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***Research Article** (Open Access)*

AN ANALYSIS OF RELATIONSHIPS BETWEEN THE POTENTIAL IMPACTS OF METEOROLOGICAL CHANGES ON DENGUE TRANSMISSION AND PREVALENCE OF *AEDES* MOSQUITOES

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ABSTRACT
Dengue fever is a mosquito viral transmitted disease, which is an increasing health concern in the India. Meteorological variables such as temperature, humidity and rainfall can affect disease transmission and vector prevalence. Such meteorological factors further spread of dengue fever and vector under a changing climatic condition. The house index, container index and breteau index were increased during the after rainy season. The number of mosquitoes increases from July to September and declined afterwards. During explicit counter acting agent positive cases were mostly announced during the post monsoon period with most extreme number of cases 58(38.66%) reported during the month of October followed by 43(28.66%) case in the November and declined afterwards. The increase in breeding indices throughout the post monsoon period was as a result of the rains in these monsoon months. This study provides an important move in understanding the connection between environment change and dengue mosquito because present and future environment scenarios can be used to represent regional, mosquito populations for comparison.

***Keywords:** Dengue fever, Humidity, Meteorological Factors, Mosquito Population, Rainfall, Temperature*

INTRODUCTION
In the tropical and subtropical regions, return of dengue for the past few decades has transformed dengue disease into a serious public health problem of widespread in the worldwide (Teixeira *et al.*, 2001; Barrera *et al.*, 2002). In recent years, dengue has been spreading globally likely because of global warming (Hales *et al.*, 2002) and climatic factors are important to the space time dynamic of dengue fever transmission (Kuhn *et al.*, 2005; Meena and Koli, 2018). Climate factors affect dengue infection in various kinds for example, very high precipitation may flush away mosquitoes, but extra stagnant water may become a perfect breeding habitat for dengue mosquitoes (Chen *et al.*, 2010; Naish *et al.*, 2014; Meena and Choudhary, 2019 and 2011). Commonly, *Aedes aegypti* was reported approximately the anthropophagic area as the flight space of *Aedes* mosquitoes are about 500m (Dom *et al.*, 2016). While *Aedes albopictus* are usually found outdoors and indoors in natural and artificial containers (Detatte *et al.*, 2009). In urban region, the increasing numbers of dengue case have been highly related with increasing numbers of vector spreading habitat and biophysical function going of the mosquito and the breeding habitat are affected by climatically fluctuates such as temperature and precipitation (Christopheres, 1960). The maximum temperature for *Aedes aegypti* larvae is 28° C. above this rate of growth is long and below 18°C the growth gets lengthy (Christophers *et al.*, 1960). Above 36°C larvae growth is not complete (Bar-zeev *et al.*, 1958). Maximum hot and dry weather may kill maximum eggs (Gubler *et al.*, 1988) and render adults vectors lifeless (Rudolfs *et al.*, 1925). Rainfall can increase mosquito density by breeding habitat (Moore *et al.*, 1978) and temperature influences mosquito generating rate, development period (Mohammed and Chadee, 2011) and survival (Tun-Lin *et al.*, 2000). Although all four serotypes of dengue have been connecting in this area, ecological and meteorological

factors are affected the seasonal prevalence of dengue vectors, *Aedes aegypti* on the basis of which in this parts are divided into four regions with different DF/DHF transmission (WHO, 1998-2000). Dengue fever and dengue hemorrhagic fever are the most arboviral disease. There are estimated that nearly 50 million cases of dengue infection occur as a whole the world every year and causing 25000 deaths (WHO, 1999). In Past studies, climatic condition, including temperature, rainfall and humidity are the main components which has been point out. In addition to climate component, land use and sociological practices also have strong connection dengue prevalence (Vanwambeke *et al.*, 2006; Bhandari *et al.*, 2008).

MATERIALS AND METHODS

Study Area

The study area was Udaipur district territory of Rajasthan province which accounts for most of the dengue fever cases in India. Udaipur is located at 24’58°N and 73.68°E. It has an average elevation of 598 meters (1961 feet) and total area 64 km^2. Study area has a hot semi-arid climate. The three seasons, summer, monsoon and winter individually, the environment and climate of study region is typically hot. The late spring season runs from mid-March to June and contacts temperature going from 23° C (73 °F) to 44 °C (111°F) in the month of March to June. Monsoons show up in the period of July proclaimed by dust and thunderstorms. The colder time of year season wins from the period of October till the month of March. Humidity, which wins during monsoons, decreases at the appearance of winters. The temperature going from 5° C (41°F) to 30°C (86°F).

Meteorological Data

Monthly meteorological data comprising average, minimum and maximum temperature, average relative humidity, and average rainfall for study area between 2015 to 2018 were obtained from the national meteorological information center in RCA, Udaipur.

Dengue Cases Data

Details of dengue fever cases in Udaipur from January 2015 to December 2018 were obtained the RNT Medical College. Data aggregation is at the month level in time. Dengue data used in our surveys is the total dengue cases of all areas within the Udaipur district.

Sample Collection

Survey was planned for two years (April, 2015 to March 2016 and April, 2016 to March 2017) Sample collections were carried out three times in every month at each selected sites. The selection of survey site was based on the prevalence of dengue fever data obtained from Chief Medical Officer, Udaipur.

