



## Climate Change and Infectious Vector Borne Diseases: Cause, Transmission, Symptom, Diagnosis, Treatment & Challenges

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### Abstract

*Climate change is a potent factor emerging as a global risk by altering disease occurrence, transmission, virulence and pathogenicity of the pathogenic microbes. It affects the main determinants of the disease ecology (host, pathogen, and environment). It poses lot of challenges in diagnosis, treatment, and prevention strategies. This paper specifically focuses on Vector borne diseases caused by climate change. Vector borne diseases are infectious disease transmitted by the bite of infected vectors. This paper covers Infectious Vector Borne Diseases, Root Cause, Transmission, Symptom, Diagnosis, Treatment & Challenges.*

**Keywords:** *vector borne diseases, tick borne diseases, climate change, infectious diseases, communicable diseases.*

### Climate Change

Climate change, defined by the United Nations framework convention on climate change as “a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time period”<sup>[63]</sup>. Climate change causes many changes in the environment such as el-nino southern oscillations, ocean acidification, sea level rise, increase in extreme weather events, melting of permafrost, etc.

### Climate Change Impacts on Human Health:

Climate change is a major threat to public health by changing the transmission mechanism of communicable diseases and increases risk of emerging and reemerging diseases due to increased frequency and severity of Extreme

Weather Events (EWE)<sup>[1,8]</sup>. For example, about half of the world’s population is at risk for malaria. It is propagated by El-Nino in affect path.<sup>[56]</sup>. Emerging infectious Diseases (EIDs) are illnesses that are newly defines or have existed but are increasing in incidence or geographic range which poses a threat to the population ,either in a particular or globally .Conversely, Re-emerging infectious Disease (REID) are illnesses that existed in the past but reappear after they have been on a significant decline ,and rapidly spread either in terms of incidence or to new geographical areas<sup>[Ref 9,7]</sup>. Simplified climate change induced diseases is tabulated in Table -1.

**Table 1:** Climate Change and Its Health Hazards<sup>[79]</sup>

S.No	Climate Effect	Health hazards
1	El Nino	Vector Borne Disease & water Borne Disease
2	La Nina	Vector Borne Disease & water Borne Disease
3	Quasi Biennial Oscillation (QBO)	Vector Borne Disease
4	Heat Waves	Vector Borne Disease & Air Borne Disease
5	Drought	Vector Borne Disease & water Borne Disease
6	Flood	Vector Borne Disease & water Borne Disease
7	Hurricane	Vector Borne Disease
8	Cyclone	Vector Borne Disease, water Borne Disease & Food Borne Disease

**Vulnerability:**

In addition to facilitating contacts between people and pathogens, climatic hazards also enhance specific aspects of pathogens including improved climate suitability for reproduction, acceleration of the life cycle, increasing seasons / length of likely exposure, enhancing pathogen vector interactions (for example by shortening incubations increased virulence). Climatic hazards were also implicated in the increasing capacity of pathogens to cause more severe illness (that is virulence). Climatic hazards have also diminished human capacity to cope with pathogens by altering body conditions; adding stress from exposure to hazardous conditions; forcing people into unsafe conditions; damaging infrastructure, forcing exposure to pathogens and / or reducing access to medical care. Body malnutrition and conditions, affect immunocompetence to diseases. As such, the broad effects of climatic hazards on land and marine food supply and the reduced concentration of nutrients in crops under high CO<sub>2</sub>, can directly cause human malnutrition, helping to explain the increased risk of food deprived populations to disease outbreaks. For example, cryptosporidium, measles and cholera. Cases of reduced resistance to various diseases were also found in reemissions. Likewise, stress, via changes in cortisol (stress hormone) and down regulation of inflammatory response can reduced the body's capacity to cape with diseases. Exposure to life threatening conditions such as floods and hurricans, extraneous conditions during heatwaves and depression from lost livelihood due to drought are a few examples in which climate hazards are inductive to stress and cortisol variations and a

likely mechanism by which climatic hazards reduce the body's capacity to deal with pathogens.

**Role of Environmental Factors:**

Climates refer to long-term shifts in temperature and weather patterns, which are disrupting ecological systems worldwide leading to shift in the global distribution of pathogens hosts and disease reservoirs<sup>[68]</sup>. The vector and agents are devoid of thermostatic systems. So many of their features are susceptible to environmental changes. The diseases & pathogens are classified by how they get transmitted & their natural reservoir. Mosquitoes typical of temperature regions have had to develop strategies to survive the winter, as well as pathogens that can be transmitted. In tropical regions similarly adaptations were needed to survive the unfavourable times of prolonged drought. In both cases, these adaptive mechanisms have affected the seasonality of transmission. Temperature plays a important role in all stages of a mosquitoes lifecycle. So only within range of temperature, mosquito can be virulent. Above the range, it can spread diseases. Raising temperature promotes the growth & development of ticks and their geographic distribution<sup>[11]</sup>. Warming and precipitation changes are associated with range expansion of vectors. Warming at higher latitudes allowed vectors & pathogens to survive winter aggravating outbreaks by several pathogens. Warming for instance had positive effects on mosquito population development survival biting rates and viral replication increasing the transmission of efficiency of west Nile virus. In other cases, warming and intense precipitation increased food and habitat resources which caused surges in rodent populations associated with cases of plaque and hantaviruses. Drought also caused

the congregation of mosquitoes and birds around remaining water sources facilitating the transmission of west Nile virus. Pathogens transmitted by vectors are particularly sensitive to climate change because they spend a good time in cold blooded vectors whose temperature depends on environment. Mosquitoes are found worldwide except in a very cold region<sup>[11]</sup>. Broadly, there are three expected threats from vector-borne disease under a warning climate: increased risk from endemic disease due to changes in temperature and rainfall, change in geographic range of vectors and the appearance of exotic disease in temperate regions due to increased climate suitability.

