



SPATIO-TEMPORAL DISTRIBUTION OF DENGUE: ANDHRA PRADESH, INDIA.

S. Rama Krishna¹, Arugolanu Raju (ICSSR Fellow)², Prof. T.V. Krishna³

^{1,2}Research Scholar, ³Professor

Department of Geography, Andhra University, Visakhapatnam, India.

Abstract: Dengue, which is transmitted by *Aedes* mosquitoes, has been endemic in Andhra Pradesh for over a decade. However, there are no proper vector-control strategies that have led to a significant increase in the disease burden and are inadequate to prevent. Year wise data on Dengue Cases was collected for the 13 districts of Andhra Pradesh (2010- 2019) to investigate large-scale Dengue outbreaks. In this context, an attempt is made in this paper to identify high risk facing districts in Andhra Pradesh by Dengue disease.

Key words: *Aedes aegypti*, Dengue, Cases, Spatial, Temporal, Rayalaseema, Coastal Andhra Pradesh.

1. INTRODUCTION

Dengue fever is breaking bone fever and also known as yellow fever (Clarke and Tom. 2002). It is a mosquito-vectored viral disease and it is transmitted by the infective bite of the *Aedes Aegypti* mosquito variety. A mosquito becomes infected only if it bites the Dengue patient during the first 3 days of illness. After biting, the mosquito incubates the virus for 9 to 12 days before it becomes a carrier of the disease. Once infected, the mosquito remains infected for the whole of its life. Man develops disease after 5-6 days of being bitten by an infective mosquito and the diseases are called as 1. Dengue Fever and 2. Dengue Hemorrhagic Fever (DHF). Dengue Fever is a severe, flu-like illness; Dengue Hemorrhagic Fever (DHF) is a more severe form of disease, which may cause death. The Dengue mosquito grows in tropical and subtropical climates (Morens 2009). According to a recent report released by the World Health Organization (W.H.O) shows; that the Dengue is noticed in 128 countries in the world with 390 million infections per year endangering 3.97 billion people (Kwan 2018). Thus, the number of Dengue cases has increased tremendously during the last five years. Dengue fever is a major problem in Andhra Pradesh and India. In recent years, the Dengue outbreaks are gradually increasing year by year in various districts of Andhra Pradesh. The Dengue cases recorded in India were 99919,129166,188401,101192,157315 cases in 2015, 16, 17,18, 2019 respectively, particularly its distribution can be seen in Rajasthan, Panjab, South Gujarat, North West part of India and all states of Southern India and also in West Bengal whereas in Andhra Pradesh 3159,3417,4925,4011, 5286 cases were recorded in 2015,16,17,18 2019 respectively. Most of the Dengue cases recorded in Andhra Pradesh were from urban areas of Visakhapatnam, Guntur, Kakinada in 2019. Visakhapatnam district reported about 1201 Dengue cases, Guntur district 894 cases and East Godavari district 557 cases in 2019.

The rise of these Dengue cases are driven by complex interactions between hosts, vectors and viruses that are influenced by environmental, climatic, demographic and socio-economic factors and also human population growth, accelerated urbanization, increased international transport, lack of proper public health infrastructure as well as a lack of effective vector control and disease surveillance system (Rigau-Pérez et al., 1998, Gubler, 2002b, Hales et al., 2002, Mackenzie et al., 2004, Chaturvedi and Nagar, 2008).

The *Aedes aegypti* mosquito, mainly a type of urban mosquito, is well suited to specific environments such as water storage common areas and areas where waste disposal services are inadequate (Chinery 2004). The favoured breeding places are Desert coolers, Drums, Jars, Pots, Buckets, flower vases, Plant saucers, Tanks, Cisterns, Bottles, Tins, Tyres, Roof Gutters, Refrigerator Drip pans, Cement blocks, Cemetery urns, Bamboo stumps, Coconut shells, Tree holes and many more places where rainwater collects or is Stored (NVBDCP 2020). Susceptibility to such environments may be related to specific statistical factors such as age and sex whereas sex-specific Dengue data is scarce because surveillance systems usually do not report or analyse sex-based Dengue data. Some studies from Singapore showed that male Dengue patients are outnumbered female Dengue patients.

2. DATA AND METHODOLOGY:

The study mostly depends upon secondary data and it was collected from the DM&HO (District Medical and Health Office) of 13 districts of Andhra Pradesh, Districts Malaria Controlling Offices and Primary health care centres regarding numbers of Dengue cases from

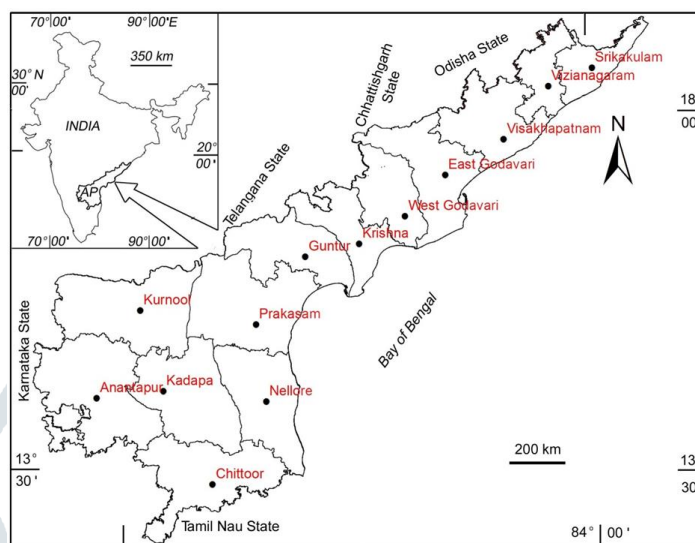
2010 to 2019 period of 10 years for 13 districts of Andhra Pradesh. In this study, SPSS has been used for descriptive analysis and Arc.GIS for generating Andhra Pradesh maps for spatial study.

3. OBJECTIVES:

1. To study the Spatial distribution of Dengue cases in the study region.
2. To examine, temporal variations of Dengue fever cases in the study region.

