International Journal of Science, Environment and Technology, Vol. 7, No 1, 2018, 193 – 200
ISSN 2278-3687 (O)
2277-663X (P)

CLIMATE CHANGE AND EMERGENCE OF VECTOR BORNE ZOONOSES

Archana S.N*[1], Vrinda Menon[2], P. Sathya[3] and C. Srinivasan[4]
[1]M.V.Sc Scholar, [2]Assistant Professor, Dept. of Veterinary Public Health,
[3]M.V.Sc Scholar, Dept. of Dairy Science, [4]M.V.Sc Scholar, Dept. of Animal Nutrition
College of Veterinary and Animal Science, Mannuthy, Kerala-680651
E-mail: archana.nairkl@gmail.com (**Corresponding Author*)

Abstract: Change in climatic condition of India is affecting the geographical distribution of vectors. Malaria, dengue, Chikungunya, filariasis, Japanese encephalitis and visceralleishmaniasis are the common vector borne diseases reported in India. The variability in climate conditions such as El Niño and La Niña lead to changes in the patterns of tropical rainfall. The warmer and humid conditions increases the risk of vector borne zoonoses whereas, hot and drier conditions decline in the incidence of disease. It is very important to understand the factors which are related to increase the vector population and hence the transmission of disease. These factors should be monitored to prevent the emergence and re-emergence of more diseases, as well as to serve as a basis for effective vector control. Researchers should continue to expand their knowledge of how climate and weather change influences the vector popultion.
Keywords: Climate, vector, zoonosis.

Introduction

Human life is totally dependent on the climatic conditions on Earth. The interactions of the atmosphere, oceans, terrestrial and marine biospheres, cryosphere and land surface determine the Earth's surface climate. Atmospheric concentrations of greenhouse gases, which include carbon dioxide, methane, and nitrous oxide are increasing, mainly due to human activities, such as use of fossil fuel, land use change and agriculture. An increase in greenhouse gases leads to increased warming of the atmosphere and the Earth's surface. A change of climate 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 periods, (Depledge *et al*., 2005). Warmer temperatures lead to increase in insects and microorganisms population where once they could not survive (Dhara *et al*., 2013). The disruption of natural ecosystems provides more suitable environments, which favors the survival of some pathogenic bacteria, viruses, and fungi.

*Received Jan 12, 2018 * Published Feb 2, 2018 * www.ijset.net*

Climate change in India

The climate of India defines easy generalization as it includes a wide range of weather conditions across a large geographic scale and varied topography. All areas of India experience four seasons: winter, summer, advancing monsoon and retreating monsoon (Beugn et *et al.,*2013*).* Nowadays, vector-borne diseases have emerged as a serious public health problem in countries of the South-East Asian region, including India (Singh *et al*., 2011). Climate change leads to warmer and humid conditions, which increases the risk of vector borne zoonoses whereas, hot and drier conditions decline in the incidence of disease (NIMR, 2001).

Indian scenario (IPCC, 2015)

1. The annual mean surface temperature will rise by the end of the century by 2.5°C to 5°C, with warming more pronounced in the northern parts of India.
2. A more than 20% rise in summer monsoon rainfall is projected except in the state of Punjab, Rajasthan and Tamil Nadu.
3. The range of maximum temperatures in any one season is predicted to vary more widely (from 27°C and 44°C to 26°C and 45°C; variations in minimum temperature are expected to increase in the same way).
4. Precipitation is expected to increase substantially, particularly over the west coast and central India.
5. The hydrological cycle is likely to be altered and the severity of droughts and intensity of floods in various parts of India are likely to increase.

Vector

It is defined as an arthropod or any living carrier that transports an infectious agent to susceptible individuals. The transmission by a vector may be mechanical or biological. The biological transmission is again divided into propagative in which agent just multiplies in vector, cyclo-propagative in which agent undergoes both multiplication and growth in vector, cyclo-developmental in which only development of pathogen takes place inside vector and transovarian type in which pathogens are transmitted from one generation to other generation. Vectors themselves are not infectious agent, but they acts as an important mode for transmission of the pathogenic microorganism (WHO, 2013).

