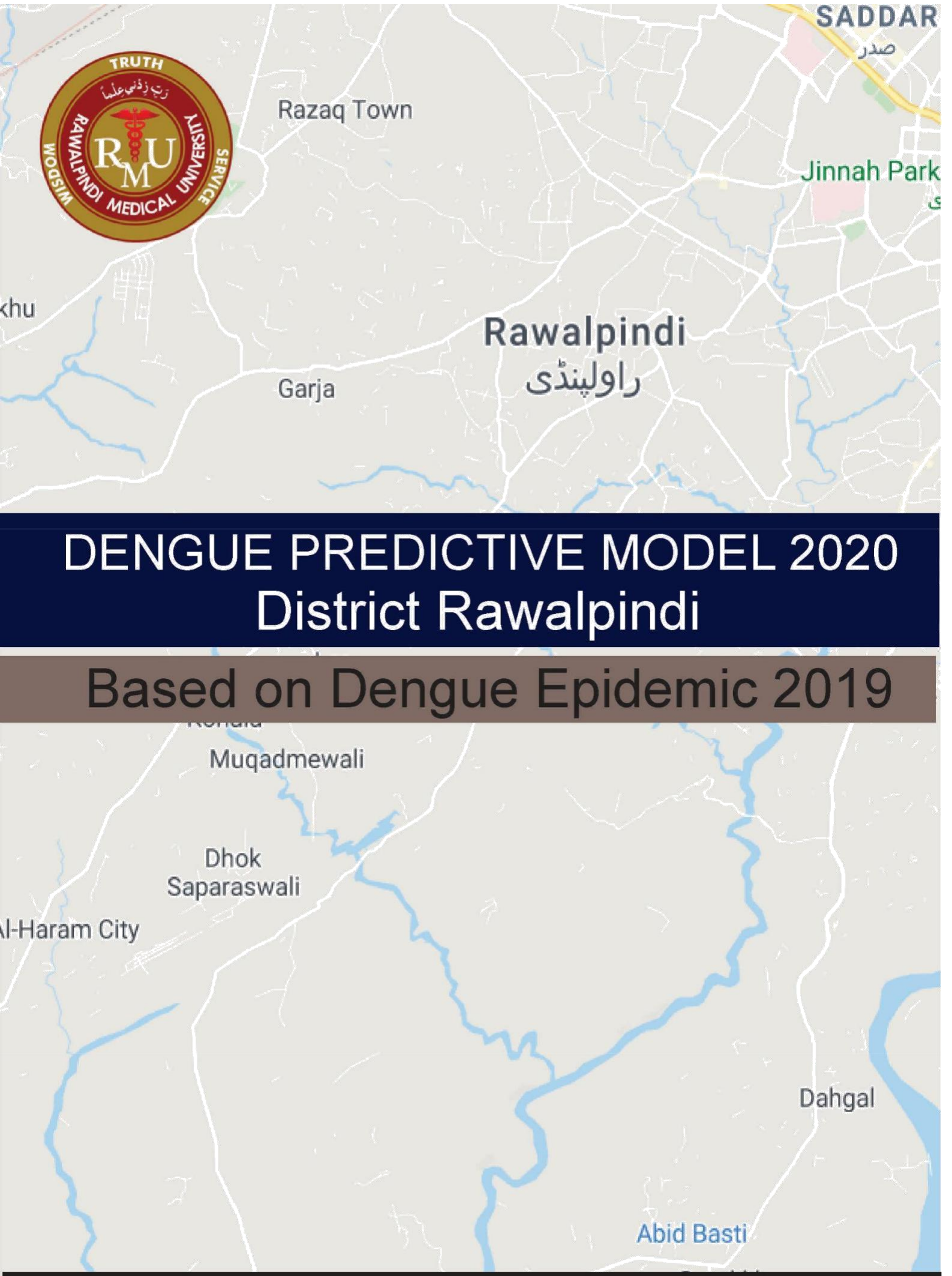

DENGUE PREDICTIVE MODEL 2020
District Rawalpindi

Based on Dengue Epidemic 2019

Rawalpindi Medical University

Project by

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Dated: 20th April 2020

لِّلْمُؤْمِنِينَ وَرَحْمَةٌ شِفَاء هُوَ مَا الْقُرْآنِ مِنَ وَنُنَزِّلُ

And We sent down in the Quran such things that have healing and mercy for the believers.

(An-Najm, 17:82)

RMU DATA MANAGEMENT CELL

University data management cell was established at new teaching block of RMU on 19th November 2019 under guidance of Prof. Muhammad Umar, Vice Chancellor RMU. It in an initial step for facilitation of comprehensive research by our faculty and residents.