Adult Mosquitoes Collection (Outdoor and Indoor)

Mosquitoes were collected by oral aspirators and light torch during the survey of resting habitats in cattle sheds and human dwellings at outdoor sites mosquitoes were collected from hollows around homes, ground of cavities. Indoor sites, mosquitoes were collected from main entry ways, basement, living rooms and underside of stairs. Indoor mosquitoes collection was carried out from cattle sheds and human dwellings using hand catch method between 6.00AM to 8.00AM and 6.00PM to 9.00PM. Collected mosquitoes were transferred into plastic containers through cut made in the side of the plastic containers. It was covered on its top with clothes netting and wrapped by rubber band. The collected mosquitoes were brought in the laboratory for further identification. Mosquitoes were collected each hour and saved individually alongside on the polyethylene and freeze by chloroform and carried to the laboratory.

Larval Surveys

The data on larvae collections were reported in the pre-arranged and pre-planned survey form (Rueda, 2004). In the year April 2016 to March 2017 larval surveys were carried out in some sites of the city irrespective of the risk for dengue/DHF in some sites searches were made for *Aedes* breeding in different types of habitats.

Identification of Aedes Mosquitoes

Aedes mosquito’s species were identified with the help of pictorial identification Key (Rueda, 2004). The *Aedes* mosquitoes prefer to rest indoor, because *Aedes aegypti* feed on cattle and human during day light hours. *Aedes* mosquitoes biting times are early in the morning and before dark in the evening. Thorax of *albopictus* has a white silver line of the thorax. Each hind leg has white bands and abdomen dark brown to back. This identification features were used and visualized using stereoscopic microscope in the laboratory.

Entomological Indices Used

The entomological indices: House Index (HI), Container Index (CI) and Breteau Index (BI) were used for density the larval population.

House Index = Number of house positive/ Number of House inspected X 100

Container Index = Number of container positive/ Number of container inspected X 100

Breteau Index= Number of container positive/ Number of house inspected X 100

RESULTS

Distribution of Aedes Mosquitoes

Table 1: Indoor collection of *Aedes* mosquito fauna from cattle sheds (April, 2015-March, 2016)

Month	*Aedes aegypti* collected	Occurrence %	*Aedes albopictus* collected	Occurrence %	Total	
					No. Collected	Occurrence %
April	0	0	1	4.16	1	2.17
May	0	0	1	4.16	1	2.17
June	0	0	0	0	0	0
July	5	22.72	7	29.16	12	26.08
August	4	18.18	3	12.50	7	15.21
September	7	31.81	8	33.33	15	32.60
October	2	9.09	1	4.16	3	6.52
November	2	9.09	1	4.16	3	6.52
December	0	0	0	0	0	0
January	0	0	0	0	0	0
February	1	4.54	1	4.16	2	4.34
March	1	4.54	1	4.16	2	4.34
Total	22	100	24	100	46	100
Total %	47.82		52.17		100	

Table 2: Indoor collection of *Aedes* Mosquito fauna from human dwellings (April, 2015-March, 2016)

Month	*Aedes aegypti* collected	Occurrence %	*Aedes albopictus* collected	Occurrence %	Total	
					No. Collected	Occurrence %
April	1	2.27	0	0	1	1.20
May	0	0	0	0	0	0
June	0	0	0	0	0	0
July	6	13.63	7	17.94	13	15.66
August	5	11.36	10	25.64	15	18.07
September	10	2272	12	30.76	22	26.50
October	7	15.90	5	12.82	12	14.45
November	8	18.18	5	12.02	13	15.66
December	2	4.54	0	0	2	2.40
January	2	4.54	0	0	2	2.40
February	2	4.54	0	0	2	2.40
March	1	2.27	0	0	1	1.20
Total	44	100	39	100	83	100
Total %	53.01		46.98		100	

Table 3: Indoor collection of *Aedes* mosquitoes from cattle sheds (April, 2016 March, 2017)

Month	*Aedes aegypti* collected	Occurrence %	*Aedes albopictus* collected	Occurrence %	Total	
					No. Collected	Occurrence %
April	1	3.70	1	3.33	2	3.50
May	1	3.70	1	3.33	2	3.50
June	1	3.70	0	0	1	1.75
July	4	14.81	5	16.66	9	15.78
August	3	11.11	4	13.33	7	12.28
September	5	18.51	6	20.00	11	19.29
October	3	11.11	4	13.33	7	12.28
November	4	14.81	3	10.00	7	12.28
December	2	7.40	3	10.00	5	8.77
January	1	3.70	1	3.33	2	3.50
February	1	3.70	1	3.33	2	3.50
March	1	3.70	1	3.33	2	3.50
Total	27	100	30	100	57	100
Total %	47.36		52.63		100	

Table 4: Indoor collection of *Aedes* mosquitoes from human dwellings (April, 2016-March, 2017)

