A review on prediction of seasonal diseases based on climate change using big data

K. Indhumathi [a], K. Sathesh Kumar [b],*

[a] Department of Computer Applications, Kalasalingam Academy of Research and Education, Krishnankoil, Virudhunagar (Dt)., India
[b] School of Computing, Kalasalingam Academy of Research and Education, Krishnankoil, Virudhunagar (Dt)., India

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ABSTRACT

Big Data occupies an important place in the prediction of diseases that happen due to climate change. In each aspect of human life, the weather plays a major role. It directly affects human society or human life. Because of an extreme weather condition creates various diseases among humans. Such as Vector-borne diseases (Malaria, dengue and chikungunya fever), Water-borne diseases (Cholera, Typhoid), Air-borne diseases (Chicken Pox, influenza and small Pox) and Food-borne diseases (Diarrhoea and Salmonella) etc. This survey presents an overview for a climate variable such as extreme temperature, precipitation, humidity and how unexpected climate conditions can affect the disease and living organism.

1. Introduction

Big data analytics is an emerging technique, and it is used in various fields such as scientific research, social networking, share marketing, health care and climate modeling [1]. In health care, big data analytics are used to mining the data to see what treatment is more powerful for a particular disease and also obtain other useful knowledge that can help patients and reduce costs. The WHO identified 12.6 million people died due to an unhealthy environment [2].

The longevity, reproduction, dissemination and transmission of bacteria need some appropriate (Table 1) climate and weather conditions [7]. Unexpected weather condition affects the entire resources of the environment [6]. So, the changes in climate or weather condition may cause infectious diseases among humans [7]. For instance, the heavy precipitation has been related to viral diseases like malaria as well as cholera.

By Air pollution may spread TB and extreme temperature may cause the diseases which are related to the stomach. For example, a study predicts the mosquito reproduction reduced if the temperature increased and also it cause the disease which is related to the intestine [23]

Climate change can affect human health and it outbreaks, many infectious diseases are concerned [3,4,5]. Three components are most important for causing an infectious disease based on climate (Fig. 1). The three elements are the host (living organism affected by agent), Agent (causing the disease) and environment (that permits to transfer the disease). Without all three elements, the disease cannot occur [6].

Climate change has also been associated with water-borne infectious diseases. For example, low rainfall and higher temperature can increase the cholera pathogens. This study identifies the cholera pathogens were increased during the warm months of June to September [23].Water borne diseases may increase due to the rainfall. Rainy season can increase the development of fecal pathogens.

After a long drought, the heavy rainfall may cause the several disease pathogens outbreaks. Climate change may improve the pathogen's reproduction, survival and its life cycle directly or indirectly [8]. Climate change is the important step to find out the everyday seasonal variations [24].

Now COVID-19 is a new pandemic. It is affecting the several people all over the world. The coronavius indications are hyperpyrexia, respiratory problems and fatigue. These are the indications of normal cold and fever. The first case of corona virus was identified on china in December 2019. Several peoples have died through this corona virus.

* Corresponding author.
E-mail address: sathesh.drl@gmail.com (K. Sathesh Kumar).

Table 1

Recent reviews in disease for climate changes.