4. STUDY AREA:

Fig.1 Location map of Study area



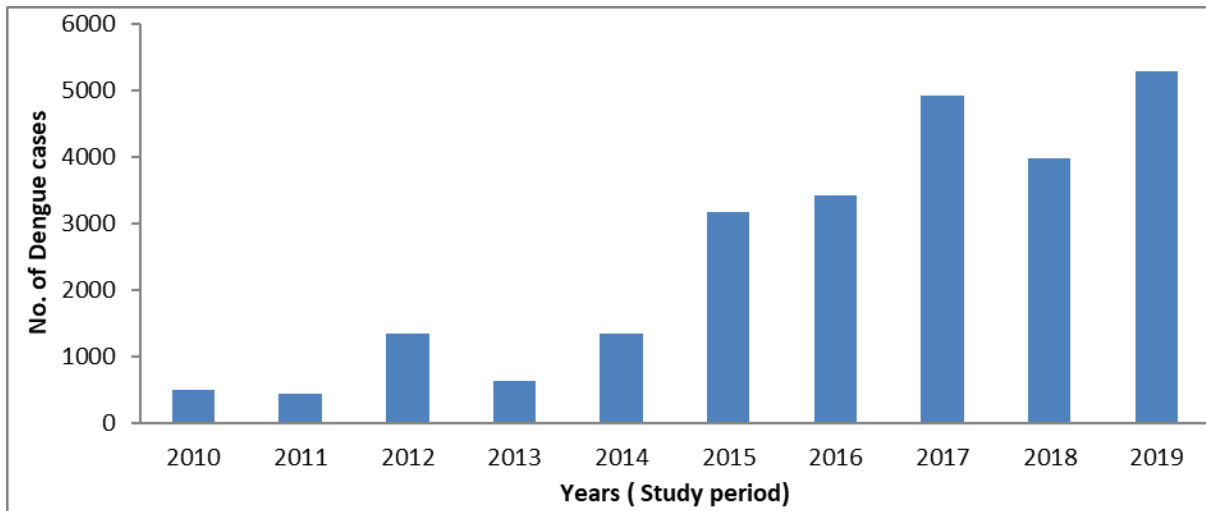
Andhra Pradesh, one of the 13 States of India lies on the eastern seaboard of the peninsular India and extends from 12° 45' to 19° 50' N latitudes and 76° 45' to 84° 45' E longitudes (Fig.1). The State is bordered by Odisha and Chhattisgarh in the north, Telangana and Karnataka in the west, Tamil Nadu in the south and Bay of Bengal in the east. The State is the eighth largest State in terms of geographical area which occupies 160,200 Km² which forms 5.13 % of the landmass of the country. The State has the second longest coastline of 974 km, among all the states. Andhra Pradesh is recognized into two regions namely Coastal Andhra and Rayalaseema with thirteen districts. [Coastal Andhra](#) region occupies the coastal plain between [Eastern Ghats](#), which runs the length of the State and the [Bay of Bengal](#). It consists of nine coastal Andhra districts namely Srikakulam, Vizianagaram, Visakhapatnam, East Godavari, West Godavari, Krishna, Guntur, Prakasam and Nellore are oriented from north to south. [Rayalaseema](#) region lies in the southeast portion of the State on the Deccan plateau. It is separated from Telangana State by the low [Erramala](#) hills, and from Coastal Andhra region by the Eastern Ghats. Rayalaseema region consists of four districts namely Anantapur, Kurnool, Kadapa and Chittoor. According to the 2011 census, Andhra Pradesh ranks ten with a population of 49.6 million which accounts for 4.08 % of Country's population. Of which 24.7 million are male population and 24.6 are female. Sex ratio is 996 females for 1000 male population. The literacy rate is 67.41 %. The population density is about 308 persons per kilometre. Andhra Pradesh State has 28 cities with 1, 00,000 plus population and cities with 2 million plus.

5. RESULTS AND DISCUSSION:

I.1 Temporal Distribution of Dengue cases during 2010-2019 period in the study region:

It can be observed from fig.2 that, about 24,990 Dengue cases recorded during 2010 – 2019 period in the study region. Highest number of Dengue cases recorded in 2019 (about 21.2%) followed by 2017 (19.7%), 2018 (15.9%), 2016 (13.7%), 2015 (12.7%), 2012 (5.4%), 2014 (5.3%), 2013 (2.5%), 2010 (2%) and very least in 2011 (1.8%). It is observed that Dengue disease gradually increased from 2010 and reached the peak stage by the year 2019 in the study region. Regarding the distribution of Dengue cases according to regions, about 43.1% of the total cases recorded in Central Coastal Andhra region, followed by the North coastal Andhra region (31.5%) and Rayalaseema region (25.4%).

Fig.2. Dengue cases during 2010-2019 period in the study area.



1.2.Temporal change in Dengue cases during 2010-2019 in the study region:

Regarding changes in Dengue cases in the study region during 2010 – 2014 & 2015 – 2019 period (table.no.2 & Fig.no.3) about 391% growth in Dengue cases recorded in the entire study region. Regarding regions, about 50% of the total Dengue cases recorded in Central Coastal Andhra region during 2010-2014 period, decreased to 41.7% of the total recorded cases during 2015-2019 period, Rayalaseema recorded 28.7% of the total cases decreased to 24.8% of the total cases during 2015-2019 period and North coastal Andhra recorded 21.3% of the total cases, Increased to 33.6% of the total cases during 2015-2019 period.

Fig.5. Dengue cases according to physical regions of the study area during 2010-2019.