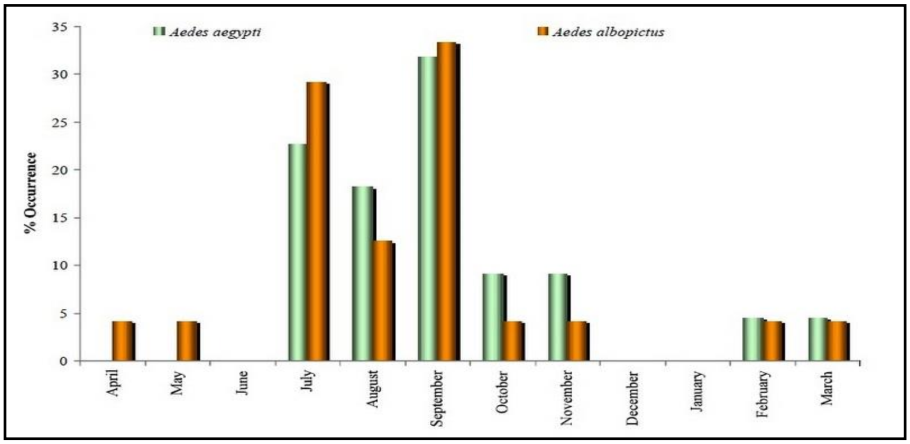
Month	*Aedes aegypti* collected	Occurrence %	*Aedes albopictus* collected	Occurrence %	Total	
					No. Collected	Occurrence %
April	1	4.76	0	0	1	2.70
May	0	0	0	0	0	0
June	0	0	0	0	0	0
July	4	19.04	2	12.5	6	16.21
August	5	23.80	3	18.75	8	21.62
September	7	33.33	6	37.5	13	35.13
October	2	9.52	1	6.25	3	8.10
November	1	4.76	2	12.5	3	8.10
December	0	0	0	0	0	0
January	0	0	0	0	0	0
February	0	0	1	6.25	1	2.70
March	1	4.76	1	6.25	2	5.40
Total	21	100	16	100	37	100
Total %	56.75		43.24		100	

Table 5: Outdoor resting collection *Aedes* mosquitoes (April, 2015-March, 2016)

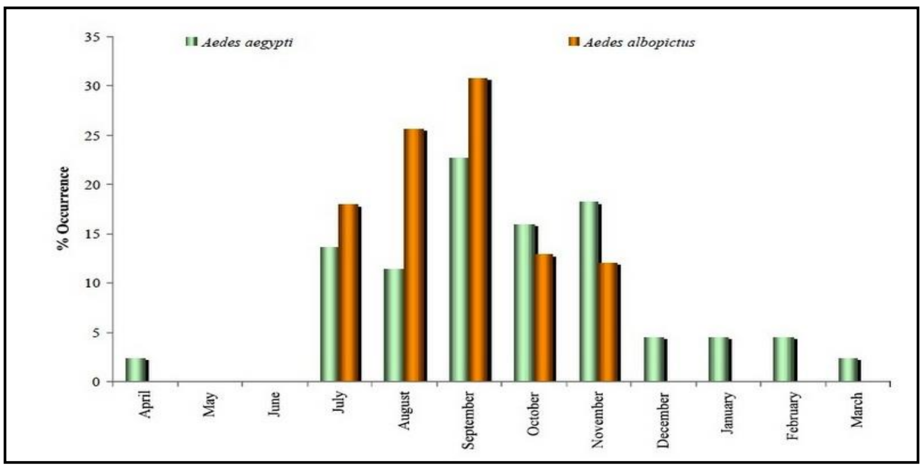
Month	*Aedes aegypti* collected	Occurrence %	*Aedes albopictus* collected	Occurrence %	Total	
					No. Collected	Occurrence %
April	0	0	0	0	0	0
May	0	0	0	0	0	0
June	0	0	0	0	0	0
July	3	25.00	4	25.00	7	25.00
August	1	8.33	2	12.50	3	10.71
September	4	33.33	5	31.25	9	32.14
October	2	16.66	2	12.50	4	14.28
November	1	8.33	1	6.25	2	7.14
December	0	0	1	6.25	1	3.57
January	0	0	0	0	0	0
February	0	0	0	0	0	0
March	1	8.33	1	6.25	2	7.14
Total	12	100	16	100	28	100
Total%	42.85		57.14		100	

Table 6: Outdoor resting collection of *Aedes* mosquitoes (April, 2016-March, 2017)

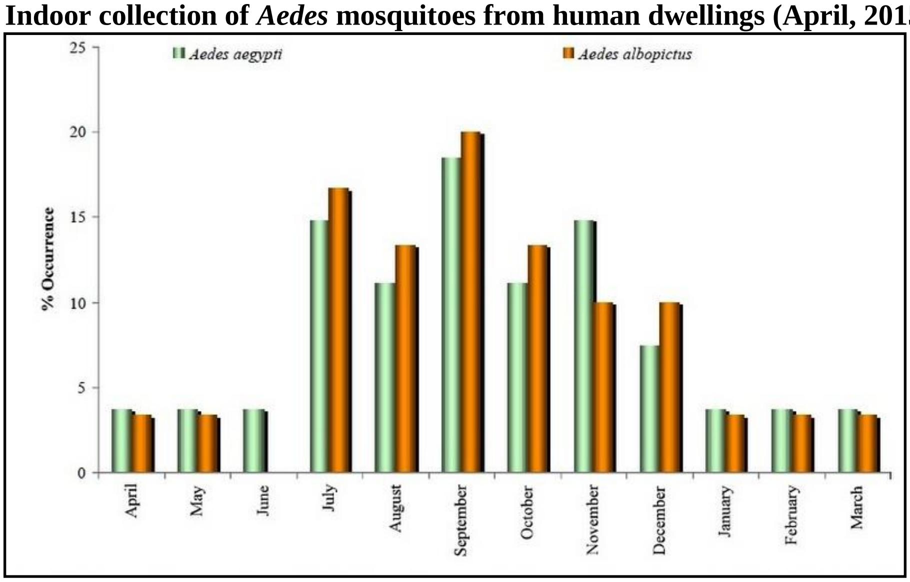
Month	*Aedes aegypti* collected	Occurrence %	*Aedes albopictus*	Occurrence %	Total	
					No. Collected	Occurrence %
April	1	4.34	1	3.84	2	4.08
May	1	4.34	0	0	1	2.04
June	0	0	0	0	0	0
July	4	17.39	5	19.23	9	18.36
August	3	13.04	4	15.38	7	14.28
September	5	21.73	7	26.92	12	24.48
October	4	17.39	4	15.38	8	16.32
November	2	8.69	1	3.84	3	6.12
December	1	4.34	1	3.84	2	4.08
January	0	0	1	3.84	1	2.04
February	1	4.34	1	3.84	2	4.08
March	1	4.34	1	3.04	2	4.08
Total	23	100	26	100	49	100
Total%	46.93		53.06			



