Analysis of Health Geography of Dengue in urban areas-A Case Study of Rajkot city, India

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Abstract

Dengue is a major global public health challenge. The rise in number of cases and the countries reporting the cases of Dengue over the last few years is alarming. The South-East Asia Region has become hyper-endemic with regular reporting of dengue cases since 2000, India too is experiencing a significant increase in dengue incidences annually since 2001. Over 34.81 dengue incidences per million people have been recorded between 2010- 2014. Gujarat has been a Dengue burdened state with a high incidence rate of Dengue recorded from the year 2010 to 2018, with significant outbreaks recorded since 2013.

The disease has been so far urban in nature with cities reporting more than 95% of the Dengue incidences. Rajkot is one of the fastest-growing city in Gujarat and 35th largest urban agglomeration in India. The city has shown an increasing trend in positive dengue cases (677) in 2013 compared to 95 cases in 2012 and a gradual increase over the years to 365 cases in 2015, 555 cases in 2016, dropping to 350 cases in 2017. However, 2018 marks the highest recorded cases over the years (763 cases). A trend is recorded with a fall in the number for two consecutive years where there is a sudden rise in the number recoded. Month-wise, seasonal and ward-wise pattern of positive dengue incidences across the city has also been plotted.

The paper looks into the health geography of dengue incidences identifying vulnerable pockets in the city of Rajkot from 2012 to 2018 and possible factors responsible for spread of the disease.

The paper also looks into steps being taken by Indian city of Rajkot to achieve Sustainable development goals SDG 11(making cities inclusive, safe, resilient and suitable) by mapping the incidences and spread of Dengue cases in the city, causal factors, actions taken by the urban local bodies and recommendations for dengue prevention and management in Rajkot.

Keywords

Dengue outbreaks, urban areas, health, Rajkot, Sustainable Development Goals, epidemic, slums , India

1. Introduction

Dengue is the most prevalent viral infection transmitted by Aedes mosquitoes. More than 3.9 billion people in over 129 countries are at risk of contracting dengue, with an estimated 96 million symptomatic cases and an estimated 40,000 deaths every year. (WHO,2020)

Vector borne diseases is a broader term for the diseases transmitted by vectors like mosquitoes, fleas and ticks. Vector-borne diseases caused by mosquitoes like Chikungunya, Dengue, Lymphatic filariasis, Rift Valley fever, Yellow Fever, Zika are a significant public health risk. According to the World Health Organization (2020) Vector-borne diseases account for 17% of the estimated global burden of all infectious diseases. Dengue is currently the world's fastest growing vector-borne disease with a 30-fold increase in disease incidence over the last 50 years. (World Health Organization, 2020).

Dengue fever, transmitted to humans by the infected mosquitoes *Aedes (Ae.) aegypti* and *Aedes. ablopictus* (Nedjadi et al. 2015), is arboviral infection with high incidence in India. Based on its endemicity and public health concern, the World Health Organization has kept India under category A, with a leading cause of hospitalization and death among children (World Health Organization 2011).

The South-East Asia Region has become hyper-endemic with regular reporting of dengue cases since 2000. Between 2000-2013, the incidenceswere50 percent higher than the average throughout the ten-year period. Dengue incidences in India are on the rise and in recent years has become a major global public health.Since the mid-1990s, dengue outbreakshaveshown an increasing trend, especially in the urban areas, and has quickly spread to new regions of Odisha, Arunachal Pradesh and Mizoram, where it was historically non-existent (Chakravarti, Arora &Luxemburge 2012). The epidemiology of Dengue in India was first reported in Chennai in 1780, and the first outbreak occurred in Kolkata in 1963; subsequent outbreaks have been reported in different parts of India (Ramakrishnan et al. 1964) (Chaturvedi & Nagar 2008). Since the 1990s, dengue outbreaks have become frequent in many parts of India. Over the period 1998–2009, 82,327 dengue cases were reported. During 2010–2014, 2,13, 607 cases of dengue fever were observed. Thus, the number of dengue cases during 2010-2014 had increased markedly, by a factor of ~ 2.6, for the 1998–2009 period (Mutheneniet al 2017).

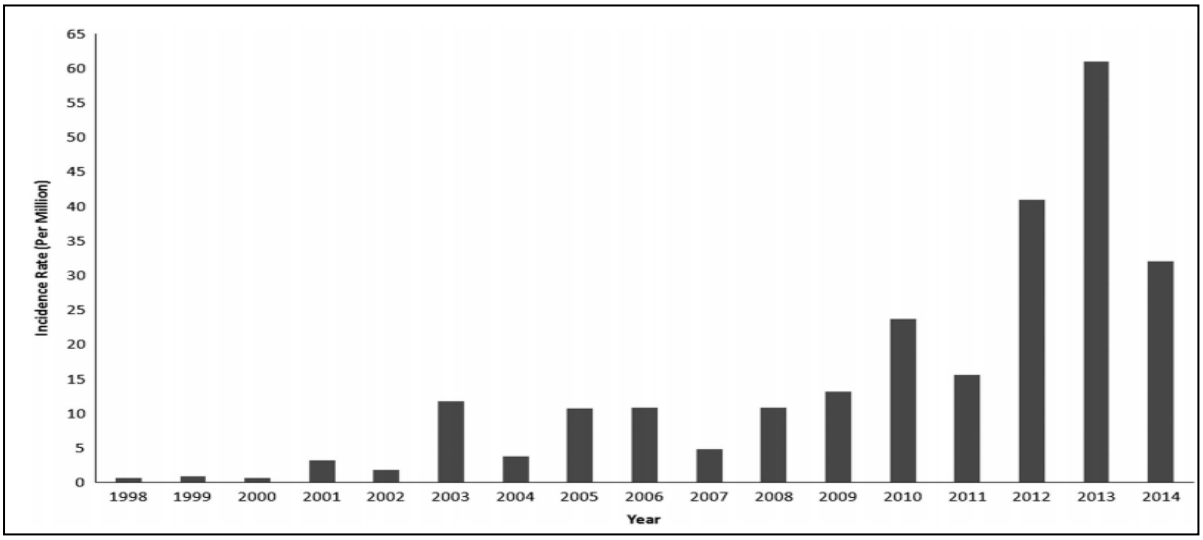


Figure 1: Dengue Incidence Rate (per million population) in India, 1998-2014
Source: NVBDCP, GoI

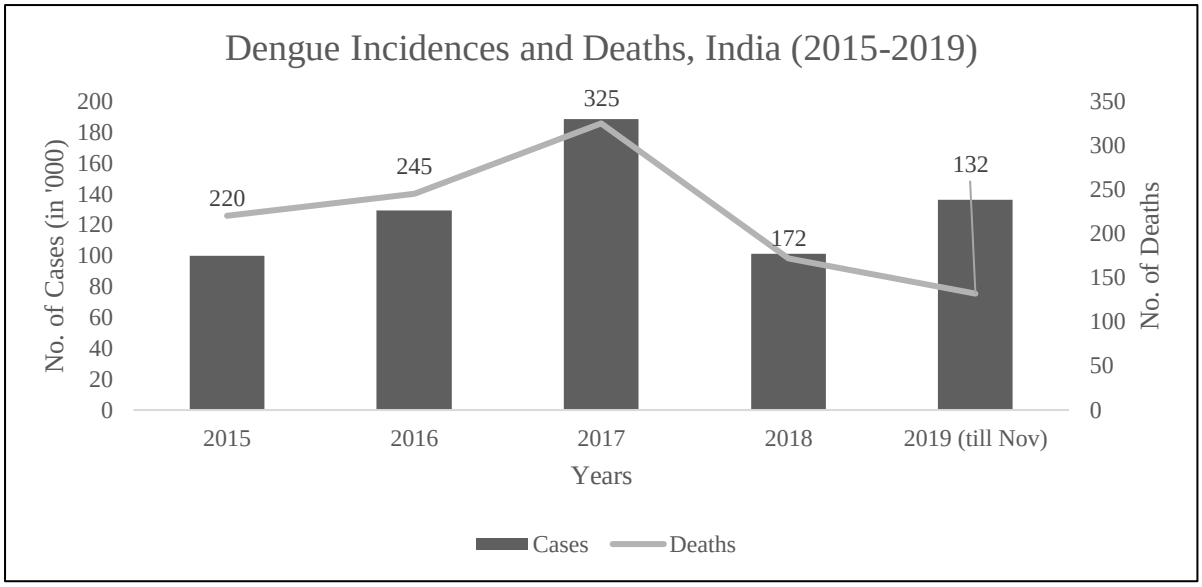


Figure 2: Dengue Incidences and Deaths, India (2015-2019)
Source: *NVBDCP, GoI, https://nvbdcp.gov.in/index4.php?lang=1&level=0&linkid=431&lid=3715*