S. no	Title	Author&Year	AlgorithmsUsed	Works carried out
1	COVID19 transmission in Mainland China is associated with temperature and humidity: a time-series analysis	Qi H, Xiao S, Shi R& 2020	–	It identifies the outbreak of COVID- 19 are reduced in 36% −57% when the mean temperature is increased in 1 °C. And also find that the development of COVID-19 is minimized when the mean humidity is increased in 1 °C
2	Temperature, humidity and latitude analysis to predict potential spread and seasonality for COVID-19	Sajadi M. M, Habibzadeh P, Vintzileos A, Shokouhi S, MirallesWilhelm F, Amoroso A & 2020	–	It find that the community spread areas are situated at 30° − 50° north latitude and the temperature of these areas are in the range from 5° C − 11° C.
3	1.Seasonality of respiratory viral infections2.Low ambient humidity impairs barrier function and innate resistance against influenza infection3.Mechanistic insights into the effect of humidity on airborne influenza virus survival, transmission and incidence4. Roles of humidity and temperature in shaping influenza seasonality.5.The effects of temperature and relative humidity on the viability of the SARS coronavirus	Moriyama M, Hungentobler W. J, Iwasaki A & 2020Kudo E, Song E, Yockey L. J & 2019Marr L.C, Tang J. W, Van Mullekom J, Lakdawala S .S & 2019Lowen A.C, Steel J & 2014Chan K. H, Peiris J. S, Lam S. Y, Poon L. L, Yuen K. Y, Seto W. H & 2011	–	This overall study presents the spread of corona virus and influenza is increased in cold and dry environment
4	The effect of potential climate change on infectious disease presentation	Smith E et.al, 2019	–	This survey analysis the humidity is strongly associated with the air-borne disease transmission. And the humidity can increase the spread of gastrointestinal infectious pathogens and polio
5	The association between temperature, rainfall and humidity with common climate-sensitive infectious diseases in Bangladesh	Chowdhury F. R et.al , 2018	–	The research found that the temperature, humidity and rainfall are how related to common seasonal infectious diseases. This study considers only six climate sensitive infectious diseases (Malaria, Diarrhoea, Enteric Fever, Encephalitis, Pneumonia and Bacterial Meningilis)
6	A Gaussian process based big data processing framework in clustering computing environment	Manogaram G, Lopez D, 2017	Local Moran's I Auto Correlation method & Gaussian Process Regression Framework	The analysis identifies most dengue outbreaks are increased during summer and winter.
7	Impact of climate change on human infectious disease: Empirical evidence and human Adaption	Wu et.al, 2016	–	This research examines how the climate change is related to infectious diseases (water-borne disease, air-borne disease and vector-borne disease) through three terms (disease pathogens, weather variable and infectious disease)
8	Avian influenza H5N1 viral and bird midration networks in Asia	Tian et.al , 2015	–	This survey analysis extreme weather conditions may increase disease transmitted by insects. And also found that some pathogens need maximum temperature and some pathogens need minimum temperature to alive
9	Climate change and Ixodes tick-borne diseases of humans&Climate change and infectious diseases	Ostfeld R. S, Brunner J. L, 2015&Rodo X et.al, 2013	–	It identifies the long term climate warming is the most favorable to the spread of infectious disease
10	Global climate anomalies and potential infectious disease risks	Chretin J.P et.al, 2014	–	This study found that Salmonellosis, cholera and giardiasis may be increased their outbreaks due to extreme temperature and flooding
11	Hantavirus infection among overnight vistors to Yosemite National Park, California, USA &Hantavirus and climate change	Nunez J. J et.al, 2012&Klempa B, 2009	–	It analysis the heavy rainfall may increase the spread of human infectious diseases through animals
12	Water-borne infectious disease outbreaks associated with water scarcity and rainfall events.	Jofre J et.al, 2010	–	This review identifies the climate change may shift the timing and amount of rainfall. so it increase the unexpected precipitation in unexpected time
13	The Magnitude of variation in temperature within a year has an effect on the seasonal variations of chickenpox incidence in Japan	Kokaze et.al, 2007	–	It examines the disease transmission of chickenpox is increased in late winter and early spring
14	Seasonality of infectious diseases, Annu Rev, Public health	Fisman D. N, 2007	–	The survey examines that, depend upon the climate change the disease transmission may increase or decreased
15	Using climate to predict infectious disease epidemics	Kunn K et.al, 2005	–	It examines the extreme temperature may stop the pathogen's development. For example, the malaria parasite stops its development, when the temperature exceeds 33 C − 39 C