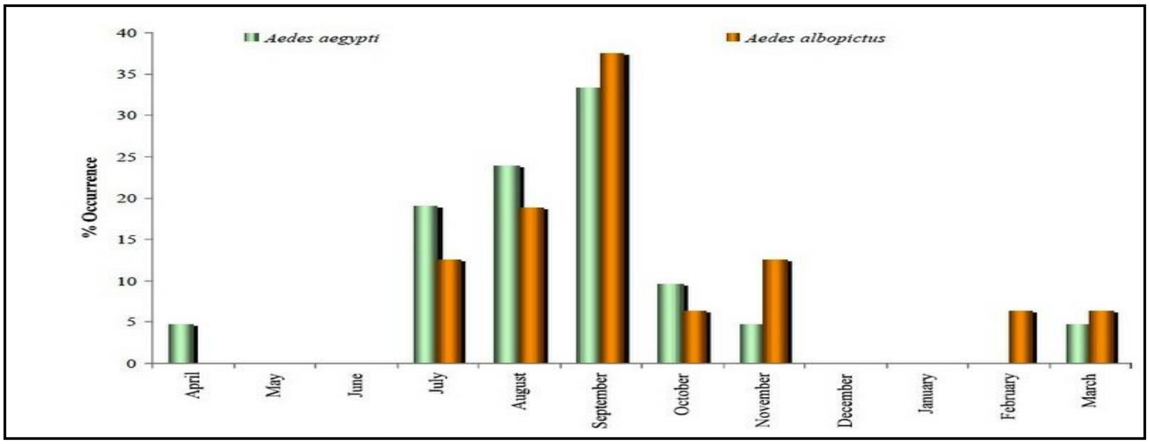
Graph A: Indoor collection of *Aedes* mosquitoes from cattle sheds (April, 2015- March, 2016)



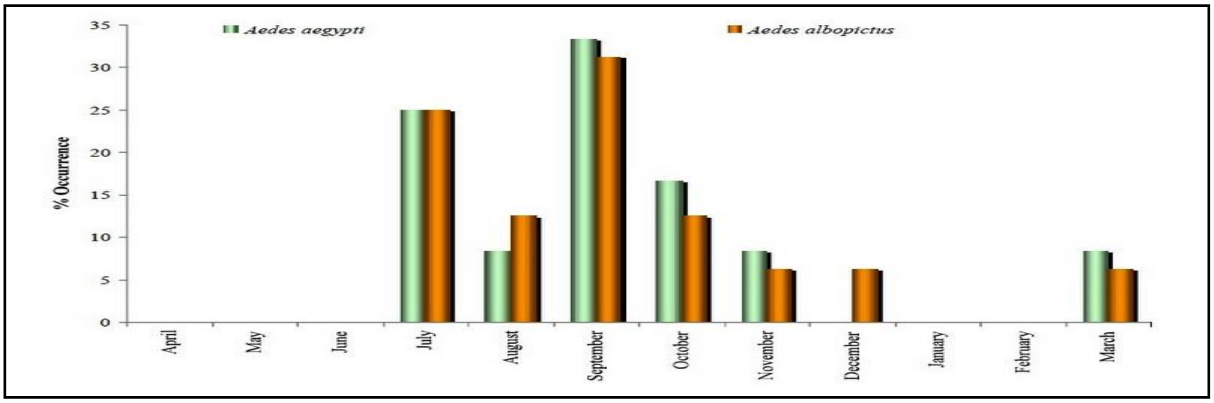
Graph B: Indoor collection of *Aedes* mosquitoes from human dwellings (April, 2015- March, 2016)



