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## AN EFFECTIVE STUDY OF GEOGRAPHICAL PATTERN AND INTENSITY OF DENGUE OUTBREAK AMONG MALES IN PUNJAB, PAKISTAN

**Shahbaz Ahmad**

Department of Computer Science, National Textile University, Faisalabad, Pakistan  
[shahbaz@ntu.edu.pk](mailto:shahbaz@ntu.edu.pk)

**Muhammad Asif** (Corresponding Author)

Department of Computer Science, National Textile University, Faisalabad, Pakistan  
[asif@ntu.edu.pk](mailto:asif@ntu.edu.pk)

**Muhammad Majid**

Department of Computer Science, Govt Post Graduate College, Sannabad, Faisalabad,  
Pakistan  
[mmajid2026@gmail.com](mailto:mmajid2026@gmail.com)

**Manaza Iqbal**

Department of Computer Science, Government College University Faisalabad, Sahiwal,  
Pakistan  
[manazaiqbal786@yahoo.com](mailto:manazaiqbal786@yahoo.com)

**Muhammad Adeel**

Department of Computer Science, National Textile University, Faisalabad, Pakistan  
[adeel@ntu.edu.pk](mailto:adeel@ntu.edu.pk)

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### Abstract

Dengue Fever is a hot issue under discussion around the world, specifically in tropical and sub-tropical countries. It is an epidemiological disease which covers the massive geographical area

*within no time from person to person. It is difficult to take over dengue fever with limited technical resources; administrative authorities should be equipped with technical resources and infrastructure. Geographical Information System (GIS) is well-developed technology to express all sort of information in thematically maps along with the reflection of hotspot areas. In this research paper, we used Arc View as GIS tool to exemplify Male Patient data of Dengue outbreak in Punjab 2011. In Punjab 14500 male patients were registered in thirty-seven epidemiological weeks during this outbreak. This research analysis discovered significant results of geographical pattern and intensity of dengue fever among males belong to all districts of Punjab. These results can assist to Health departments and decision making authorities to make plans to avoid from future outbreak and emphasis on hotspot areas with preventive measures so that human and financial losses can control up to a minimum.*

### **Keywords**

Dengue Fever, Aedes aegypti, GIS, Outbreak, Health Surveillance

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## **1. Introduction**

Dengue Fever (DF) is arbovirus disease which spread in tropical and sub-tropical countries in short time and almost covering 125 countries of the world (S.-S. Sam et al. 2013). Dengue Fever is found in three types with respect to the intensity of fever like Dengue Fever (DF), Dengue Hemorrhagic Fever (DHF) and Dengue Shock Syndrome (DSS). The first type is normal fever while second and third types are more warning and threatening, in its normal fever move to extreme along with blood through nose and gums and patient feel extreme joint pain (J. E. Sam, Gee, and Nasser 2016). Dengue Virus is spread due to a bite of female mosquito known as Aedes aegypti. It is a freshwater mosquito which is found mainly in urban and semi-urban areas. The main driving force behind the development and growth of virus is meteorological factors like temperature, humidity and rainfall (Tun-Lin, Burkot, and Kay 2000). Dengue starts its activities in the specific temperature like ten centigrade to forty-five centigrade (Hatanaka and Tanaka 2016). If the temperature is below 10 centigrade or it is above then forty-five centigrade, in these meteorological conditions Dengue stops its activities and moves to its den. While humidity and rainfall also play a significant role to restore and stop its activities (Ahmad et al. 2016). If it is August season then it starts for monsoon rain which lowers down the temperature and dengue moves out of its den (Chopra et al. 2009). If it is December or January when the temperature is



lower than ten centigrade then it is not suitable for the Dengue to continue its activities and it moves back to its den (Islam et al. 2016). In result humidity rain fall and temperature play a significant role in a specific range of attributes (Swarnamali, Jayasinghe, and Katulanda 2015). Every year about 50 millions of peoples suffered from Dengue Fever and almost half million suffered from Dengue Hemorrhagic fever (Rasheed, Butlin, and Boots 2013).

### 1.1 Dengue Fever Symptoms

It gets to start from mild fever to severe by raising the temperature to a high level, acute pain in joint, vomiting, headache along with bleeding through gum, nose and mouth. When Dengue injects its virus then its incubation time is from 3-14 days (Lwin et al. 2016). Patient body temperature suddenly rises up to 40°C in short time while heart beat is lower with the passage of time. The temperature may continue for 2-7 days with the consistent situation (Nisalak et al. 2016). It is also possible that a person is infected with Dengue Virus but due to his/her strong immune system, he/she does not feel the effect of the virus. When a person is infected by Dengue first time then IgM antibody is found in his body. If the same person gets infected with the Dengue Second time then IgG antibody will found in this body. IgG indicates that this person is infected by the Dengue Second time (Hunsperger et al. 2014).

## 2. Geographical Information System

It is a smart technique to capture, store and manage the information after processing into thematic maps. Thematic maps reflect the true situation of outbreak along with detection of hot spots. In it information is deployed into multiple layers, it is upon the user to utilize single layer or multiple layers (Palaniyandi et al. 2016). A thematic map can have layers like, transportation, hydrography, hypsography, irrigation, crops, the location of universities, park, food points etc. (Brondeel, Pannier, and Chaix 2015). GIS plays a substantial role in developing a surveillance system for arbovirus diseases. GIS can assist health official and decision makers to make advance plans to cope up with any sort of outbreak and take preventive measures at hotspot areas, in the result, it can reduce human and economic losses (Rehman 2017).

## 3. Literature Review

A model for forecasting Dengue outburst based on climatic and disease surveillance data designed for Indonesia in 2016. Data selection range was from 2011 to 2013 for external validation purpose of prediction accuracy of the model. Past data collected from Yogyakarta,



Indonesia exposed most effective forecasting of Dengue occurrence. Data comprised of lag patterns along with meteorological and surveillance data. The analysis was a focus on observing the association between Dengue time series and meteorological variables along with self-inherent usefulness within Dengue itself time series. Past studies reflect an association between weather and Dengue transmission in the range of 16-20 weeks delay between the influence of Dengue and disparity in weather dynamics (Ramadona et al. 2016). Due to this reason, a priori algorithm was deployed to trace out significant temporal patterns of Dengue outbreak.

