. poor maintenance of life-stocks is also considered as one of the reasons for VBDs. Agriculure is also a reason for the formation of VBDs. after making many metropolitical works there occurs some ecological changes which is a starting point for the origin of new VBDs. Reports shows that changes in agricultural works are one of the reasons for causing some harmful diseases. Irregular and wrong practice of irrigation is one of the main reasons for the growth and survival VBDs. Research shows over 25% of Emerging VBDs and 50% of animal infectious Diseases are caused by Irregular practice of Irrigation. Social density is one of the reasons for the spreadness of many harmful diseases. Many African & Asian countries which lacks in basic medical infrastructure couldn't be able to handle the intensity of diseases. Poor hygiene of people is also a reason for the rapid spreading of those diseases. Irregular and wrong practice of irrigation is one of the main reasons for the growth and survival VBDs. Research shows over 25% of emerging VBDs and 50% of animal infectious diseases are caused by Irregular practice of Irrigation. Social density is one of the reasons for the spreadness of

many harmful diseases. many African & Asian countries which lacks in basic medical infrastructure couldn't be able to handle the intensity of diseases. Poor hygiene of people is also a reason for the rapid spreading of those diseases.



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	A. aegypti	*A. albopictus*	*C. pipiens*
Pathogens:	Dengue, Zika and chikungunya viruses	Dengue, Zika and chikungunya viruses	West Nile and Usutu viruses
Biting rate:	33.8 °C (13.8–40.0 °C)	31.8 °C (10.4–38.1 °C)	32.7 °C (9.4–39.6 °C)
Fecundity:	29.6 °C (14.7–34.4 °C)	29.4 °C (7.9–35.6 °C)	22.1 °C (5.3–38.9 °C)
Mosquito dev. rate:	32.7 °C (11.6–33.0 °C)	32.6 °C (8.7–39.6 °C)	30.9 °C (0.1–38.5 °C)
Immature survival:	25.9 °C (13.6–38.3 °C)	24.2 °C (9.1–39.3 °C)	23.1 °C (7.8–38.4 °C)

d

	I. scapularis	*A. americanum*	*D. variabilis*
Pathogens:	*Borrelia burgdorferi* and Powassan virus	*Francisella tularensis* and Heartland virus	*Francisella tularensis* and *Rickettsia rickettsii*
Lower lethal temperature:	–15 °C	–15 °C	–20 °C
Upper lethal temperature:	41 °C	45 °C	43 °C
Greatest activity:	30–40 °C	30–40 °C	30–40 °C
Thermal preference:	10–14 °C	15–20 °C	20–24 °C

Figure 1. Climate and Weather Effects on Vector Life Cycle and Pathogen Transmission Data Procured From De Souza et al., 2024 [14]

Types of Vector Diseases

The Vector disease will be affected by a transporting agent. In this there are some vectors like mosquitoes, flies, sand flies, ticks etc. By this they produce a disease which is caused by the virus which is present inside the insects which are acting like a vector. There are some diseases which are commonly spread through the world in some cases. The diseases are dengue, Malaria, Chikungunya, Zika fever, yellow fever and many more diseases are there. Table 1 depicts Vector born diseases and their causative agents, transmission, symptoms, prevention and treatment.

Malaria

The malaria is the well known disease which is the vector borne disease in presents of tropical and subtropical areas of killing people in the parasitic diseases [15]. The malaria is caused by the female mosquitoes *Anopheles* which are plasmodium parasites which they are infected. So the malaria is caused by the ecological conditions and parasites of malaria will transmitted the malaria in this case there are around 30-40 species of *Anopheles* are present and affecting in the world and approximately about 530 species are now present as the malarial parasites [16]. In 2018 the malaria which is the most deadly and

world health burden in the case around 200 million cases in the world wide, in which there are 400000 are the cases of death cases. Now this disease is becoming higher and higher yearly according to the WHO there are the report about malaria raised about 241 million cases in 2020 and 221 million cases on 2019. The malaria is the disease of proverty, and which contributes national contribution limiting the foreign investments tourism and labours [17].

