
Prediction of Dengue with Climate Change over Rajkot

WORKING PAPER

Trend in Dengue Incidences A Case Study of Rajkot City, Gujarat



© 2020 Integrated Research and Action for Development (IRADe)

"Trend in Dengue Incidences: A Case Study of Rajkot city, Gujarat"

Supported by: Department of Science and Technology, GoI

Authors

Integrated Research & Action for Development (IRADe), Delhi

Rohit Magotra, Deputy Director

Moumita Shaw, Research Analyst

Disclaimer

All rights reserved. No part of this publication may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopy, recording, or any information storage and retrieval system, without permission in writing from IRADe. The presentation of material in this publication that appears herein does not imply the expression of any opinion on the part of IRADe concerning the legal status of any country, state, or city or the delineation of their frontiers or boundaries.

Abstract

Dengue is one of the major public health concern globally. It is a life threatening viral disease spread by the bite of the virus infected Aedes mosquito. Dengue incidents have grown dramatically across the globe and in India too number of cases are on rise since 2001. During 2015-20, there have been 0.71 million reported cases of Dengue in India. Most of the cases are reported from the urban areas. However, the number of infections may be much higher as testing facilities are limited and are not accessible by the urban poor vulnerable groups. It is important to document, assess and analyze the spatio - temporal distribution of the dengue in the cities. This in turn will help urban authorities to identify dengue hot spots and devise appropriate strategies and focused interventions for management of Dengue. This study aims to assess the spatio-temporal patterns of dengue in Rajkot City of Gujarat. Data on dengue incidence were obtained from January 2010 to December 2018. Rajkot one of the fastest growing city in Gujarat, and has recorded increasing dengue incidences from 327 cases (2010) to 763 (2018). The study also assess correlation between the concentration of slum pockets and the dengue incidences. Hot-spot areas across the city has been mapped wherein higher incidences have been recorded over the past decade. These areas are required to be prioritized or resource allocation for more efficient prevention and control of dengue. The study maps the spread of Dengue in the city, causal factors, actions taken for dengue prevention and management in Rajkot city.

Key Words

Dengue, Dengue Hot-spot areas, Public health, Urban area, Spatial – temporal analysis, Prevention & Mitigation

1. Introduction

Dengue fever is a major cause of illness and death in sub-tropical and tropical countries (refer to Fig 1). The vector-borne disease is caused by the dengue virus transmitted to humans by the infected mosquitoes *Aedes (Ae.) aegypti* and *Aedes. Ablopictus* (Nedjadi T, 2015).

As per the World Health Organization (WHO), severe dengue was first recognized in the 1950s during dengue epidemics in the Philippines and Thailand. Today, severe dengue affects most Asian and Latin American countries and has become a leading cause of hospitalization and death among children and adults in these regions. The number of dengue cases reported to WHO increased over 8 fold over the last two decades, from 505,430 cases in 2000, to over 2.4 million in 2010, and 4.2 million in 2019. Reported deaths between the year 2000 and 2015 increased from 960 to 4032. Figure 1 shows worldwide distribution of Dengue incidences reported in 2020 (WHO, 2020) .

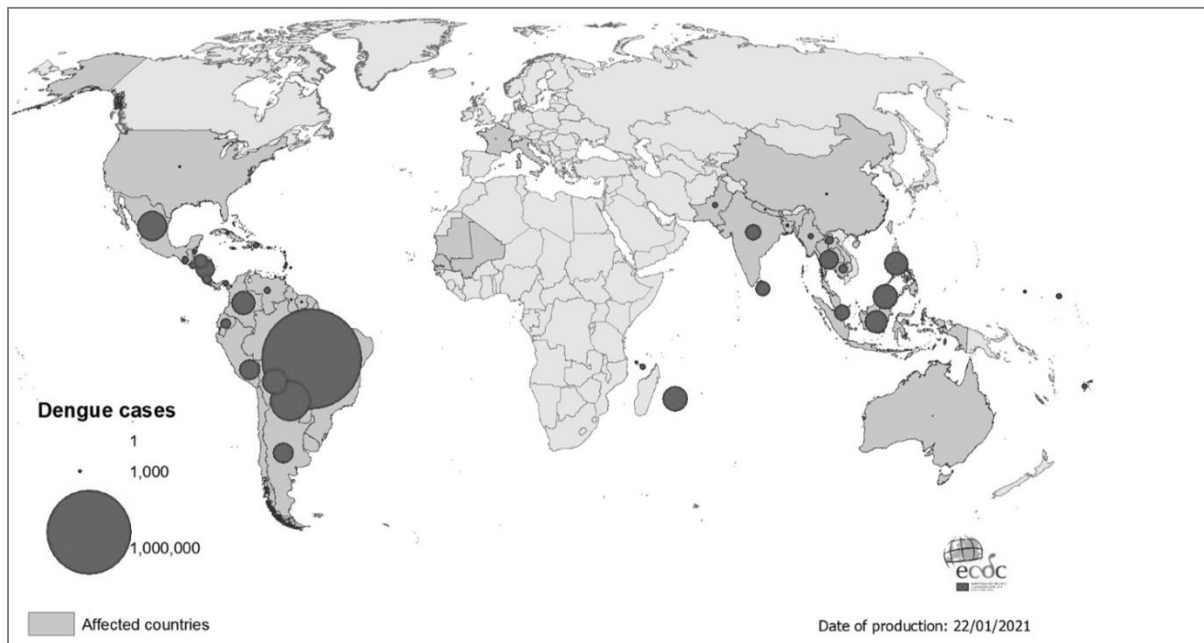


Figure 1: Geographical distribution of dengue cases reported worldwide, 2020

Source: European Centre for Disease Prevention and Control <https://www.ecdc.europa.eu/en/publications-data/geographical-distribution-dengue-cases-reported-worldwide-2020>

In 2020, dengue continues to affect several countries, with reports of increases in the numbers of cases in Bangladesh, Brazil, Cook Islands, Ecuador, India, Indonesia, Maldives, Mauritania, Mayotte (Fr), Nepal, Singapore, Sri Lanka, Sudan, Thailand, Timor-Leste and Yemen. High number of cases were reported in Bangladesh (101,000), Malaysia (131,000) Philippines (420,000), Vietnam (320,000) in Asia (WHO, 2020) .

In lieu of the world scenario, annual incidences of dengue cases have significantly increased in India since 2001. In the early 2000s, dengue was endemic in a few southern (Maharashtra, Karnataka, Tamil Nadu and Pondicherry) and northern states (Delhi, Rajasthan, Haryana, Punjab and Chandigarh). It has recently spread to other states, including the union territories (Chakravarti A, 2012).

Over the period 1998–2009, 82,327 dengue cases were reported. During 2010–2014, 2,13, 607 cases of dengue fever were observed. Number of dengue cases during 2010–2014 had increased markedly, by a factor of ~ 2.6, with respect to the 1998–2009 period (Mutheneni, 2017).

Between 2015 -2020, a total of 715406 people was affected by dengue with 1184 deaths across India (NVBDCP, 2020) (Refer to Figure 2). During the period from 2015 -2020, there was a spike in the Dengue cases in 2017 and 2019 and a dengue outbreak was reported in several states. The disease, which typically had an urban distribution a few decades earlier, is now reported from peri-urban as well as rural areas.