This research study comprised of 457 villages of Kaohsiung city of Taiwan in the duration of 2009-12. During this three year period, 2997 confirmed Dengue cases were registered. Logistic regression model was fitted to trace out daily happening in town for thirty days. A prediction model designed in which meteorological information used. Prediction model performance observed for 122 consecutive days. Here threshold was eighty percentile while the sensitivity of median was 83% and the false positive median was 23% (Chan, Hu, and Hwang 2015). So it was observed that this model could provide near real-time prediction of Dengue risk but for a small area. This research will be used as decision-making tool as the front line for public health to control Dengue epidemics.

Mapping and estimation of Dengue and Chikungunya designed in 2015 by using geographical information system in Central American country Honduras. GIS Kosmo Desktop software used for thematic mapping presented in this research study. Overall 19289 Dengue cases registered, 85386 cases of chikungunya registered with a median of 726 patients of Dengue and 1460 patients of chikungunya per week during 2015. Maximum patient's registration slots were 25th and 27th weeks respectively. National Dengue and chikungunya patients rate were estimated about 224.9/100,000 and 995.6/100,000 patients (Lowe et al. 2015). Epidemiological maps developed by GIS-assisted decision making authorities to take action for prevention and control of a disease that still shows major issues in the country.

#### **4. Study Area and Data Collection**

Pakistan is among the top ten countries with respect to its population in the world. It is rich with textile, sport and agricultural resources these attributes are the back bone of Pakistan economy. It is comprised of four provinces, our study area Punjab province is the most populated province with 110 million people along with 205,344km<sup>2</sup> area and located at (30°55'59.63"

N/73°46'22.72" E). Natural rich agricultural resources are irrigated with five rivers flowing through Punjab. It is distributed among 38 administrative geographical regions (Hussain 2017).

For this research, study data is collected from district hospitals of Punjab Province. In this research study, we make an analysis on 14500 male registered patients in Punjab, while 78.53% were only from capital city Lahore which proved a launching pad for Dengue Virus (Ahmad et al. 2016).