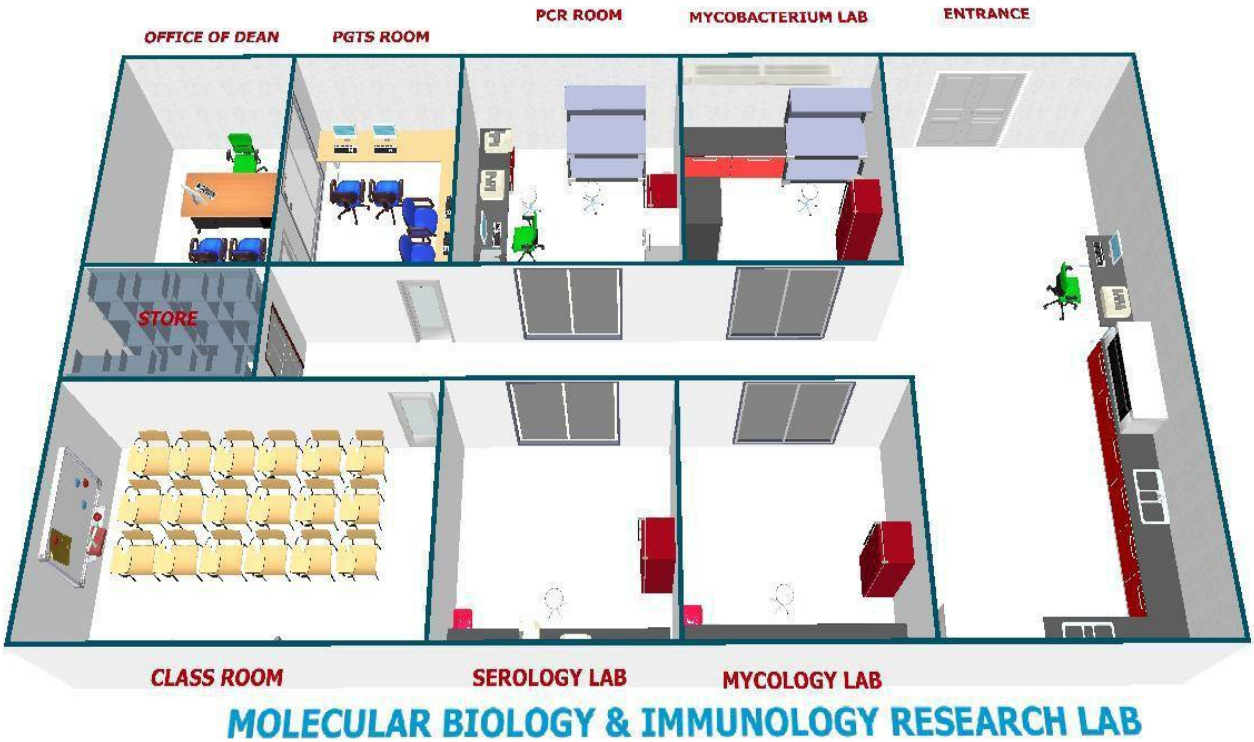
Objectives

- Data Availability
- Data Integrity
- Data Security
- Data independence

RMU Motto

GOALS: USE DATA FOR

- Prevention of Diseases
- Patient care management.
- Education of health professionals
- Research.
- Identification of disease incidence
- Planning and Marketing
- Logistic management
- Financial management
- HR management



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Introduction

Dengue is a disastrous health problem found to be prevalent worldwide. About 128 countries are found to be suffering from this disease. Pakistan is facing a drastic dengue outbreak menace since 2005. Propagation and survival of 4 serotypes of Aedes mosquito in Pakistan is mainly attributed to climatic conditions, urbanization, communication gap and poor surveillance, thus paving the way towards emergence of peak incidence of this disease[1].

Approximately 50% of global population is residing in dengue prone regions and 100 million dengue cases are reported annually[2]. High mortality and morbidity are mainly attributed to dengue hemorrhagic fever and dengue shock syndrome that are considered to be the most severe form of this ailment[3]. Even no internationally authorized vaccine is available for its prevention[4].

Globally dengue virus transmission is found to be endemic in about 128 countries of tropical and subtropical region that constitute approximately 3.9 billion of the world population[5].Dengue is a multifaceted disorder with varied symptoms ranging from mild to severe. Patients suffering with this complex disease are diagnosed as having dengue fever, dengue haemorrhagic fever, dengue shock syndrome and extended dengue syndrome[1].

Pakistan is hotspot for numerous vector borne diseases in addition to dengue fever and this disease is attributed to circulation of all four serotypes of dengue virus[6]. WHO regional office is seriously concerned with outbreak of dengue in Pakistan during 2019 and is providing technical support in this regard to manage this alarming situation[7]. Despite of support of WHO for vector control, case management and community awareness, about 47,120 confirmed cases of dengue fever including 75 deaths were reported from the 3 provinces of Pakistan. A total of 9,676 confirmed dengue fever cases including 16 deaths were testified from Punjab province. Generally the risk of dengue at national level in Pakistan was appraised to be high[8]. It seemed that all control measures failed to arrest the dissemination of problem.

Dengue predictive model designed in this regard will definitely facilitate our policy makers, strategic planners and respective health work force to take appropriate measures for timely management of dengue cases in 2020 by getting intimation of expected cases from our dengue predictive model.