Storms, heavy rainfall and floods create stagnant water, increasing breeding and growing grounds for mosquitoes and the carry of pathogens that they transmit for example Leishmaniasis, malaria rift valley fever, yellow fever, St.louis encephalitis dengue and west Nile fever<sup>[2]</sup>. For instance, in some cases, Schistosomiasis infections were reduced by floods, limiting habitat, suitability of the snail host. However, in other cases, floods increased human exposure and broadened the dispersal of host.

The changing climate will lead to an increase in the size of vector borne disease transmission zones an appearance of tropical disease in temperature regions and the emergence of native species that have the capacity to transmit tropical pathogens. Although much attention is focused on the threat of invasive species there is also a risk from native species which may have the potential to become vectors for tropical disease. Climate change affects diseases by affecting Vectors, Reservoir, Organism & Humans<sup>[9,16]</sup>.

The factors determining tick-borne diseases also vary by species (some may be adapted to urban while some to forest). The factors that affect mosquito-borne disease are anthropogenic environment (e.g. Urban areas), natural environment (e.g. Forest), climate factor and microclimate factors<sup>[20]</sup>. The ticks have increased along with the disease carried parallel with climate change<sup>[22]</sup>. Ticks have

- Increased in number
- Increased in geographic distribution
- Increased activity

Prolonged extremes values of temperature (high or low), low humidity and intense rainfall could adversely affect tick development by reducing

their activity and increasing their mortality rate. Reservoir host (pathogen container) is very important in tick lifestyle. (Reproduction host-blood donors). With environmental change, disease range prevalence and seasonality may change in direct relationship to the vector or animal host<sup>[26]</sup>. Climate change is causing warmer temperature and changes in precipitation that impact the habitat distribution and mating cycles of diseases carrying mosquitoes and ticks increasing the risk of exposure to disease in some areas<sup>[28]</sup>. Even small changes in temperature can have strong non-linear effects on the outcomes of ectotherm host parasite and host pathogen interaction<sup>[34]</sup>. Reservoir host (pathogen container) and reproductive host (blood donor) is very important in tick's life. Ticks are active from the time the ice melts till the ice forms. Those who spend more time outdoors and residence in endemic area are the people of high risk<sup>[22]</sup>. Temperature and associated factor affect vectors pathogens and humans which causes an upsurge in vector -borne disease.<sup>[Ref 76]</sup>

In general, transmission of any diseases can be classified into four, namely direct transmitted diseases, vector borne diseases, environmentally mediated diseases and zoonotic diseases. Environmentally mediated diseases can be further classified into two namely Environmentally mediated with host transmission and environmentally mediated without host transmission. Similarly zoonotic transmission can be further categorised into two namely zoonotic transmission with vector & zoonotic transmission without vector.

### **Layers of Protection Analysis & Risk Assessment:**

Vector environment suitability and infection: Vector must have a suitable microclimate to live, survive and reproduce. It needs optimal temperature and other factors to effectively carry on life processes and reproduction as well as transmit the diseases because they are mostly ectothermic. Climate change affects the microclimate of the vector, thus changing its geographical presence and its ability to carry and transmit the diseases and its behaviour like increase in blood meals.

Disease-climate suitability: These are limitations of some pathogens, such as the reduction in

infectivity of mosquitoes in low temperatures. So there must be favourable conditions for a disease to spread. climate change increases the availability of such conditions that leads to an increasing trend in the vector borne diseases

Availability of hosts and Host-vector contact and infection of hosts: Human-vector contact is crucial for diseases to spread, and this is the most important part. Climate change changes the human behaviour and increases the chance of exposure to vectors, like exposure to vectors as summer temperatures force people to spend their time outside

Host immune vs diseases: This part involves the person’s immune and disease causers and involves multiple factors like immunity, nutrition, poverty, previous exposure to pathogen, vaccination, coinfection, etc. It also depends on the nature of the pathogen. Climate change also affects it by various ways such as social conditions and exposure to extreme weather events, malnutrition due to increased carbon dioxide which pressures plants, multiple coinfections, etc.

Diagnosis and treatment for the diseases: it depends on the healthcare infrastructure and economic conditions. Better outcomes rely on correct diagnosis and availability of tools and correct treatment and availability of drugs and treatment efficacy on the diseases. It again is influenced by the nature of the pathogen. Climate change affects it by influencing the economic factors and healthcare infrastructure through extreme weather events.

highly localised acidic environments induce oxidative and aerobic stress and release bioactive antimicrobial agents. Primary pathogens evade these host responses by avoiding detection, hijacking the host immune system, countering with their own bioactive agents, generating completing high affinity nutrient sequestration molecules and rapidly modulating their metabolism to survive and prosper in nutrient and oxygen-poor environments.

Risk of Infection = F (E,S,A), where, E = Exposure, S = Sensitivity, A = Adaptive capacity / social resistance.

F is depending on temperature (maximum, minimum, range), precipitation (total, days with or without), humidity (specific, relative), wind (speed, direction), El Nino Southern Oscillation (ENSO), climate change. Therefore, if any organism is going to affect human population must cross many numbers of challenges and is also represented in the below simplified pictorial representation (Figure – 1).