Table 1. Vector Born Diseases and their Causative Agents, Transmission, Symptoms, Prevention and Treatment

Disease	**Vector**	**Causative Agent**	**Transmission**	**Symptoms**	**Prevention & Treatment**
Malaria.	Mosquito [Anopheles]	Plasmodium Sp	Bite of Infected Mosquito	Fever, Chills, Flu	Anti-Malarial Medication, Indoor Residual Spraying
Dengue Fever	Mosquito [Aedes]	Dengue Virus	Bite of Infected Mosquito	Fever, Head-Ache, Joint Pain	Vaccines,Fluid Replacement, Supportive Care
Zika Virus	Mosquito [Aedes]	Zika Virus	Bite of Infected Mosquito, Vertical Transmission	Fever, Rash, Neurological Disorders	Eliminating Breeding Sites, Supportive Care
Yellow Fever	Mosquito [Aedes]	Yellow Fever Virus	Bite of Infected Mosquito	Fever, Chills, Head-Ache, Muscle & Joint Pain	Vaccination, Elimination Of Breeding Sites, Fluid Replacement
Rift Valley Fever [Rvf]	Mosquito [Aedes] & [Culex]	Phlebo Virus	Bite of Infected Mosquito	Fever,Chills, Head-Ache, Muscle & Joint Pain	Smithburn Vaccine,Mp-12 Vaccine,Clone 13 Vaccine
Japanese Encephalitis.	Mosquito [Culex]	Flavivirus	Bite of Infected Mosquito	Fever, Vomitting, Head-Ache	Imbv And Live Attnuated Vaccines
Chikungunya	Mosquito [Aedes]	Chikv	Bite of Infected Mosquito	Fever,Rash, Head-Ache, Muscle & Joint Pain	Elimination of Breeding Sites,Pain Management

The studies reported the cost of illness and treatment are coats atleast around USD$12 billion per year in Africamorbidity and molarity among the sub-Saharan African region in general and Ethiopia region. In the regarding of the co-infection in the affecting of malaria where also found in the children [18]. This co-infection of malaria parasites is genetically different from Pl.falciparum. The protective effect against the episode of the febrile illness in the three months subsequent follows up. The group of hazards associated with found about 0.84(95% Cl: 071-0.99) with the genotype of detected baseline and called into the phenomenon, in the host in chronic infection [18]. In other cases of studies the malaria and helminth dual at the infection among the pregnant women in the infection of

HIV treatment for about less than a year. In this studies the affection of this disease shows the rate of transmission is high in urban area other than rural area [19]. In the regarding of the hypothesized authors potential to aggravating on the anemia of the type of the infection of malaria, helminths, HIV.

Dengue

The dengue is the typical and antropod-viral disease which they serves as the public health effect affect over 2.5 billion people and around 100 nations are affected with this disease [19]. *Ae.aegypti*and *Ae. Albopictus* mosquitoes both spread by this virus. This virus comes in this family *Flavivridae, genus.* At this point we could see that this is transmitted by the mosquitoes, and which is present and broadly spread at the tropical and subtropical region, and also called as one of the oldest diseases. In this case we could see that the documentation is first done by Chinese medical encyclopedia in the year 1992. Lately this disease became familiar mainly in the expansion of the global shipping industry and port cities in early 18^{th} centuries and 19^{th} centuries. But the real case is the dengue is orginally brought Africa and spread to the America by the conjunction of the trading of slaves from Africa. We see that dengue is the most typical and arthropod-borne disease which has severe public health effect, and this disease affect nearly about 2.5 billion people and over 100s of nations have been affected [20]. Most importantly the humans are the bacis and primary host for this disease. They are prevelant in the region of warm temperature and tropical region [21]. The research of dengue is most identified and researched in Asia and America, in that case most of them are evaluated. The relationship between the dengue disease and incident cases are in endemic area of vector density and mobility in human population. In that case the large studies show the factors of asympotomatic factor which are related to the spread of the dengue virus. Now the spread of dengue is by virus infection, climate condition and variation in the vector abundance and in the socioeconomic conditions. Though they are the triggering outbreak in non-endemic cities [22, 23].