Based on dengue endemicity and its public health concern, World Health Organization (WHO) has kept India under category A, considering the dengue as a leading cause of hospitalization and death among children.¹ *

¹ * *Variable endemicity of DF/DHF in countries of the SEA Region categorizes* Bangladesh, India, Indonesia, Maldives, Myanmar, Sri Lanka, Thailand and Timor-Leste in Category A under the aspects of Dengue fever being:

- Major public health problem.
- Leading cause of hospitalization and death among children.
- Hyperendemicity with all four serotypes circulating in urban areas.
- Spreading to rural areas

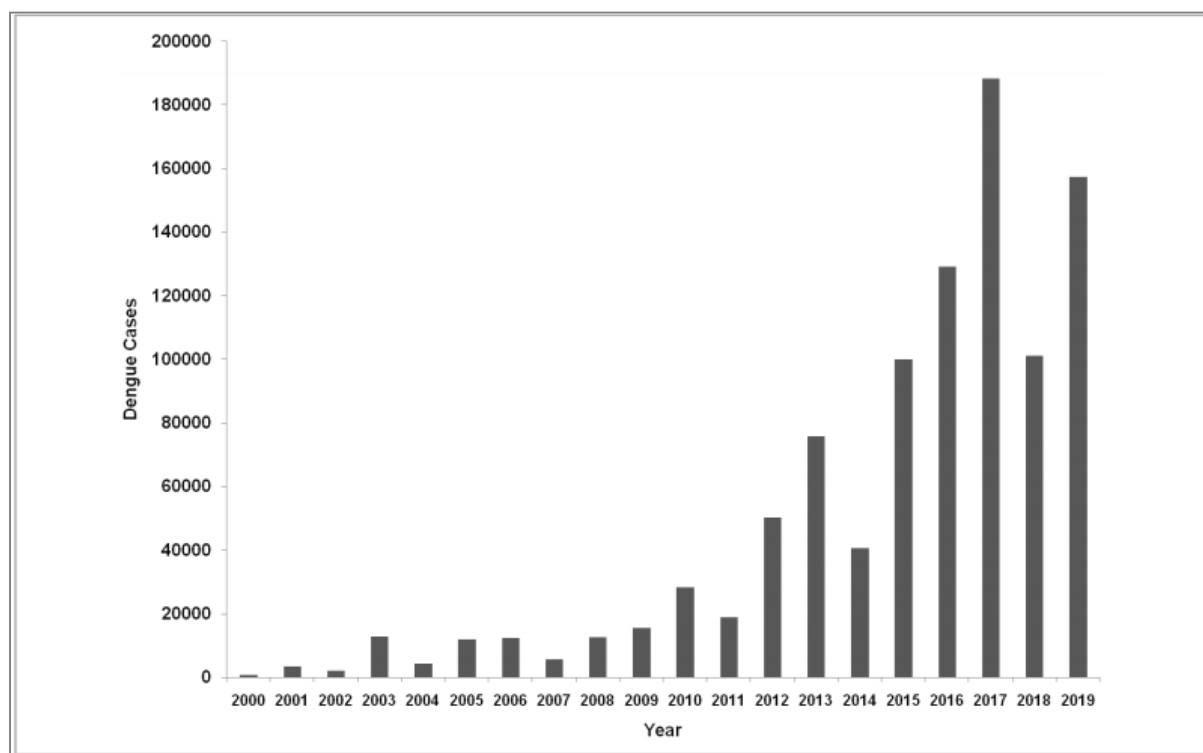


Figure 2: Dengue Morbidity Trend in India, 2000-2019

Source: [NVBDCP, GoI](https://nvbdcpl.gov.in/)

Between 2015 -2020, a total of 715406 people was affected by dengue with 1184 deaths across India (NVBDCP, 2020) (Refer to Figure 2). During the period from 2015 -2020, there was a spike in the Dengue cases in 2017 and 2019 and a dengue outbreak was reported in several states. The disease, which typically had an urban distribution a few decades earlier, is now reported from peri-urban as well as rural areas.

In 2020 a decline in dengue incidences was also reported in India, with dengue cases dropping by 70% compared to previous year. The decline of incidences may have occurred due to fewer hosts available outdoors leading to less vector-host contact, relatively fewer artificial breeding sites for the vector due to less solid waste , limited movement of infected patients due to the COVID-19 restrictions in India during Lockdowns and Partial lockdowns.

Since 2015, India has recorded over 7 lakh dengue incidences and 1184 deaths across the country (refer to figures 3 & 4)

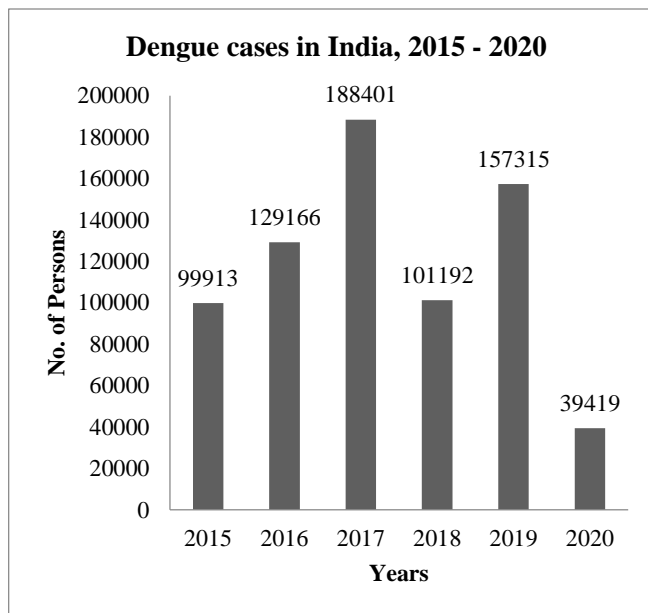


Figure 3: Dengue Cases in India, 2015-2020
Source: National Vector Borne Disease Control Programme, Ministry of Health & Family Welfare, Govt. of India

<https://nvbdcp.gov.in/index4.php?lang=1&level=0&linkid=431&lid=3715>

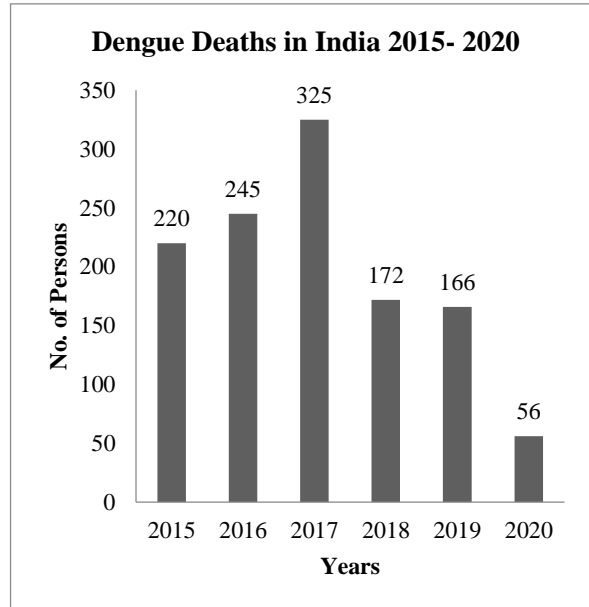


Figure 4: Dengue Deaths in India, 2015-2020
Source: National Vector Borne Disease Control Programme, Ministry of Health & Family Welfare, Govt. of India

<https://nvbdcp.gov.in/index4.php?lang=1&level=0&linkid=431&lid=3715>

2. Rajkot City, Gujarat

2.1 Dengue Case Study of Rajkot City

Gujarat has reported a significant increase in the dengue incidences from 2010 to 2020 (Till September (Fig 5). The state faced major outbreaks in 2013 (6272 cases, 15 deaths), 2015 (5590 cases, 9 deaths), 2016 (8028 cases, 14 deaths) and 2019 (19219 cases and 17 deaths) (NVBDCP, 2020).

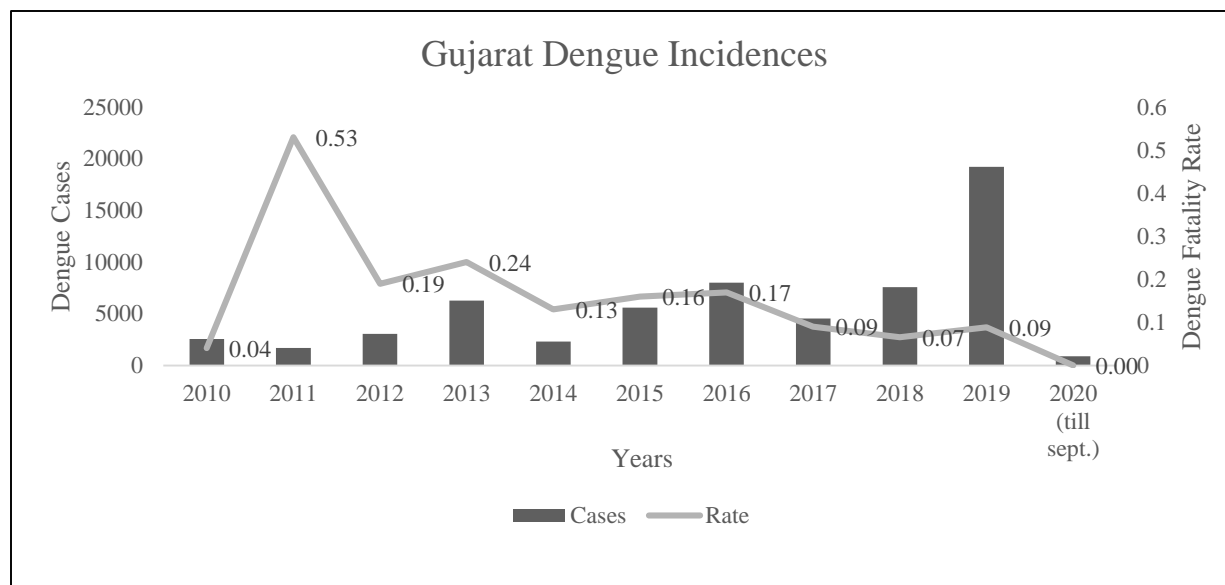


Figure 5: Morbidity and Mortality due to Dengue in Gujarat from 2010 to 2020

Source: National Vector Borne Disease Control Programme (NVBDCP), Ministry of Health and Family Welfare, GoI (<http://nvbdc.gov.in/den-cd.html>)