Vector Borne Zoonoses

The diseases which are transmitted from infected animal to the susceptible human population by arthropod vector are called as vector borne zoonosis.

Vector Borne Disease (VBD)

A disease that is transmitted to humans or other animals by an insect such as a mosquito or another arthropod is called a vector-borne disease**.** The transmission depends upon the attributes and requirements of at least three different living organism's *i.e.* pathological agent, vector and human host. Intermediary hosts such as domesticated and wild animals often serve as a reservoir for the pathogen until susceptible human populations are exposed. Most of the vector-borne diseases are commonly found in tropical and sub-tropical regions which estimated 17 per cent of the global burden of all infectious diseases. Malaria is the most deadly vector-borne disease which causes an estimated 660,000 deaths in 2010 and 627,000 deaths in 2012, especially in African children (NVBDCP, 2015).Dengue is considered as world's fastest growing vector-borne disease with a 30 times increase in disease incidence over the last 50 years. It was estimated that 1.3 million new cases of leishmaniasis occur annually (Singh *et al.* 2011).Globalisation of trade and travel, climate change and urbanisation are all having an impact on the global spread of vector-borne diseases.The major VBDs in India are malaria, filariasis, dengue, chikungunya and Japanese encephalitis which are transmitted by mosquitoes and visceral leishmaniasis by sand flies. About 1-2 million new cases of malaria and about 1000 deaths occur every year (NVBDCP, 2014). Japanese encephalitis is currently endemic in 135 districts in 15 states whereas, Chikungunya and dengue outbreaks are occurring more frequently and explosively in both urban and rural areas of the country**.**

Climate Change as an agent of VBD

In the atmosphere, gases such as water vapors, carbon dioxide, ozone, and methane act like the glass roof of a greenhouse by trapping heat and warming the planet. These gases are called greenhouse gases. The natural levels of these gases are supplemented mainly due to human activities such as the burning of fossil fuels, farming activities and change in land-use. The Earth's surface starts warming with increasing atmospheric temperature accompanied by many other changes including patterns of ecosystem which ultimately leads to re-emergence of vector borne diseases (Githeko *et al.,* 2000). Climate change is already forcing biodiversity to adapt either through shifting habitat, changing life cycles, or the development of new physical traits (Tabachnick, 2010).

Important properties in the transmission of vector-borne diseases include

- Survival and reproduction rate of the vector
- Time of year and level of vector activity, specifically the biting rate

- Rate of development and reproduction of the pathogen within the vector

The most influential climatic factors for vector borne diseases include temperature and precipitation but sea level elevation, wind, and daylight duration are additional important considerations.

Temperature sensitivity

A small increase in temperature may be lethal to the pathogen to grow inside vector;it may result in increased development, incubation and replication of the pathogen within the vector. An emergence of malaria in the cooler climates may be a result of the mosquito vector shifting habitats to cope with increased ambient air temperatures (Patz *et al*., 2006). The vectors can undergo an evolutionary response to adapt to increasing temperatures *i.e.* genetic shift within the mosquito species. The mosquitos can adopt in newer environment by their micro-evolutionary changes. They can digest blood in warm and humid weather and spreads infection at a faster rate.

Precipitation sensitivity

Increased precipitation rate expands the size of existent larval habitat and creates new breeding grounds for the vectors. Increased rainfall and flooding may force insect or rodent vectors to seek refuge in houses and increase the likelihood of vector-human contact (Patz *et al*., 2006). During drought, water level decreases and can cause rivers to slow and creates stagnant pools which serve as an ideal vector breeding habitats.

Humidity sensitivity

Humidity can greatly influence transmission of vector-borne diseases, particularly for insect vectors. The mosquitoes and ticks can desiccate easily and survival decreases under dry conditions. Saturation deficit has been found to be one of the most critical determinants in climate/disease models, for example, dengue fever and Lyme disease (Patz *et al*., 2006).