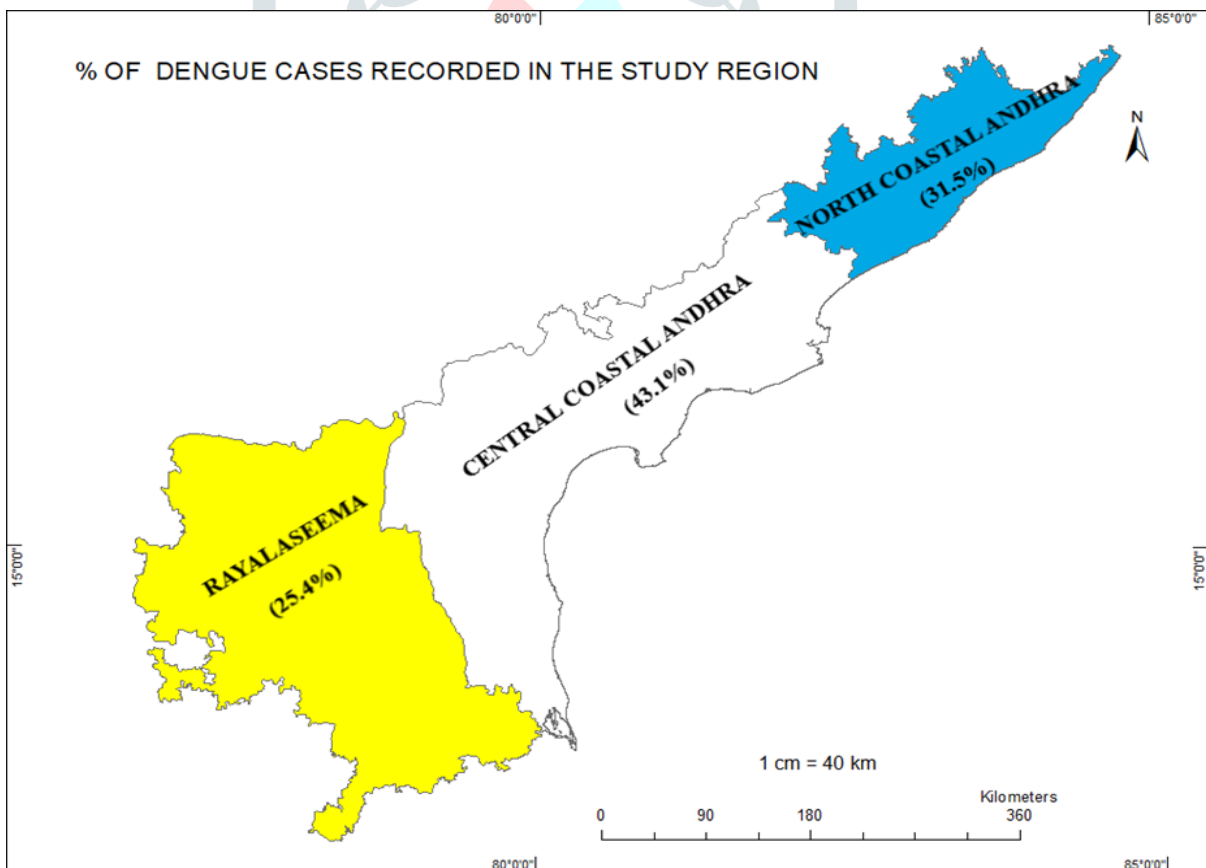
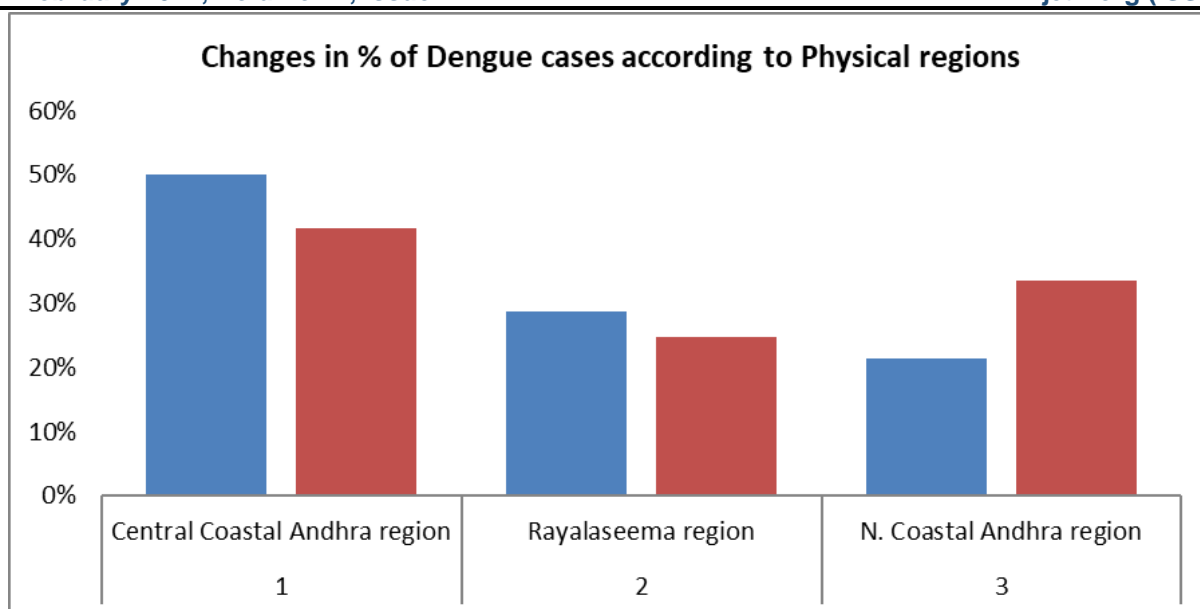


Fig.3. Changes in Dengue cases during 2010-2014 & 2015-2019 according to regions:



Tab.2. Changes in Dengue cases during 2010-2014 & 2015-2019 according to districts.