As per the National Vector Borne Disease Control Programme (NVBDCP) GoI, since 2015 the Dengue incidences (cases) have increased along with the number of deaths registered, with highest cases in 2017 (129,166 cases and 325 deaths). However, the numbers have decreased in the following years. Though 2019 marked higher incidences (136,422 cases), the registered number of deaths has been low (132) as compared to the previous years. (Figure 2)

Health geography studies the distribution, diffusion, determinants, and delivery associated with health and health systems in human populations (Elliott S. 2014). Hence it becomesessential to understand disease risk factors and how risks such as genetics, lifestyle, environment and occupation interact with the social, built and natural environments (Dahlgren G, Whitehead M, 1991). Spatial analysis can help identify the source of infectious disease outbreaks, understand and simulate the mode of transmission, and provide support for the prevention, prediction, and monitoring of infectious diseases. Many core geographic research themes, including health inequalities and polarization, scale, globalization and urbanization, are directly related to public health (Asthana S, Curtis S, Duncan C, et al., 1998-2000).

Health geography has played an essential role in disease management and prevention of vector-borne diseases at an international and national scale. In 1854, during the London Cholera epidemic, mapping of cholera cases by John Snow helped to reduce the cases with removal of pump handles. During the SARS period in 2003, a SARS Epidemic Control and Early Warning Geographic Information System was developed to organically integrate spatial positioning, spatial information management, spatial information analysis technology and communication technology. An integrated control strategy to control the Kala-azar (Visceral Leishmaniasis) in Bihar, India was performed, which included Spatio-temporal mapping of case distribution, active case detection, chemical-based vector control using indoor residual spraying (IRS), community awareness campaigns, the training of IRS members, the training of medical doctors for effective treatment, daily monitoring and the supervision of IRS activities, logistic management, post-IRS quality assurance, epidemiological surveillance, and entomological monitoring.

Similarly,the attempt has been to map the Spatio-temporal distribution of dengue incidences across the city of Rajkot, Gujarat, to develop a correlation between the incidences and the slum pocket location across the wards between 2011 and 2018, to guide in the disease mitigation, prevention and generating awareness among the locals. Mapping the Health geography of Rajkot city will determine the correlation between surrounding conditions and epidemic transmission from the perspective of the natural environment by framing steps and suggestions for emergency management, social governance, and public awareness under epidemic prevention and control. The mapping will also aid in monitoring the spread of the epidemic in real-time.

2. Rajkot, Gujarat

2.1 Dengue Incidences, Rajkot City

Gujarat has reported a significant increase in the dengue incidences from 2010 to 2017 (Figure3). With substantial outbreaks in 2013 (6272 cases, 15 deaths), 2015 (5590 cases, 9 deaths), and 2016 (8028 cases, 14 deaths) (NVBDCP, Ministry of Health and Family Welfare, GoI 2018).

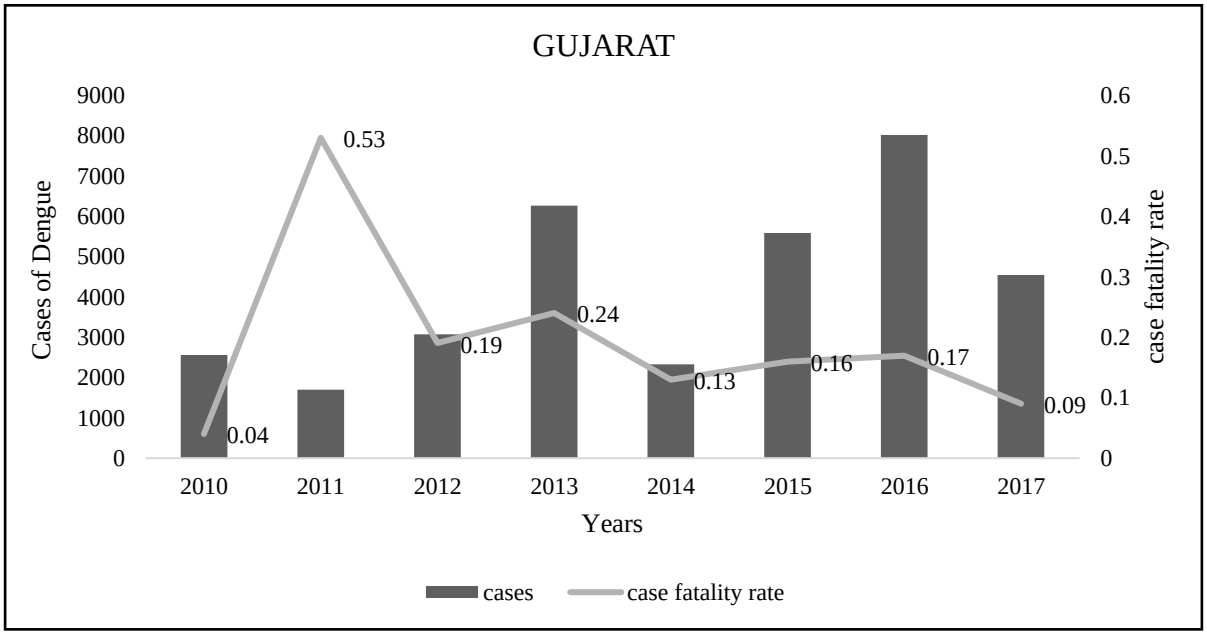


Figure 3: Morbidity and Mortality due to Dengue in Gujarat from 2010-2017
Source:National Vector Borne Disease Control Programme (NVBDCP), Ministry of Health and Family Welfare, GoI(http://nvbdcp.gov.in/den-cd.html)

Though the disease has a seasonal pattern that peaks following the monsoon season,the disease is perennial in Gujarat (Ministry of Health and Family Welfare, India 2011). In a study conducted in 2015 by PanditDeendayalUpadhyay Government Medical College, Rajkot, it was found that of the total positive dengue cases registered in Saurashtra region in 2013, almost two-thirds (61.8%) cases were reported from the Rajkot district (Mistry 2013). Reporting of positive dengue cases in Gujarat was low during the first six months of the year 2013, followed by a significant increase from July to September,maximum cases were reported in September 2013.

Rajkot, the fourthlargest city in Gujarat, after Ahmedabad, Surat and Vadodara and the 35th largest urban agglomeration in India, with a semi-arid climate, has a population of 13.9 lakh, (Census- 2011) and decadal growth of 38.6 per cent. The city reports increasing incidence

of Dengue and other mosquito-borne diseaseswhich may be attributed to urbanization and growing slum pockets. Over the decades, Rajkot has experienced a phenomenal increase in the population and size, and it's all-round development in education, industry, commerce, culture, etc. The city has grown in area and population over the years. The city comprised of 23 wards spread across 104.86 sq. Km till 2015, which has now increased in size engulfing the nearby villages and sub-urban areas to an area of 170 sq. Km. The wards have been rearranged and comprise of 18 wards at present.

Rajkot registered its first case in 2009 in the regions of Shivshakti area of Veraval of Rajkot (Shiloh 2009). Dengue incidences recorded from 2011to 2018 shows a rise in the number (Health Department of Rajkot Municipal Corporation) (Figure 4), with a **record-high number of 677 positive reported cases of Dengue in Rajkot municipal area for 2013, whereas 2012 reports 95 positive cases, again the numbers drop to 85 cases in 2014.**It was claimed that during 2013, a higher number of cases of male patients were recorded as compared to females, which could be attributed to their longer outdoor daytime exposure, as compared to the lower dengue reporting rate among the females, attributed to less exposure to the risks of this vector-borne infection. The number of cases has gradually increasedover the years to 365cases in 2015, 555cases in 2016, and dropping to 350cases in 2017. However, 2018 marks the highest recorded cases over the years (763 cases), which is almost double of the cases being recorded in the previous year. Here a trend is recorded with a fall in the number for two consecutive years,and there is a sudden rise in the number recorded (Figure 4)

One of the primaryreasons for the low records of dengue incidences in 2014, compared to 2013 and 2015, is due to the cyclic trend, a similar patternis reported in the state. In 2014, Gujarat recorded a drop in fatality rate cases to 0.13 and lower number of cases being recorded when compared to 2013 and 2015 (Figure 3), due to low rainfall which may be accounted to the lower occurrences of dengue incidence in Rajkot and across Gujarat. However, Dengue cases are under-reportedas several laboratories in India are not equipped with properdiagnostic tools and due to the differences in the diagnostic methods. Also, the data which is collected is mainly from the government hospitals; private hospitals and diagnostic laboratories hardly share the dengue cases data with the government health agencies. The National Vector Borne Disease Control Programme (NVBDCP) captures not even 1% (only 0.35%)of the clinically diagnosed dengue cases in India. *(Shepard, 2014).*

With record-high cases by 2016, the Health Department, RMC, set up10 teams with 20 members to carry out preventive measures in different areas along with fogging and collection of fines from breeding areas (Parmar 2016).