Sea level sensitivity

The increased in sea level along with climate change eliminate breeding habitats for salt-marsh mosquitoes, which would also results in elimination of viruses endemic to the perticular habitat. On the other hand inland intrusion of salt water may turn the fresh water habitats into salt-marsh areas which could support vector growth (Patz *et al*.,2006).

RISK FACTOR ASSOCIATED WITH OCCURRENCE OF DISEASE

Vector-borne diseases have emerged as a serious public health problem in countries like India (Singh *et al.,* 2011). The risk factors that play a key role in the spread and transmission of dengue and other vector-borne diseases in India are globalization, unplanned

and uncontrolled urbanization, developmental activities, poor environmental sanitation and household water-storage practices, improper drainage of water, widespread travelling and human migration (Myaing *et al.,*2001).

Mosquito-Borne Diseases

Changes in lifestyles, living conditions and climate-related natural disasters may change the dynamics of human–mosquito contact but heavy rainfall or floods may create conditions that favors mosquito proliferation and enhance mosquito–human contact (Singh *et al.,* 2011). High humidity acts as major factors in the occurrence of epidemics by increasing the breeding and transmission of diseases (Reiter, 2000). The geographical and tropical distribution of mosquito in future will increase the incidence of mosquito borne diseases by bringing mosquitoes more in contact with the humans which would further extend the season of transmission of diseases (NIMR, 2014).

Important mosquito borne diseases in India

- Malaria: - *Anopheles species*
- Dengue :- *Aedes species*
- Filarial :-*Culexquinquefasciatus*
- Japanese Encephalitis: -*Culexvishnui grp.*
- Chikungunya :- *Aedes species*

Tick-borne diseases

The ticks and their mammalian hosts are influenced by land use, land cover, soil type, elevation, and weather conditions. Temperature accelerates the development cycle, egg production, population density, and distribution of ticks. Rising temperatures will increase tick distribution while droughts and severe floods will affect their distribution. A milder weather condition influences Crimean-Congo Hemorrhagic Fever distribution. Kyasanur Forest Disease is reported in Mallupuram and Wayyanad district of Kerala in the year 2015. It occurs more in the area were tick population is more (Gage *et al*., 2008)

Important tick borne diseases in India

- Kyasanur Forest Disease :- *Hemaphysalisspinigera*
- Tick Typhus :- *Larval mite (chigger)*
- Tularaemia :- *Dermacentor sp*
- Relapsing fever:- *Ornithodoros sp.*
- Lyme disease :-*Ixodes sp.*

Fly-borne diseases

Temperature influences the biting rate, the diapauses and the maturation of the protozoan parasite in the fly vector. If the climatic conditions become too hot and dry for vector survival, the disease may be contained. Visceral leishmaniosis is the commonly occurring fly borne disease in India. The states like Bihar, West Bengal, Uttar Pradesh and Jharkhand are more prone for this disease. Sporadic cases have also been reported from Gujarat, Tamil Nadu, Kerala and sub Himalayan parts of north India due to change in distribution of vectors (NICD, 2006). Many diseases such as bacillary dysentery, amoebic dysentery, gastroenteritis, paratyphoid, cholera, poliomyelitis, viral hepatitis are transmitted by fly. Leishmaniosis is one of the important diseases which are transmitted by *Phlebotmus* fly in northern part of India.

Flea-Borne Diseases

Flea-borne infections are emerging or re-emerging throughout the world, and their incidence is commonly seen in different parts of India. Increase in ambient temperature, rainfall, and relative humidity, along with rodent habitat has affected the seasonal abundance of rodent fleas (Bitam *et al.,*2010). The increase in flea borne plague has been attributed to increase in rodent population. Changes in land-use patterns are associated with occurrence of plague in U.S. during the year 1980s and 1990 (Parmenter *et al*.,1999).