Table No.2	Changes in Dengue cases			
	NAME OF THE DISTRICT	Cases during		Change in Cases (%)
		2010-2014	2015-2019	
	North coastal Andhra			
1	Srikakulam	126(3%)	410 (1.8%)	+284 (225.40%)
2	Vizianagaram	59(1.4%)	410(1.8%)	+351 (595%)
3	Visakhapatnam	712(16.8%)	6150(29.6%)	+5438 (763%)
	<i>Total of the region</i>	897(21.3%)	6970 (33.6%)	+6073 (677%)
	Coastal Andhra			
4	East Godavari	207 (4.9%)	1707(8.2%)	+1500 (724.60%)
5	West Godavari	151(3.6%)	666(3.2%)	+515 (341%)
6	Krishna	703(16.6%)	1069(5.1%)	+366 (52%)
7	Guntur	362(8.6%)	2406(11.6%)	+2044 (64.60%)
8	Prakasam	488(11.5%)	1618(7.8%)	+1130 (231%)
9	Nellore/ Potti Sriramulu district	207(4.9%)	1186(5.7%)	+975 (473%)
	Total of the region	2118(50%)	8652(41.7%)	+6534 (308.50%)
	Rayalaseema			
10	Chittoor	436 (10.3%)	1961(9.4%)	+1525(350%)
11	YSR Kadapa	157(3.7%)	469(2.3%)	+312(198.70%)

12	Anantapur	400(9.5%)	2163(10.4%)	+1763(440.80%)
13	Kurnool	220(5.2%)	547(2.6%)	+327(148.60%)
	Total of the region	1213(28.7%)	5140(24.8%)	+3927(327.70%)
	Grand Total	4228 (100%)	20,762	+16,534 (391%)

I.3. Temporal distribution of Dengue cases during 2010-2019 period:

It can be observed from table no. 2. That is, about 4,228 Dengue cases recorded **during (2010-2014)** period in the study region. In Visakhapatnam district highest number of cases about 712 (16.8% of the total cases) in which highest number of cases about 712(16.8% of the total cases) cases recorded during 2010-2019 period in which, highest number of cases about 381 recorded in 2014, followed by 163 cases in 2012, 159 cases in 2013, 8 cases in 2011 and lowest 1 case recorded in 2010 and showing increasing trend dengue cases during the study period.

In Krishna district about 703 cases (16.6% of total cases) recorded during 2010-2014 period in which about 201 cases recorded in 2010 (This is the highest figure in the entire study region), followed by 158 cases in 2011, 139 cases in 2012, 130 cases in 2013 and 75 cases in 2014 and showing decreasing trend of cases during the study period

In Prakasam district about 488 cases (11.5% of total cases) were recorded during 2010 -2014 period in which about 188 cases were recorded in 2012, 185 cases in 2011, 100 cases in 2010, 15 cases in 2013 and nil cases in 2014 which showing decreasing trend during 2010-2014 period.

In Chittoor district about 436 cases (10.3% of total cases) recorded during 2010-2014 period in which about 329 cases recorded in 2012 (very highest number of recorded cases in the entire study region), followed by 81 cases in 2014, 15 cases in 2011, 7 cases in 2013, and 4 cases in 2010 showing decreasing trend of cases during the study period

In Anantapur district about 400 (9.5% of total case) recorded during 2010-2014 period in which about 330 cases recorded (second highest recorded cases in the study area), followed by 51 cases in 2012, 9 cases in 2013, and 5 cases each in 2011 and 2011 showing increasing trend of cases during the study period

In Guntur district about 362(8.6% of all total cases) cases recorded during 2010-2014 period in which about 151 cases recorded in 2012 (third highest recorded cases in the study area), followed by 133 cases in 2010 which was second highest cases record in the study area, 31 cases in 2011, 30 cases in 2014 and 17 cases in 2013. Showing decreasing trends during 2010 – 2014 period.

In Kurnool district about 220 (5.2% of total cases) cases recorded during 2010 – 2014 period in which about 110 cases were recorded in 2012, followed by 95 cases in 2014, 11 cases 2013, 4 cases in 2010 and nil cases in 2011 year.

In Nellore district, about 207 (4.9% of total cases) cases were recorded during 2010 – 2014, in which 76 cases in 2014 followed by 68 cases in 2013, 41 cases in 2010, 18 cases in 2012 and 4 cases in 2011.

East Godavari district 207 (4.9% of total cases) recorded during 2010 – 2014 period in which about 151 cases recorded in 2014 followed by 35 cases in 2013, 18 cases in 2012, 3 cases in 2010 and nil cases in 2011 and showing an increasing trend of cases during the study period.

In Kadapa district, about 157 (3.7% of total cases) during 2010 – 2014 period in which about 72 cases recorded in 2014 followed by 50 cases in 2013, 34 cases in 2012, 1 case in 2011, and nil cases in 2010 showing Increasing trend of cases during the study period.

In West Godavari district about 151 (3.6% of total cases) were recorded during 2010 – 2014 period in which 101 cases were recorded in 2012 followed by 20 cases in 2013, 19 cases in 2011, 6 cases in 2014 and 5 cases in 2010.

In Srikakulam district about 126 (3% of total cases) cases were recorded during 2010-2014 period in which 84 cases recorded in 2013 followed by 19 cases in 2012, 14 cases in 2014, 9 cases in 2011 and nil cases in 2010.

In Vizianagaram district, about 59 cases (1.4% of total cases) recorded during 2010 – 2014 period in which 23 cases were recorded in 2014 followed by 16 cases in 2012, 15 cases in 2013, 5 cases in 2011 and nil cases in 2010. This district recorded very least number of Dengue cases than other districts during the (2010 – 2014) period.

Temporal distribution of Dengue during 2015 and 2019 period:

During the 2015-2019 period about 41.7% of the total cases were recorded in the Central Coastal Andhra region, followed by the North Coastal Andhra region (33.6%) and Rayalaseema region (24.8%). about 20,762 Dengue cases recorded in the study region in Visakhapatnam district about 6150 (29.6% of total cases) recorded during 2015-2019 period in which, about 2480 cases recorded in 2018, followed by 1275 cases in 2019, 1127 cases in 2016, 983 cases in 2017 and 285 cases in 2015.