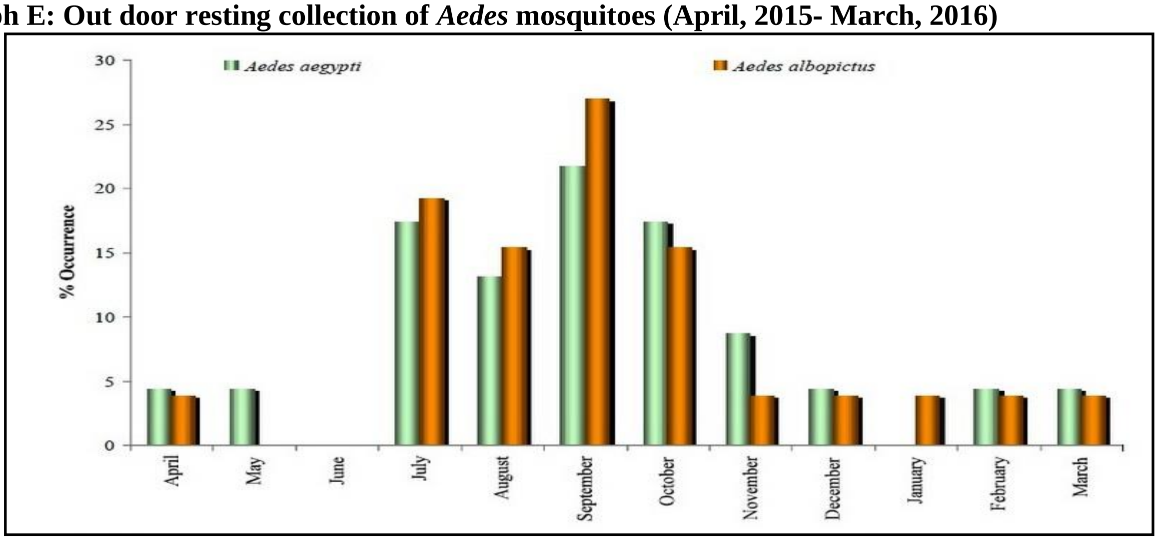
Graph C: Indoor collection of *Aedes* mosquitoes from cattle sheds (April, 2016- March, 2017)



Graph D: Indoor collection of *Aedes* mosquitoes from human dwellings (April, 2016- March, 2017)



Graph E: Out door resting collection of *Aedes* mosquitoes (April, 2015- March, 2016)



Graph F: Outdoor resting collection of *Aedes* mosquitoes (April, 2016- March, 2017)

Tables (1 to 6) present the geographic distribution and bionomics of *Aedes* mosquitoes among the habitats in the study area. The collection was carried out in all months for two years from April, 2015 to March, 2016 and April, 2016 to March, 2017. Among 103 *Aedes* specimens collected from cattle sheds, 54(52.42%) were

Aedes albopictus and the remaining 49 (47.57%) were *Aedes aegypti*. Out of 120 *Aedes* specimen collected from human dwellings, 55 (45.83%) were *Aedes albopictus* and 65 (54.16%) of *Aedes aegypti*. In outdoor, the study was carried out for two years from April, 2015 to March, 2016 and April, 2016 to March, 2017 with help of oral aspirators in the two hours after sunrise and several before sunset. *Aedes* mosquitoes were collected from different types of habitats *viz;* flower pots, tin cans and tree holes etc. In total 77 specimens of adult stages of *Aedes* were identified comprising 54.54% of *Aedes albopictus* and 45.45% of *Aedes aegypti*. However, *Aedes albopictus* was predominant comprising in all locations exception indoor sites, and *Aedes aegypti* more in indoor sites.

Larval Survey

The information for *Aedes aegypti* in the various regions are displayed in table (7,8) During the pre-monsoon season over head tanks and cement tanks filled in as breeding sites for *Aedes aegypti*. The breeding of *Aedes aegypti* spreads to different habitats like containers, coolers and tires in post monsoon. Out of 3531 houses surveyed, 49 houses and 62 containers were reported positive for *Aedes aegypti*. The house index, container index and breteau index were increased during the post monsoon season. The container indices were very high 6.1% in Gogunda and Kotra area in September 2016. The entomological indices *viz;* House index, container index and breteau index for the number of *Aedes* mosquito increased from July to September and declined after wards. The increase in breeding indices throughout the post monsoon period was as a result of the rains in these months.

Table 7: The Survey of *Aedes aegypti* Larvae from April, 2016 to March, 2017 (Data for *Aedes aegypti* in Gogunda and Kotra)

Month	Total houses checked	Total houses positive	Total containers checked	Total containers positive	HI	CI	BI
April	188	1	183	1	0.5	0.5	0.5
May	167	1	187	1	0.5	0.5	0.5
June	185	0	200	5	0	2.5	2.7
July	190	5	185	7	2.6	3.7	3.6
August	170	3	117	5	1.7	4.2	2.9
September	150	5	180	11	3.3	6.1	7.3
October	127	2	190	3	1.5	1.5	2.3
November	150	1	115	2	0.6	1.7	1.3
December	180	1	180	0	0.5	0	0
January	110	0	190	0	0	0	0
February	112	1	191	1	0.8	0.5	0.8
March	117	1	195	1	0.8	0.5	0.8
Total	1846	21	2113	37	1.1	1.7	2.0

Notes - [BI=Breteau Index; HI = House Index; CI= Container index.]

The numbers of monthly dengue cases in Udaipur between 2015 to 2018 totaling 150 cases are showing in table 9. We are observed to be a seasonal disease in Udaipur. According to amount of rainfall weather data was included in three periods namely; pre monsoon period; from June- September and Post monsoon period; from October – January. During the monsoon period only 2 cases (1.33%) were confirmed serologically positive in the month of the June, 7 case (4.66%) in the August and 33 cases (22.00%) in the September month. During specific antibody positive cases were mainly reported during the post monsoon period with maximum number of cases 58 (38.66% cases) reported during the month of October followed by 43 (28.66%) cases in November (Table- 9). The distinction between quantities of positive dengue cases when contrasted with negative ones in post monsoon period was higher than during in other monsoon period which 71.33% of absolute yearly cases reported during this period.