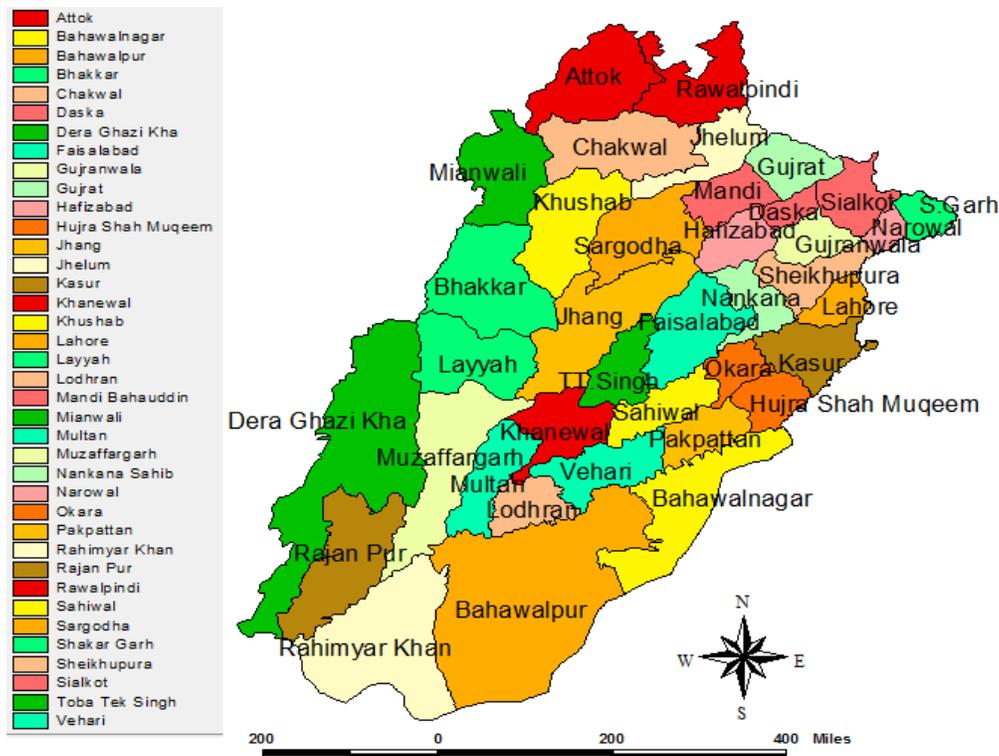


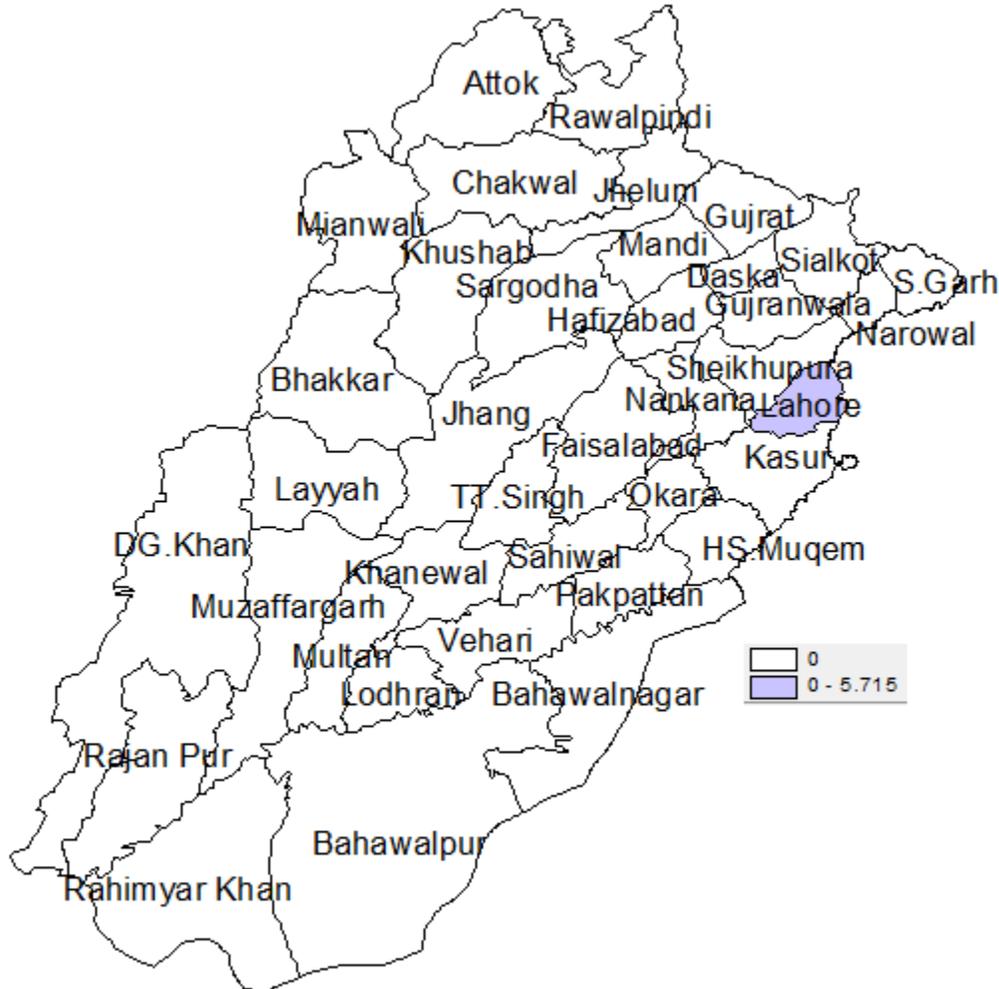
Figure 1: District Administrative boundaries of Punjab

Figure 2 reflect district boundaries of Punjab province with respect to different colours. Every geographical region is discrete to understand the district area. We will show the flow and intensity of Dengue Virus through these administrative boundaries in later thematic maps.

#### 4.1 Data Analysis

In this research study we used data from almost 6700 female registered patients; it is collected from all districts of Punjab. While 5800 females patients are just from capital city Lahore. We have distributed data month wise so that we can analyze the geographical pattern and intensity of each month. We have Pakistan map with three layers, the third layer defined administrative boundaries of districts. We used the third layer for this research study, female

registered patients are represented with pink colour, and a variety of colour reflect the intensity of Dengue Fever with respect to the number of patients.

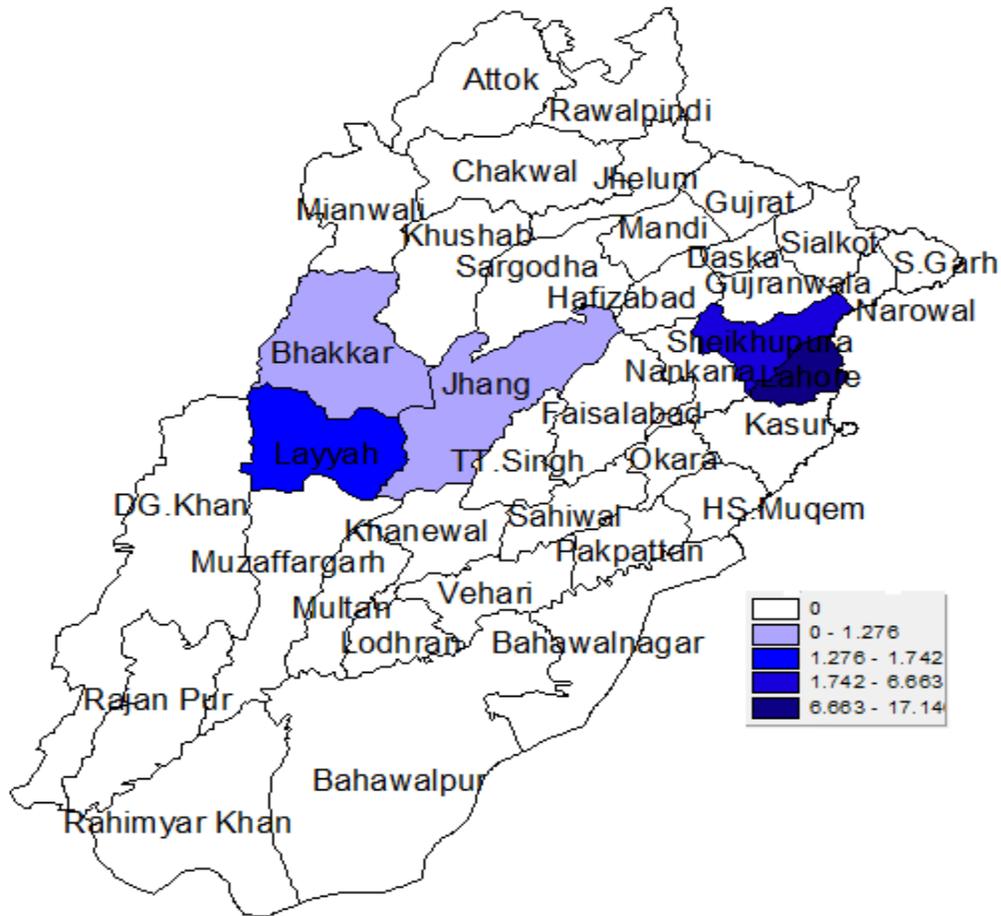


**Geographical Pattern and Intensity of Dengue Virus among Males in March**

**Figure 2: Geographical Pattern and Intensity in March**

#### 4.2 Geographical Pattern and Intensity of Dengue in March

Figure 3 represents Dengue Fever's geographical pattern and intensity in the month of March at Lahore. This city proved an initial point for Dengue Fever, as in March weather condition are not suitable for Dengue to carry on its activities so its effect is limited to Lahore.