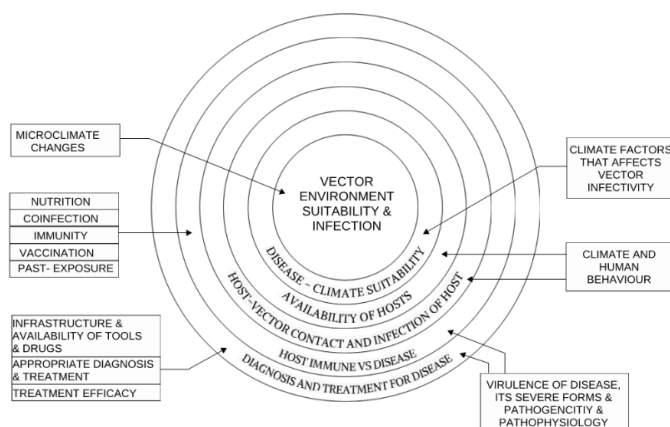
**Developing a Strategy to mitigate Climate Change Health Hazards:**

Developing a strategy for climate induced health hazards, strategy shall cover below protection methods. Elimination, Prevention, Detection and Control, Mitigation and pandemic response.

**Challenges** [8,13,14,16,55,89].

The challenges associated with prediction, prevention, diagnostics, surveillance and treatment are listed below:

- Most microbes in ectothermic animals have great virulence to defeat immunity but lack to survive the temperature of body. When they acquire this feature, they can affect body. Recent studies reveal that pathogens are acquiring the thermotolerance feature.
- Pathogen drug resistance can be linked to multiple factors, such as exposure to the drug in question creating selective pressure for resistance, population size, a pool of pre-existing resistance strains and the fitness cost associated with resistance. Resistance can also result as a bystander effect from other selective pressure.
- Genetic changes (mutation) will affect the transmissibility, virulence or immune



**Figure 1:** Layers of Protection

Hosts can deploy a number of sequestration strategies to limit micronutrient levels, generate

escape & also affects frequency or geographic distribution. The study on mutation of each pathogen is more complex.

- Climate change affects both people's immunity and susceptibility and pathogen's ability and availability.
- Adaptability of vector to unfavourable environmental conditions such as freshwater vector adapting to saline / brackish water environment and saline soils.
- Interconnection and interaction between Extreme Weather Events, Climate change data, pathogen, vector & host. Due to complexity of interaction, dependency on numerous variables make the prediction more difficult.
- Unavailability of Surveillance tools for pathogen, vector & host health.
- Research infrastructure, Data gathering and analysing & cost.
- Adapting to breed, grow, mature and multiply in the different environmental conditions and possessing possess the necessary physiological mechanisms to survive may have gone unnoticed. For example, *Ae. aegypti* larva possess the necessary physiological mechanisms to withstand a limited, short-term increase in salinity.

### Prevention

There must be a collaboration between researchers and healthcare providers, policymakers and businesspersons. This multidisciplinary and multiplatform collaboration is very important in terms of building a pillar against the climate change related disasters in terms of both Extreme weather events and emerging infectious diseases. Models must be developed for prediction and strategies and efforts must made to minimize the effects of the upcoming or predicted climate change related disasters. Tracking and stimulation models must be in use for the effective planning, and it must be notified to the individuals of the region which is going to be affected. Mobile application can be created so that people can access healthcare from their homes. Diagnostics should be revolutionised so that correct treatment can be given, and resistance can be prevented due

to inappropriate treatment. Satellite imaging technology must be used to find areas under risk for certain diseases. Epidemiological analysis must be done to detect any epidemics. Weather forecast is a must. Surveillance must include vector surveillance. Not only prediction, detection and surveillance measures but also countermeasures are necessary<sup>[70]</sup>. Healthcare sector must be made resilient and improved. Solution is of two parts: adaptation and mitigation. Mitigation strategies are insufficient<sup>[81]</sup>. Early warning systems must be developed<sup>[4]</sup>. Researchers form this field must collaborate with researchers from another fields<sup>[5]</sup>. Public health measures must be taken at a large scale. A one health approach is needed.

### Treatment

Table (Table-2) provides the detailed analysis of major vector borne diseases and their cause, Transmission, Symptom, Diagnosis, Treatment & Challenges. The treatment suggested are preliminary and treatment shall also be covered based on symptoms, co-infections, travel history, test reports, radiology reports, age, sex, patient conditions, available infrastructure, etc. This table also offers an insight to vector borne diseases and influence of climate changes.

### Future

In future, if in the current trend, the temperature will be rising. Diseases would be a common part of human's life. Everywhere there would be extreme weather events. Diseases would be uncountable, and vectors would expand their territories thus expanding diseases. At one stage, there would be no life because of extreme temperature except if some organisms survive via developing resistance to heat or thermotolerance. Climate change cannot be put to an end because for example, favourable conditions for fungus given by climate change would lead to decomposition which causes release of methane and carbon dioxide that promotes climate change.

Table - 2. Climate Change and Infectious Vector Borne Diseases: Cause, Transmission, Symptom, Diagnosis, Treatment & Challenges