Table 8: The survey of *Aedes aegypti* larvae from April, 2016 to March, 2017 (Data for *Aedes aegypti* in Girwa and Jhadole)

Month	Total houses checked	Total houses positive	Total containers checked	Total containers positive	HI	CI	BI
April	165	1	190	0	0.05	0	0
May	100	0	191	0	0	0	0
June	190	0	205	0	0	0	0
July	108	3	150	7	2.7	4.6	6.4
August	165	2	159	5	1.2	3.1	3.0
September	140	7	190	8	5.0	4.2	5.7
October	126	6	181	2	4.7	1.1	1.5
November	144	5	110	1	3.4	0.9	0.6
December	157	1	158	0	0.6	0	0
January	180	2	156	0	1.1	0	0
February	110	1	187	1.	0.9	0.5	0.9
March	120	0	105	1	0	0.9	0.8
Total	1705	28	1982	25	1.6	1.2	1.4

Note - [BI=Breteau Index; HI = House Index; CI= Container index}

Distribution Of Dengue Fever Cases

Table 9- Yearly distribution of dengue fever cases in Udaipur (2015 to 2018)

Month	2015	2016	2017	2018
January	0	0	0	1
February	0	0	0	0
March	0	0	0	0
April	0	0	0	0
May	1	0	0	0
June	0	0	0	2
July	0	0	0	0
August	1	2	2	2
September	9	1	2	21
October	18	8	11	21
November	3	3	13	24
December	1	1	0	3
Total	33	15	28	74

The Relationship Between Meteorological Factors And The Risk Of Dengue Fever

Rainy season runs from June to September and rainfall helps in formation of mosquito breeding habitats and discharging off the immature stages of mosquitoes. Rainfall increase relative humidity and changes temperatures, which affects the life of mosquitoes, thus infection of disease. Table- 10, 11, 12 and 13 indicated in this study area that the relative humidity is high from 60 % between July to September and there is high growth rate of dengue mosquitoes and dengue cases in this season. Relative humidity is below from 60% in other season therefore dengue mosquitoes and dengue cases spread become low.

Table 10: The relationship between meteorological factors and dengue cases in 2015

Month	2015					
	Temperature °C		Relative Humidity %		Rainfall in mm	Month wise Dengue cases
	Maximum	Minimum	Maximum	Minimum	Rainfall	Dengue case
January	30.1	15.1	97	80	6.2	0
February	34.3	23.5	93	47	0	0
March	38.1	19.6	98	58	9	0
April	41.2	29.5	74	15	11.4	0
May	42.2	37.2	58	18	0	1
June	42	30.5	90	36	26.2	0
July	35.4	24	97	65	122	0
August	32.5	27.6	95	75	34.4	1
September	36	25	97	56	24.6	9
October	36.5	26.2	78	53	0	18
November	33.7	24	85	33	0	3
December	33.2	21.7	90	40	0	1

Table 11: The relationship between meteorological factors and dengue cases in 2016

2016						
Month	Temperature °C		Relative Humidity %		Rainfall mm	Month wise Dengue cases
	Maximum	Minimum	Maximum	Minimum	Rainfall	Dengue cases
January	30.5	22	98	69	0	0
February	32	24.4	86	51	0	0
March	38.2	28.4	80	37	0	0
April	41.2	34	62	29	0	0
May	45.5	35.2	71	17	1.6	0
June	43.3	32.5	90	26	19.6	0
July	35.2	26.3	100	74	69	0
August	31.8	25.2	100	78	53.8	2
September	36	29.2	90	65	3.4	1
October	34.3	29.6	95	63	15.4	8
November	32.5	28	91	67	0	3
December	31.2	24	95	72	0	1

Table 12: The relationship between metrological factors and dengue cases in 2017

2017						
	Temperature °C		**Relative Humidity %**		**Rainfall (mm)**	**Month wise Dengue cases**
Month	**Maximum**	**Minimum**	**Maximum**	**Minimum**	**Rainfall**	**Dengue cases**
January	29.6	19.1	95	62	1.4	0
February	33	22.2	93	59	0	0
March	39.5	25	83	25	0	0
April	41.4	33.8	66	16	0	0
May	42.4	36.2	80	17	14	0
June	41	29.4	97	63	54.2	0
July	33.5	25.2	98	73	46.5	0
August	34	27.2	100	78	45.2	2
September	36	25.5	93	65	20.4	2
October	36.5	31.5	88	47	0	11
November	33	25	96	70	0	13
December	28.5	17.5	100	74	4.2	0

Table 13: The relationship between meteorological factors and dengue cases in 2018

2018						
	Temperature °C		**Relative Humidity i%**		**Rainfall in mm**	**Month wise Dengue cases**
Month	**Maximum**	**Minimum**	**Maximum**	**Minimum**	**Rainfall**	**Dengue cases**
January	30.5	23	97	78	0	1
February	32.5	24	92	52	0	0
March	35	31	82	30	0	0
April	41	35.5	62	20	2.2	0
May	43.5	37.2	72	24	0	0
June	41.6	28.8	97	28	33.8	2
July	35.6	27	98	72	54.4	0
August	32.8	27	93	72	53.4	2
September	34	24	100	70	28.2	21
October	35	31	89	46	0	21
November	32.5	27	88	48	0	24
December	27.2	20.5	93	55	0	3