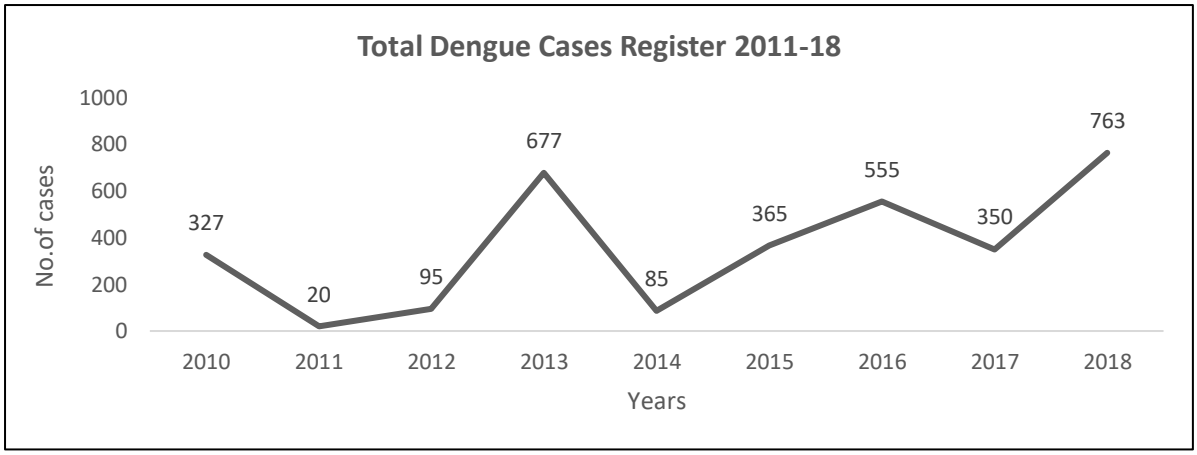


Figure 4: Yearly Trend in Dengue cases recorded in Rajkot city (2011- 2018)
Source: Health Department, Malaria Scheme, Rajkot Municipal Corporation, 2018-2019

Month-wise registered dengue cases across Rajkot city over the years, clearly indicates an increase in dengue cases post-July to December (Figure 5).The peak months being September, October and November, wherein the highest number of cases are recorded. July and August, the rainy and humid seasons, marks the breeding period of the dengue virus-infected mosquitos while spreading in the following months. Highest incidences of Dengue being recorded in October which is validfor all years studied except for 2013 when the highest incidences were reported for September.

For the year 2018, the months September to November (highest recorded in October, 289 cases), mark the peak season, with Ward 18 being mostly affected by the denguevirus with total 82 cases. However, higher cases are recorded in Ward 1(36 cases) in October 2018, followed by Ward 18 (32 cases) (Figure 6)

A ward-level dengue incidence trend from 2010- 2015 (Figure 7), indicated Ward No.1 to record the highest number of 150 reported positive cases, accounting for nearly 10% of the total positive cases registered. This was followed by Ward No. 12 & 21 with a total of 144 cases or 9% of the caseload. The lowest number of 35 cases (2%) was recorded in Ward No. 7, followed by Ward No. 2 with 57 cases (4%). The top five wards with the highest number of reported dengue cases were Ward No. 1, 12, 21, 18&23 with cases numbering between 150 - 124 (descending order) (Figure 9). Then again, for the period 2015-2018, the incidences have increased at the ward level, with the highest cases being recorded in ward 4 with 170 cases, accounting to 10% of the positive cases, followed by ward 1 with 9% positive cases being registered. Wards 14 and 17 record the lowest dengue incidences (2%) over the years. (Fig.9, Fig.10)

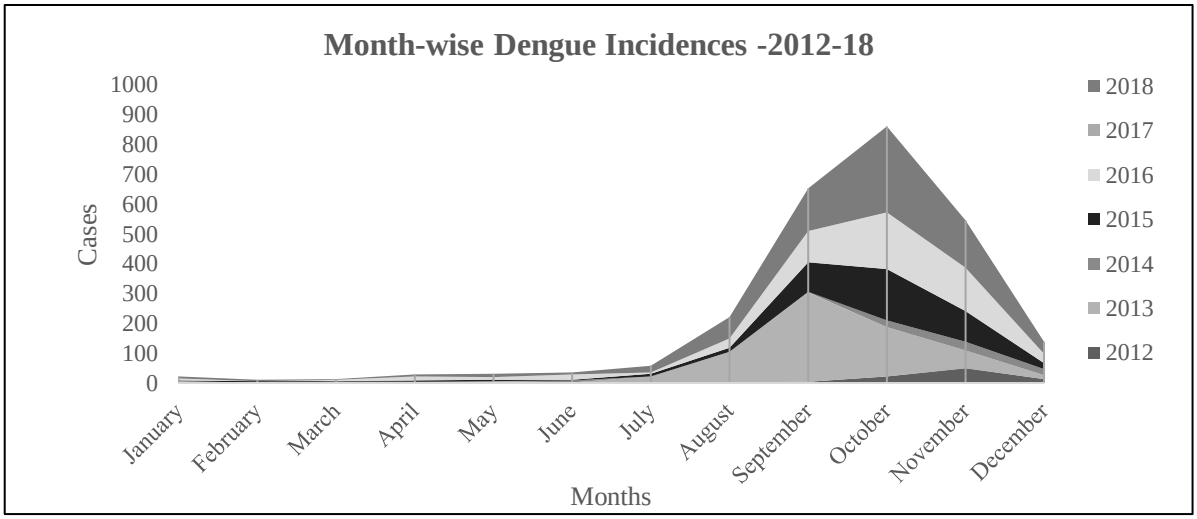


Figure 5: Monthly Trend in Dengue cases recorded in Rajkot city (2012- 2018)
Source: Health Department, Malaria Scheme, Rajkot Municipal Corporation, 2018-2019