Data Collection Summary

Start Date	19/11/2019 (36 Days)
End Date	31 Dec 2019
Total File Entered	12192
Variables	Demographic =25 Clinical Features =18 Investigation = 30 (10 days) Comorbidity = 23 Total Variables = 96 Total Entries = 366 Per File

Report

The report explains the process of analyzing the dengue spread in the district of Rawalpindi in the year of 2019. It also presents the outcome of analysis and provides the recommendation to tackle dengue this year.

Data-Set

The data-set consists of hospitalization of dengue cases for the year of 2019 in the three major hospitals of the Rawalpindi which are basically the teaching hospitals affiliated with Rawalpindi |Medical University namely:

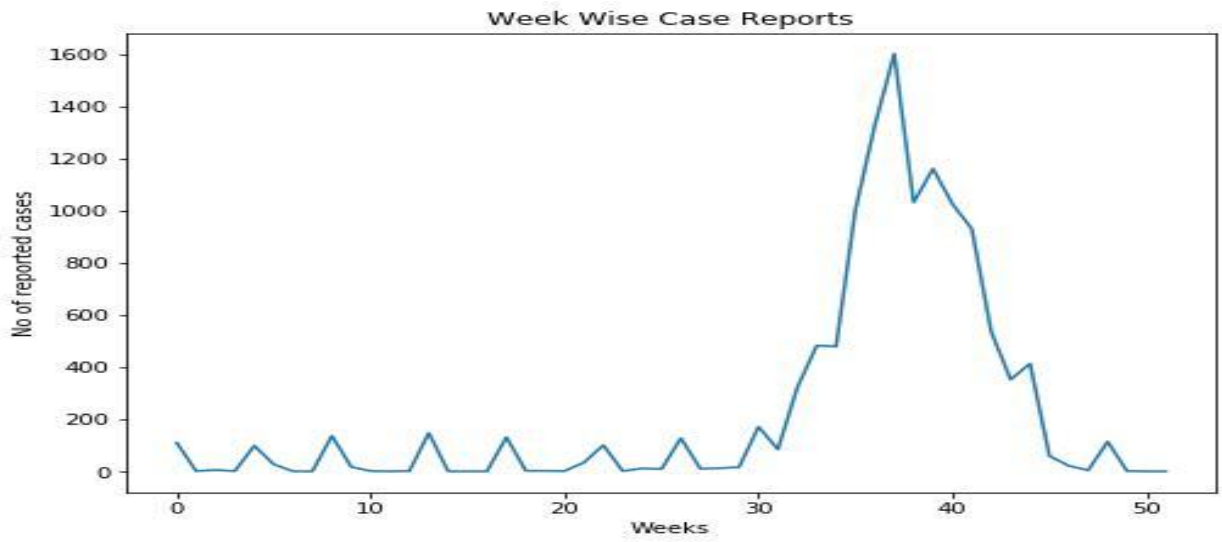
1. Holy Family Hospital (HFH)
2. Benazir Bhutto Hospital (BBH)
3. District Head Quarter Hospital (DHQ)

Around 12192 persons were hospitalized in the said time frame. Among which around 6500 were residents of Rawalpindi. Analysis is performed on those 6455 cases.

Data Wrangling

Apart from earlier mentioned data-set, weather data for the Rawalpindi was extracted from Texas A&M university weather data archive (https://globalweather.tamu.edu/). For data wrangling and later analysis python stack was used. Following tools have been frequently used for this project, Pandas, Numpy, Matplotlib, Sklearn, Pylab, Ipyleaflet, Seaborn, Geopanda, Geopy, jupyter notebook, etc.