In Guntur district, about 2406 (11.6% of the total cases) cases recorded during 2015 – 2019 period in which about 971 cases recorded in 2019 followed by 686 cases in 2017, 349 cases in 2016, 262 cases in 2018 and 138 cases in 2015. Increasing trend of cases noticed during 2010 – 2014 during 2015 – 2019 periods about 41.7% of the total cases recorded in Central Coastal Andhra Region, followed by North Coastal Andhra Region (33.6%) and Rayalaseema Region (24.8%).

In Anantapur district, about 2163 (10.4% of the total cases) cases recorded during 2015 – 2019 period in which, about 805 cases recorded in 2017, followed by 526 cases in 2016, 408 cases in 2015, 348 cases in 2019 and 76 cases in 2018.

In Chittoor district about 1961 cases (9.4% of total cases) were recorded during 2015 – 2019 period in which about 998 cases were recorded in 2015. Further Chittoor recorded the highest number of Dengue cases recorded in 2015. About 421 cases recorded in 2017 followed by 327 cases in 2019, 166 cases in 2016 and 49 cases only in 2018 and showing a decreasing trend of Dengue cases noticed during 2015 – 2019 period.

In East Godavari district about 1707 (8.2% of total cases) cases were recorded during 2015 – 2019 period in which about 576 cases recorded in 2019 followed by 566 cases in 2018, 336 cases in 2016, 170 cases in 2017 and 59 cases in 2015. Increasing trends of Dengue cases noticed during 2015 – 2019 period.

In Prakasam district, about 1618 (7.8% of total cases) cases recorded during 2015 – 2019 period in which, about 751 cases in 2017, followed by 437 cases in 2019, 194 cases in 2005, 174 cases in 2016 and 62 cases in 2018.

In Nellore district, about 1186 (5.7% of total cases) cases were recorded during 2015 – 2019 period in which 536 cases were recorded in 2015 followed by 378 in 2017, 153 in 2019, 80 in 2016 and 39 in 2018. Decreasing trend of cases noticed during 2015- 2019 period.

In Krishna district about 1069 (5.1% of total cases) cases were recorded during 2015 – 2019 period in which, about 399 cases recorded in 2016 followed by 240 cases in 2015, 181 cases in 2019, 142 cases in 2017 and 107 cases in 2018. Decreasing trend of cases noticed during 2015 – 2019 period.

In West Godavari district about 666 (3.2% of total cases) cases recorded during 2015 – 2019 period in which, about 434 cases recorded in 2019 followed by 132 cases in 2018, 61 cases in 2017, 32 cases in 2016 and 7 cases in 2015. Increasing trend of cases noticed during 2015 – 2019 period.

In Kurnool district about 547 (2.6% of total cases) cases were recorded during 2015 – 2019 period in which about 322 cases were recorded in 2017 followed by 113 cases recorded in 2019, 55 cases in 2015, 48 cases in 2016 and 9 cases in 2018. Increasing trend of cases noticed during 2015 -2019 period.

In Kadapa district, about 469(2.3% of total cases) cases were recorded during 2015-2019 period in which, about 220 cases recorded in 2015 followed by 111 cases in 2019,103 cases in 2017, 22 cases in 2018 and 13 cases in 2016. It is showing a decreasing trend of cases during the 2015-2019 period.

In Srikakulam district about 410(1.8% of total cases) and in Vizianagaram district about 410 (18% of total cases) cases recorded and both districts showing an increasing trend of cases during 2015-2019 period.

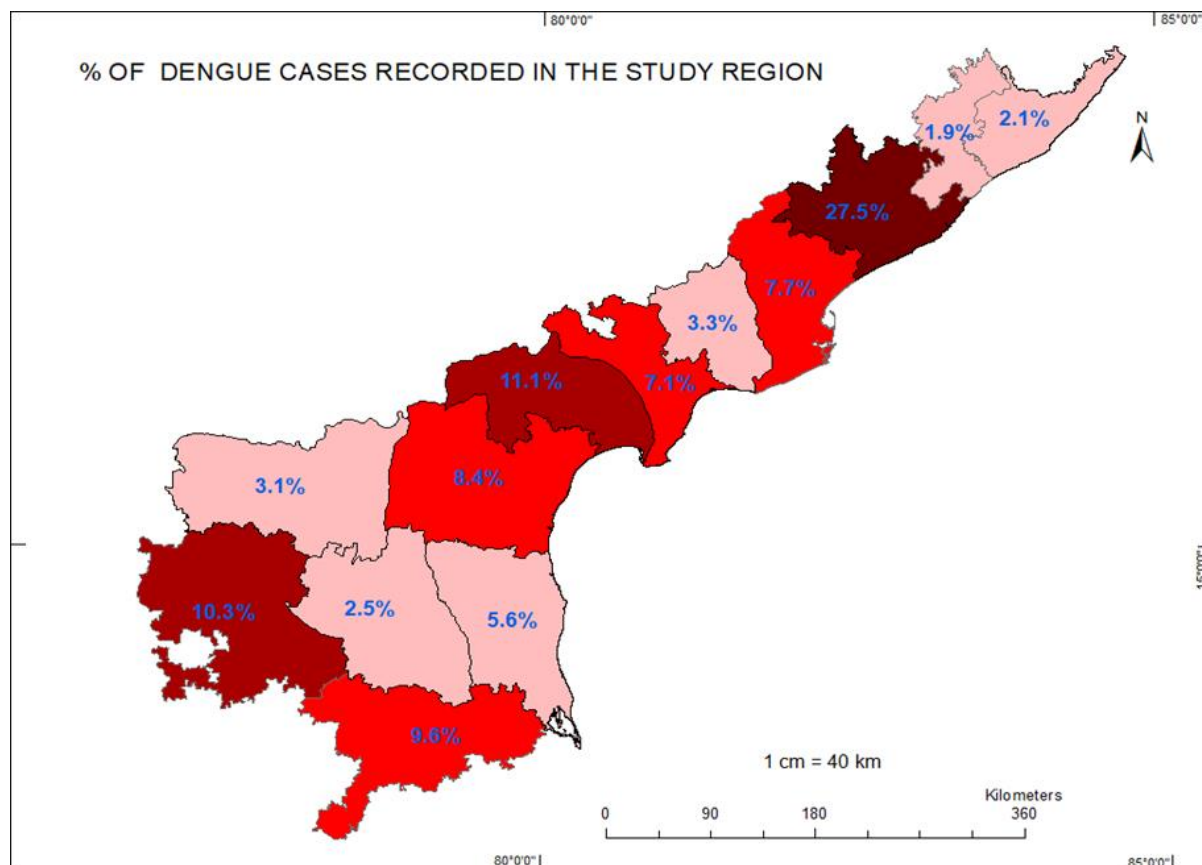
I.4. Changes in Dengue cases during 2010 – 2014 & 2015 – 2019 periods:

Table no. 2 showing that highest growth in Dengue cases recorded in North Coastal Andhra Region (677%), followed by Rayalaseema Region (327.7%) and Central Coastal Andhra Region (308.5%) and the entire study area registered about 391% growth in Dengue cases during 2010 – 2014 & 2015 – 2019 period. Regarding changes in districts about 763% growth in Dengue cases recorded in Visakhapatnam district during 2010 – 2014 & 2015- 2019 period followed by East Godavari district (724.6% growth), Vizianagaram district (595% growth), Guntur district (564.6%), Nellore district (473%), Anantapur district (440.8%), Chittoor district (350%), West Godavari district (341%), Prakasam district (231%), Srikakulam district (225.4%), Kadapa district (198.7%), Kurnool district (148.6%) and Krishna district (52%). This discussion indicates that a large number of Dengue cases were recorded in all districts during the 2015-2019 period when compared to the 2010-2014 period.

II.1. Spatial distribution of Dengue cases recorded during 2010-2019 period in the study region:

It can be observed from the fig .4 that, about 24,990 Dengue cases recorded in 13 districts of the study region during 2010 – 2019 period. Highest percentage about 27.50% of the total Dengue cases recorded in Visakhapatnam district followed by Guntur district (11.6% cases), Anantapur district (10.4% cases), Chittoor district (9.4% cases), East Godavari district (8.2% cases), Prakasam (7.8% cases), Nellore (5.7% cases), Krishna district (5.1% cases), West Godavari district (3.2% cases), Kurnool district (2.6% cases), Kadapa district (2.3% cases), Srikakulam district (2.1% cases), Vizianagaram district (1.9% cases). Further, according to regions (Fig.5), about 43.1% of the total Dengue cases recorded in Central Coastal Andhra region, followed by North Coastal Andhra region (31.5%) and Rayalaseema Region (25.4%).

Fig.4. Spatial distribution of Dengue cases recorded during 2010-2019 period in the study region.



II.2. Spatial distribution of Dengue cases according to districts during 2010-2019 period in the study area.

In this section spatial change of Dengue disease is examined according to districts during 2010 to 2019 period. In the year 2010, about 497 Dengue cases were recorded in the study area, in which 40.4 % of the total cases were recorded in Krishna district (201 cases) and recorded in the low cases category (Fig.7). About 26.8 % of the total cases were recorded in Guntur district (133 cases) and recorded under the very low cases category. About 20% of the total cases registered in Prakasam district (100 cases) and recorded under the very low cases category. Further, Nellore district (41 cases), Anantapur (5 cases), West Godavari district (5 cases), Chittoor district (4 cases), Kurnool district (4 cases), East Godavari district (3 cases) and Visakhapatnam district (1 cases) were also recorded under very very low cases category, whereas Srikakulam district, Vizianagaram district, and Kadapa district registered nil cases.

In the year 2011, about 440 Dengue cases were recorded which is about 11.5 % less than 2010-year cases (Fig.6.a). About 78% of the total Dengue cases were recorded in Prakasam district (185 cases) and Krishna district (158 cases) which comes under the very low cases category. Very very low number of cases recorded in Guntur district (31 cases) West Godavari district (19 cases), Chittoor district (15 cases), Srikakulam (9 cases), Visakhapatnam (8 cases), Vizianagaram (5 cases), Anantapur district (5 cases) and Kadapa district (1 cases) districts. Nil cases were recorded in East Godavari district and Kurnool district.

In the year 2012, about 1337 Dengue cases were recorded which was 203% of more case than 2011(Fig.6.b) cases. About 24.6 % of the total Dengue cases of the study area were recorded in Chittoor district (329 cases) which were recorded under moderate category of cases. About 63.7 % of the total Dengue cases were recorded in Prakasam district (188), Visakhapatnam district (163), Guntur district (151), Krishna district (139), Kurnool district (110), and West Godavari district (101), which comes under very low category. Very very low cases were recorded in Anantapur district, Kadapa district, Srikakulam district, East Godavari district, Nellore district and Vizianagaram district. Hence from 2012 onwards all districts recorded growth in Dengue cases.

In the year 2013, about 620 Dengue cases were recorded which was about 53 % less cases than 2012 cases (Fig.6.c). About 46.6% of the total Dengue cases recorded in Visakhapatnam (159) and Guntur (130) which comes under the very low cases category. Under the very very low cases category Srikakulam (13.5% of cases), Kadapa (8.1 % cases), East Godavari district (5.6%) of cases) and the remaining 6 districts shared the remaining percentage of cases.

In the year 2014, about 1334 cases were recorded which was 115% of more cases than 2013 cases (Fig.11). About 53.3% of the total Dengue cases recorded in Visakhapatnam district (381) and Anantapur district (330) which comes under moderate category of cases. Under very low category, East Godavari district (11.3%) and under very very low cases category 9 districts recorded and nil cases recorded in Prakasam district.