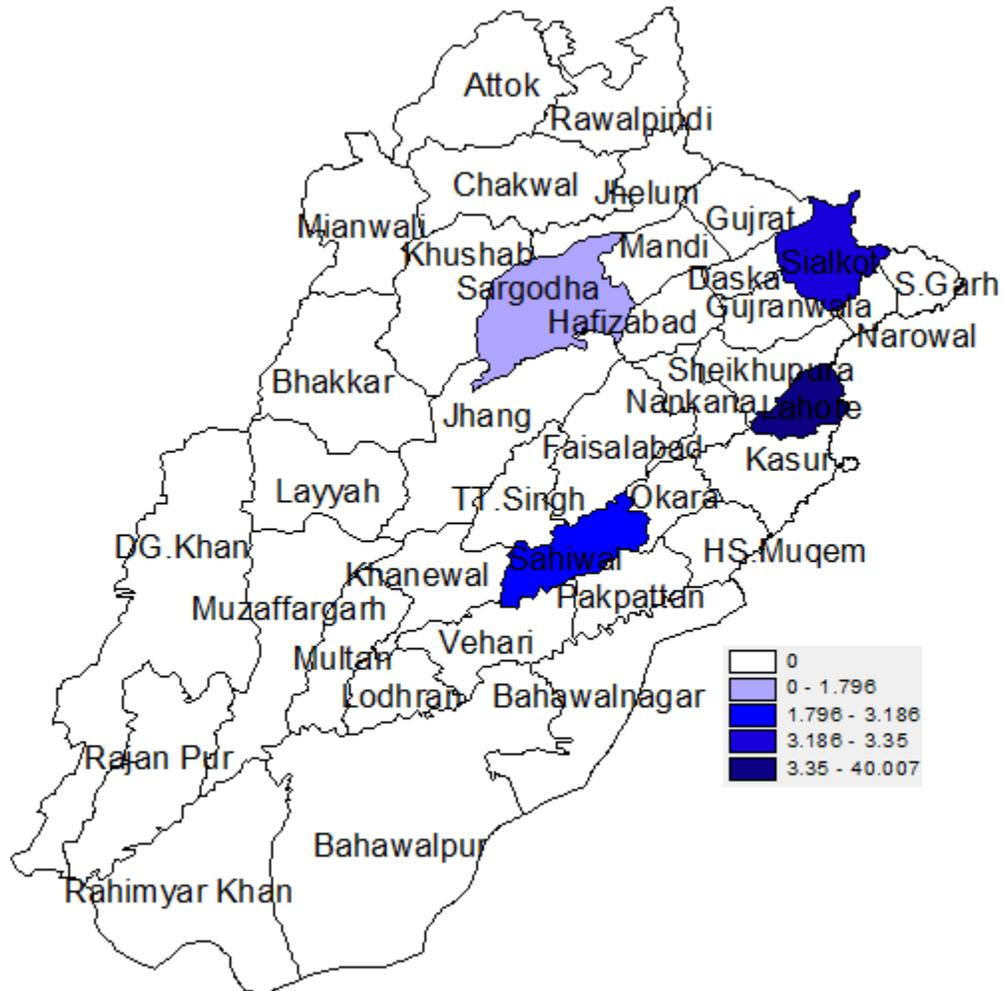


**Geographical Pattern and Intensity of Dengue Virus among Males in April**

**Figure 3: Geographical Pattern and Intensity in April**

### 4.3 Geographical Pattern and Intensity of Dengue in April

Figure 4 represents the current situation of Punjab province in April with respect to Geographical pattern and intensity of Dengue Fever. In last month pattern was just confined to Lahore but in April it moves from Lahore to adjacent city Sheikhupura along with Jhang, Layyah and Bhakkar because the most of the traffic flow on the track from Lahore and virus moves through transportation of patients.