DISCUSSION

Udaipur is large romantic populated city in India that suffered from dengue fever and dengue hemorrhagic fever, during the last few years from laboratory reported cases of dengue fever from 2015 to 2018, one major outbreak in 2018 were detected. The dengue cases in this year recorded for more than 49.33% of the cases in the entire study period. Environmental factors generally co-vary, leading to problems in our living exact results about the effect of any specific factors. In Udaipur, winters are relatively cooler than summers however not cold by any means. This colder time of year season wins from the period of October till the long stretch of March. Humidity which wins during monsoon lessens at the appearance of winters. The city notices charming radiant days and pleasant cool evenings. The temperature tumbles to the degree of 11.6°C in the evening. However, the temperature stays moderate during that time in Udaipur, still it is desirable over visit the city during winters, when the climate is charming neither not nor damp not at all like summers and monsoon. Although, temperatures, rainfall and humidity may be associated with more dengue cases, environments are causative factors for dengue fever. The adult population of mosquitoes reactions well to temperature, rainfall and humidity. Both *Aedes aegypti* and *Aedes albopictus* which were the most abundant caught over the sampling period were significantly affected by temperature, humidity and precipitation.

The relative affect of daily normal temperature factored largely in our review and many other connected studies, helping the hypothesis that dengue mosquitoes feed more often and spread faster from larvae to adult at high temperature (Hales *et al.,* 2002; Lambrechts *et al.,* 2011; Focks *et al.*, 2000). An environmental factor on dengue fever infection is relatively complex, different factors affecting to dengue mosquitoes other indirect factors. The being alive of mosquito eggs and adults can be affected by relative humidity. Even through extreme heavy rainfall may decline the dengue mosquitoes (Githeko *et al.,* 2000), remaining water may supply basic breeding habitats for larval and adult mosquitoes (Chen *et al.,* 2010; Naish *et al.,* 2014; Patz *et al.,* 2000). The habitats chosen for this study were particularly chosen to express same breeding sites which may occur near human dwellings. Heavily vegetations habitats are greatest threat because they provide the mosquitoes production. Temporary water habitats occur in every area, generally in the form of water tanks, small rock holes, cattle tanks, tires, drainage canal and construction pits, depression and refuse filled holes. These habitats provide protection forms predators and temperature fluctuations and would increase to a greater breeding rate of larvae and pupae, leading to a larger quantity of adult mosquitoes. Studies have also revealed that water –related facilities are strongly inter connected with prevalence of *Aedes aegypti* (Tuan *et al.,* 2004-2008; Saifur *et al.,* 2013) mainly in study areas with several water-holding containers (Shang *et al.,* 2010), because it produces a good habitat for the *Aedes* mosquitoes (Cheong *et al.,* 2014).

CONCLUSION

This study focuses precipitation, temperature and relative humidity as the main and very important environment factors, which could as a whole be responsible for an eruption. The maximum mosquito index was observed in 2015 to 2018 in the month of July to September (rainy season) and larvae density prevailed high during the months of September and October (peak periods of monsoon). More studies in this condition could further reveal the improvement between the environment changes and dengue disease, which would help in making the scheme and ideas to forecast any out breaks in future well in progress.

REFERENCES

Bar- Zeev M (1958). The effect of temperature on the growth rate and survival of the immature stages of *Ades aegypti (L.). Bulletin of entomological research*, **49** 157-159.

Barrera R, Delgado N, Jimenez M and Valero S (2002). Eco-epidemiological factors associated with hyper endemic dengue hemorrhagic fever in Maracay city, Venezuela. *Dengue Bulletin*, **26** 84–95.

Bhandari KP, Raju P, Sokh BS (2008). Application of GIS modeling for dengue fever prone area based on socio-cultural and environmental factors—A case study of Delhi city zone. *International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences,* **37** 165–170.

Chen SC, Liao CM, Chio CP, Chou HH, You SH, Cheng Y and Lagged H (2010). Temperature effect with mosquito transmission potential explains dengue variability in southern Taiwan: Insights from a statistical analysis. *Science of the Total Environment*, **408** 4069–4075

Cheong YL, Leitão PJ and Lakes T (2014). Assessment of land use factors associated with dengue cases in Malaysia using Boosted Regression Trees. Spat. Spatial. Temporal. *Epidemiol.* **10** 75–84.

Christophers SR (1960). *Aëdes aegypti* (L.), the Yellow Fever Mosquito; Its Life History, Bionomics, and Structure. *Cambridge, UK: University Press*.

Delatte H, Elissa N, Quilici S and Fontenille D (2009). *Aedes* (Diptera: Culicidae) vectors of arboviruses in Mayotte (Indian Ocean): distribution area and larval habitats. *Journal of Medical Entomology*, **46**(2) 198-207.

Dom NC, Madzlan MF, Yusoff SNN, Ahmad AH, Ismail R and Camalxaman SN (2016). Profile distribution of juvenile *Aedes* species in an urban area of Malaysia. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, **110**(4) 237-245.

Focks DA, Brenner RJ. Hayes J and Daniels, E. Transmission thresholds for dengue in terms of Aedes aegypti pupae per person with discussion of their utility in source reduction efforts. *American Journal of Tropical Medicine and Hygiene*, **62** 11-18.

Githeko AK, Lindsay SW, Confalonieri UE and Patz JA (2000). Climate change and vector-borne diseases: A regional analysis. Bull. *World Health Organization*, **78** 1136–1147.

Gubler DJ (1988). The Arboviruses: Epidemiology, Vol.II. *CRC Press*, Florida, Chapter **23**: 233-260.