Rajkot is the 4th largest city in Gujarat, after Ahmedabad, Surat and Vadodara and the 35th largest urban agglomeration in India. It has a semi-arid climate, with hot, dry summers from mid-March to mid-June and the wet monsoon season from mid-June to October at an elevation of 420 ft (above sea level). The city has a population of 13.9 lakh and a decadal growth of 38.6 per cent. The city comprised of 23 wards spread across 104.86 sqkm till 2015, which has now increased in size engulfing the nearby villages and sub-urban areas

Though the official records of dengue cases are available from 2011 (Rajkot Municipal Corporation), records and documents show that cases have been registered since 2009 in the regions of Shivshakti area of Veraval of Rajkot (Shiloh , 2009). Though the disease has a seasonal pattern that peaks following the monsoon season, is perennial in Gujarat (Ministry of Health and Family Welfare, India, 2011). In a study conducted in 2015 by Pandit Deendayal Upadhyay Government Medical College, Rajkot, it was found that of the total positive dengue cases registered in Saurashtra region in 2013, almost two-third (61.8%) cases were reported from the Rajkot district (Ministry of Health and Family Welfare, India , 2013). Reporting of dengue positive cases in Gujarat was low during the first six months of year 2013, followed by significant increase from July to September, Maximum cases were reported in September 2013

The data collected from the Health Department of Rajkot Municipal Corporation for the years 2011 to 2018 shows a rise in the number of dengue cases in the city (Fig 6). **It shows 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 greater number of cases of male patients were recorded as compared to female, which could be attributed to their longer outdoor day-time exposure, as compared to the lower dengue reporting rate among the females be attributed to less exposure to the risks of this vector-borne infection.

The number of cases gradually increases over the years to 365cases in 2015, 555cases in 2016, again drops to 350 cases in 2017. However, 2018 marks the highest recorded cases over the years (763 cases). Here a trend is recorded with fall in the number for two consecutive years there is a sudden rise in the number recoded.

One of the major reasons for the low records of dengue incidences in 2014 when compared to 2013 and 2015 is due to the cyclic trend, similar trend is reported in the state. In the year 2014, Gujarat too recorded drop in fatality rate cases to 0.13 and lower number of cases being recorded when compared to 2013 and 2015 (referee to Fig. 5), due to drop in the rainfall which may be accounted to the lower occurrences of dengue incidence in Rajkot and across Gujarat.

However, Dengue cases are under-reported as several laboratories in India are not equipped with good diagnostic 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)

The year 2016 recorded reported 555 positive cases, which made the health department more cautious. It set up 10 teams with 20 members to carry out preventive measures in different areas along with fogging and collection of fines from breeding areas (Parmar V , 2016). In year 2018 the number of dengue cases have increased to 763 cases which is almost double of the cases being recorded in the previous year.

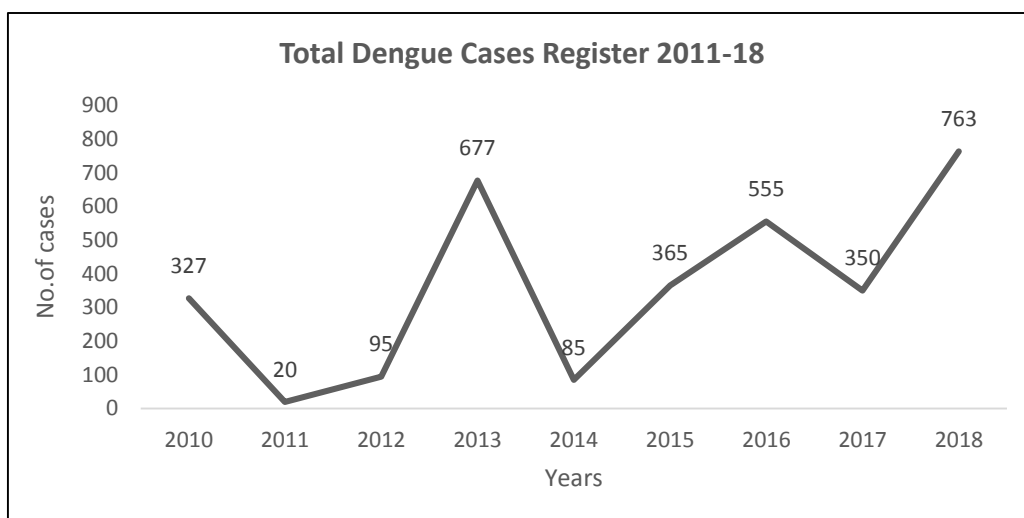


Figure 6: Yearly Trend in Dengue cases recorded in Rajkot city (2011- 2018)

Source: Health Department, Malaria Scheme, Rajkot Municipal Corporation, 2018-2019

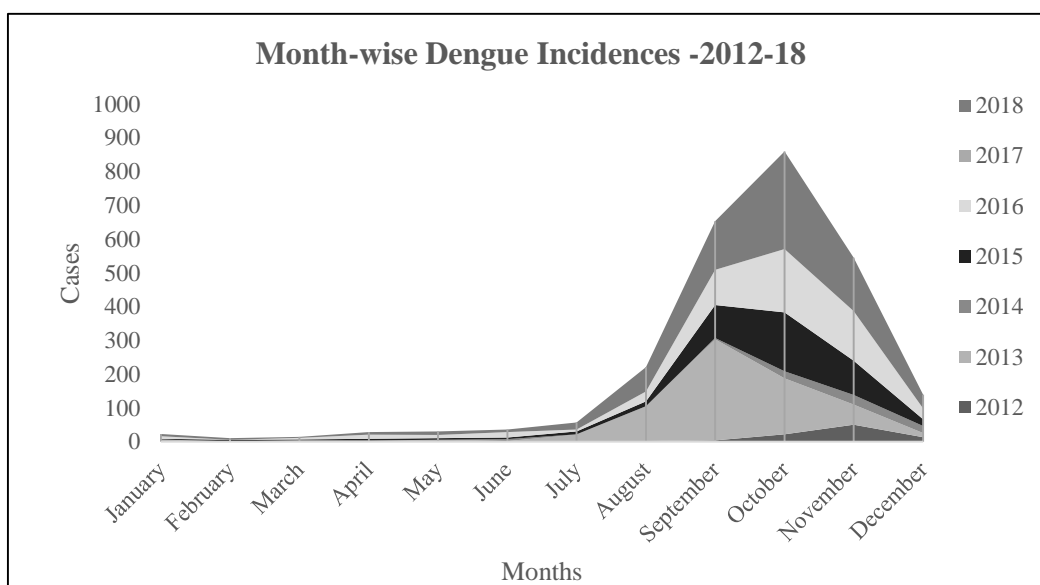


Figure7: Monthly Trend in Dengue cases recorded in Rajkot city (2012- 2018)

Source: Health Department, Malaria Scheme, Rajkot Municipal Corporation, 2018-2019

The month-wise registered dengue cases cross Rajkot city over the years, clearly indicates the occurrences of dengue cases are increases post July to December (Fig.7). 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 are recorded

in the month of October which is true for all years studied except for 2013 when highest incidences were reported for the month of September.

Over the decades Rajkot has experienced 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 sqkm till 2015, which has now increased in size engulfing the nearby villages and sub-urban areas to an area of 170 sqkm. The wards have been rearranged and comprises of 18 wards at present.