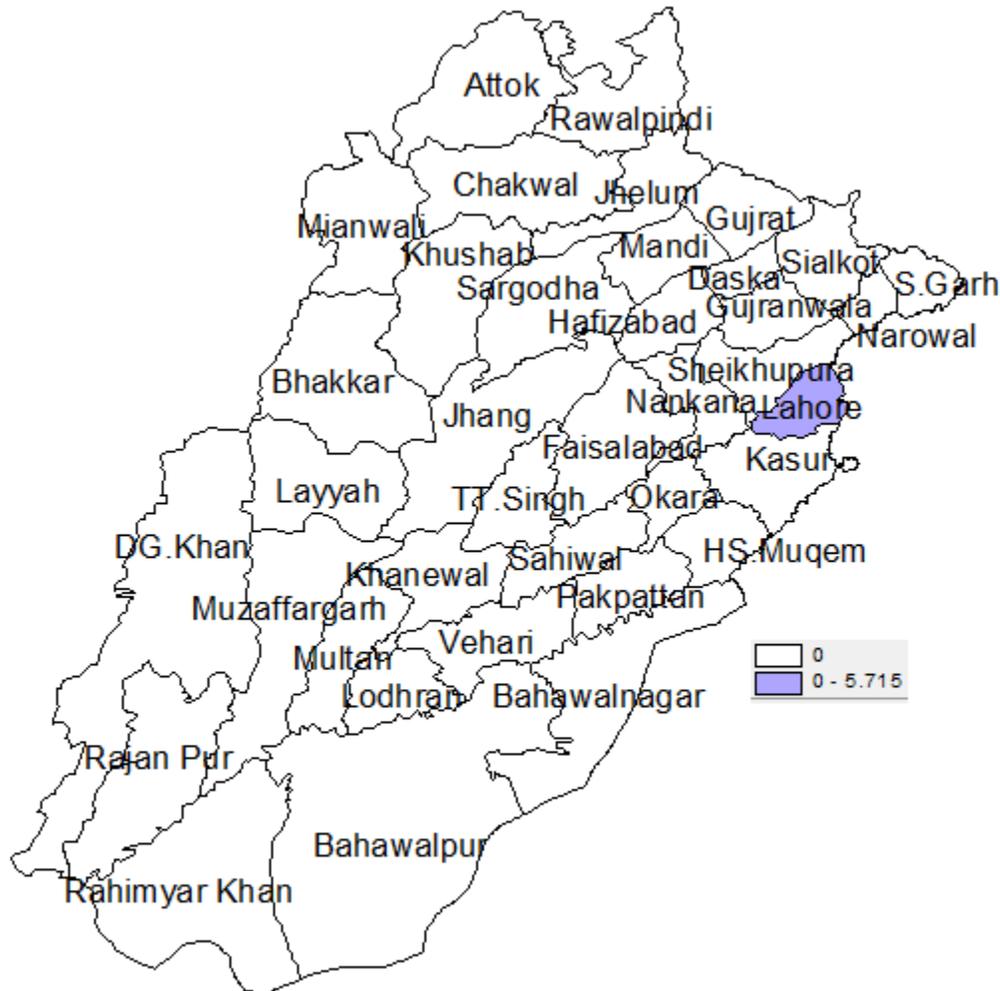


**Geographical Pattern and Intensity of Dengue Virus among Males in May**

**Figure 4:** *Geographical Pattern and Intensity in May*

#### 4.4 Geographical Pattern and Intensity of Dengue in May

Figure 5 reveals the Dengue's geographical pattern and intensity in the month of May. This time Dengue Fever moves from Lahore to Sahiwal, Sargodha and Sialkot. The number of patients registered in these cities is under threshold value as the weather conditions are not suitable for Dengue outbreak. Just 10% geographical area is under influence of Dengue while 90% is Dengue free zone.

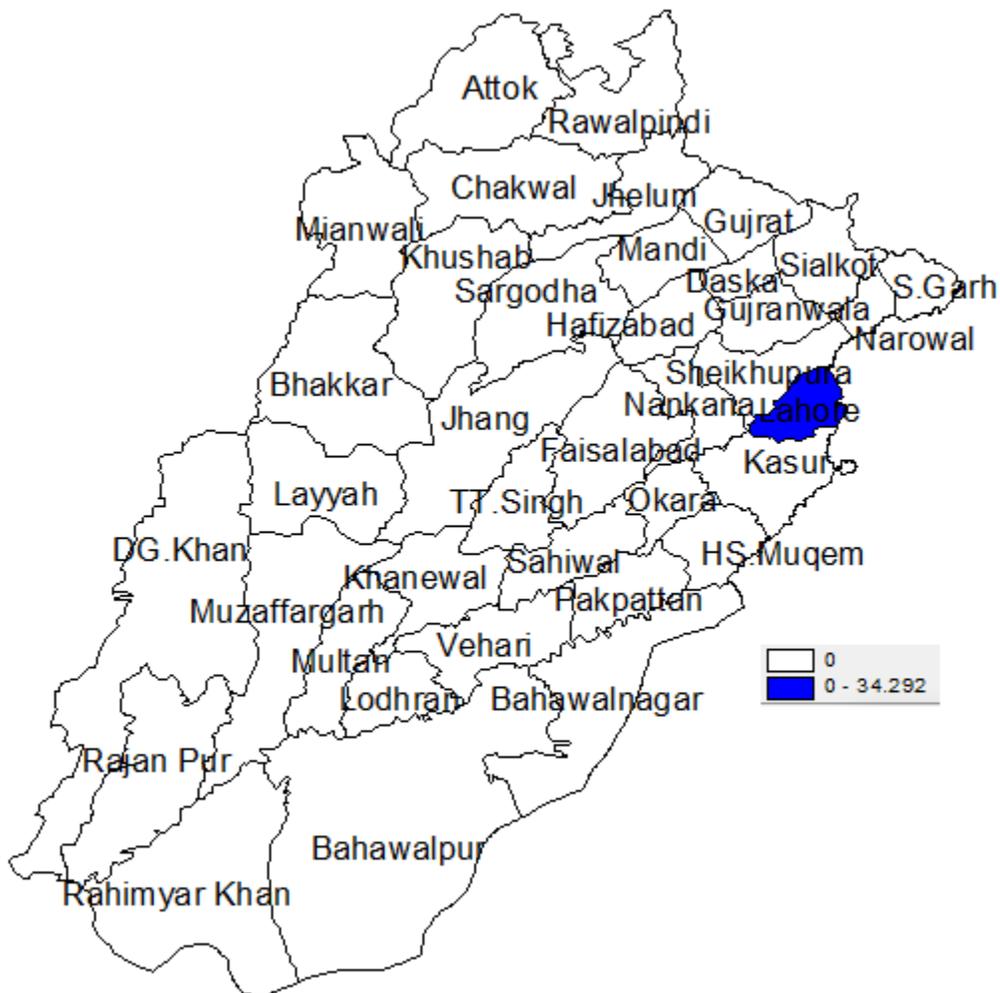


**Geographical Pattern and Intensity of Dengue Virus among Males in June**

**Figure 5: Geographical Pattern and Intensity in June**

#### 4.5 Geographical Pattern and Intensity of Dengue in June

Figure 6 shows the current situation of Punjab in the month of June. In June in Punjab summer season is on a rampage. The temperature is more than forty centigrade and Dengue is back to its den. In these conditions, Dengue effect is up to minimum level. Whole Punjab is now Dengue free zone except Lahore.