S.NO	DISEASE	MICROBE	VECTOR	TRANSMISSION	CLIMATE CHANGE FACTORS WHICH CAUSE AN INCREASE	NATURAL RESERVOIR	VACCINE AVAILABILITY	SYMPTOMS	DIAGNOSIS(EXCEPT CLINICAL DIAGNOSIS)	TREATMENT(EXCEPT SYMPTOMATIC TREATMENT)	PREVENTION	REFERENCE
1	ZKA	ZKA VIRUS	AEDES SPP	VECTOR MOSQUITO-HUMAN-MOSQUITO, ZOOOTIC, BLOOD TRANSFUSION, MOTHER TO BABY, SEXUAL	HIGH TEMPERATURE(S), HIGH PRECIPITATION, FLOODS, DROUGHTS	MONKEY, HUMANS, PRIMATES	NO	80% OF PEOPLE ARE ASYMPTOMATIC; FEVER, RED EYES, JOINT PAIN, HEADACHE, MACULOPAPULAR RASH	NAAT, ANTIBODY DETECTION, ANTIGEN TEST, NEUTRALIZATION ASSAYS	NOT SPECIFIC(SUPPORTIVE CARE)	(AVOIDING MOSQUITO BITES AND PREVENT CONTACT WITH MOSQUITOES) DEET & PICARDIN BASED MOSQUITO REPELLENTS, CLOTHING, MOSQUITO NETS, INSECTICIDES	3.11.10, 3.41.21, 3
2	RIFT VALLEY FEVER	RIFT VALLEY FEVER VIRUS	AEDES AND CULEX SPP	VECTOR, CONTACT WITH FLUIDS OR TISSUES OF INFECTED ANIMALS, ZOOOTIC	HIGH TEMPERATURE, HIGH PRECIPITATION	CATTLE	YES	FEVER, MUSCLE PAIN, HEADACHE, BACK PAIN, DIZZINESS, WEIGHT LOSS, LOSS OF SIGHT, CONFUSION, LIVER PROBLEMS, HEMORRHAGIC FEVER SYNDROME, MENINGOENCEPHALITIS, EYE INFECTION	NAAT, ANTIBODY DETECTION, ANTIGEN TEST, VIRUS ISOLATION BY CELL CULTURE, RT-PCR	NOT SPECIFIC(SUPPORTIVE CARE)	(AVOIDING MOSQUITO BITES AND PREVENT CONTACT WITH MOSQUITOES) DEET & PICARDIN BASED MOSQUITO REPELLENTS, CLOTHING, MOSQUITO NETS, INSECTICIDES, USING APPROPRIATE PPE WHILE HANDLING DEAD AND INFECTED ANIMALS AND HUMANS, PROPER COOKING OF ANIMAL PRODUCTS	3.11.71
3	CHAGAS DISEASE(AMERICAN TRYPANOSOMIASIS)	TRYPANOSOMA CRUZI	TRIATOMINE BUGS	VECTOR, CONTACT WITH FLUIDS OR TISSUES OF INFECTED HUMANS, FOOD BORNE	HIGH TEMPERATURE, LOW PRECIPITATION	BATS, DOGS, MAMMALS	NO	FEVER, SWOLLEN LYMPH NODES, HEADACHE, SWELLING, HEART DISEASE, DIGESTIVE COMPLICATION	ANTIBODY TESTING, DNA TESTING	ANTIPROTOZOAL(NITROIMIDAZOLE, BENZAZOLE)	(AVOIDING BUG BITES AND PREVENT CONTACT)	3.15.71, 9, 1.93
4	WEST NILE FEVER	WEST NILE VIRUS	MOSQUITO	VECTOR, BLOOD OR GAN TRANSFUSION, MOTHER TO BABY	HIGH TEMPERATURE	INFECTED BIRDS, HORSES, RODENTS	NO	80% OF PEOPLE ARE ASYMPTOMATIC; FEVER, HEADACHE, VOMITING, RASH, ENCEPHALITIS, MENINGITIS	BLOOD SERUM CEREBOSPINAL FLUID ANALYSIS, ANTIBODY TESTING	NOT SPECIFIC(SUPPORTIVE CARE)	(AVOIDING MOSQUITO BITES AND PREVENT CONTACT WITH MOSQUITOES) DEET & PICARDIN BASED MOSQUITO REPELLENTS, CLOTHING, MOSQUITO NETS, INSECTICIDES	8.11.41, 8.71, 88
5	DENGUE	DENGUE VIRUS	AEDES MOSQUITO	VECTOR	HIGH TEMPERATURE, HIGH PRECIPITATION	AEDES, MONKEYS, HUMANS	YES	FEVER, HEADACHE, VOMITING, MUSCLE AND JOINT PAIN, SKIN RASH, DENGUE HEMORRHAGIC FEVER, DENGUE SHOCK SYNDROME	ANTIBODY TESTING, VIRAL RNA DETECTION	NOT SPECIFIC(SUPPORTIVE CARE)	(AVOIDING MOSQUITO BITES AND PREVENT CONTACT WITH MOSQUITOES) DEET & PICARDIN BASED MOSQUITO REPELLENTS, CLOTHING, MOSQUITO NETS, INSECTICIDES, VACCINATION	8.11.41, 71
6	LYMPHATIC FILARIASIS(ELFANTIASIS)	WUCHERERIA BANCROFTI, BRUGIA MALAYI, BRUGIA TIMORI	AEDES, ANOPHELES, CULEX, MANSIONIA SPP	VECTOR	HIGH TEMPERATURE, HIGH HUMIDITY	CONTAMINATED WATER	NO	SWELLING OF THE TORSO OR THE LOWER EXTREMITIES	ANTIBODY DETECTION, BLOOD TESTS	ANTHELMINTHIC(ALBENDAZOLE, IVERMECTIN), DIETARY(CARBAZEPINE)	(AVOIDING MOSQUITO BITES AND PREVENT CONTACT WITH MOSQUITOES) DEET & PICARDIN BASED MOSQUITO REPELLENTS, CLOTHING, MOSQUITO NETS, INSECTICIDES	3.15.48, 1, 02.71