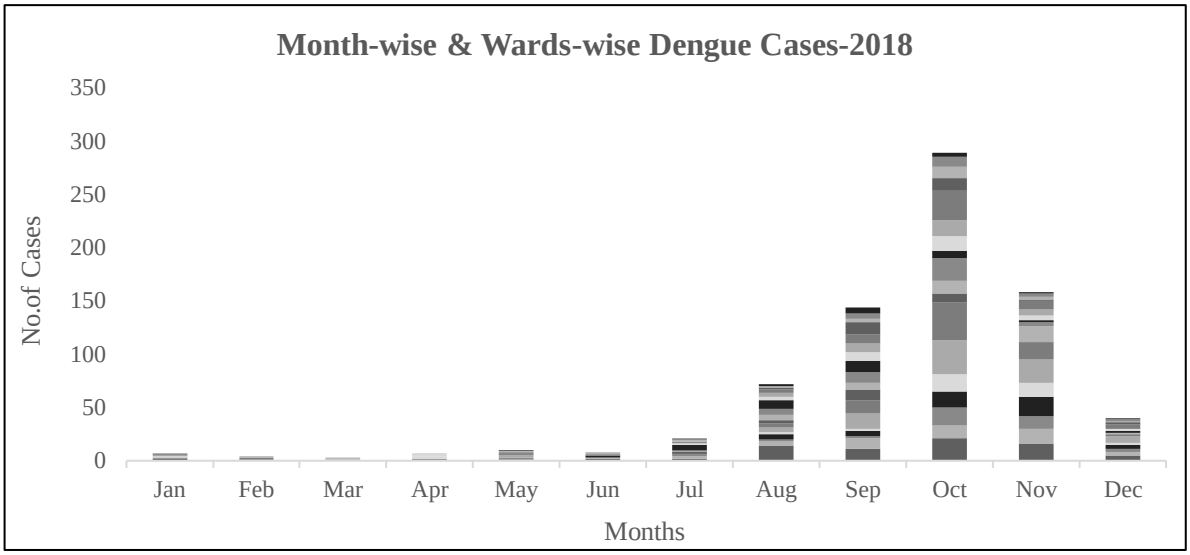
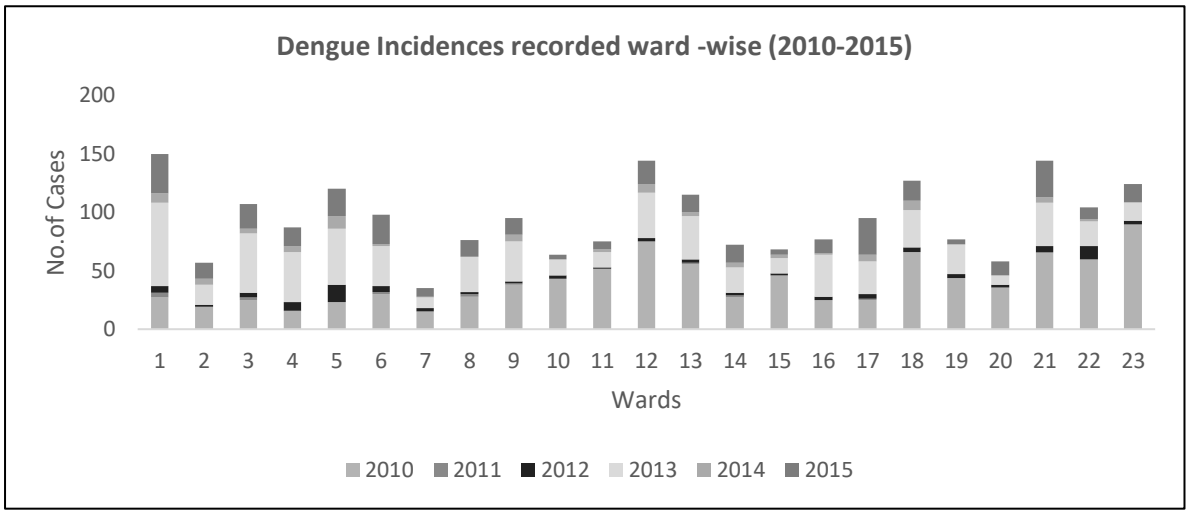


Figure 6: Monthly and Ward-wise Trend in Dengue cases recorded in Rajkot city 2018
Source: Health Department, Malaria Scheme, Rajkot Municipal Corporation, 2018-2019



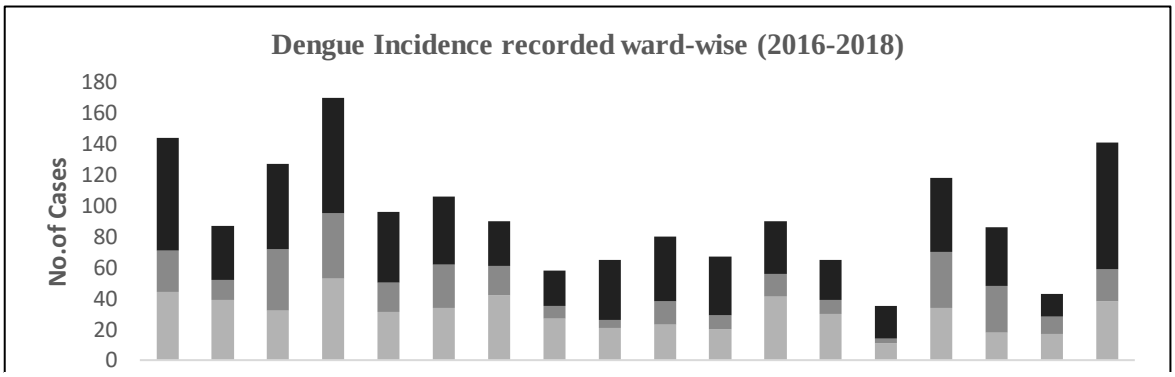


Figure 7:Ward wise Dengue cases record (2010-2015)
Ward 1,12 and 21 records highest Dengue cases, with 150&144 cases respectively
Lowest numbered recorded in Ward No.7&2 with 35&57 cases respectively
Source: Health Department, Malaria Scheme, Rajkot Municipal Corporation, 2018

A ward Analysis indicates that only 1 ward had registered dengue cases below 50(2010-15) and on an average 13wards (out of 23wards)have registered dengue cases between 50-100. Whereas, for the years 2016-18, its seen that almost 10 out of 18 wards have registered 50-100 cases and one ward above 150 cases.(Table 1)

Table1: Dengue cases reported in the total number of wards

Dengue Case Categories	No. of wards (2011-15)	No. of wards (2016-18)
Less than 50cases	1	2
50-100 cases	13	10
101- 150 cases	9	5
Above 150cases	0	1

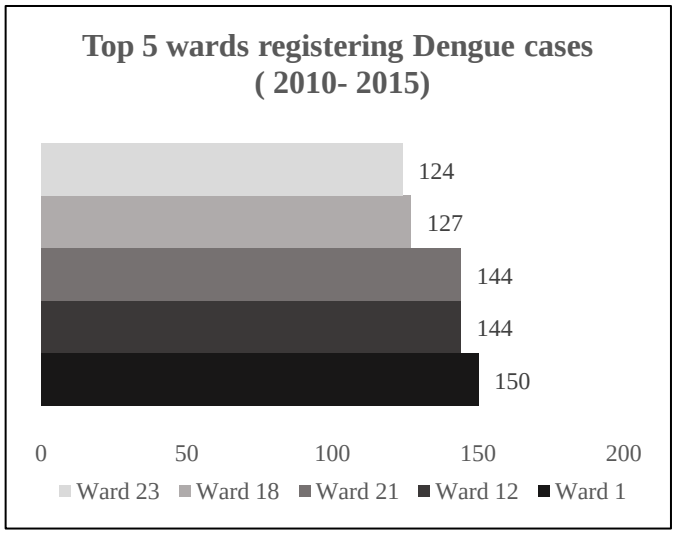


Figure 97:Top 5 wards registering Dengue cases (2010-2015)
Source: Health Department, Malaria Scheme, Rajkot Municipal Corporation, 2018-2019

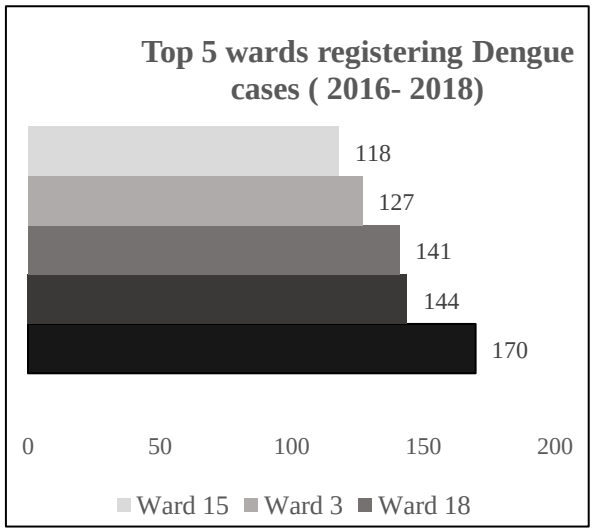


Figure 8: Top 5 wards registering Dengue cases (2016-2018)
Source: Health Department, Malaria Scheme, Rajkot Municipal Corporation, 2018-2019