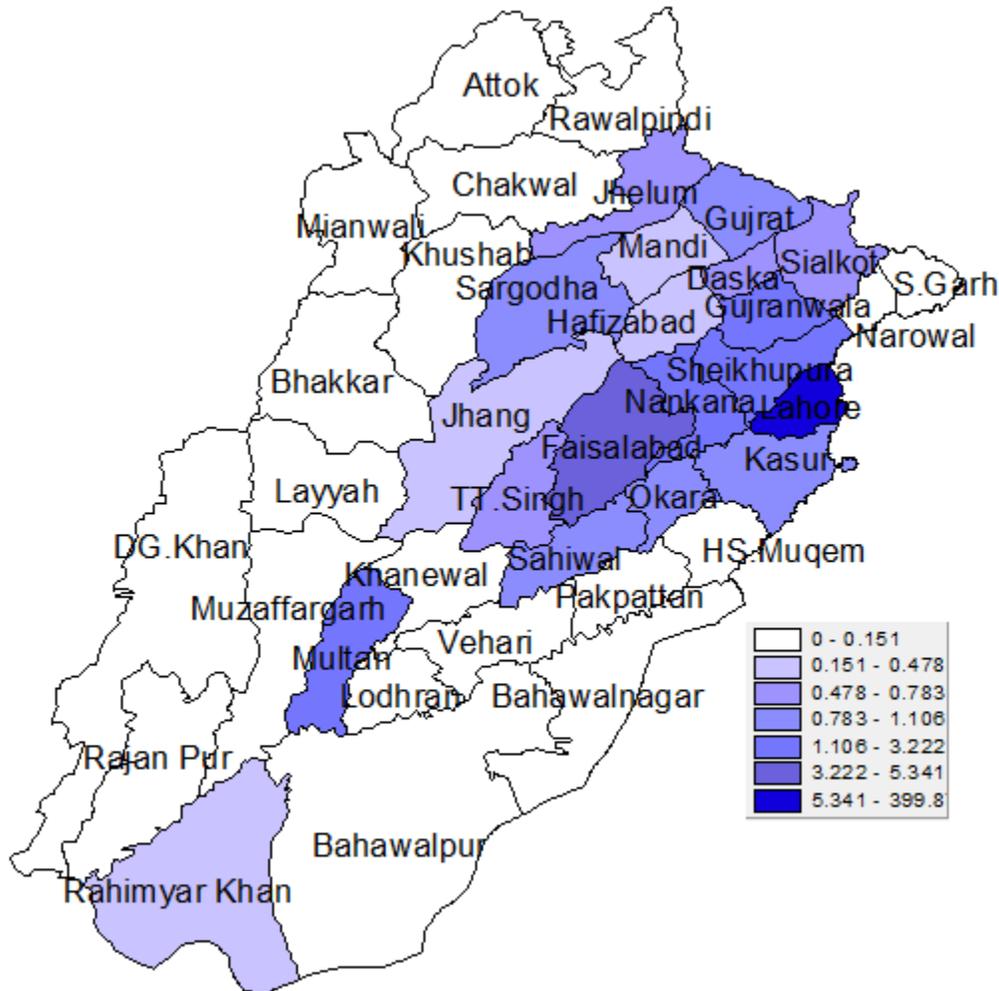


**Geographical Pattern and Intensity of Dengue Virus among Males in July**

**Figure 6:** *Geographical Pattern and Intensity in July*

#### 4.6 Geographical Pattern and Intensity of Dengue in July

Figure 7 shows intensity and geographical pattern in the month of July. This thematic map shows the consistency with respect to geographical pattern and intensity. Dengue is confined to Lahore only as the temperature is much higher in July and no chance of Dengue to move out of the den and continue its activities. So again whole Punjab is Dengue free zone except Lahore.

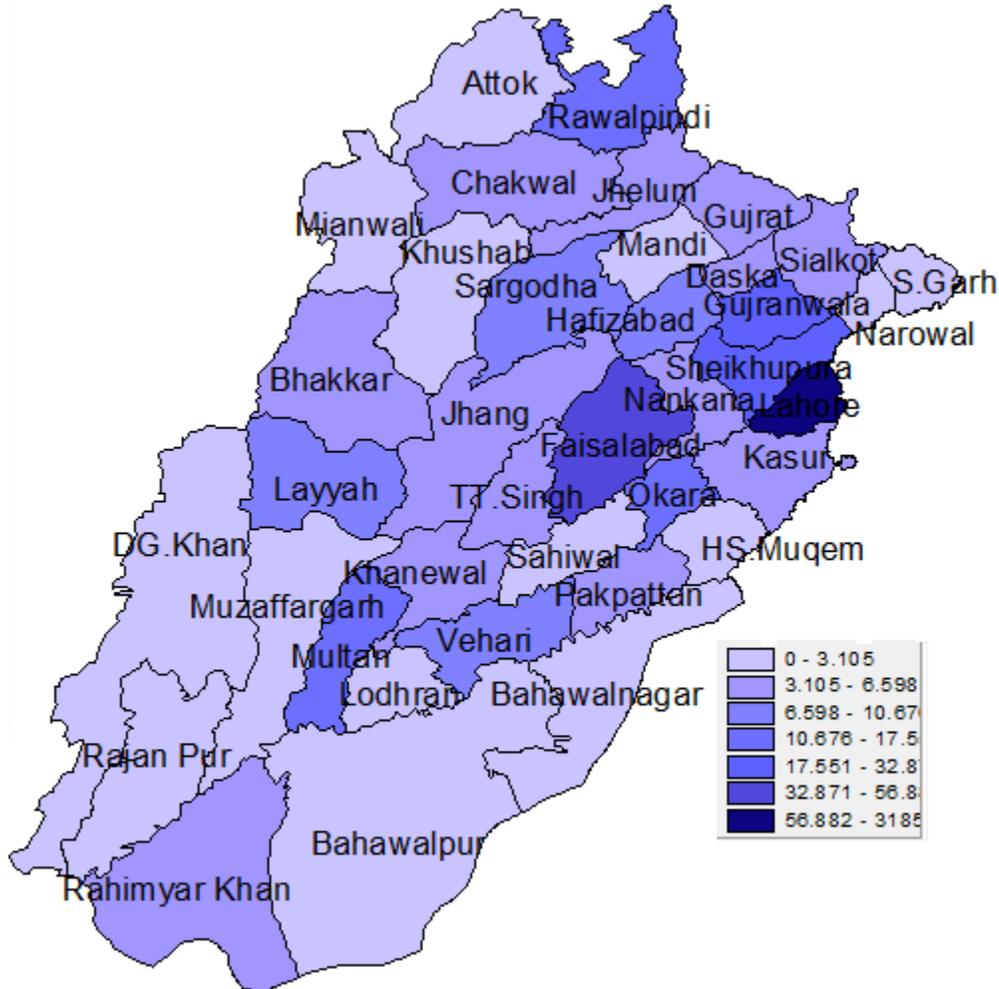


**Geographical Pattern and Intensity of Dengue Virus among Males in August**

**Figure 7: Geographical Pattern and Intensity in August**

#### 4.7 Geographical Pattern and Intensity of Dengue in August

Figure 8 shows the drastically changed situation of geographical pattern and intensity of Dengue Fever in the Punjab Province. Monsoon season is started in August in Punjab which lower down the temperature and humidity is increased along with rain fall. In this month Dengue Fever crossed the threshold limit and covered almost 50% geographical area and intensity is high at Lahore while in other cities it is low and under control.