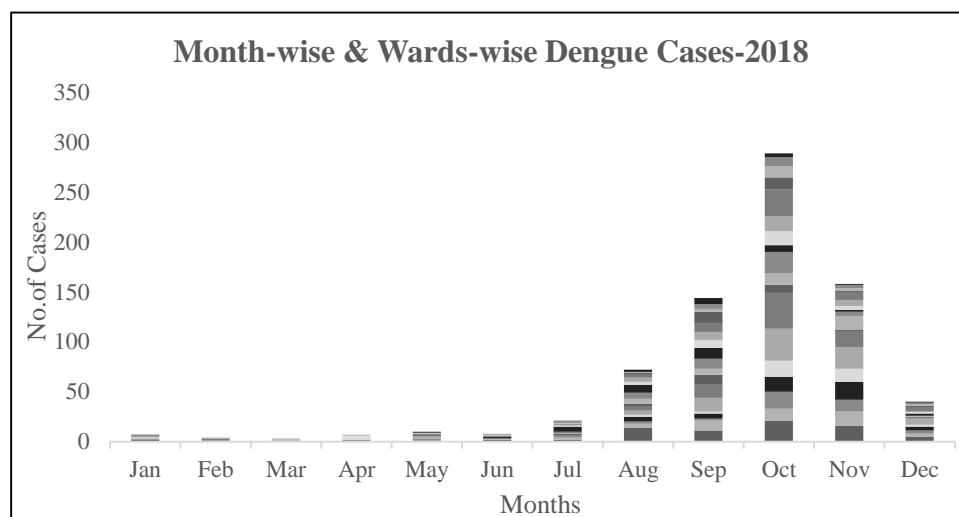


Figure 8 : Monthly and Ward-wise Trend in Dengue cases recorded in Rajkot city 2018

Source: Health Department, Malaria Scheme, Rajkot Municipal Corporation, 2018-2019

For the year 2018, the month-wise data indicates the peak season for the dengue incidences in the city is September to November (highest recorded in October, 289 cases). Ward-wise dengue cases indicate Ward 18 being mostly affected by the dengue virus with total 82 cases recorded throughout the year, however, higher cases are recorded in Ward 1(36 cases) in the month of October, 2018, followed by Ward 18 (32 cases) (Fig. 8)

At the ward-level dengue incidence trend from 2010- 2015 (Fig 9), it was found that Ward No. 1 had recorded the highest number of 150 reported positive cases over the years 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).

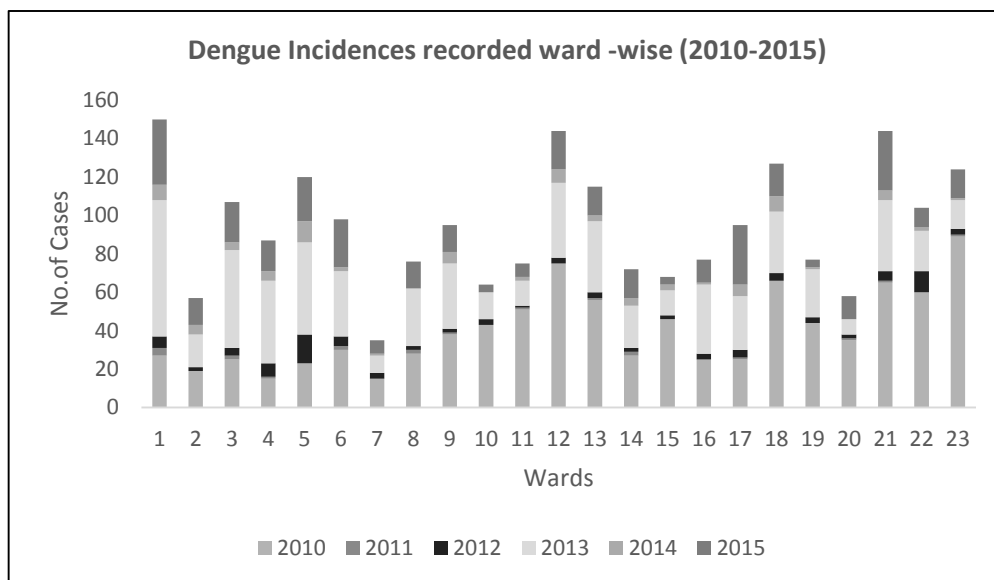


Figure 9: Ward wise Dengue cases record (2010-2015)

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

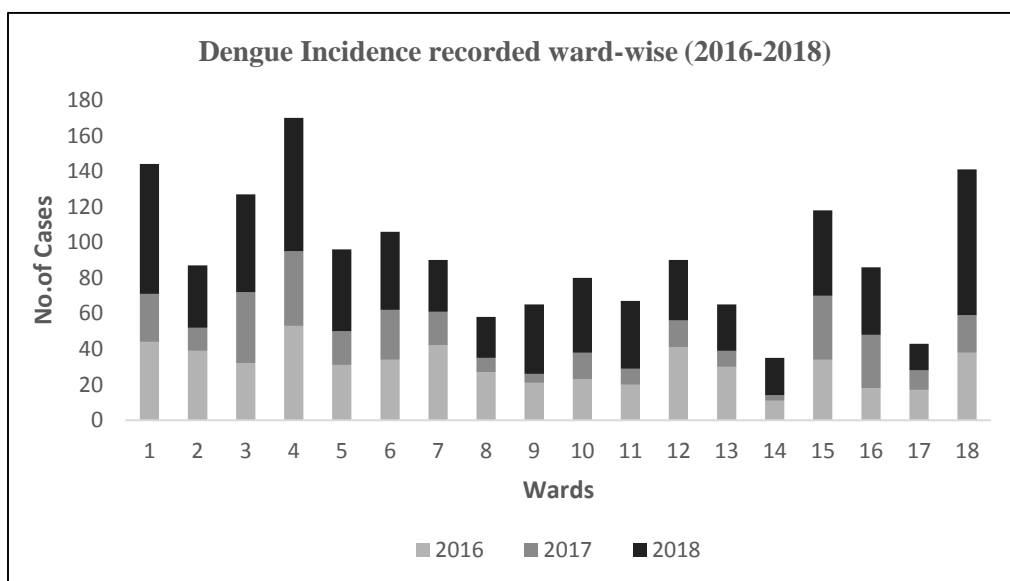


Figure 10: Ward wise dengue cases record (2016–2018)

Ward 4 and 1 records highest Dengue cases, with 170 & 144 cases respectively
 Lowest numbered recorded in Ward No.14 & 17 with 35 & 43 cases respectively

Source: Health Department, Malaria Scheme, Rajkot Municipal Corporation, 2018-2019

As per the records, its observed that the trend in dengue cases has increased over the years, 2016-2018 (Figure 10). In the three-year time period 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.

Table 1: Ward-wise Dengue Incidences (2010-2015)

Ward No.	2010	2011	2012	2013	2014	2015	Total
1	27	4	6	71	8	34	150
2	19	0	2	17	5	14	57
3	25	2	4	51	4	21	107
4	15	1	7	43	5	16	87
5	23	0	15	48	11	23	120
6	30	2	5	34	2	25	98
7	15	0	3	9	1	7	35
8	28	2	2	30	0	14	76
9	38	1	2	34	6	14	95
10	43	0	3	14	0	4	64
11	51	1	1	13	2	7	75
12	75	0	3	39	7	20	144
13	56	1	3	37	3	15	115
14	27	2	2	22	4	15	72
15	46	0	2	13	3	4	68
16	25	0	3	36	1	12	77
17	25	1	4	28	6	31	95
18	66	0	4	32	8	17	127
19	44	0	3	25	1	4	77
20	35	1	2	8	0	12	58
21	65	1	5	37	5	31	144
22	60	0	11	21	2	10	104
23	89	1	3	15	1	15	124
Total	327	20	95	677	85	365	1569
<i>Source: Health Department, Malaria Scheme, Rajkot Municipal Corporation, 2018</i>							

Table 2:Ward-wise Dengue Incidences

Ward No.	2016	2017	2018	Total
1	44	27	73	144
2	39	13	35	87
3	32	40	55	127
4	53	42	75	170
5	31	19	46	96
6	34	28	44	106
7	42	19	29	90
8	27	8	23	58
9	21	5	39	65
10	23	15	42	80
11	20	9	38	67
12	41	15	34	90
13	30	9	26	65
14	11	3	21	35
15	34	36	48	118
16	18	30	38	86
17	17	11	15	43
18	38	21	82	141
Total	555	350	763	1668
<i>Source: Health Department, Malaria Scheme, Rajkot Municipal Corporation, 2018-19</i>				