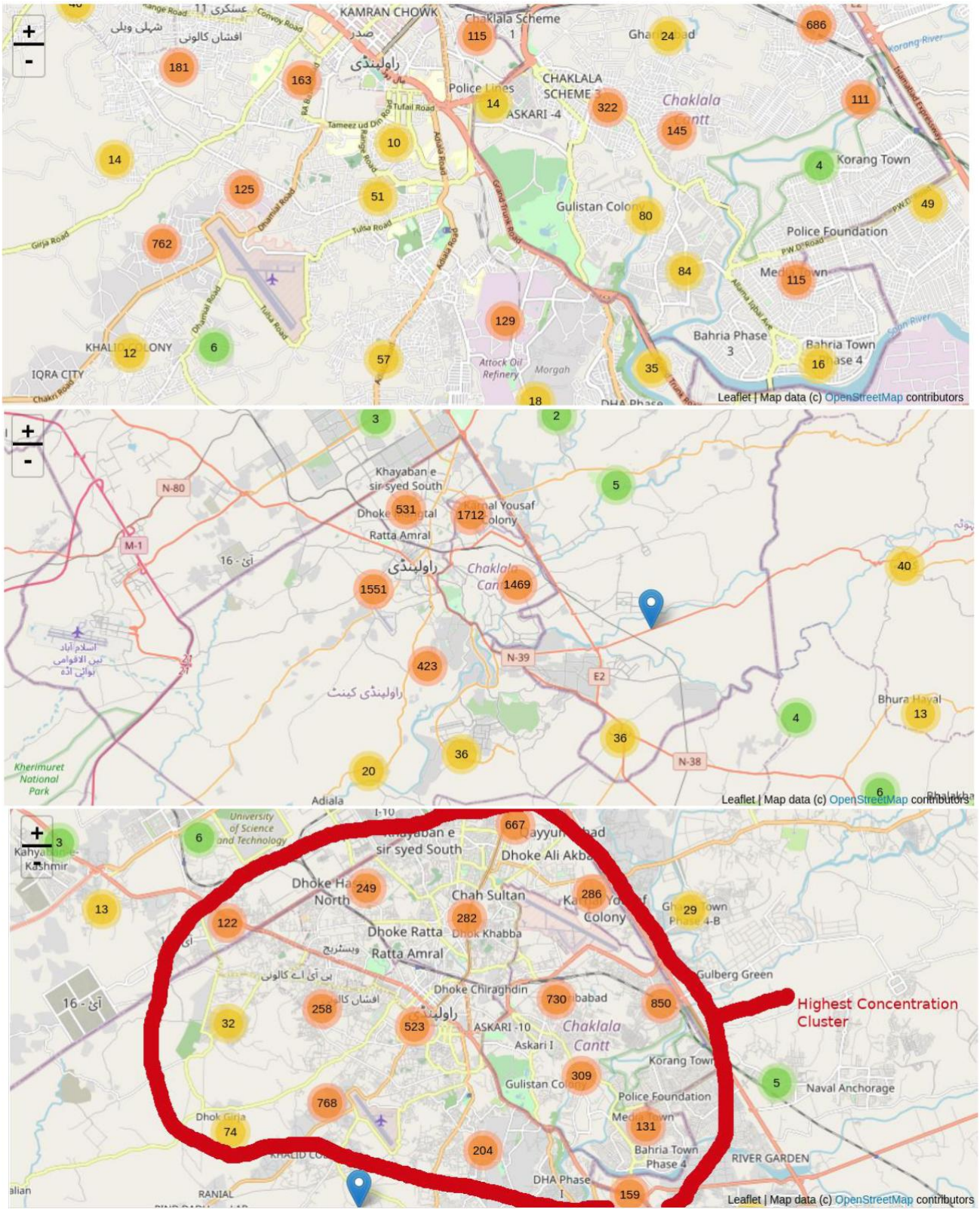
Analysis



The following graph shows the spread of the dengue in year 2019:
The graph clearly validate that dengue spread start increasing in the month of July it peaks in October then onward start declining by mid of November goes back its minimum level.

Area Wise Dengue Concentration

Map clearly shows the areas affected by the dengue. More preventive focus should be placed on these areas in terms of spray, fumigation and awareness.



Disease Cluster

Higher concentration of disease is visible through this map. The figure below is obtained through DBSCAN state of the art clustering algorithm. It is also showing the same cluster as visible in above map.

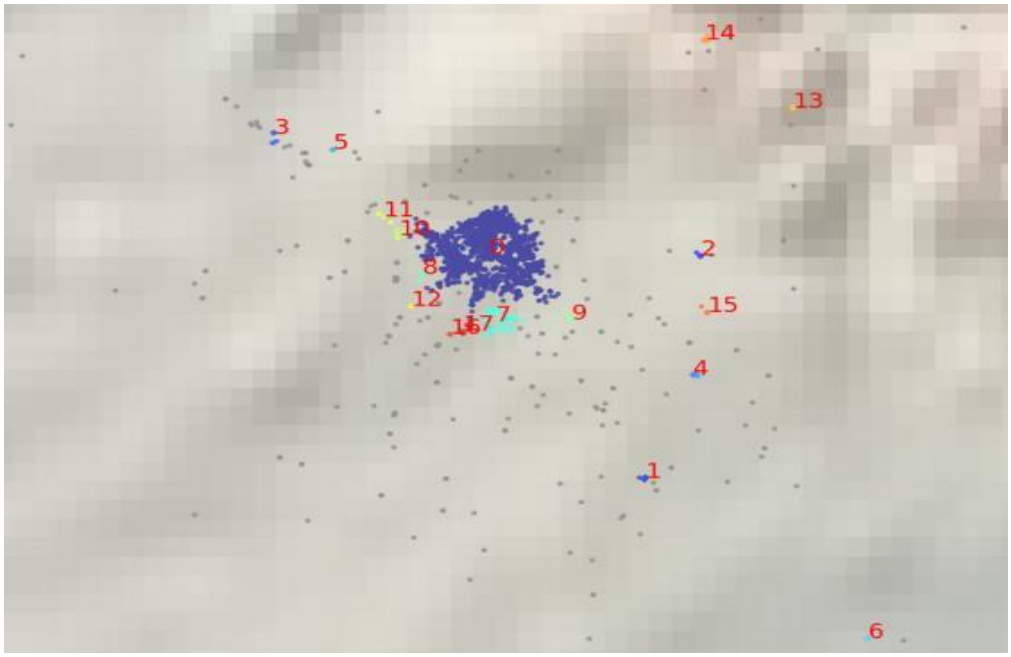


Table below shows the number of reported cases in each cluster. Cluster 0 is in the center of the city and is highlighted through red circle in the top map.