7	DROFILARIASIS	PARASITIC ROUNDWORMS (DROFILARIA) D. IMMITIS, D. REPERENS, AND D. TENNIS	CULEX SPP., AEDES SPP., ANOPHELES SPP., CULEX SPP., AND COQUILLETIA SPP	BITES OF MOSQUITOES INFECTED WITH DROFILARIA LARVAE	HIGH TEMPERATURE	DOGS	NO	COUGH (INCLUDING COUGHING UP BLOOD), CHEST PAIN, FEVER, AND PLEURAL EFFUSION (EXCESS FLUID BETWEEN THE TISSUES THAT LINE THE LUNGS AND THE CHEST CAVITY). IMMUNIZATION REDUCED BY DYING ADULT WORMS IN PULMONARY ARTERIES THAT APPEAR AS CONFLUENCES ON CHEST X-RAYS, RARELY, D. IMMITIS WORMS HAVE BEEN FOUND IN HUMANS OUTSIDE THE LUNGS, INCLUDING THE BRAIN, EYE, AND TESTES. WENES REFIN AND D TENNIS INFECTION IS REPORTED IN HUMANS, IT IS GENERALLY AS THE CAUSE OF NODULES UNDER THE SKIN, BUT ON OCCASION, WORMS ARE FOUND IN THE CONJUNCTIVA.	LUNG IMAGING, SKIN NODULE EXAMINATION	ANTHelmINTHIC, SURGICAL REMOVAL OF NODULES AND GRANULOMAS	(AVOIDING MOSQUITO BITES AND PREVENT CONTACT WITH MOSQUITOES) DEET & PICARDIN BASED MOSQUITO REPELLENTS, CLOTHING, MOSQUITO NETS, INSECTICIDES	11.12.46, 71
8	CRIMEAN CONGO HAEMORRHAGIC FEVER	CRIMEAN CONGO HAEMORRHAGIC FEVER VIRUS	TICK	VECTOR	HIGH TEMPERATURE, LOW HUMIDITY, HIGH PRECIPITATION	TICKS, OVINES, CATTLE	NO	FEVER, HEADACHE, MUSCLE PAIN, VOMITING, DIARRHOEA, LIVER FAILURE, BLEEDING INTO SKIN, DIZZINESS, NICK PAIN, STIFFNESS, BACKACHE, HEADACHE, SORE EYES, PHOTOPHOBIA, NAUSEA, SHARP MOOD SWINGS, SLEEPINESS, DEPRESSION, LASSITUDE, ABDOMINAL PAIN, BRUISES, NOSEBLEEDS, UNCONTROLLED BLEEDING AT INJECTION SITES, TACHYCARDIA, LYMPHADENOPATHY, PITCHING, ECCENTROSEX, HEPATITIS, KIDNEY DETERIORATION, LIVER AND/OR PULMONARY FAILURE	ANTIBODY DETECTION, ANTIGEN DETECTION, VIRUS ISOLATION BY CELL CULTURE	NOT SPECIFIC(SUPPORTIVE CARE), ANTI-VIRAL(HEPARIN)	(PREVENTING TICK BITES) PERSONAL TICK AVOIDANCE, INSECT REPELLENTS, CLOTHING, BODY INSPECTION FOR ADHERENT TICKS, AVOID CONTACT WITH INFECTED OR THEIR BODY FLUIDS, AVOID TICK INFESTED AREAS	15.41.71, 11
9	SEVERE FEVER WITH THROMBOCYTOPENIA SYNDROME(SFT)	SABIE BANDAVIRUS(SFTS VIRUS, SFTSV)	TICK	PERSON TO PERSON TRANSMISSION	HIGH TEMPERATURE	CATS, DOGS	NO	MULTIPLE ORGAN FAILURE, LOW PLATELET COUNT, LOW WBC COUNT, ELEVATED LIVER ENZYME LEVEL, FEVER WITH THROMBOCYTOPENIA	ANTIBODY DETECTION, ANTIGEN DETECTION, NEUTRALIZATION ASSAYS, RT-PCR, VIRUS ISOLATION	NOT SPECIFIC(SUPPORTIVE CARE), ANTI-VIRAL(HEPARIN)	(PREVENTING TICK BITES) PERSONAL TICK AVOIDANCE, INSECT REPELLENTS, CLOTHING, BODY INSPECTION FOR ADHERENT TICKS, AVOID CONTACT WITH INFECTED OR THEIR BODY FLUIDS, AVOID TICK INFESTED AREAS	15
10	PLAGUE	YERSINIA PESTIS	FLAECARDINOPSYLLA (CHEST), RODENTS	VECTOR, AIRBORNE(PNEUMONIC), CONTAMINATED FOOD AND WATER, DIRECT CONTACT WITH CONTAMINATED SURFACES	HIGH TEMPERATURE(11-22 C), HIGH HUMIDITY(60-80%)	RODENTS	YES	FEVER, WEAKNESS, HEADACHE, CHILLS, NAUSEA, PNEUMONIC, SHORTNESS OF BREATH, COUGHING, CHEST PAIN, BRUISES, SWELLING OF LYMPH NODES SEPTICEMIC NECROSIS OF TISSUE	PCR, CULTURE( TISSUE FROM BPSBY, AUTOBIO, BLOOD, LYMPH NODE, LUNGS, SPLEEN, LIVER) AND STAINING	ANTIBIOTIC(SIGNIFICANTLY FLUOROQUINOLONE, STREPTOPHYMICIN, CLORAMPHENICOL, TRACICLIN, PIPERACILLIN, OFLOXACIN, CIPROFLOXACIN, TRIMETHOPRIM-SULFAMETHOXAZOLE, AMIKACIN, GOSULFON, AZITHROMYCIN, DOXYCYCLINE), SUPPORTIVE CARE	PROPHYLAXIS, REDUCE RODENT HABITAT, PPE, REPELLANT, AVOID CONTACT WITH FLEAS	15.71