Flea borne diseases in India

1) Plague :- *Xenopsyllacheopis*2) Endemic/Murine Typhus:- *Xenopsyllacheopis*

Response towards vector borne diseases

More surveillance on direct impacts of climate changes in the reproduction rate of the vector or the agent, biting frequency of the vector and amount of time the host is exposed to the vector due to changes in temperature, rainfall, humidity, or storm patterns needs to be undertaken. The major changes in hydrology, agriculture, forestry, and infrastructure in response to global warming may also indirectly affect the inter-relationship among the disease agent, vectors, and hosts. Measures are taken to protect children against mosquito bites by eliminating potential breeding sites in standing water and household garbage. Using insecticide impregnated mosquito net screens on windows or doors, appropriate clothing and use of mosquito repellants should be followed to protect from mosquito bite. Measure to be taken to eliminate vector breeding site such as water holding containers and logging areas. Proper knowledge and information should be given to the public and children about the risks of malaria and other vector-borne diseases. Immunization campaigns should be followed

were health services are weak, such as for yellow fever. Natural remedies are used for the prevention of disease by using lavender oil, burning of coconut husk, planting of lemon grass and clove plant. Periodic application of insecticides should be followed in highly endemic areas.

Conclusion

Climate change has main role in increasing the risk of vector borne disease by expanding the ranges of species due to destruction of natural habituate. These diseases are spreading to the newer geographical area due to change in climate which indirectly affects its population and abundance. The increases in temperature and rainfall have direct influence on prevalence of disease and also the growth of pathogens inside the vectors. So further studies are required to find out the extend of impact of this climate changes on vector population and emergence of zoonoses.

References

[1] Beugnet, F. and Chalvet-Monfray, K. 2013. Impact of climate change in the epidemiology of vector-borne diseases in domestic carnivores. *Compa. Immunol, Microbial. Infect. Dis.* **36**(6):559-566.

[2] Bitam, I., Dittmar, K., Parola, P., Whiting, M.F. and Raoult, D. 2010. Fleas and flea-borne diseases. *Int. J. Infect. Dis*. **14**(8):667-676.

[3] Dhara, V.R., Schramm, P.J. and Luber, G. 2013. Climate change & infectious diseases in India: Implications for health care providers. *Indian. J. Med. Res.* **138**(6):847.

[4] Depledge, J., Lamb, R. and Lawler, C., 2005. Caring for climate: a guide to the climate change convention and the Kyoto protocol. In *Caring for climate: a guide to the climate change Convention and the Kyoto Protocol*. ONU/UNFCCC.

[5] Githeko, A.K., Lindsay, S.W., Confalonieri, U.E. and Patz, J.A. 2000. Climate change and vector-borne diseases: a regional analysis. *Bul. Wld. Hlth. Org.* **78**:1136-1147

[6] Gray, J.S. 2008. Ixodesricinus seasonal activity: Implications of global warming indicated by revisiting tick and weather data. *Int. J. Med.Microbiol.***298**:19-24.

[7] Myaing, T.T. 2011. Climate Change and Emerging Zoonotic Diseases. *KKU Vet. J.***21**(2):172-182.

[8] nvbdcp.gov.in/Doc/Annual-report-NVBDCP-2014-15.pdf

[9] Patz, J.A., Graczyk, T.K. and Geller, N. 2000. Effects of climate change on parasitic disease. *Inter. J. Parasitol*. **3**:1-11

[10] Reiter, P. 2000. Malaria in England in little ice age. *Emerging. Infect. Dis.* **6**:1-11.

[11] Sachan, N. and Singh, V.P. 2010. Effect of climatic changes on the prevalence of zoonotic diseases. *Vet. Wld.* **3**(11):519-522.

[12] Singh, B.B., Sharma, R., Gill, J.P.S., Aulakh, R.S. and Banga, H.S. 2011. Climate change, zoonoses and India. *Rev. Scient. Tech. OIE*. **30**(3):779.

[13] Tabachnick, W.J. 2010. Challenges in predicting climate and environmental effects on vector-borne disease episystems in a changing world. *J. Exp. Biol.* **213**(6):946-954.