S.no	Zone	Areas of Rawalpindi District (5 Km Radius)	No of Dengue Cases in 2019
1.	Red Zone	Khayaban-e-sir syed / Dhoke Mangtal / Ratta Amral	531
2.		Colonel Yousaf colony	1712
3.		Rawalpindi City	1551
4.		Chaklala Cantt	1469
5.		Rawalpindi Cantt	423
6.		Dhamyal Road/ Tulsa Road	762
7.	Others	Adyala Road	60
8.		Police Foundation	115
9.		Bahria Town	140
10.		Afshan Colony	181
11.		Morgah	128
Total			7072

58% form Rawalpindi district
34 % form ICT
8% AJK, Abbottabad, Attock, etc.

Predictive Model

We took inspiration from literature and experimented with following independent variables:

Average weekly temperature

Average weekly precipitation

Average weekly wind speed

Active Cases (last two weeks total reported cases)

We applied Ordinary Linear Sequential Regression analysis. Our experiment show two variables: *'Active Cases '*and *'Average weekly temperature'* are significant variables. Other two are insignificant.

Following equation represents our predictive model:

Reported Cases = α + β1 *(average weekly temperature)* + β1 *(number of active cases)* ----*>EQ1*

OLS Regression Results

Dep. Variable:	y	R-squared:	0.794
Model:	OLS	Adj. R-squared:	0.785
Method:	Least Squares	F-statistic:	94.23
Date:	Mon, 20 Apr 2020	Prob (F-statistic):	1.62e-17
Time:	15:11:22	Log-Likelihood:	-343.74
No. Observations:	52	AIC:	693.5
Df Residuals:	49	BIC:	699.3
Df Model:	2		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
const	-113.0093	82.852	-1.364	0.179	-279.506	53.487
x1	5.4860	3.132	1.752	0.086	-0.807	11.779
x2	0.4442	0.034	13.252	0.000	0.377	0.512

Example:

Suppose there were 1000 active cases and weekly average temperature for previous week was 30C. We want to calculate how many cases are expected this week. We will plugin these values into following equation:

Expected Cases = -113 + 5.5*(average weekly temperature)* +0.44*(number of active cases)*

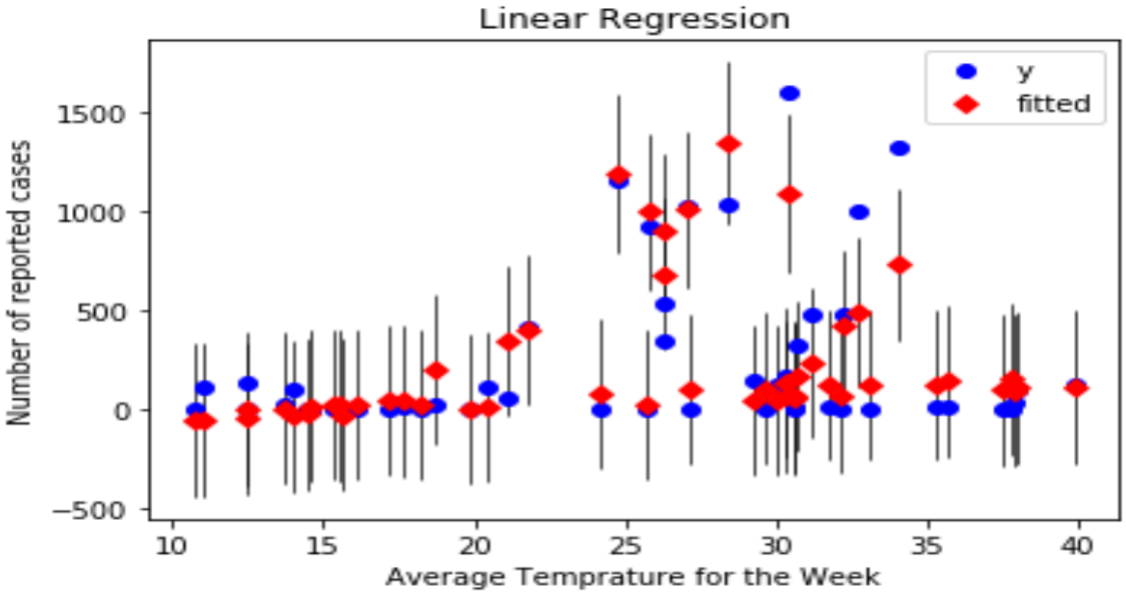
Expected Cases = -113 + 5.5 *(30)* + 0.44*(1000)*