11	TUNGIASS	TUNGIA PENETRANS		DIRECT CONTACT WITH SAND FLEAS	WARM, DRY ENVIRONMENTS WITH SANDY SOIL AND DUST	HUMANS, PIGS, DOGS, RATS, SHEEP, CATTLE, DONKEYS, MONKEYS, BIRDS, ELEPHANTS	NO	SKIN INFLAMMATION, SEVERE PAIN, ITCHING, LESION, SEVERE PRURITUS	BIOPSY	SURGICAL REMOVAL OF THE FLEAS FOLLOWED BY THE APPLICATION OF A TOPICAL ANTIBIOTIC	MAINTAIN HYGIENE, WEAR SHOE, AVOID BAREFOOT WALKING.	
12	BARTONELLOSIS	BARTONELLA SPP	FLEAS, SANDFLIES, MOSQUITO	VECTORS	INCREASED REPORTING EL NINO EVENTS USUALLY OCCURS EVERY 2 TO 7 YEARS)	BATS, HUMANS, CAT, RAT, MOUSE, JAPANESE MACAQUE, DOG, SQUIRREL	NO	FEVERS, CHILLS, HEADACHE, WEAKNESS, LYMPHADENOPATHY, WEIGHT LOSS, SORE THROAT, LOSS OF APPETITE, INFLAMMATION	PCR, DNA SEQUENCING, MICROSCOPI EXAMINATION, CELL CULTURE, MOLECULAR TECHNIQUES, SEROLOGICAL TESTING, BIOPSY, ANTIBODY DETECTION, SILVER STAINING	ANTIBIOTIC(AMACROLES AND TETRACYCLINE, GENTAMICIN, RFAMPIN, CIPROFLOXACIN, TRIMETHOPRIM-SULFAMETHOXAZOLE, AMIKACIN, GOSULFON, AZITHROMYCIN, DOXYCYCLINE), SUPPORTIVE CARE	USE MOSQUITO NET, REPELLANT, COMMUNITY HYGIENE, AVOID STAGNATION OF WATER	91
13	POWASSAN VIRUS ENCEPHALITIS AND RHOMBENCEPHALITIS	POWASSAN VIRUS	KODDES	ZOOOTIC, VECTOR	SPRING TO FALL MONTHS	MAMMAL, MICE, BAT	NO	MENINGOENCEPHALITIS AND RHOMBENCEPHALITIS(RARE); FEVER, HEADACHE, NAUSEA, CONFUSION, WEAKNESS, SEIZURES, APHASIA, CRANIAL NERVE PALSES, PARESIS, ALTERED MENTAL STATUS)	BLOOD TESTS, LUMBAR PUNCTURE, IMAGING, ANTIBODY DETECTION, NEUTRALIZATION ASSAYS	NOT SPECIFIC(SUPPORTIVE CARE)	(PREVENTING TICK BITES) PERSONAL TICK AVOIDANCE, INSECT REPELLENTS, CLOTHING, BODY INSPECTION FOR ADHERENT TICKS, AVOID CONTACT WITH INFECTED OR THEIR BODY FLUIDS, AVOID TICK INFESTED AREAS	22.24.71
14	BORRELLIA MYAMOTI DISEASE HARD TICK RELAPSING FEVER	BORRELLIA MYAMOTI	KODDES	ZOOOTIC, VECTOR	TEMPERATURE AND MOISTURE, TICK DEVELOPMENT RATES INCREASE WITH TEMPERATURE	MICE, VOLES, RATS	NO	MENINGOENCEPHALITIS(BURSE); FLU LIKE SYMPTOMS, FEVER, NAUSEA, VOMITING, HEADACHE, ARTHRALGIA, MALAISE, MYALGIA, ELEVATED LIVER TRANSAMINASES, THROMBOCYTOPENIA, EUCYTOPENIA	PCR, ANTIBODY DETECTION, BLOOD TESTS, URINE TESTS, LIVER FUNCTION TESTS, COMPLETE BLOOD CELL COUNT, MICROSCOPY WITH STAINING, SEROLOGICSS	ANTIBIOTIC(DOXYCYCLINE, CEFTRIAXON, IFAMOXICILLIN)	(PREVENTING TICK BITES) PERSONAL TICK AVOIDANCE, INSECT REPELLENTS, CLOTHING, BODY INSPECTION FOR ADHERENT TICKS, AVOID CONTACT WITH INFECTED OR THEIR BODY FLUIDS, AVOID TICK INFESTED AREAS	
15	HEARTLARD TICK DISEASE	HEARTLAND VIRUS	LOW STAR TICK(AMBLONYMMA AMERICANA)	ZOOOTIC, VECTOR	WARM SUBTROPICAL HAS A MEAN ANNUAL HIGH TEMPERATURE	WHITE TAILED DEER	NO	FEVER, CHILLS, HEADACHE, MUSCLE PAIN, LOSS OF APPETITE, NAUSEA, DIZZINESS, WEIGHT LOSS, JOINT PAIN, LOW WBC COUNT, EASY BRUISES DUE TO LOW PLATELET COUNT, ELEVATED LIVER TRANSAMINASES	RT-PCR, ANTIBODY TESTS, ANTIBODY DETECTION, NEUTRALIZATION ASSAYS, WHITE BLOOD CELL COUNT, PLATELET COUNT, LIVER ENZYME LEVEL	NOT SPECIFIC(SUPPORTIVE CARE)	(PREVENTING TICK BITES) PERSONAL TICK AVOIDANCE, INSECT REPELLENTS, CLOTHING, BODY INSPECTION FOR ADHERENT TICKS, AVOID CONTACT WITH INFECTED OR THEIR BODY FLUIDS, AVOID TICK INFESTED AREAS	22