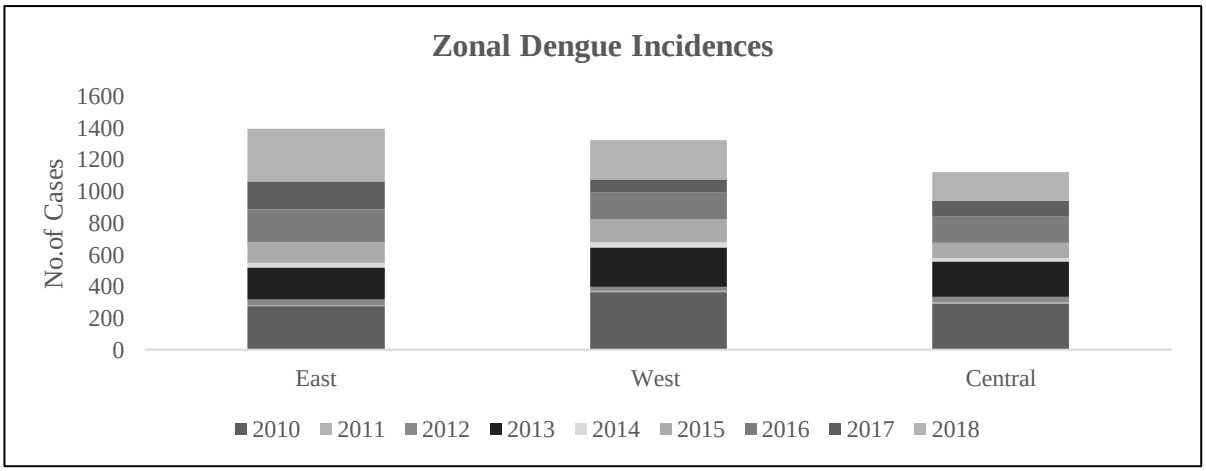


Figure 11: Zonal distribution of Dengue Cases
Source: Health Department, Malaria Scheme, Rajkot Municipal Corporation, 2018-2019

The zonal dengue incidences from 2010- 2018, indicate West Zone records the highest number of cases. (Figure 11)However, looking into the two time periods, from 2010-15 West Zone recorded the highest cases, while during 2016-18, with the change in the area and the ward boundaries East zone recorded higher cases.

The spatial mapping using GISRajkot ward maps (Figure 12), shows the trend in the dengue incidence cases from 2010-2015 in Rajkot city, wherein the cases range frombelow 10 cases to above 50 cases. In 2016, ward 4 reported 53 cases followed by Ward No. 1 with 44 cases or 9.5% 8% of the caseload, respectively. Six wards recorded 31-40 cases each in 2016 (Figure 13). Again ward 4 recorded the highest reported 42 cases (12%), followed by Ward No. 3 with 40 cases in 2017. Compared to these, ward No. 14 recorded only 3 cases or 0.8% of the caseload. Ward No, 8, 9, 11, 13 & 14 recorded fewer than 10 cases each. Seven wards recorded 10-20 cases each in 2017 (Figure 13). In 2018, Ward No. 18 registering as high as 82 cases followed by ward 4 and 1 with 75 and 73 cases respectively.

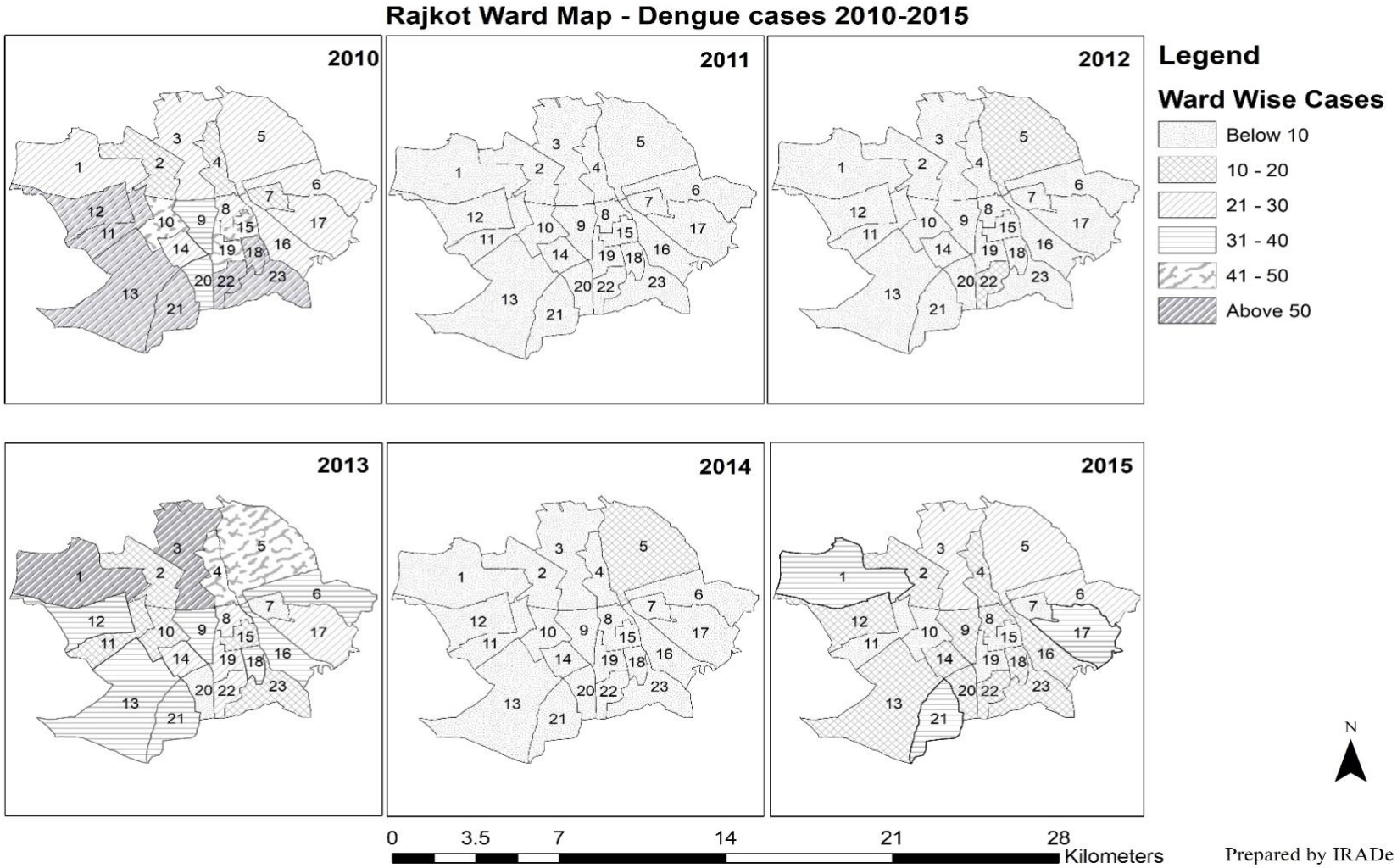


Figure 12: Ward-wise Trend of Dengue Cases, Rajkot (2010-2015), IRADe
Data Source: Health Department, Malaria Scheme, Rajkot Municipal Corporation, 2018, Map: IRADe