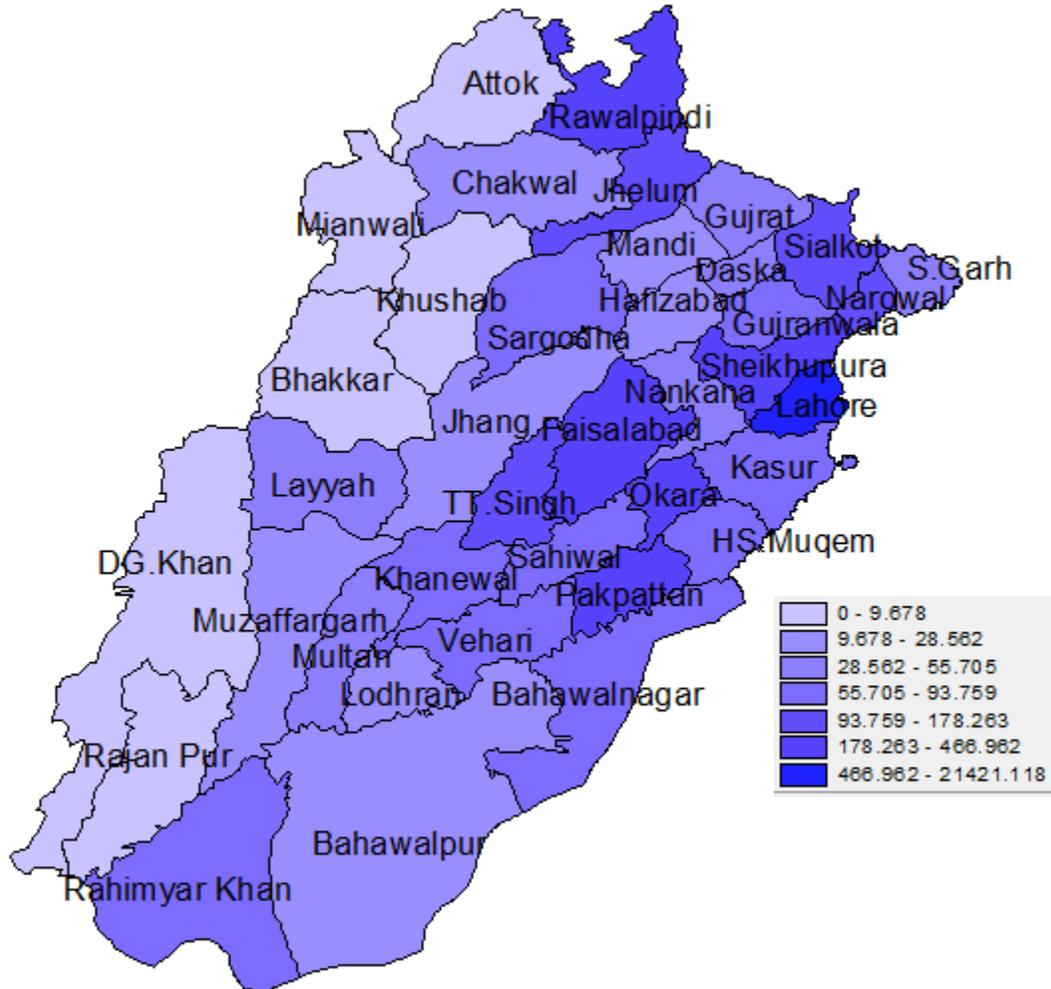


**Geographical Pattern and Intensity of Dengue Virus among Males in September**

**Figure 8:** *Geographical Pattern and Intensity in September*

#### 4.8 Geographical Pattern and Intensity of Dengue in September

Figure 9 reflects the dynamic changing situation of geographical pattern and intensity of Dengue Fever in the month of September. No Dengue free zone visible on thematic map, 100% geographical area is covered and under Dengue influenced. Seven layers categorize the present condition of Punjab, 68% geographical area is at a marginal level, and 16% area is at a high level while 16% area is hotspot area reflecting the highest intensity of Dengue Fever.