Chikungunya

Now the chikungunya is the next illness which they belong to the toguviridae family. This disease primarily spread by the *Aedes*, which are *Aeder aegypti* which are the vectors they spread [24]. *Aedes aegypti and Aedes albopictus*are the chikunguniya virus spread in the region of Indian ocean and Asia and they outbreak during rainy season and the population of this virus will be high in this time [25]. Origining of this virus is in Africa in the place of Tanganyika in the year 1952-1953 [26] and first epidemics were noticed in Thailand in the year 1967 [27]. In this case chikungunya was first observed in India at 1963-1973 and in the time gap of 2005-2019, in that case the chikungunya was affect all over the country including the six union territories indicated in the public health issue [28]. For this disease the vaccine and drugs are not available to prevent or to cure [25]. For now, the prevention method for chikungunya is mosquito management and personal safeguarding method from the mosquitos this disease means the bends up the joints in the region of Tanzanian Makonde in which they are mosquito-borne disease caused by the alphavirus which family comes under *Togaviridae* family [30].

Japanese Encephalitis

Japanese is a root cause for viral meningo-Encephalitis also known as brain eating amoeba. it is mainly caused by single standard RNA virus of flavivirus genus. first identified in the Japan region in 1870s JE is mostly spread in the Asian subcontinents and an average of 68000 cases were reported every year Culex a type of mosquito (Primarily culex Tritaeniorphynchus) is the vector which

transmits the virus. Pigs and birds act as Reservoir for JE. The main reason for the spreading of JE is still a mystery whereas some basic changes like its Expansion of irrigation and different irrigation practices or one of the main reasons for its spreading. due to expansion of irrigation the maintenance of life stocks was improved as a result the Reservoir where benefited and it becomes more easy to proliferate [31]. it is mainly found in the high altitude region of Tibetan Chinese border. Symptoms like fever, headache vomiting, seizusare found When a person is affected with JE. In severe condition acute Encephalitis syndromes may occur. inactivated Mouse brain derived vaccine (IMBV) and live attenuated vaccine were used for its treatment [32]. surveillance of JE should be insisted in the sub-Continents for its prevention. Vector control programs and vaccination campaigns must be implemented across the world [33].

Zikavirus

zika virus was first identified in the zika forest in Uganda from a Rhesus Macaque by the year 1947. It also comes under the flavivirus genus. they are similar to JE as they are also single standard RNA with positive sense. Aedes Aegypti a type of mosquito spreads the zika virus primarily. Even though they were first isolated in Uganda they were most emerged in the southern& central region of America i,e Florida and Mexican borders. Identification of zika in the Yap Island in the federal state of Micronesia shows that the virus spread outside the African and Asian countries. Pacific Islands are one of the main factors for the transmission of Zika virus in the American countries. Over 200,00 cases were reported during the outbreak in the southern and Central American countries. The World Health Organisation (WHO) declared an emergence for public health against zika virus in the year 2016. Symptoms like fever, Rash joint pain, muscle pain, nausea, vomiting were found in the 80% of cases [34]. Microcephaly (birth defect) Contrail zika Syndrome, meningitis & Encephalitis are major complications produced by zikavirus. Preventive measures were taken by the WHO to control it's spreading since 2016 [35].

Rift Vally Fever

Rift Valley fever is a viral genetic disease caused by genus Phlebo virus of bunyaviridae family. They are enveloped single standard RNA. RVFs was first identified by Veterinary scientist in the rift Valley region of Kenya. They werefirst isolated from sheeps and cattles. It mainly affects domestic animals and humans in the African countries. They are characterized by zoonatic transmission to humans in the Sahara region. RVF was once a major thread for the human species as it affected both health and economy. They are mainly transmitted by mosquitoes. Aedes and culex both varieties ofmosquitoes spreads rift Valley fevers the infected mosquitoes transmits virus between the animals. Human to human transmission occurs in a rare site when there is a contact between infected body Fluids. Drinking raw milk, eating uncooked meats also one of the reasons for animal human transmission. Climatic changes play a huge factor for its spreading most of the outbreaks are associated with heavy rainfall and Flooding. Over 1 million cases were reported since 1931. Symptoms like fever, Headache, Muscle pain, Joint pain, Rashes may occur. Some severe complications like Encephalitis, retinitis, Homerrhogic fever may occur. At some extent death may be caused (50% mortality rate) Vaccines like Smithburn vaccine(1950s) MP-12 vaccine(1980s) Clone 13 Vaccine (2000s) were Used.