Table 1 (*continued*)

| S. no	Title	Author&Year	AlgorithmsUsed	Works carried out
16	Is global warming harmful to health?	Epstein P.R, 2000	–	This study examines the extreme weather conditions may cause more clustered disease outbreaks at unexpected place and time
17	Global climate change and emerging infectious diseases. JAMA	Patz J. A et.al, 1996	–	The study found that the climate change may also introduce new pathogen already it does not exist in the society.
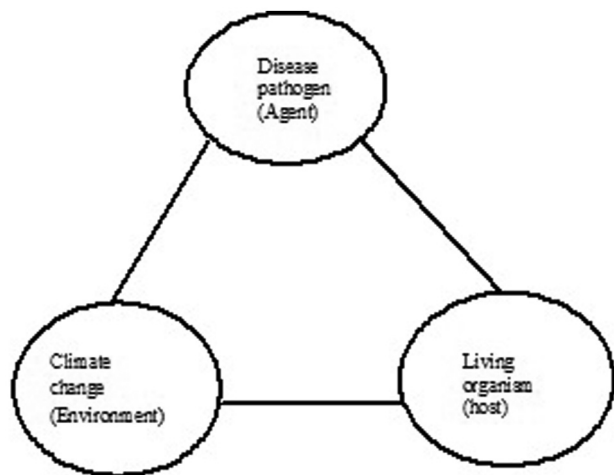
Fig. 1. Three important components.

Till date 7, 09, 511 peoples have died around the world. And 41,585 people have died in India. The death rate of COVID-19 has increased day by day. The winter season plays an important role to cause several deaths of corona virus.

Because the winter season provides humidity and rainfall. So it increases the respiratory problems of peoples. Based on these climatic factors will not easily recover people from COVID-19.To improve the health environment of the society, the people must aware of the seriousness of the disease. Correspondingly the people must follow the prevention methods. Through this we will create a diseaseless society [6].

2. Related works

This research [8] presents an overall study of how the climate change is related to human infectious diseases. This study describes the three sets of terms. The first one is virus and bacteria of the disease. Another is meteorological variable like heat, rainfall and snow. And the third one is infectious diseases. This survey examines how much viral disease, respiratory diseases and intestine diseases are increased through climate changes

The Studies [9 and 10] identified the long term climate warming is the most favorable to the spread infectious diseases. The survey [11] presents the extreme weather conditions may cause many infections in unexpected locations. The review [12] examines the extreme weather events may increase disease transmitted by insects. The temperature may impact the life process of pathogens. Because the pathogens plays an important role in disease transmission.

Pathogens need some range of temperature to live and reproduction. For example, to the mosquito reproduction require the maximum temperature of 22℃ – 23℃. Similarly, the transmission of Japanese Encephalitis Virus needs the minimum temperature of 25 °C–26 °C. Instead lower temperature may decrease other vector-borne disease transmission such as dengue. Because some of the mosquitoes cannot live a long time.

The study [13] identifies the other infectious diseases such as Salmonellosis, cholera and giardiasis may be increased their outbreaks due to extreme temperature and flooding. The analysis [8] conducts the survey using web of science / knowledge, Google scholar, Elsevier Science Direct, Springer Online Journals and CNKI. This survey identifies the 131 articles out of 400 articles related to human disorders created by unexpected weather conditions.

The study [14] examines the extreme temperature increase the death rate of some pathogens. When temperature increases 33℃ – 39℃, the malaria parasite stops its development. The study [6] found that the humidity is strongly associated with the air-borne disease transmission. The humidity permits the gastrointestinal infectious pathogens are more time in the humid environment than in the dry environment. And also the polio has been spread morely in the humid environment.

The research work [15] identifies the climate change may shift the timing and amount of rainfall. So, the climate change may increase the unexpected precipitation in unexpected time. From this, unexpected water-borne diseases are transmitted in the environment. The analysis [16] and [17] found that the amount of increased rainfall in areas with mice can move into the indoors. The mice may spread their dung into the indoors. From this, the Hantavirus may increase.