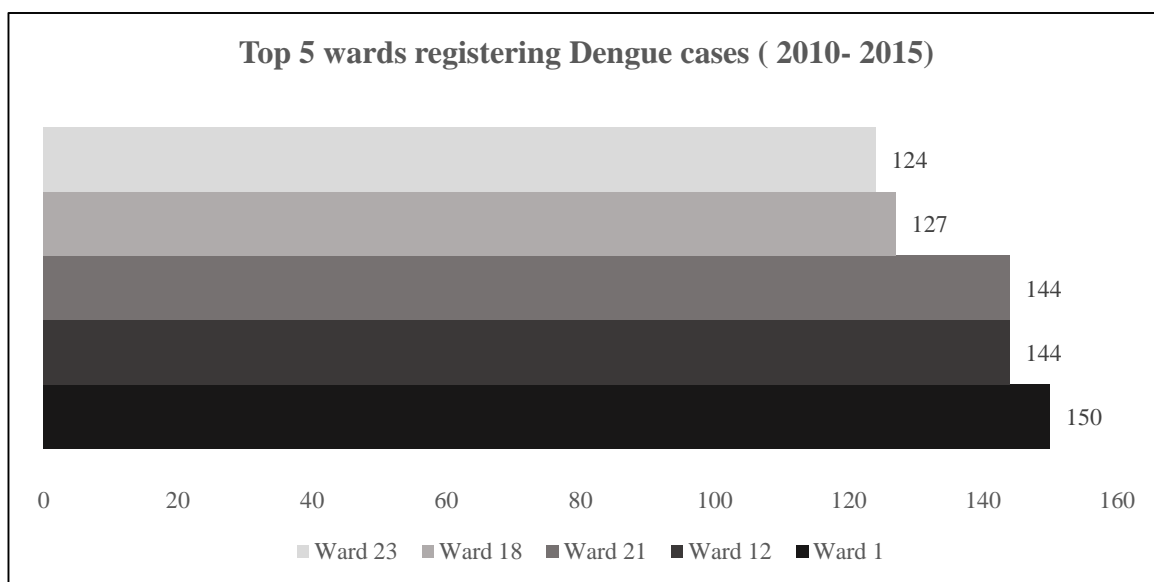


Figure 11: Top 5 wards registering Dengue cases (2010-2015)

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

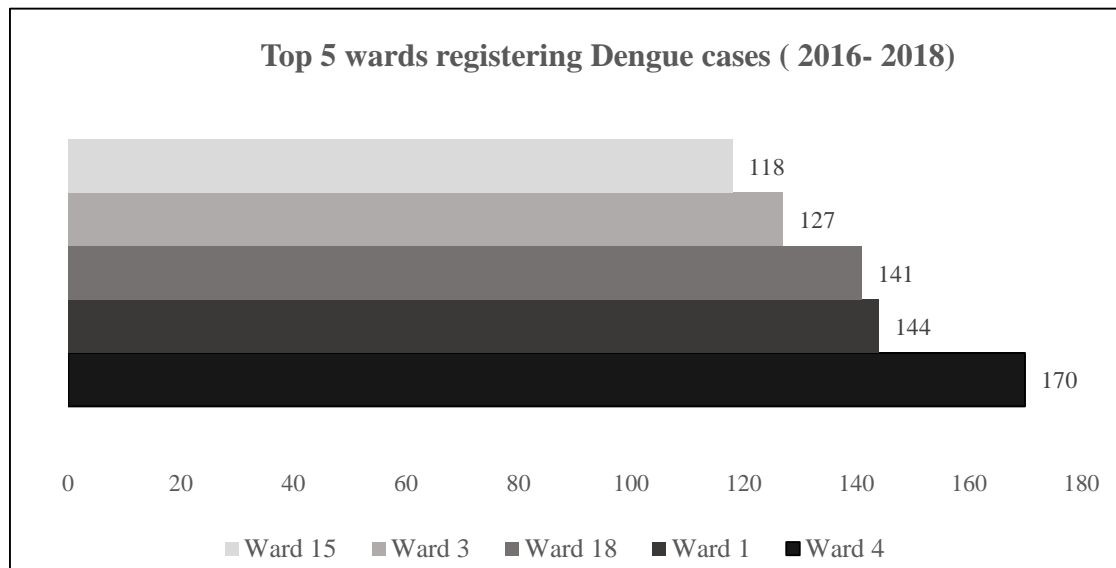


Figure 12: Top 5 wards registering Dengue cases (2016-2018)

Source: Health Department, Malaria Scheme, Rajkot Municipal Corporation, 2018-2019

A look into the ward-wise share of the dengue cases registered indicate that only 1 ward had registered dengue cases below 50 (2010-15) and on an average 13 wards (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 a above 150 cases. (Table 3)

Table 3: Dengue cases Ward wise (2011-18)

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

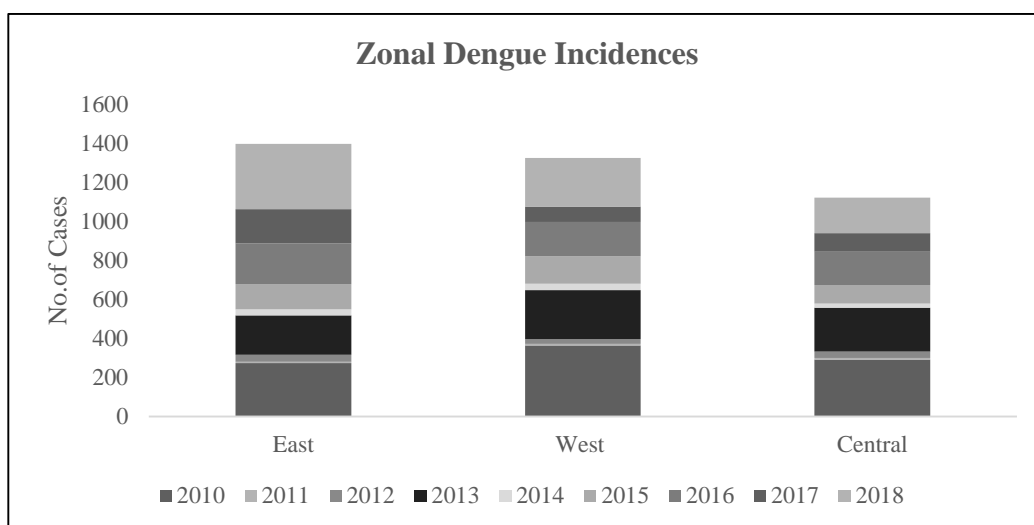


Figure13: Zonal distribution of Dengue Cases

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. (Fig.13) However, if 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 GIS Rajkot ward maps (Fig. 14), shows the trend of in the dengue incidence in the city for cases from 2010- 2015 in Rajkot city, wherein the cases ranges between below 10 cases to above 50 cases.