Yellow Fever

Yellow fever is a severe viral disease caused by yellow Fever virus they belongs to the favivirus genus in the flaviviridae family. They are acute and homirrhegic and

transmitted by infected mosquitoes. They are one of the deadliest vectors born disease in the history of mankind. They are mostly transmitted by mosquitoes. aedes Aaegyptia type of mosquito transmits this disease. yellow fever is one of the VBDs which have a long history. Evidence of outbreak dating back to the 15th century. In 1648 the first outbreak was identified in Cuba. In 1927 the virus was isolated and characterized in 1951 yellow fever was recognised as a major public health problem by World Health Organisation. Occurrence of yellow fever in many parts of the African subcontinents were found in the last decade. Migration and increase in international travel are one of the main reasons for reporting yellow fever across the world, W H O shows there are 47 countries in the African continent and some American countries are endemic for yellow virus and average of 2 lakh cases were reported every year with 60000 severe cases. Its similar symptoms like fever, vomiting, muscle and joint pains where occur some severe symptoms like Hepatitis, Jaundice, Renal Failure, Coma may arise.MD Vaccine, YF-VAX, Stamaril, Biothrax are vaccines used against yellow fever [36].

Lymphatic Filariasis

The Lymphatic filariasis is commonly called as Elephantiasisn which also a vector borne disease which transmitted by mosquito which is caused by the larve called as filarial worns which comes under the spieces *Brugia timori*(Brugia spp), *Brugia Malavi* where the mosquito species is *Wuchereria timori*. So, this disease damages the lymphatic system and makes hydrocele and lymphoedema which is Elephantiasis. According to the WHO, 2020 around globally 15 million people have been affecting for this disease. In this disease the primary factor of filariasis is long-term illness which affect the people living in the tropical and subtropical region of Asia, west pacific, Africa and other parts of America. There are many types of species present in this disease which we already know that they spread by mosquitoes and cause filariasis vector. In that case there are some common species are there which are the *Culex, Anopheles, Aedes* mosquitos and *Culex quinquefaciatus.* In 72 nations have this problem and 1 billion peoples have rick that contracting lymphatic filariasis before the World Health Organization is began by the way they are related to the morbidity of affection is approximately 36 million people have affected which the data studies given by Global Program to Eradicate Lymphatic Filariasis [37].

Controls Measures and Challenges of Vector Borne Disease

In the disease spreading there are also controls and challenges are there in very disease, in that case there are several tools and approaches of practices are there to emeraging and reemerging the migrated infection of vector-borne infection. In the paramount of surveillance are active in intensifying the active surveillance and the quality assurance. In the genomic sequencing of the molecular approaches are significance in this case they play a role in phylogenetic tracing studies are there in previously identified in the novel pathogen [38-44]. Now in the world health program the control of vector borne disease is so challenging and had to prevent the methods of spread. In the unpredictable growth of urbanization, the control of the problem is by implemented by global and local stages by using the structural strategic concern. In this they are well noticed, and they are several disase in the spreading all around the world and are zoonotic in the facilitated by wildlife reservoirs. In this case the animals and humans have become as the host for this disease perhaps they will also became the bottleneck of the prevention of the spread in the disease [45]. The most common factors which they affect the approach of the diverse control at

our disposal in the most common controls are like climatic changes, insecticide resistance, environmental changes, population growth and urbanization are still challenging. In this there is the huge problem is shortage of funding and weak programmatic capacity and a prompt to enhance the partner shipping with required collaboration for the capacity of empowering the surveillance and vector control tools [46].

Conclusion

Now the vector borne disease is an important global burden across the world by this for past few decardes they are rising perhaps they are also driving through socioeconomics, environments, global warming, climatic conditions and other important things related to the world condition which also reacted to this disease spreading. In some disease there are medical treatment and in some cases, they are only prevention and safety measures to create a breakage for this spreading of the disease. Now the world knows how to handle but in cases there are still lacks maintaining the disease precautions mostly in Africa region. So, for now we are fighting for the disease to spread this disease soon we will completely stop and erase the disease from this world.

Conflict of Interest

All authors declare that there are no conflicts of interest.

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