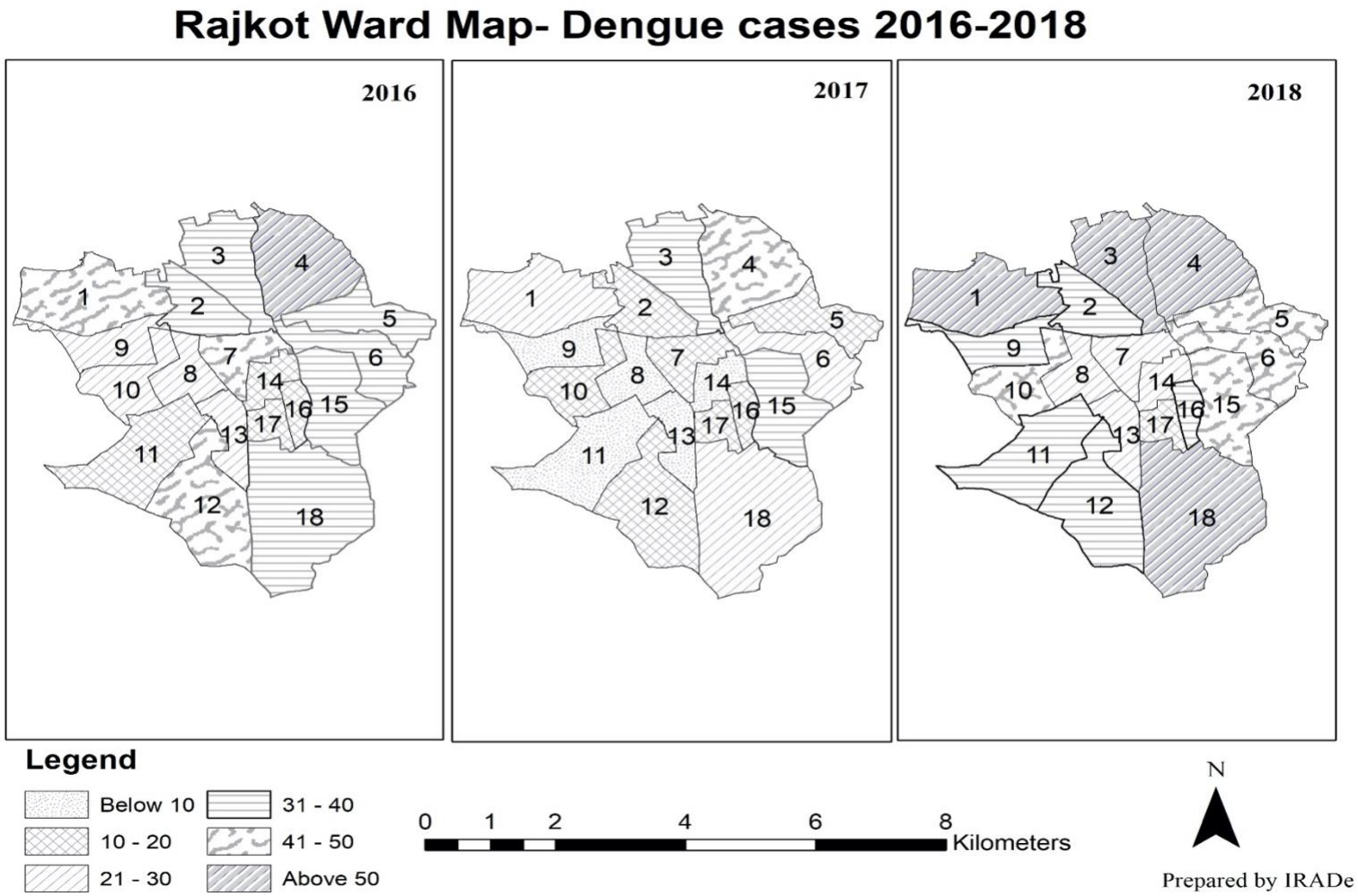


Figure 13: Rajkot Dengue Cases, 2016-2018

Source: Health Department, Malaria Scheme, Rajkot Municipal Corporation, 2018-19

Map: IRADe

2.2 Dengue emergence in Rajkot city- Causes

Dengue viruses and their mosquito vectors are sensitive to environmental factors. High temperature, high levels of precipitation and change in humidity are strongly associated with elevated dengue risk. Like other Indian cities, dengue occurrence is seasonal for Rajkot city too. A study conducted by PanditDeendayalUpadhyay Medical College, Rajkot, revealed that positive dengue cases remained low during the first six months of a year, followed by a significant increase from July to September and again during December.

One of the factors that is causing the perennial occurrence of dengue cases was related to the growing number of slum population/numbers. The city has 145 slums as of 2017 (Gujarat Government Gazette,2017) compared to 118 slums in 2012 (Slum Free City Plan of Action, SFPoA, Rajkot, 2012). Increase in the slum population and the absence of safe water storage infrastructure in these areas has made it conducive for the growth of dengue vectors. Looking at the previous analysis, we find that the major occurrences of the dengue cases have been found in the wards number 23,21,18,1 &12- top five wards for the year 2010-15 and their respective slum pockets has been 3,2,1,5 & 4 respectively. For the year 2016 -18, the major wards affected by dengue were 4,1,18,1&12 with cases recorded 16,5,16,12 &23 respectively.(Table 2)

Table 2: Correlation between Ward Population & No. of Slum Pockets

Ward No.	Ward-level population- 2011 census	Slum Pockets (2010-15)	Dengue Incidences
1	76,424	**5**	**150**
12	74,369	**4**	**144**
21	80,991	**2**	**144**
18	53,863	**1**	**127**
23	64,650	**3**	**124**

Ward No.	Ward-level population- 2011 census	Slum Pockets (2016 -18)	Dengue Incidences (2016-18)
4	40,398	16	170
1	76,424	5	144
18	53,863	16	141
3	51,696	12	127
15	39,496	23	118

Yet another factor for the recorded cases in wards is correlated to the population of the wards. As per 2011 Census of India, if we look into the highest dengue cases recorded in 2010-15, Ward 1 records 150 cases with a population of 76,424persons and 5 slums. There is no direct correlation between the three variables of ward population, slum pockets and dengue incidences, except for ward 4 in 2016-18, where higher dengue cases are recorded with highest slum pockets;however, the ward population is not high.

If we look into the dengue occurrences year-wise we see that in **2015**, higher cases were recorded in **Ward No. 1**, which may be due to higher slum population, where availability of water is a significantissue. People tend to store water in open/ uncovered containers and buckets, which are untreated and form the breeding grounds for vector-borne diseases. A lot of construction work also took place due to rapid urban development, wherein water is used in large quantity and stored untreated again, adding to the breeding grounds.

Similarly, **Ward No. 21**, is an industrial area, wherein we find squatter settlement being more added by the migratory population, which float in from the adjacent rural and semi-urban

area in search of work and livelihood and forced to settle down at squatter settlements, with poor sanitation facilitations.

In **2016, Wards 4, 1 7 and 12** recorded the highest dengue cases, owing to the larger slum area cover and the slum population, with poor sanitation and water supply facilities and increase in the construction sites. A survey in **Ward No. 4** recorded a larger number of water storage containers per house, when compared to the other wards, hence the serum samples collected were more and also the literacy rate in the ward was less compared to the other wards which added to the ignorance level of the people to treat water and take necessaryprecautions. **Ward No. 7 and 12** has a large concentration of commercial and industrial units which includes higher migratory population residing in squatter settlements.

Ward No 4 and 3 records higher incidence sin **2017,** include the similar reasons of higher slum population concentration, especially along with the developing and construction sites, with excess and poor water storage facilities and higher migratory population engaged in construction and labour work and settles in shanty scattered settlements along with the sites. Again in **2018, Ward No. 4** records the highest dengue incidences followed by **Ward No. 1.**

The environment and the immediate surrounding add up to the incidence and increase in the cases in any particular locality. The major factors pointed out by the RMC health officers were the accumulation of scraps, like old used tyres, solid waste, air coolers, broken water storage drums, flower pots/ planters, rooftop plastic sheet covers, water supply pits which areso forth are enablers in *A. aegypti* mosquito growth, the principal urban vector of Dengue (Figure 14). There is no direct correlation with the number of slum pockets and the incidence of dengue cases as the total slum population plays an essentialdeterminate.

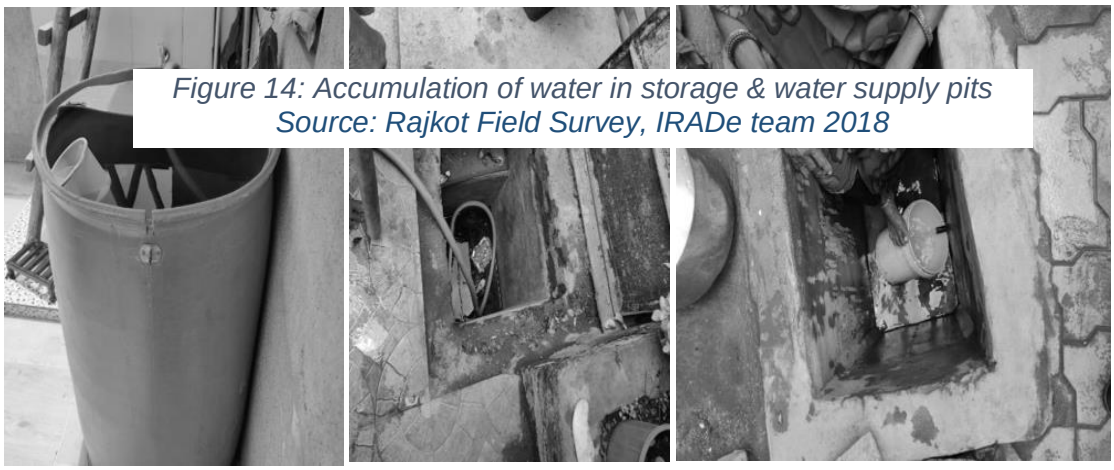


Figure 14: Accumulation of water in storage & water supply pits
Source: Rajkot Field Survey, IRADe team 2018