16	COLORADO TICK FEVER, MOUNTAIN TICK FEVER OR AMERICAN MOUNTAIN FEVER	COLTIVIRUS	ROCKY MOUNTAIN WOOD TICK(DERMACENTOR ANDREONNI)	VECTOR	ROCKY MOUNTAIN WOOD, WOODED AREAS AND FIELDS / SPRING - SUMMER	SQUIRREL, DEER, MICE, RABBITS	NO	FEVER, CHILLS, HEADACHES, PAIN BEHIND THE EYES, LIGHT SENSITIVITY, MUSCLE PAIN, GENERALIZED MALAISE, ABDOMINAL PAIN, HEPATOSPLENOMEGALY, NAUSEA, VOMITING, ASEPTIC MENINGITIS, ENCEPHALITIS, HEMORRHAGIC FEVER	ANTIBODY DETECTION, IMMUNOFLUORESCENCE FOR COLORADO TICK FEVER, LIVER FUNCTION TESTS, RT-PCR, NEUTRALIZING ASSAYS, VIRAL RNA DETECTION	NOT SPECIFIC(SUPPORTIVE CARE)	(PREVENTING TICK BITES) PERSONAL TICK AVOIDANCE, INSECT REPELLENTS, CLOTHING, BODY INSPECTION FOR ADHERENT TICKS, AVOID CONTACT WITH INFECTED OR THEIR BODY FLUIDS, AVOID TICK INFESTED AREAS	22
17	TICK BORNE RELAPSING FEVER	BORRELLIA HERMSI	ORNITHODOROS HERMSI	VECTOR, ZOOOTIC	TEMPERATURES BETWEEN 33 AND 35C WITH HIGHER HUMIDITY	SMALL RODENTS, MAMMALS, WHITE TAILED DEER	NO	FEVER, HEADACHE, MYALGIA, NAUSEA, VOMITING, ARTHRALGIA, CHILLS, ERYTHEMA MARGINIS, DIARRHOEA, SWELLING, FATIGUE, ABDOMINAL PAIN, MALAISE, ANOREXIA, PHOTOPHOBIA, RASH, REDDOR, JAUNDICE, ASTHENA, ACHE, SPLENOGALY, NECK STIFFNESS, LYMPHADENOPATHY, DIZZINESS, TACHYCARDIA, NACK PAIN, EPITAXIS, SUBCONJUNCTIVAL HEMORRHAGE, HEPATOSPLENOMEGALY, LETHARGY, BILLIRUBIN VISION, CONFUSION, EYE PAIN, LOSS OF APPETITE, SORE THROAT, CHEST PAIN, INSTABILITY, DYSPNOEA, MACULAR RASH, MENINGITIS, DISTURBED GAIT, ESRICHAR, PITCHING, MEMORY DEFICIT, PRURITUS, BRUXISMUS, SLEEP DISTURBANCES, CONVULSIONS, DEHYDRATION, DIFFICULT HEARING, DIPLOPIA, DYSMETRIA, DYSURIA, FLANK PAIN, HALLUCINATION, HAND NUMBNESS, LOWER LIMB PAIN, LUMB PAIN, PHONOPHOBIA, SWEETFOOT, MENINGITIS, RITS, ACUTE RESPIRATORY DISTRESS SYNDROME, LETHARGY, FACIAL PALSY, ENCEPHALITIS, ACUTE RENAL FAILURE, ANGINA PECTORIS, COMA, FACIOBRONCHIAL HEMIPARESIS, CAVEIROUS SINUS THROMBOSIS, PRESUMED RETROVIRAL COAGULATION, CRANIAL NERVE PALSES, ENOCHALAMITIS, HEARING LOSS, HE PATTIS, MYOCARDITIS, NEPHRITIS, PNEUMONIA, SEPTIC SHOCK, NEONATAL SEPTICEMIA, THROMBOCYTOSIS, SUBARACHNOIDAL HEMORRHAGE, THROMBOCYTOPENIA, LEUCOCYTOSIS, ANAEMIA, PROTEINURIA, TROPONEMIA, ELEVATED ALANINE AMINOTRANSFERASE, ALKALINE PHOSPHATASE, ASPARTATE TRANSAMINASE, CREATINE KINASE, C-REACTIVE PROTEIN, ERYTHROCYTE SEDIMENTATION RATE, GAMMA-GLUTAMYLTRANSFERASE, LACTATE DEHYDROGENASE	RT-PCR, CULTURE, ANTIBODY DETECTION, BIOPSY, IMAGING, LUMBAR PUNCTURE, IMAGING, SEROLOGICAL ASSAYS, BLOOD TESTS, NEUTRALIZATION ASSAYS, VIRUS ISOLATION	NOT SPECIFIC(SUPPORTIVE CARE)	AVOID RODENTS, (PREVENTING TICK BITES) PERSONAL TICK AVOIDANCE, INSECT REPELLENTS, CLOTHING, BODY INSPECTION FOR ADHERENT TICKS, AVOID CONTACT WITH INFECTED OR THEIR BODY FLUIDS, AVOID TICK INFESTED AREAS	22.91
18	EHRLICHIOSIS	EHRLICHA MURRI	BLACK LEGGED TICK(SCAPULARIS)	VECTOR	FALL AND WINTER 5-15 C	DEER, DOGS	NO	FEVER, HEADACHE, RASH, NACK PAIN, ARTHRITIS, NAUSEA, VOMITING, MACULAR RASH, NEUROLOGICAL SYMPTOMS	PCR, ANTIBODY DETECTION, ANTIBODY TITERS, CULTURE AND STAINING, BLOOD SMEAR TESTING, BLOOD TEST, BLOOD CELL COUNT, LIVER FUNCTION TESTS	ANTIBIOTIC(TETRACYCLINE)	(PREVENTING TICK BITES) PERSONAL TICK AVOIDANCE, INSECT REPELLENTS, CLOTHING, BODY INSPECTION FOR ADHERENT TICKS, AVOID CONTACT WITH INFECTED OR THEIR BODY FLUIDS, AVOID TICK INFESTED AREAS	22.91