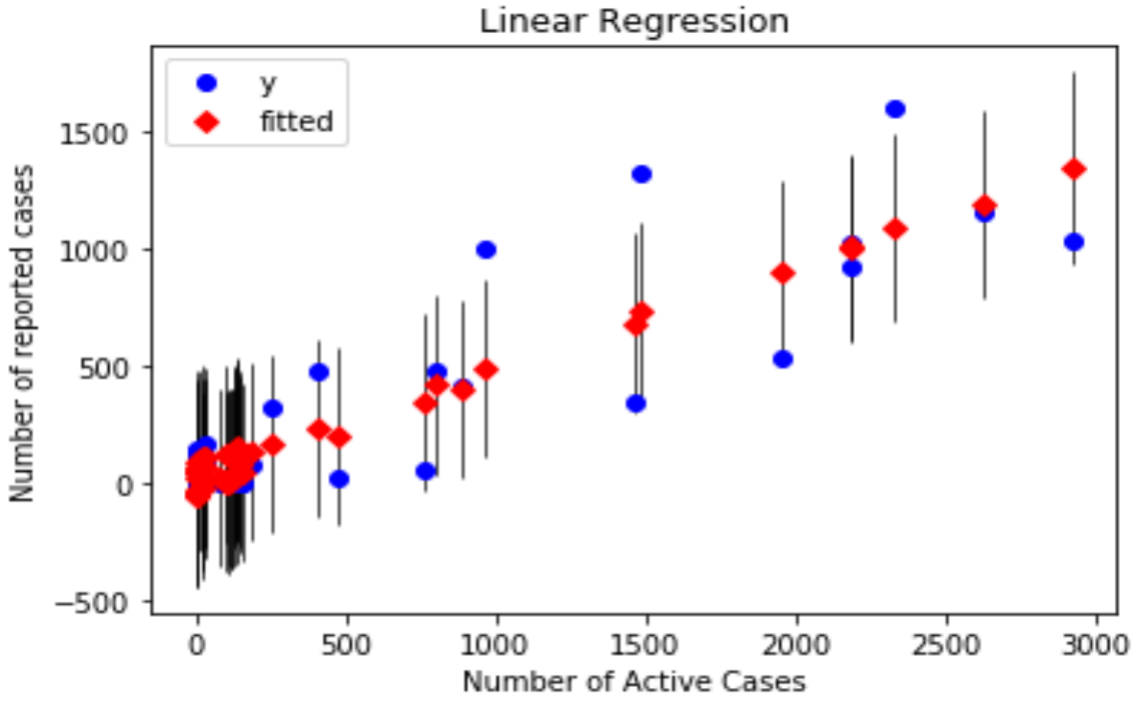
Expected Cases = -113 + *165* + 440

Expected Cases = 492

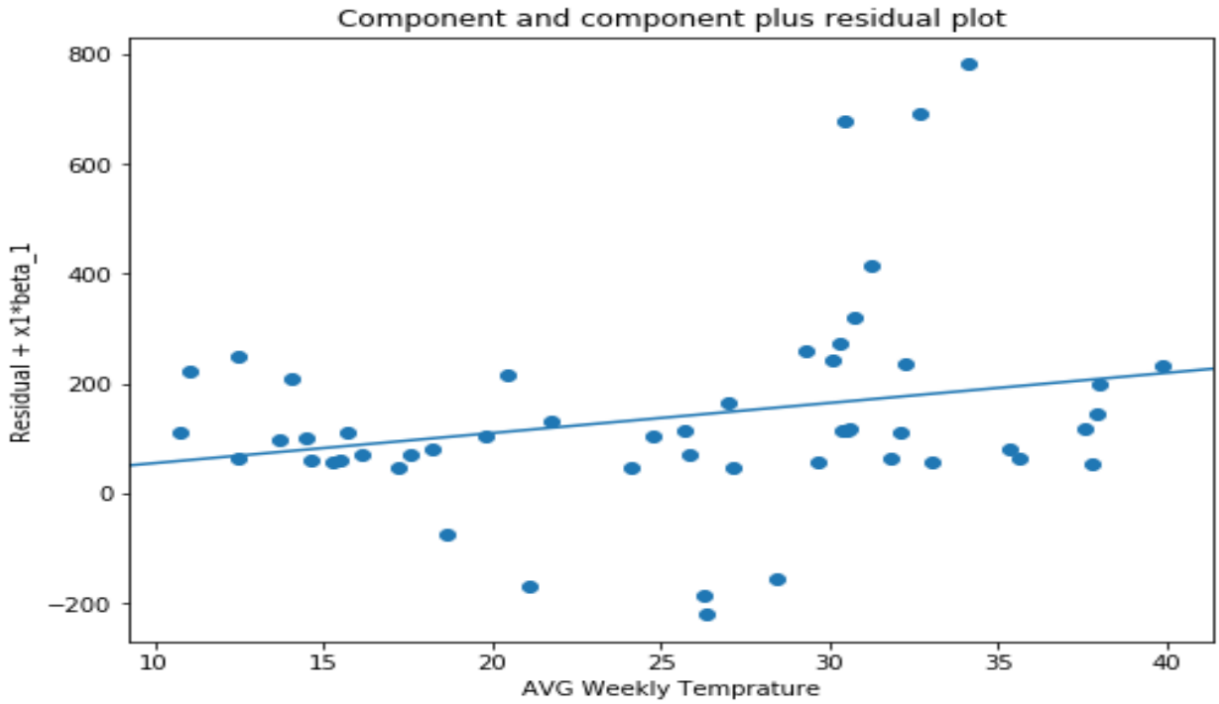
Goodness of the Model Fit:

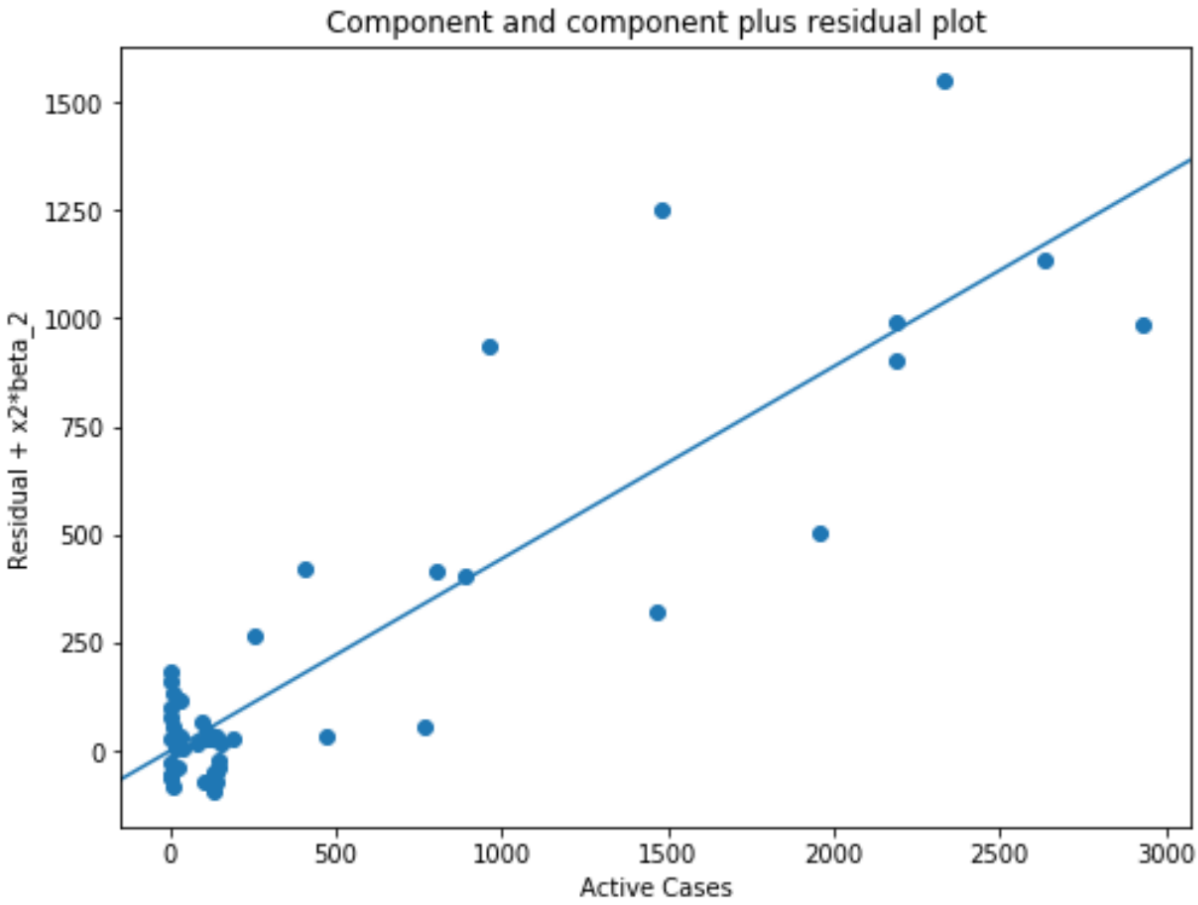
The figure in this section depicts the goodness of the fit model. As apparent blue dots are real values, whereas red squares are predicted values. Blue and red dots are moving together that means our model fits well.





In the following two figures solid line represents the predicted values whereas blue dots represent real values. Again these plots show model is good fit.