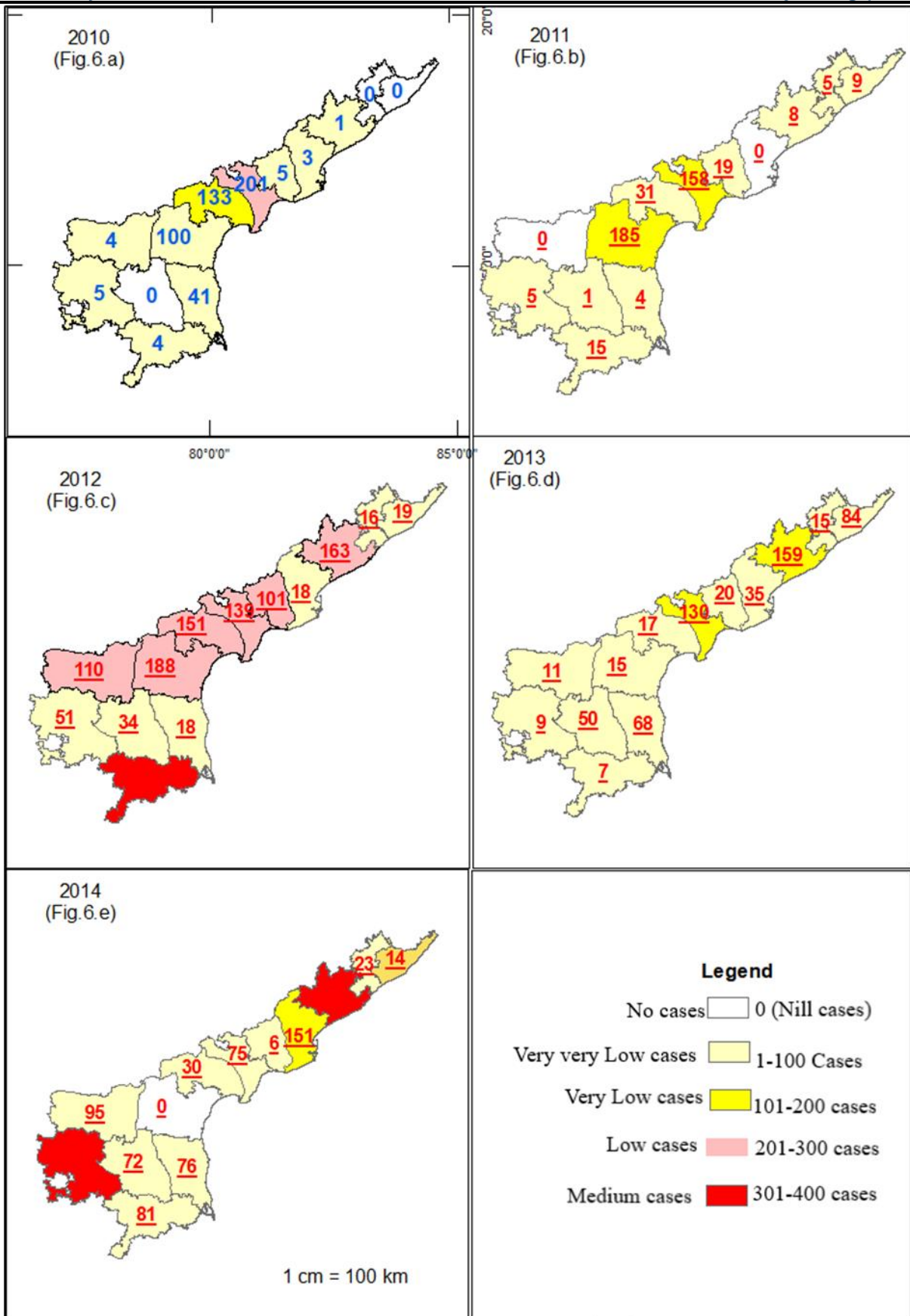
In the year 2015, about 3162 cases were recorded which was about 137% more cases than 2014 (Fig.6.d). About 48.5% of cases are recorded in Chittoor district (998 cases) and Nellore district (536 cases) which comes under the very high cases category. About 12.9% of cases recorded in Anantapur district (408 cases) and recorded under high cases category about 34% of cases recorded in Visakhapatnam district (285), Krishna district (240), Kadapa district (220), Prakasam district (194), Guntur district (138) and recorded under low cases category. Kurnool district (55 cases) East Godavari district (59) Vizianagaram district (16) West Godavari district (7) Srikakulam district (6 cases) districts under very very low cases category.

In the year 2016, about 3417 Dengue cases were recorded which was 8% of more Dengue cases than 2015 cases (Fig.6.e). Highest percentage about 33% of the total Dengue cases recorded in Visakhapatnam district (1127 cases) and recorded under the very very highest cases category. About 15.4% of the total cases were recorded in Anantapur district (526 cases) and recorded under the very high cases category. About 31.7% of cases recorded in Krishna district (399 cases), Guntur district (349 cases) and East Godavari district (336 cases) were recorded under moderate cases category. About 13.3% of cases were recorded in Prakasam district (174 cases) in Chittoor (166 cases), Srikakulam district (144 cases) and recorded under the very low cases category. Nellore district (80 cases), Vizianagaram district (53 cases), Kurnool (48 cases) West Godavari district (32 cases) Kadapa district (13 cases) districts recorded under very very low cases category.

In the year 2017, about 4925 Dengue cases were recorded which was 44% of more Dengue cases noticed than 2016 cases (Fig.6.e). About 65.5% of total cases were recorded in Visakhapatnam district (983 cases), Anantapur district (805 cases), Prakasam district (751 cases), Guntur district (686 cases) and recorded under the very high cases category. About 8.5% of cases are recorded in Chittoor district (421 cases) and occupied under the high cases category. About 14.2% of cases were recorded in Nellore district (378 cases) and Kurnool (322 cases) districts and were under the moderate cases category. About 8.4% of cases were recorded in East Godavari district (170 cases), Krishna district (142 cases), Kadapa district (103 cases), and occupied under the very low cases category. West Godavari district (61 cases), Srikakulam (57 cases) and Vizianagaram districts are under very very low cases category.