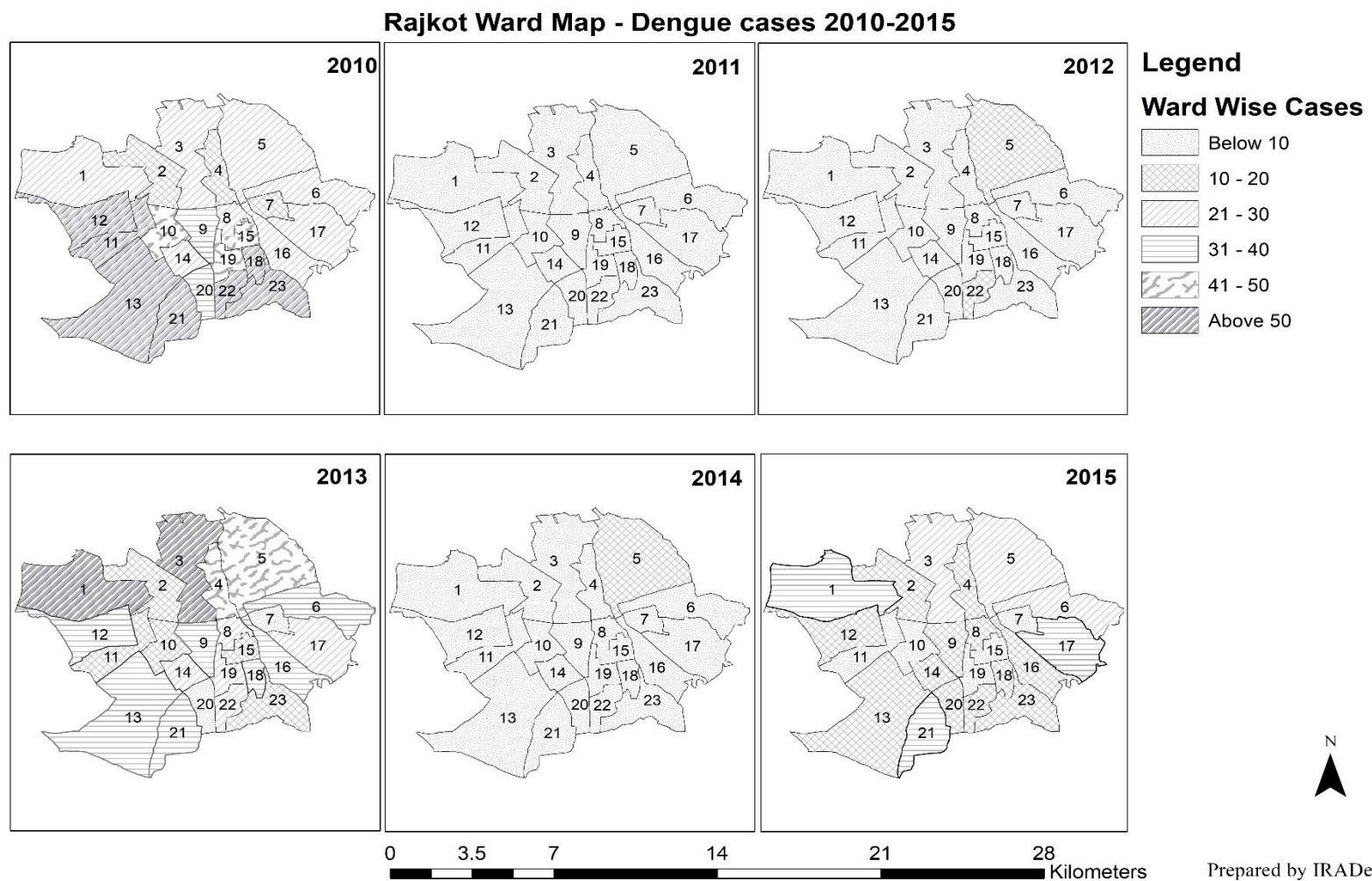


Figure 14: Ward-wise Trend of Dengue Cases, Rajkot (2010-2015), IRADe

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

Rajkot Ward Map- Dengue cases 2016-2018

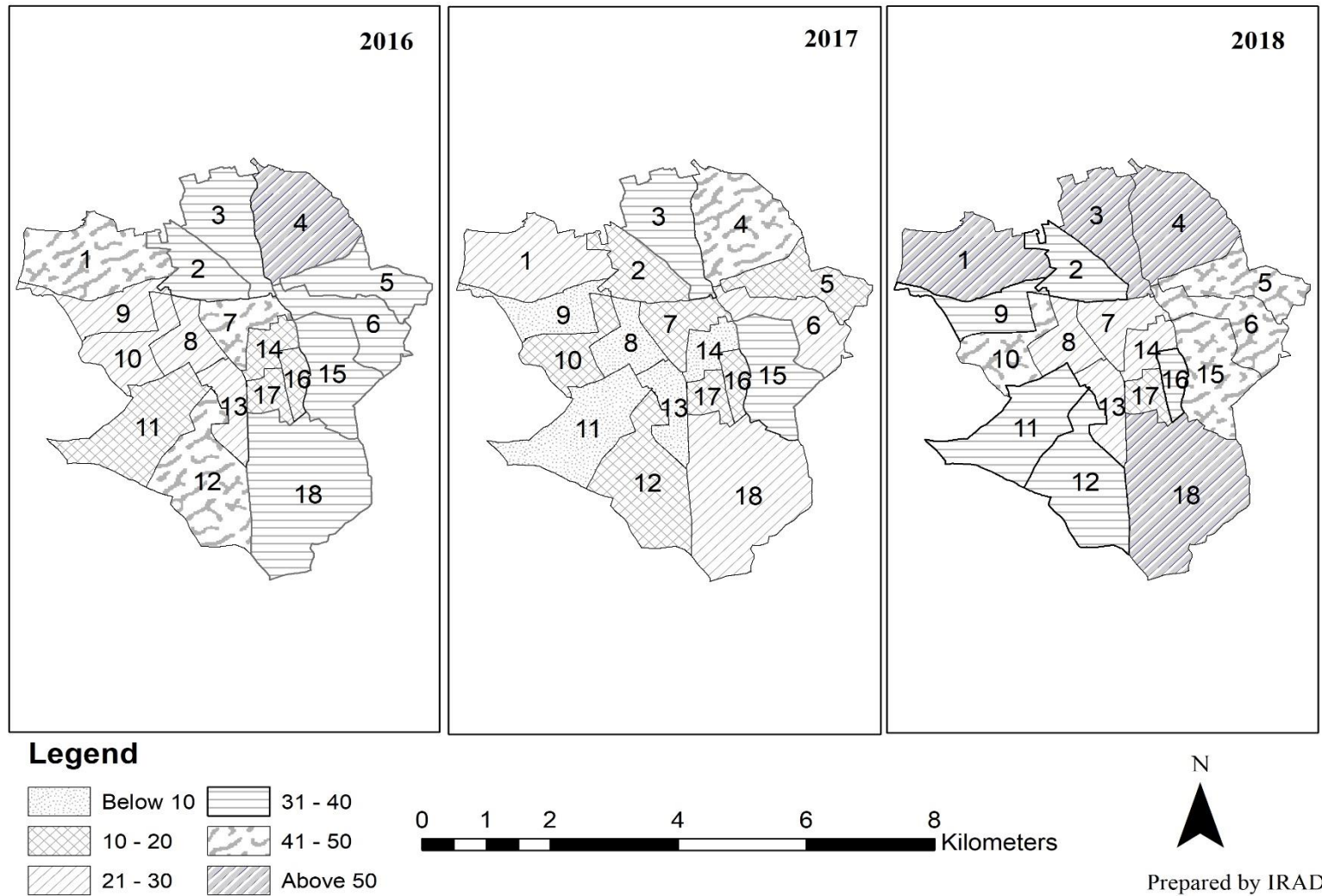


Figure 15: Rajkot Dengue Cases, 2016-2018

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

In 2016, the city recorded a total of 555 dengue positive cases. Of these, the highest number of dengue positive cases were recorded in Ward No. 4. It reported 53 cases or 9.5% of the city's caseload. This was followed by Ward No. 1 with 44 cases or 8% of the caseload. Ward No. 14 with 11 cases had the smallest number of people inflicted by dengue. Six wards recorded between 31-40 cases each in 2016 (Fig. 15).

In 2017, 350 cases were recorded. Ward No. 4 reported 42 cases (12%), followed by Ward No. 3 with 40 cases. 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 between 10-20 cases each in 2017 (Fig 15).

Year 2018 has recorded the highest number to dengue cases over the decade (763 cases), with Ward No. 18 registering as high as 82 cases followed by ward 4 and 1 with 75 and 73 cases respectively.

2. 2 Causes of Dengue emergence in Rajkot city

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 in nature for Rajkot city too. A study conducted by Pandit Deendayal Upadhyay Medical College, Rajkot, revealed that dengue positive 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 (Rajkot Municipal Corporation , 2012). With increase in the slum population and the absence of safe water storage infrastructure in these areas has made it conducive for 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 4: Correlation between Ward Population & No. of Slum Pockets

Wards 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

Wards 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 76,424 persons 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 major issue and people tend to store water in open/ uncovered containers and buckets, which are untreated and form the breeding grounds for the 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, 17 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 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 required precautions. **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 record higher incidence sin **2017**, include the similar reasons of higher slum population concentration, especially along 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 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. As the major factors pointed out by the RMC health officers were 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 and so forth are enablers in *A. aegypti* mosquito growth, the principal urban vector of dengue (Fig 16). There is no strong correlation with the number of slum pockets and the incidence of dengue cases as the total slum population plays an important determinate.