Table 3: Yearly Zonal Slum and Dengue Cases

East Zone			West Zone		Central Zone	
Years	**Slums**	**Cases**	**Slums**	**Cases**	**Slums**	**Cases**
2010-2015	104	678	30	820	38	673
2016-2018	88	717	24	504	33	447

Looking into the yearly zonal slum and dengue cases registered its observed that there lies no strong relation with the number of slum pockets and incidence of dengue cases (Table 3). **Simple Linear Regression** analysis was also made to calculate the correlation between the denser concentration of slum pockets and the higher dengue incidences across the city for

the years 2011- 15 and for years 2016- 2018. This was separatelydone as there was a revision in the wards from the year 2016

For the year 2011-2015, it was observed that that the *r square* obtained from *the linear regression* is 0.15, indicating a faint relation between the total dengue cases and the number of slum pockets in the different wards of the city (Fig 15). Therefore, there is no relationship between the two variables. The analysis indicates that the ward no.1 with only 5 slum pockets records the highest dengue cases (79), which is attributed to the higher slum population, while ward 16 with more than 20 slum pockets record only 25 cases and ward 18 with only 1 slum pocket recorded 41 cases, over 6 years.

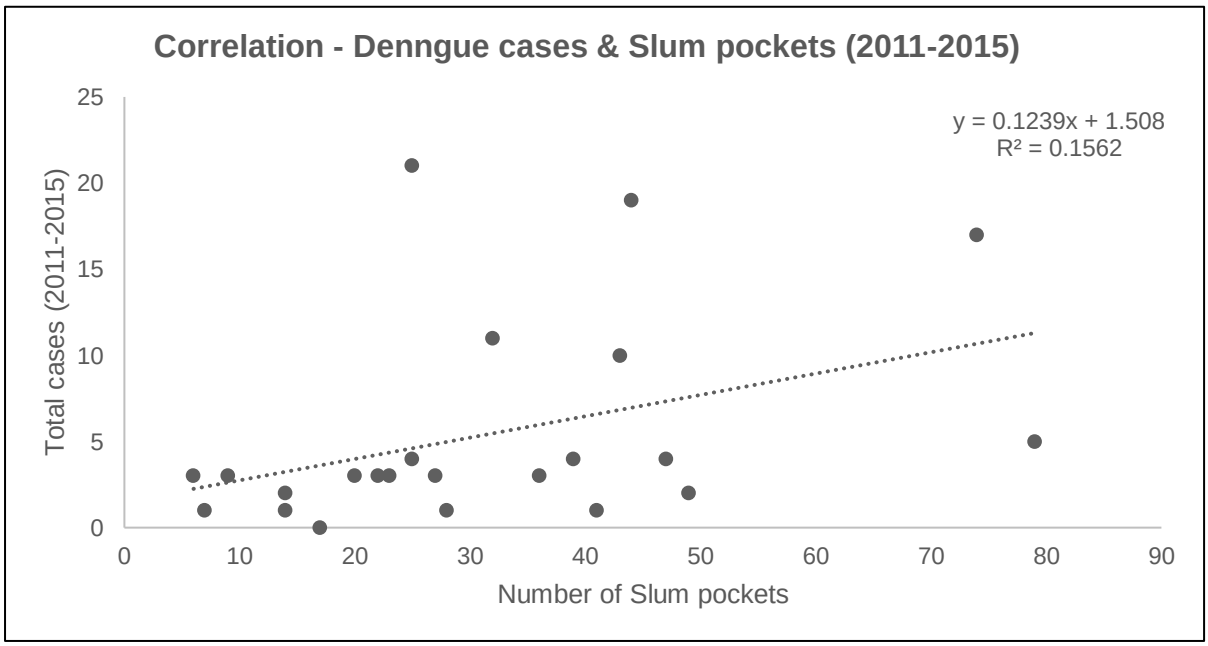


Figure 15: Correlation - Dengue Cases & Slum Pocket's (2011-2015)

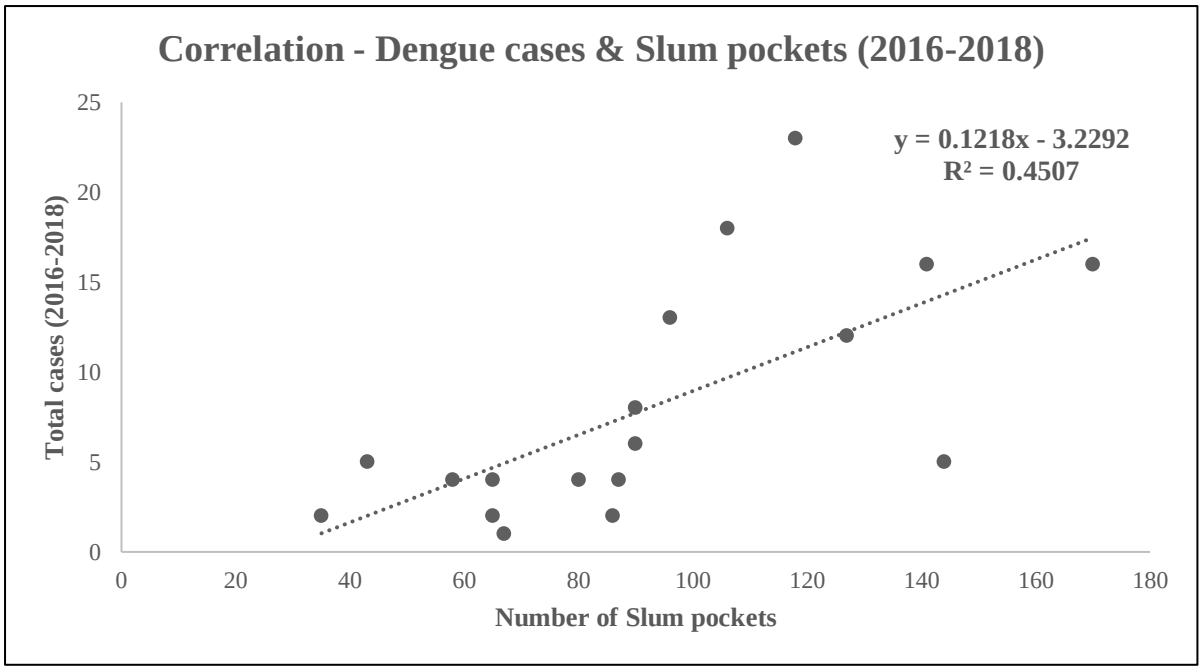
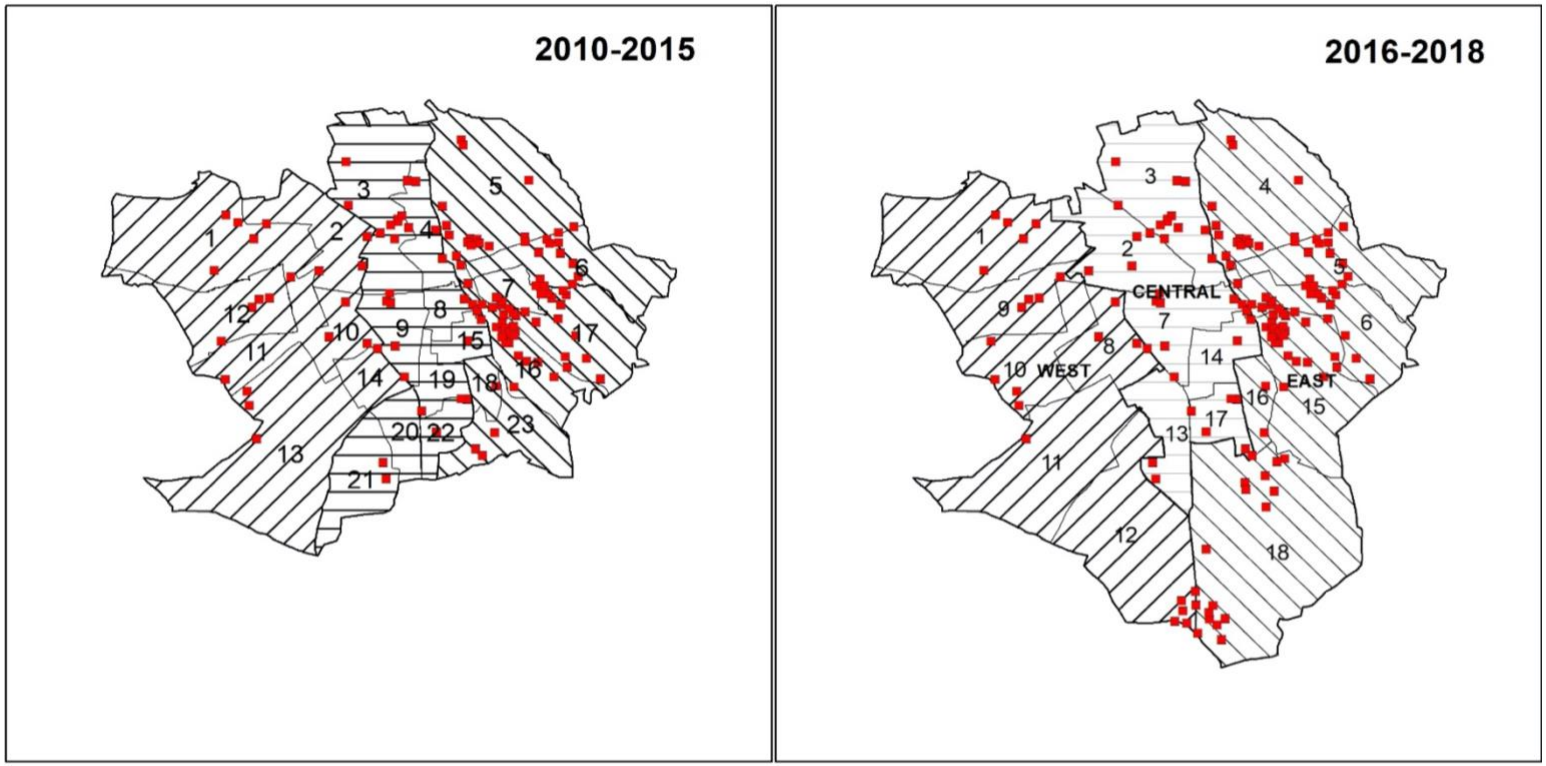