The review [18] identifies climate change may affect the pathogens of chickenpox. This study found that the disease transmission of chickenpox is increased in late winter and early spring. As well as, the other infectious diseases are outbreaks their pathogens based on seasons. The survey [19] examines that, depend upon the climate change the disease transmission may increase or decreased

The study [20] found that the climate change may also introduce new pathogen already it does not exist in the society. So the health authorities are prepared to face these types of infectious diseases and the health care providers will educate the people to prevent the spread of these types of infectious diseases. For example, public must follow social distancing to avoid the spread of these infectious diseases

The analysis [21] identifies most dengue outbreaks are increased during summer and winter. Data was taken from the Global Weather Data for SWAT Inc (2016). Local Moran's I Auto correlation method utilizes to visualize the dengue hotspot regions. Through a Gaussian Process Regression Framework Model, dengue outbreaks are identified accurately. This is the best method when compared to other artificial intelligence procedures like multiple linear regression, superised learning algorithms, decision trees.

The Root Mean Square Error (RMSE), Mean Square Error (MSE), R-squared, Q-squared, Sum of Squared errors (SSE) are low when compared to other machine learning algorithms such as multiple

regression, Support vector machine (SVM), Random Forests. But the Gaussian Process Regression Model is only applicable for large data sets.

The research work [22] found that the temperature, humidity and rainfall are how related to common seasonal infectious diseases. This study considers only six weather epidemics (Plasmodium falciparum, Diarrhoea, Typhoid, chamki fever, Streptococcus pneumoniae and Viral Meningilis). It contains five year of climate data (2008–2012). It identifies three types of correlations between disease and climate change.

The first one is when the temperature is increased, the disease transmission of malaria and diarrhoea are also increased. Similarly, the disease transmission of encephalitis, meningitis and pneumonia are decreased when the temperature is increased.

The second one is when the humidity is increased, the disease stransmission of malaria, enteric fever and diarrhoea are also increased. At the same time the disease transmission of meningitis, encephalitis and pneumonia are decreased.

And the third one is when the rainfall is low, the pathogen development of encephalitis and meningitis are decreased. Similarly, the occurrences included in diarrhoea, Plasmodium falciparum, Streptococcus pneumoniae and Typhoid are raised when the precipitation is high. These results are most similar with national and international predictions.

The research [25–29] finds that the spread of influenza and corona virus is increased in the cold and drought environment. The survey [33] identifies the humidity (22 °C − 25 °C) and high temperature (<38° C) affects the stability of influenza and corona virus.

The review [30] found that COVID- 19 community spread areas are situated at 30° − 50° north latitude and the temperature of these areas are in the range from 5° C − 11° C. The study [31] identified that the observed case of COVID-19 is decreased in 36% − 57% when the average temperature is increased in 1 °C.

And the conformed case of COVID-19 is decreased in 11% − 22% when the average humidity is increased in 1 °C. The survey [32] examines the bulk of corona virus spread is related to high temperature and humidity in Huai'an Jiangsu cities of china

3. Conclusion

Climate change plays an important role in disease transmission. Some seasonary diseases like dengue, cholera, salmonellosis and giardiasis have increased in extreme temperature. And also extreme temperature can increase the death rate of some disease pathogens. The malaria parasite stops its development when the temperature exceeds 33C- 39C. The gastrointestinal infectious pathogens are more time in the humid environment than in the dry environment. And Polio can increase its spread in the humid environment.

Heavy rainfall can increase the human diseases spread through animals. The pandemic disease of COVID-19 may change their spread based on the latitudinal attribute, humidity and temperature of the places. Some of the seasonary infectious diseases may be increased or decreased due to climate change. Sometimes, climate change may also introduce new disease pathogen already it does not exist in the environment. So the depend upon the climate change the diseases can be pre-identified. This is very helpful to the health authorities. Based on the prediction the health care providers can prevent the people from the infections.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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