Figure 16: Accumulation of water in storage & water supply pits

Source: Rajkot Field Survey, IRADe team 2018

Table 5: Correlation between Dengue Incidences and Slum pocket

Ward No.	Total (2010-15)	No. of Slum Pockets	Ward No.	Total (2016-18)	No. of Slum Pockets
1	150	5	1	144	5
2	57	3	2	87	4
3	107	10	3	127	12
4	87	4	4	170	16
5	120	17	5	96	13
6	98	11	6	106	18
7	35	3	7	90	8
8	76	3	8	58	4
9	95	4	9	65	4
10	64	3	10	80	4
11	75	1	11	67	1
12	144	4	12	90	6
13	115	3	13	65	2
14	72	1	14	35	2
15	68	2	15	118	23
16	77	21	16	86	2
17	95	19	17	43	5
18	127	1	18	141	16
19	77	1	Total	1668	145
20	58	0			
21	144	2			
22	104	3			
23	124	3			
Total	1569	124			

Table 6: 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 6). A **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 done separately as there was revision in the wards from the year 2016

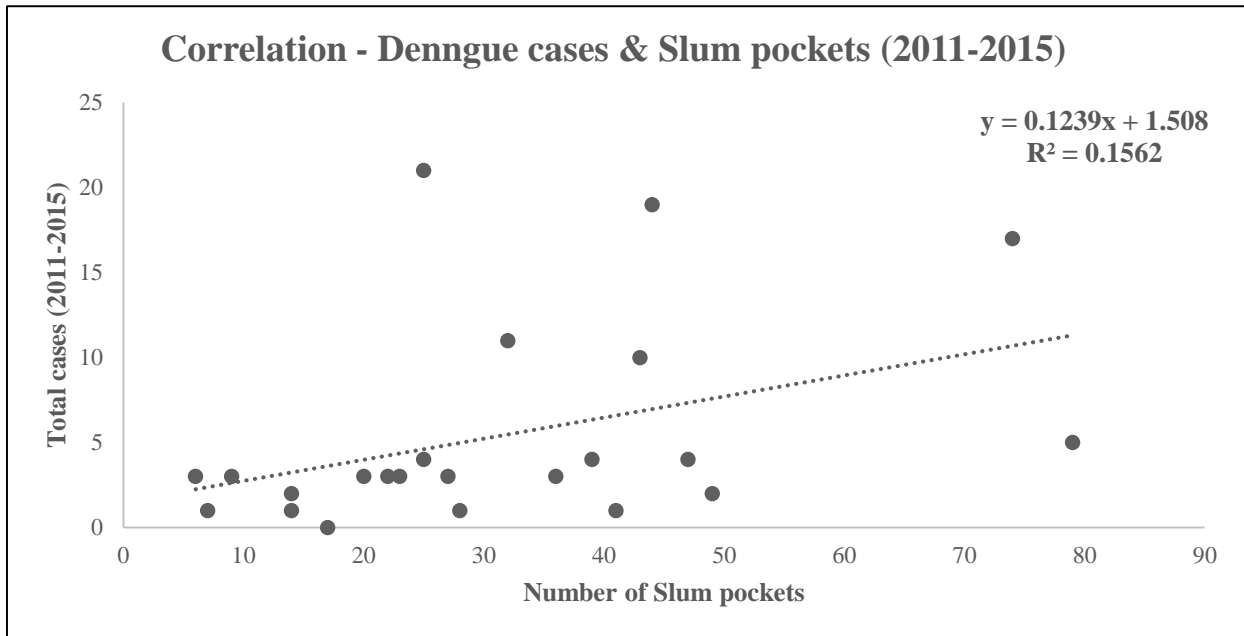


Figure 17: Correlation - Dengue Cases & Slum Pocket's (2011-2015)

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 17). 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 the period of 6 years (Table 5).

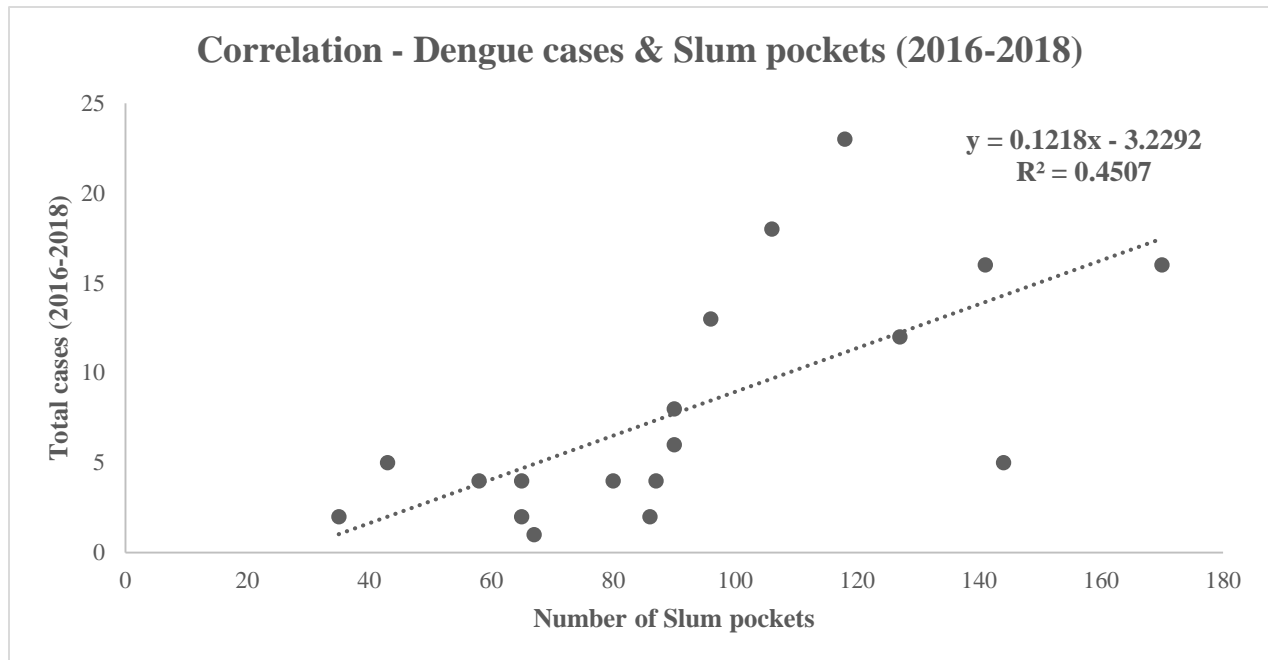


Figure 18: Correlation - Dengue Cases & Slum Pocket's (2016-2018)

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 number of slum pockets but significant (Figure 15). During this period (2015-2018) its observed that though the wards with large number of slum pockets have recorded high dengue incidences (Table 5)

Though the number of wards has reduced over the period of time the total number of slum pockets within the city have increased from 124 to 145, along the recorded dengue cases which were 721 for the period of 6 years and have increased to 1668 cases in a span of 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).(Fig. 19)

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 sqkm. 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.