Figure 16: Correlation - Dengue Cases & Slum Pocket's (2016-2018)

However, for the period 2016-2018, the analysis indicates that *r square* is 0.45, showing a weak relation between the total dengue cases and the number of slum pockets, hence the dengue incidences are affected by the rise in the number of slum pockets but significant (Figure 16). During this period (2015-2018) it is observed that though the wards with a large number of slum pockets have recorded high dengue incidences.

Though the number of wards hasreduced over time,the total number of slum pockets within the city hasincreased from 124 to 145, along with recorded dengue cases which were 721 for the period of 6 years and have increased to 1668 cases in 3 years. For the year 2010-15, west zone with only 80 slum pockets records as high as 820 dengue cases while east with 104 slum pockets records 678 cases. However, in 2016-18 its found east zone with higher slum pockets (88) records higher incidences (717 cases).(Figure 17)

The city has grown in size and population density over the years, with a total population of 1,390,640 (2011 India census) and density of over 8000 people per sq.km. The city has increased in area to accommodate the migratory population and floating population from the nearby area who come in for better job opportunities and better economic condition. However, they end up living in slums and squatter settlement with poor living conditions and scarcity of the basic amenities.



	East		West		Central	
	Slums	Cases	Slums	Cases	Slums	Cases
2010-2015	**104**	**678**	**30**	**820**	**38**	673
2016-18	88	717	24	504	33	447

Figure 17: Zonal distribution of Slum Pockets and Dengue cases incidences

2.3 Mitigation and Adaption

With the increasing number of dengue incidences, the Municipal Corporation has taken up some rigorous preventive steps to control the spread of this vector-borne disease. Larval surveillance and supervision have been carried out by the Superior Fieldworker, Malaria Inspector, Biologist and Medical Officers and Asha Workers at each ward level. Biological control methods like distribution of Gambusiaaffinis (the mosquito fish) (22,845 Households) to the community and sprinkling of Temifose medicine, MLO/BTI Larvicide solution (18,74,242 Households) and fogging (2,00,077) at infected and high-risk sites have been carried out. Pamphlets distribution, hoarding and LED screen displays, socials media communication, workshopshave been adopted at a large scale to spread dengue awareness within the city.

2.3.1 Awareness Measures

The RMC Health Department has undertaken intensive mass media awareness campaigns and programmes to encourage dengue prevention and treatment-seeking behaviour for its early detection and treatment. The department observes **July as the Dengue Awareness Month,** to spread awareness among the community members about Dengue. The department also works with the government and private schools in the city for sensitizing school teachers in raising awareness about vector-borne diseases among school children and their immediate community.

2.3.2 Medical Measures

The symptoms of Dengue,which usually begins 2-3 days after one is bitten by an infected mosquito, includehigh fever, headaches, muscle, bone and joint pain, pain behind the eyes and also cases of rashes, nausea and vomiting. Though no specific medication has is prescribed, patients are given a pain reliever, with fever medication like paracetamol/ crocin, rest, drinking plenty of fluids isalso recommended. It usually takes 15-20 days to recover.

2.3.3 Public Health/ environment measures

To avoid any major public outbreaks, certain measures are adopted by the health department of the Municipal Corporation, including:

- **Scrap removal drive**
- **Distribution of mosquito nets**
- **Fogging of the areas**

Apart from these IRADe has also recommended the city to adopt the 4S Protection method against Dengue, viz-a-viz:

1. **Search and destroy:**
    a. possible breeding places of dengue-causing mosquitoes like flower pots, vases, discarded plastic bags, bottles, old tires, cans, earthen jars, coconut husks, roof gutters, water drums, and other containers that might hold clean stagnant water
    b. add kerosene/diesel oil, cover water containers, change the water in pots to kill the larvae/eggs.
2. **Self-protection**measures are given below:
    a. Wear long sleeves or long pants
    b. Avoid dark-coloured clothes like dark shades of blue and black, as dark clothing has been observed to attract mosquitoes.
    c. Apply mosquito repellant on the skin to deter mosquito bites; however, parents are cautioned against using strong repellants on small children because of potentially harsh chemicals.

d. Organic mosquito repellant alternatives such as all-natural citronella bug spray are readily available.
e. Use mosquito coils, electric vapour mats and mosquito spray during the daytime.
f. Screens and mosquito nets are also good deterrents against mosquitoes.

3. **Seek early consultation** because Dengue is crucial. See a doctor immediately if you show early signs and symptoms of Dengue.
4. **Say yes to fogging**
    a. Fogging is only advisable and recommended when outbreaks and epidemics are positively determined in a particular area.
    b. Fogging can only kill the adult infected mosquito; it cannot get rid of the larvae. Indiscriminate fogging will only drive away other mosquitoes to other places to find new breeding grounds.

The 4S implementation calls on everyone to become prime movers in achieving substantial change and be positive influencers to others within the community. The challenge to adhere to an enhanced 4S implementation is doing it*consistently and regularly*.

Mosquito-borne diseases like Dengue have a detrimental impact on the health and livelihoods of millions of people in India. Environmental factors, including climate change and variability, may further aggravate the dengue incidences in India. There is a need for new knowledge on the impact of climate change on mosquito-borne diseases, assessing socio-economic impacts, strengthening early warning systems and dengue management strategies to manage the public health challenge in India.

3. SDGs and Vector-Borne Diseases

Fighting Vector-Borne diseases covers following SDG goals

- SDG Goal 3 for Good Health and Well- Being: Ensure healthy lives and promote well-being for all at all ages
- SDG Goal 6 for Clean Water and Sanitation: Ensure availability and sustainable management of water and sanitation for all
- SDG Goal 11 for Sustainable Cities and Communities: Make cities and human settlements inclusive, safe, resilient and sustainable

The 70th session of the World Health Assembly (WHA) addressed vector-borne disease, in adopting the 'Global Vector Control Response 2017–2030,' on 31st May 2017. The Response aims to: strengthen national capacities for implementing integrated vector management for disease prevention and control and responding to outbreaks; and overcome challenges related to poor vector control, poor housing and planning, and rapid population growth (WHO)

At the local level, the targeted goals can be achieved by monitoring the water and sanitation conditions, mapping of the incidences, reducing the number of deaths and number of causalities affected by epidemics and protecting the vulnerable urban poor population.

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