19	HUMAN MONOCYTC EHRLICHIOSIS	EHRLICHA CHAFFINSEI	LONG STAR TICK(AMBLONYMMA AMERICANA)	VECTOR, ZOOOTIC	HIGHER HUMIDITY, INTERACTION EFFECT BETWEEN DURNAL TEMPERATURE RANGE	WHITE TAILED DEER, GOATS, DOGS, RABBITS, COYOTES	NO	FEVER, HEADACHE, MALAISE, LOW BACK PAIN, GASTROINTESTINAL SYMPTOMS, MYALGIA, ARTHRALGAS, COUGHING, PHARYNGITIS, DIARRHOEA, VOMITING, ABDOMINAL PAIN, CHANGE IN MENTAL STATUS	PCR, SEROLOGICAL TESTING, BLOOD CELL COUNT, ANTIBODY DETECTION, ANTIBODY TITERS, WESTERN BLOTTING, STAINING AND MICROSCOPY, ISOLATION OF PATHOGEN.	ANTIBIOTIC(TETRACYCLINE/DOXYCYCLINE)	(PREVENTING TICK BITES) PERSONAL TICK AVOIDANCE, INSECT REPELLENTS, CLOTHING, BODY INSPECTION FOR ADHERENT TICKS, AVOID CONTACT WITH INFECTED OR THEIR BODY FLUIDS, AVOID TICK INFESTED AREAS	22
20	YELLOW FEVER	YELLOW FEVER VIRUS	AEDES AEGIPTI	VECTOR	HIGH TEMPERATURE, HIGH PRECIPITATION	MONKEYS	YES	FEVER, CHILLS, LOSS OF APPETITE, NAUSEA, MUSCLE PAIN, HEADACHES, JAUNDICE, KIDNEY PROBLEMS, FATIGUE, LIVER DAMAGE, BLEEDING, HEART DISEASE(SARINATHMIS), SEIZURES	RT-PCR, CULTURE, ANTIBODY DETECTION, BIOPSY, IMAGING, LUMBAR PUNCTURE, IMAGING, SEROLOGICAL ASSAYS, BLOOD TESTS, NEUTRALIZATION ASSAYS, VIRUS ISOLATION	NOT SPECIFIC(SUPPORTIVE CARE)	(AVOIDING MOSQUITO BITES AND PREVENT CONTACT WITH MOSQUITOES) DEET & PICARDIN BASED MOSQUITO REPELLENTS, CLOTHING, MOSQUITO NETS, INSECTICIDES	11.71
21	CHIKUNGUNYA	CHIKUNGUNYA VIRUS	AEDES AEGIPTI, AEDES ALBOPICTUS	VECTOR	HIGH TEMPERATURE, HIGH PRECIPITATION	HUMANS	YES	FEVER, JOINT PAIN, MUSCLE PAIN, HEADACHE, NAUSEA, BACK PAIN, FATIGUE, RASH, ABDOMINAL PAIN, VOMITING, SENSITIVITY TO LIGHT, CONDUCTIVITIES, PAIN BEHIND THE EYES, ARTHRITIS, TENOSYNOVITIS, BURSITIS, STIFFNESS, NERVE DAMAGE, NEUROPATHIC PAIN, RHOCCYCLITS, LIVERITIS, RETINAL INFLAMMATION, SWELLING AND DEGENERATION OF THE EYE, NEUROINFLAMMATION AND DEGENERATION OF THE NERF, SENSITIVITY AND/OR NEUROGICULAN-BARRIS SYNDROME, ACUTE DISSEMINATED ENCEPHALOMYELITIS, HYPOTONIA, RIBSIS WITH VIBRAL PERIPHERAL CHANGES, SEIZURES, PRESSION ON THE CEREBELLUM OR MENINGES, OCULOMOTOR NERVE PALSY, PARALYSIS OF THE EYE MUSCLE, SWELLING OF THE EXTREMES, HEART AND VASCULAR DISEASES, BLEEDING	RT-PCR, SEROLOGICAL TESTING, BLOOD TEST, ANTIBODY DETECTION, ANTIBODY TITERS, ISOLATION, AND CULTURE, NEUTRALIZATION ASSAYS	NOT SPECIFIC(SUPPORTIVE CARE)	(AVOIDING MOSQUITO BITES AND PREVENT CONTACT WITH MOSQUITOES) DEET & PICARDIN BASED MOSQUITO REPELLENTS, CLOTHING, MOSQUITO NETS, INSECTICIDES	11.41.42, 48.45.71



### Conclusion

People see it as floods, tornadoes, tsunamis, droughts, heatwaves, etc. but they need more education about diseases and climate change. It affects population unequally, but still all are affected in any one way at least. It increases the host susceptibility, host-pathogen interaction (mainly due to habitat destruction and exposure to contaminated transmitters) and the ability of the organisms (disease causers) to get transmitted and infect people. It also affects vectors by providing suitable climate and habitat, thereby increasing the risk of vector borne diseases. It influences the hosts. The adaptation of pathogen to one environmental stressor also primes them to withstand another adverse environment. Vectors are also getting adapted like humans to climate change. It also provides abundance of medium through which diseases transmit. Therefore, It can be concluded that requirement of various expert committees and their inputs are required for development of broader roadmap to address climate induced communicable diseases.

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