Zonal Slum Pockets and Dengue Incidences

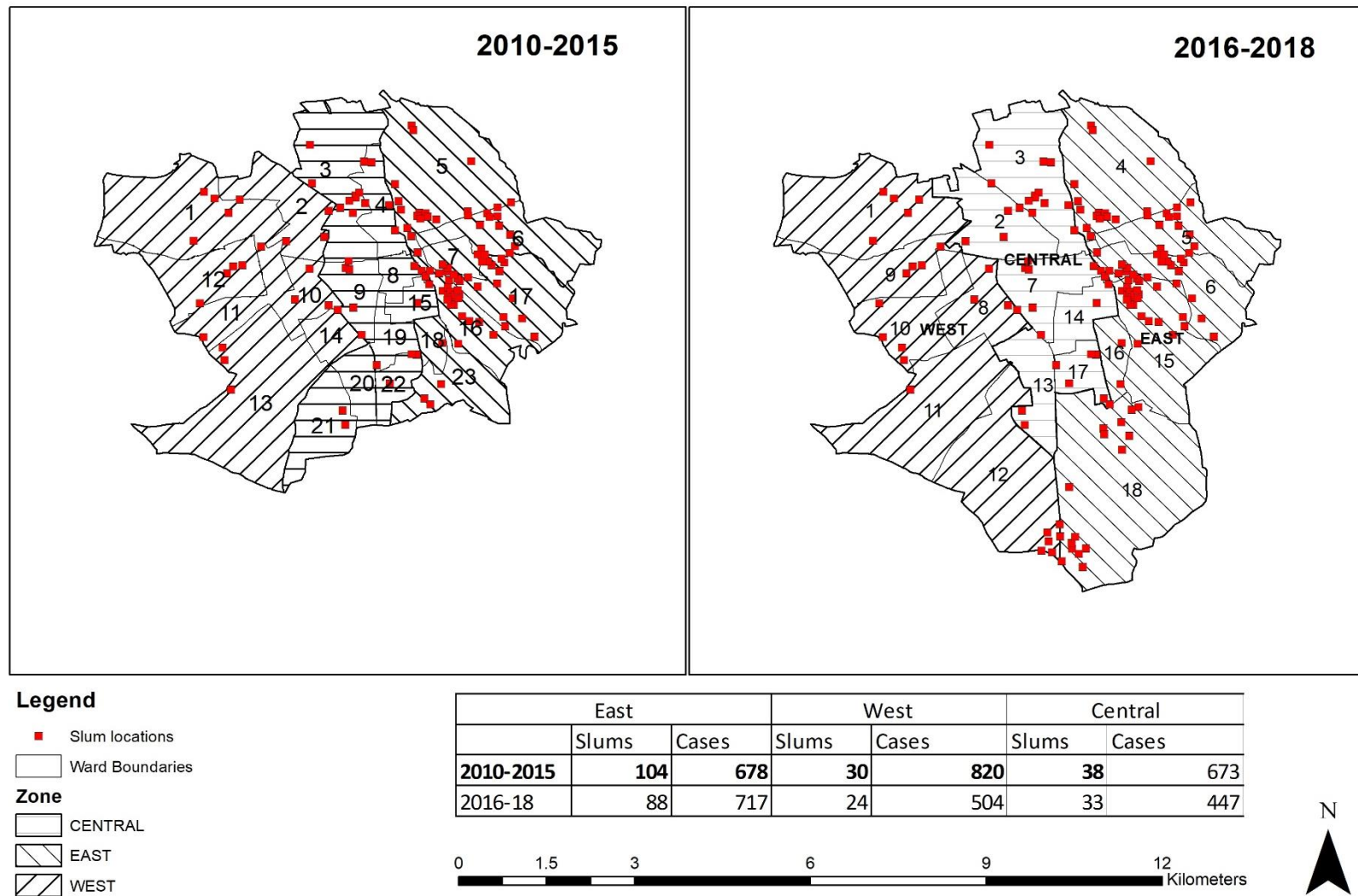


Figure 19: Zonal distribution of Slum Pockets and Dengue cases incidences

2. 3 Steps taken by Rajkot Municipal Corporation

The RMC Health Department has undertaken intensive mass media awareness campaigns and programmes to encourage dengue prevention and treatment-seeking behavior 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.

If we look into the records the cases have increased over the period of time and the corporation is now taking steps to reduce the numbers. With the increasing number of dengue incidences, the Municipal Corporation have 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 Field worker, Malaria Inspector, Biologist and Medical Officers and Asha Workers at each ward level. Biological control methods like distribution of *Gambusia affinis* (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, workshops etc. have been adopted at a large scale to spread dengue awareness within the city.

Medical Treatment

The symptoms of dengue which usually begins 2-3 days after one is bitten by an infected mosquito, including high 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 pain reliever, with fever medication like paracetamol/ crocin, rest, drink plenty of fluids are also recommended. It normally takes 15-20 days to recover.

Public Health/ environment measures

To avoid any major public outbreaks, certain measures are adopted by the health department of the Municipal Corporation which are listed as (details given):

- **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 water in pots to kill the larvae/eggs.

2. **Self-protection** measures are given below:
 - a. Wear long sleeves or long pants
 - b. It is best to avoid dark-colored clothes like dark shades of blue and black, as dark clothing has been observed to attract mosquitoes.
 - c. Apply mosquito repellent on the skin to deter mosquito bites. Mosquito repellent lotions and liquid sprays are available on the market; however, parents are cautioned against using strong repellents on small children because of potentially harsh chemicals.
 - d. Organic mosquito repellent alternatives such as all-natural citronella bug spray are readily available.
 - e. Use mosquito coils, electric vapor 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 an enhanced 4S implementation is doing it *consistently and regularly*.

Mosquito borne diseases like Dengue have 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 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.

PREVENTIVE CONTROL: DENGUE & CHIKUNGUNYA

CAUSES & SYMPTOMS

- Caused by Bite of *Aedes aegypti* mosquitoes (black with white spots)
- Generally bites in early morning and evening hours
- Causes acute viral infections that affect infant, youth and adults.
- Once bitten takes 2-3 days for one to fall sick
- Symptoms include high fever, joint & muscle pain, headache, vomiting, rashes and diarrhea etc.



4S ACTIONS

1. Search & Destroy



- Change water in flower pots, bird pots and indoor plants/ plates once a week
- Clean roof drain pipes and cover over head tanks & other vessels
- Clean air coolers every week before refilling
- Avoid water stagnation after rainfall and turn over empty buckets/ pots and puddles
- Put garbage in covered containers
- Add kerosene/ diesel oil to stagnant water puddles
- Contact M.Corp if mosquito breeding found at/near house

2. Self Protection Measures



- Wear long clothes covering arms and legs
- Use screens on doors & windows
- Use mosquito nets while sleeping
- Use mosquito/ insect repellants containing DEET/ repellant creams on clothing & exposed skin
- Avoid going outdoors in early morning or evening (Dusk & Dawn)

3. Seek Early Consultation



- Consult a doctor immediately if fever lasts over 2 days with skin rashes
- To relief fever take PARACETAMOL/ CROCINE as recommended by Doctor

4. Say YES to Fogging



- Allow fogging during outbreaks & epidemics

3. Conclusion

The risk of dengue has shown an increase in recent years due to rapid urbanization, lifestyle changes and deficient water management including improper water storage practices in urban, peri-urban and rural areas leading to proliferation of mosquito breeding sites. *Ae. aegypti* breeds almost entirely in domestic man-made water receptacles found in and around households, construction sites and factories. Vector control measures in such a scenario become a challenge.

Dengue virus and the mosquito are sensitive to environmental factors. High temperature, high levels of precipitation and change in humidity are strongly associated with elevated dengue risk. Dengue being a vector borne disease, the growth and development of dengue vector is climate dependent. The ecological and climatic factors influence the seasonal prevalence of both the vector and the dengue virus. The seasonality of transmission of dengue with increased severity has been observed in the post monsoon season. The cases peak after monsoon and it is not uniformly distributed throughout the year. Like other Indian cities, dengue occurrence is seasonal in nature for Rajkot city too. One of the factors that are causing the perennial occurrence of dengue cases was related to the growing number of slum population/numbers. With an 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.

Acknowledgement

We acknowledge inputs and support from Mr. B. Pani IAS, Municipal Commissioner Rajkot Municipal Corporation, Dr. Gulzar and Dr. Vaishali of Health Department, RMC for their support and sharing their data, inputs and knowledge. We would also like to thank Ms. Asha Kaushik, Senior Research Associate, IRADe and Ms. Yashi Sharma, Research Assistant, IRADe for their support and contribution in the research paper.

Reference

- WHO. (2020). Retrieved from <https://www.who.int/news-room/fact-sheets/detail/dengue-and-severe-dengue>
- Nedjadi T, E.-K. S. (2015). Tackling Dengue Fever: Current Status and Challenges . *Virol J*, 12, 212.
- Chakravarti A, A. R. (2012). Fifty years of dengue in India. *Trans R Soc Trop Med Hyg*, pp 273–282.
- Mutheneni, S. R. (2017). Dengue burden in India: Recent Trends and Importance of Climatic Parameters . *Emerging Microbes & Infections*.
- Shepard. (2014). Economic and disease burden of dengue illness in India. *INCLEN Study Group. Am Soc Trop Med & Hygiene* 91(6):, 1235–42.
- Gujarat Government Gazette,. (2017). *Gujarat Government Gazette, Vol. LVIII, Wednesday, 18th October, 2017/ Ashvina 26, 1939*. Rajkot: Gujarat Government .
- Rajkot Municipal Corporation . (2012). *Rajkot Slum Free Plan of Action, 2012-13*. Rajkot.
- Shiloh . (2009, April 30). “*Dengue claims one life in city*” *Times of India City*,. Retrieved from <https://timesofindia.indiatimes.com/city/rajkot/Dengue-claims-one-life-in-city/articleshow/4469011.cms>
- Ministry of Health and Family Welfare, India. (2011). “*Annual report to the people on health*” .
- Ministry of Health and Family Welfare, India . (2013). “*National health profile 2013*” .
- Parmar V . (2016, September 3). “*Three more suspected dengue cases reported in Rajkot*” . Retrieved from Times of India City: <https://timesofindia.indiatimes.com/city/rajkot/Three-more-suspected-dengue-cases-reported-in-Rajkot/articleshow/53994078.cms>
- NVBDCP. (2020). *National Vector Borne Disease Control Programme, Ministry of Health and Family Welfare, GoI* . Retrieved from <http://nvbdcp.gov.in/den-cd.html>