In the year 2018, about 3972 cases were recorded which was, 19.4% less number of cases than 2017 cases (Fig.6.f). About 62.4% of the total cases were recorded in Visakhapatnam district (2480 cases) and occupied the extreme cases category. About 14.2% of the total cases were recorded in East Godavari district (566 cases) and occupied under the very high cases category. About 6.6% of cases were recorded in Guntur district (262 cases) and occupied under the low cases category. About 6% of cases were recorded in West Godavari district (132 cases), Krishna district (107 cases) and occupied under the very low cases category. About 10.7% of cases recorded in Vizianagaram (99 cases), Anantapur district (76 cases), Srikakulam district (69 cases), Prakasam district (62 cases), Nellore district (39 cases), Chittoor district (49 cases), Kadapa district (22 cases), Kurnool district (9 cases) and occupied very very low cases category.

In this year 2019, about 5286 Dengue cases were recorded which was 33.1% more cases than 2018 year (Fig.6.j). About 24.1% cases were recorded in Visakhapatnam district (1275 cases) and occupied a very very high cases category. About 29.3% of cases were recorded in Guntur district (971 cases), East Godavari district (576 cases) and occupied a very high cases category. About 16.5% of cases were recorded in Prakasam district (437 cases), West Godavari district (434 cases) and occupied high cases category. About 12.8% cases were recorded in Anantapur district (348 cases), Chittoor (327 cases) and occupied the moderate cases category. About 17.4% of cases recorded in Vizianagaram district (196 cases), Krishna district (181 cases), Srikakulam district (164 cases), Nellore district (153 cases), Kurnool district (113 cases), Kadapa district (111 cases) and occupied very low cases category.



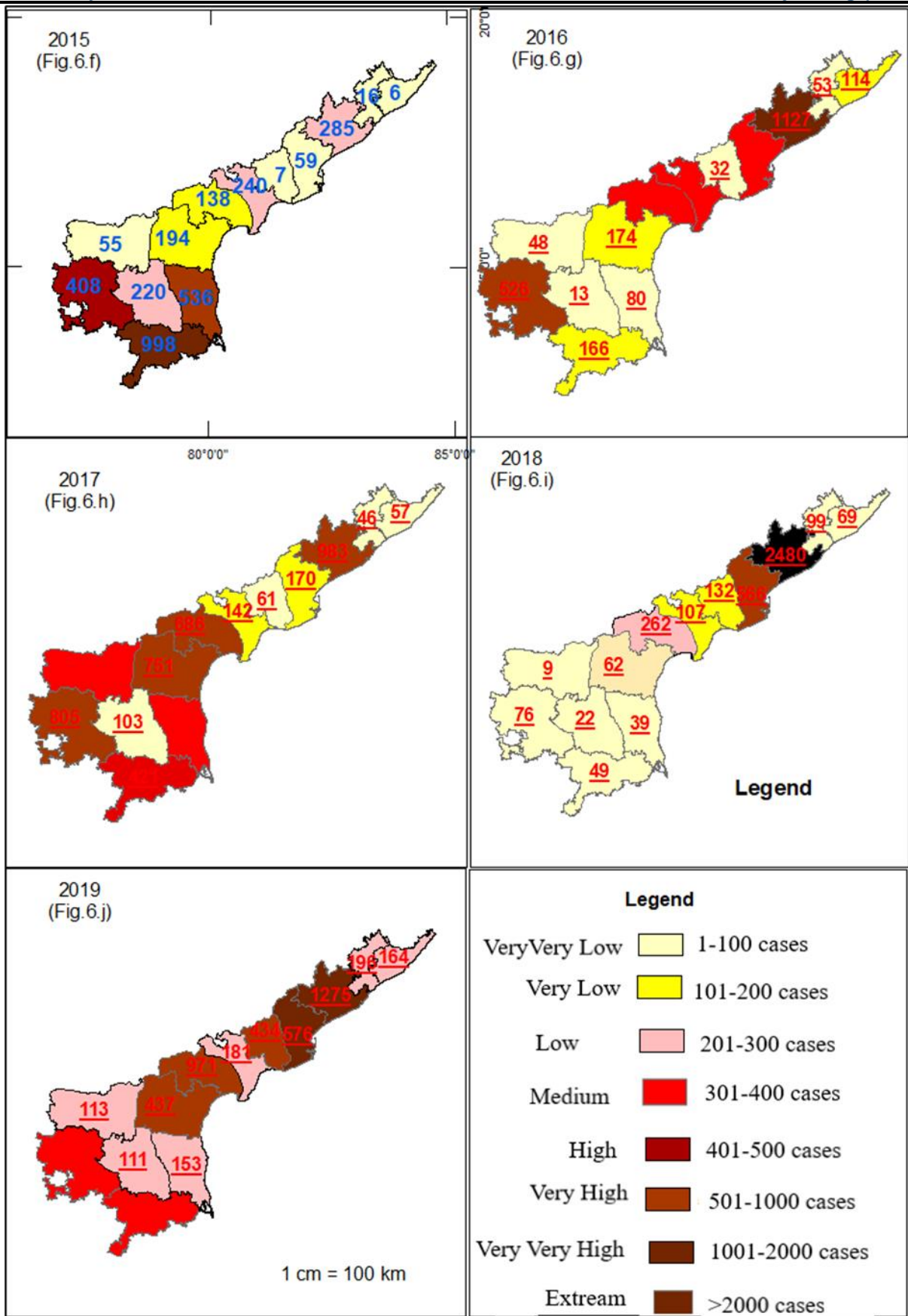


Fig.6. (a-j). Spatial distribution of Dengue cases during the period of 2010-2019.

CONCLUSION:

From the above discussion it is concluded that, highest number of Dengue cases recorded in Visakhapatnam district, followed by Guntur district, Anantapur district, Chittoor district, East Godavari district, Prakasam district, Nellore district, Krishna district etc., and it also observed that gradually Dengue cases are increasing over the study period. As it is a *Aedes Aegypti* mosquito –Vected viral disease and mostly noticed in Urban areas, Studies must be conducted on interactions between hosts, Vectors and Viruses that are influenced by environmental, Climatic, Demographic and Socio-economic factors along with accelerated urbanisation.

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