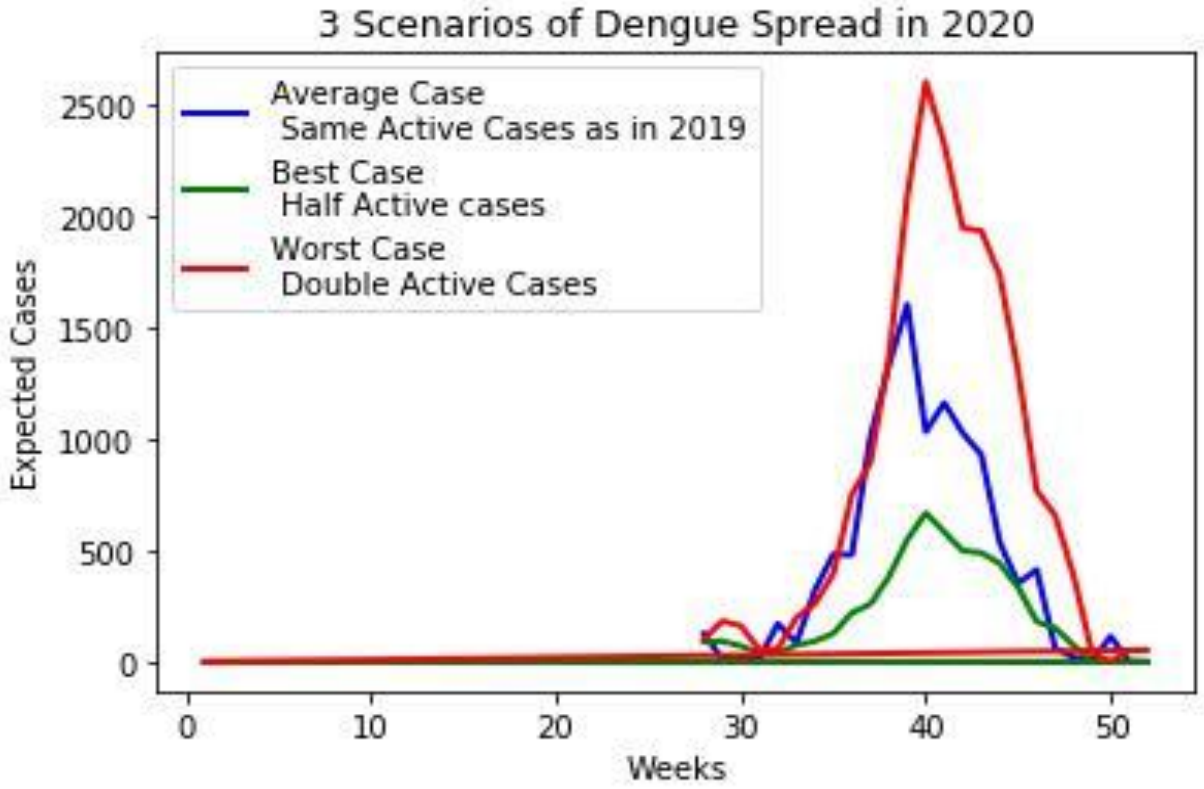


Average weekly temperature (blue solid line) is reasonably estimating cases reported(blue dots).

Active cases (blue solid line) are also moving in the same direction as reported cases (blue dots). It is also good estimator of reported cases.

Disease Spread Scenarios for 2020

The model estimated, rely on the two variables (number of active cases and average weekly temperature). Since temperature is an exogenous variable out of any one control. All efforts should be made to reduce the number of active cases. If at July we have double the number of active cases then worst case would materialize and peak will touch 2500 cases. If active number of cases remain the same as previous year then peak will be around 1500 cases. However, due to better management, and timely action the number of active case are reduced to half then peak would be around 5 hundred and epidemic will end in November 2020.



	Best Case	Average Cases	Worst Case
Expected Total Number of Cases in 2020	3072	7806	14025

Recommendations

The following recommendations would help to mitigate the dengue cases in 2020 to great extent: **Integrated vector management (IVM)** is the strategic approach to vector control promoted by WHO[9] and includes control of the vectors of dengue. This includes combination of environmental management and chemical control.

a) Environmental management: By environmental modifications in terms of :

- Drainage of vector breeding sites by frequent emptying and cleaning of water-storage vessels, flower vases and desert room coolers; cleaning of gutters; sheltering stored tyres from rainfall proper disposal of discarded containers and tyres

- Reduction of human–vector contact by installing mosquito screening on windows, doors and other entry points and using mosquito nets while sleeping during daytime.

b) Chemical Control

- Use of insecticides for killing of mosquitoes specifically in areas with increase density of cases in 2019
- Monitoring the effectiveness of insecticides
- Use of larvicides on stagnant water

c) **Personal protection**

- Proper clothing to minimize skin exposure

- Repellents may be applied to exposed skin or to clothing.

- Insecticide-treated mosquito nets afford good protection for those who sleep outdoor during the day Household insecticide aerosol products, mosquito coils or other insecticide vaporisers may also reduce biting activity.

Other Measures

- Advocacy & Social Mobilization by giving awareness through social media on protective measures against mosquito biting

- Inter-sectoral collaboration (collaboration between public and private sector health, educational, environmental, tourism and finance and planning ministries to make dengue vector control effective.

- Monitoring and evaluation by concerned District health teams from time to time for situation analysis and respective logistics arrangement[10]

Training Sessions

The following public health workers should have capacity building sessions[11]:

- Public health entomologists
- Vector control personnel,
- Environmental specialists,
- Social scientists

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