Gubler DJ (1998). Dengue and dengue hemorrhagic fever. *Clinical Microbiology Review*, **113** 480–496.

Hales S, de Wet N, Maindonald J and Woodward A. (2002). Potential effect of population and climate changes on global distribution of dengue fever: An empirical model. *Lancet* **360** 830–834.

Hales S, Weinstein P and Woodward A (1996). Dengue fever Epidemics in the south Pacific: Driven By EI Nino South Oscillation?, *Lancet* **348** 1664-1665.

Kuhn K, Campbell-Lendrum D, Haines A, Cox J, Corvalán C and Anker M.(2005). Using Climate to Predict Infectious Disease Epidemics; WHO: Geneva, Switzerland, 2005.

Lambrechts L, Paaijmans KP, Fansiri T, Carrington LB, Kramer LD, Thomas MB, Scott TW (2011). Impact of daily temperature fluctuations on dengue virus transmission by *Aedes aegypti. Proceedings of the National Academy of Sciences of the United States of America*, **108**(18) 7460–7465.

Meena AR and Choudhary NL (2019). Container breeding preference of *Aedes albopictus* in urban environment. *International Journal of Mosquito Research*, **6** (5):44-47.

Meena AR and Choudhary NL (2021). Seasonal Prevalence of *Aedes aegypti* in Urban and Industrial Areas of Udaipur District, Rajasthan. *Indian Journal of Natural Sciences*, **12**(68) 33917-33922.

Meena AR and Koli VK (2018). Seasonal fluctuations of *Aedes aegypti* (Diptera: Culicidae) in some areas of Udaipur city, Rajasthan. *International Journal of Zoology Studies*, **3**(3) 42-44.

Mohammed A and Chadee DD (2011). Effects of different temperature regimens on the development of *Aedes aegypti* (L.) (Diptera: Culicidae) mosquitoes. *Acta Tropica*, **119** 38–43.

Moore CG, Cline BL, Ruiz-Tibén E, Lee D, Romney-Joseph H and Rivera-Correa E (1978). *Aedes aegypti* in Puerto Rico: environmental determinants of larval abundance and relation to dengue virus transmission. *American Journal of Tropical Medicine and Hygiene*, **27**(6) 1225-31.

Morin CW, Comrie AC and Ernst K (2013). Climate and dengue transmission: Evidence and implications. *Environ Health Prospect*, **121**:1264–1272.

Naish S, Dale P, Mackenzie JS, McBride J, Mengersen K and Tong S (2014). Climate change and dengue: A criticaland systematic review of quantitative modelling approaches. *BMC Infectious Diseases*, **14**:167.

Nicholls N (1993). El Nino- Southern Oscillation and Vector- Borne Disease. *Lancet* **342** 1284-1285.

Patz JA, Graczyk TK, Geller N and Vittor AY (2000). Effects of environmental change on emerging parasitic diseases. *International Journal of Parasitology*, **30** 1395–1405.

Rueda LM (2004). Pictorial keys for the identification of mosquitoes (Diptera: Culicidae) associated with Dengue Virus Transmission. Walter Reed Army Inst of Research Washington DC Department of Entomology.

Saifur RGM, Hassan AA, Dieng H, Salmah MRC, Saad AR and Satho T (2013). Temporal and spatial distribution of dengue vector mosquitoes and their habitat patterns in Penang Island, Malaysia. *J. Am. Mosq. Control Assoc*. **29**:33–43.

Shang CS, Fang CT, Liu CM, Wen TH, Tsai KH and King CC (2010). The Role of Imported Cases and Favorable Meteorological Conditions in the Onset of Dengue Epidemics. *PLoS Neglected Tropical Diseases,* 4 775.

Teixeira MDG, Costa MCN, Guerra Z and Barreto ML (2002). Dengue in Brazil: Situation-2001 and trends. *Dengue Bulletin,* **26** 70–76.

Tuan YC, Hung MN, Lin LJ, Shih WY, Huang CC, Chang C, Chen J and You CY (2009). Analysis on dengue vector density survey in Kaohsiung and Pingtung areas of southern Taiwan, 2004–2008. *Epidemiology Bulletin,* **25** 462–485.

Tun-Lin W, Burkot TR and Kay BH (2000). Effects of temperature and larval diet on development rates and survival of the dengue vector *Aedes aegypti* in north Queensland, Australia. *Medical and Veterinary Entomology,* **14** 31–37.

Vanwambeke SO, van Benthem BH, Khantikul N, Burghoorn-Maas C, Panart K, Oskam L, Lambin EF and Somboon P (2006). Multi-level analyses of spatial and temporal determinants for dengue infection. *International Journal of Health Geographics 5 5.*

W. Rudolfs (1925). Relation between temperature, humidity and activity of house mosquitoes. *Journal of New Jersey Entomological Society,* **33**:163-169.

Watts DM, Burke DS, Harrison BA, Whitmire RE and Nisalak A (1987). Effect of temperature on the vector efficiency of *Aedes aegypti* for dengue 2 virus. *American Journal of Tropical Medicine and Hygiene,* **36** 143–152.

WHO (1998-2000). WHO Health Situation in the South East Asian Region 1998–2000. WHO Regional Office, South East Asia, New Delhi.

World Health Organization (1999). Strengthen implementation of the global strategy for dengue fever/ dengue hemorrhagic fever prevention and control. Geneva: (WHO/CDS/(DEN)IC/2000.1