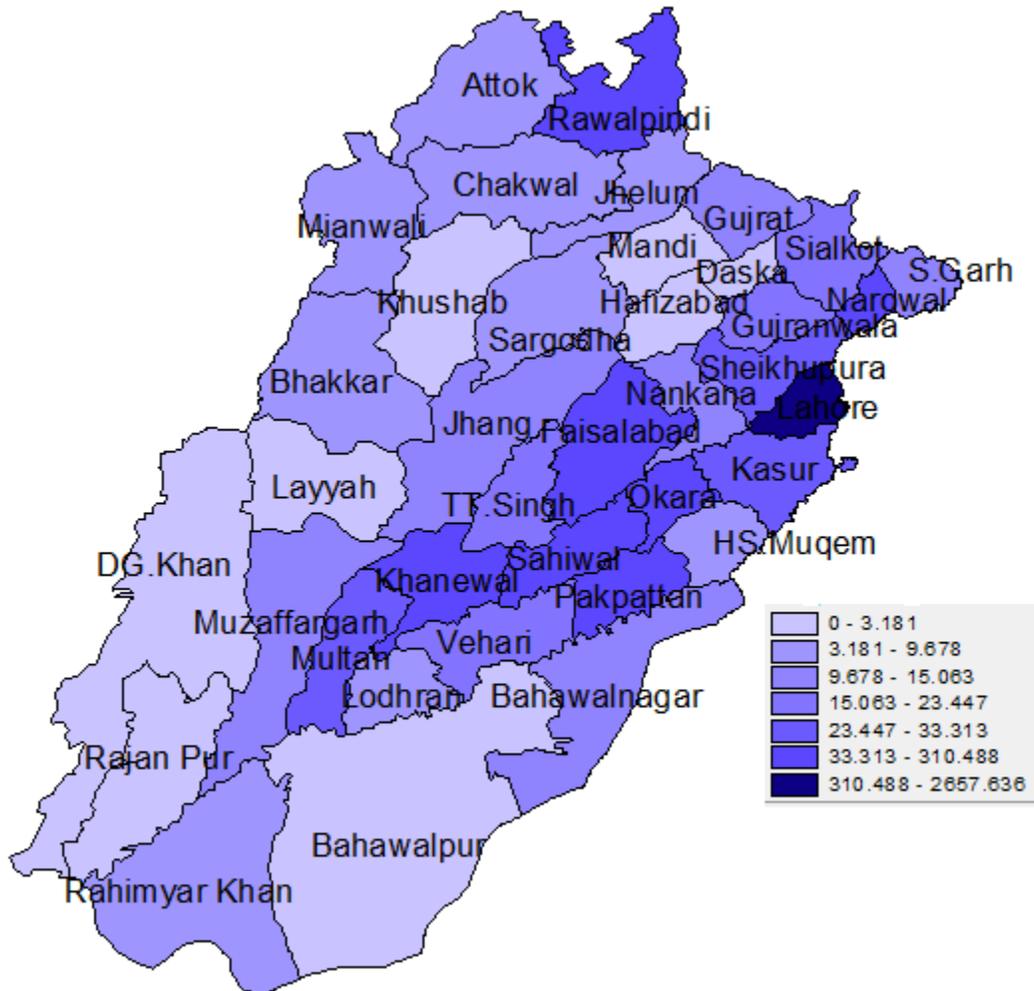


**Geographical Pattern and Intensity of Dengue Virus among Males in October**

**Figure 9: Geographical Pattern and Intensity in October**

#### 4.9 Geographical Pattern and Intensity of Dengue in October

Figure 10 represents geographical pattern and intensity of Dengue Fever in the month of October. The situation of the whole province is almost identical as compared to September. Dengue Fever is at booming condition 84% geographical area is at high risk with high intensity and 16% area is at a marginal level. Lahore, Rawalpindi, Jhelum, Sheikhupura, Faisalabad, Okara, Sialkot, Narowal and Pakpattan are hotspot areas in this month.

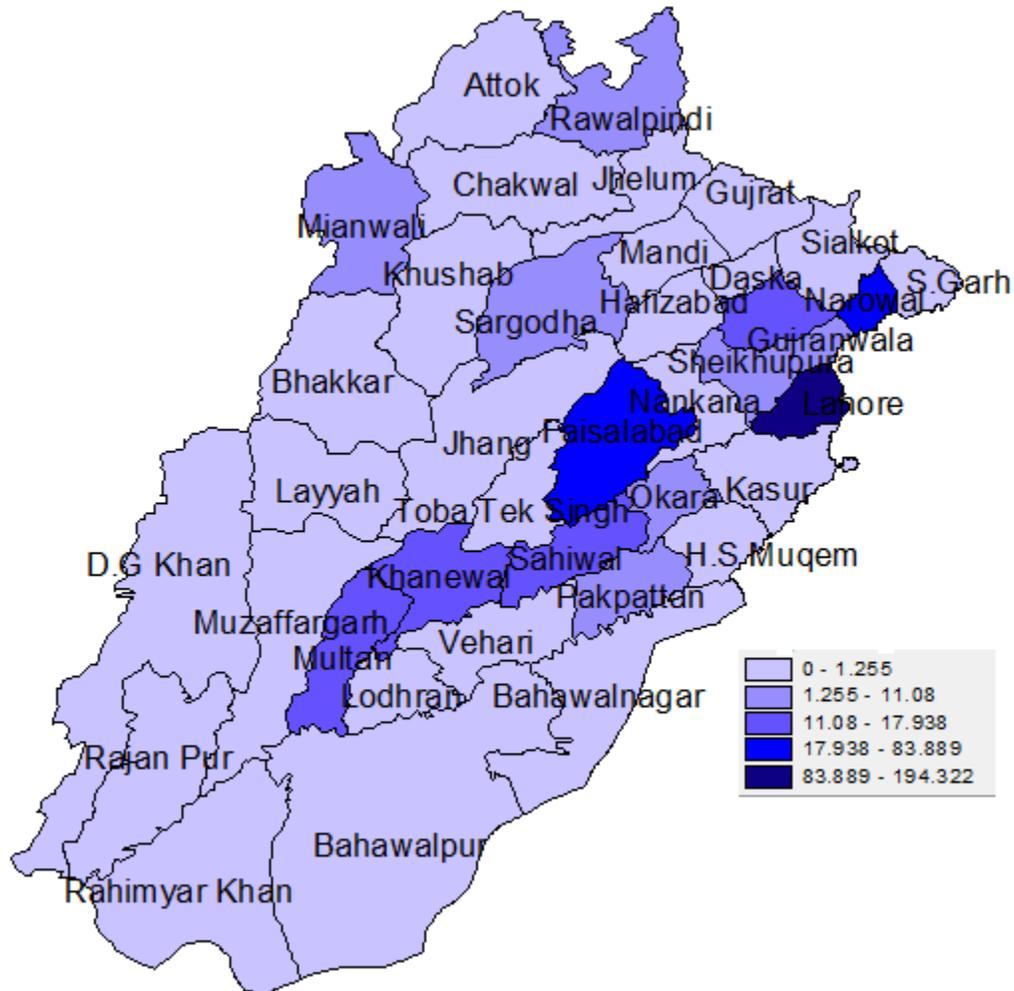


**Geographical Pattern and Intensity of Dengue Virus among Males in November**

**Figure 10:** *Geographical Pattern and Intensity in November*

#### 4.10 Geographical Pattern and Intensity of Dengue in November

Figure 11 shows intensity and geographical pattern of Dengue Fever in the month of October. Here 24% geographical area is hotspot area in this thematic map as reflecting the highest intensity of Dengue Fever. 16% geographical area is at marginal level while 60% geographical area is showing the high intensity of Dengue Fever with respect to the number of registered patients. No Dengue free zone whole province is under influence of Dengue Fever.

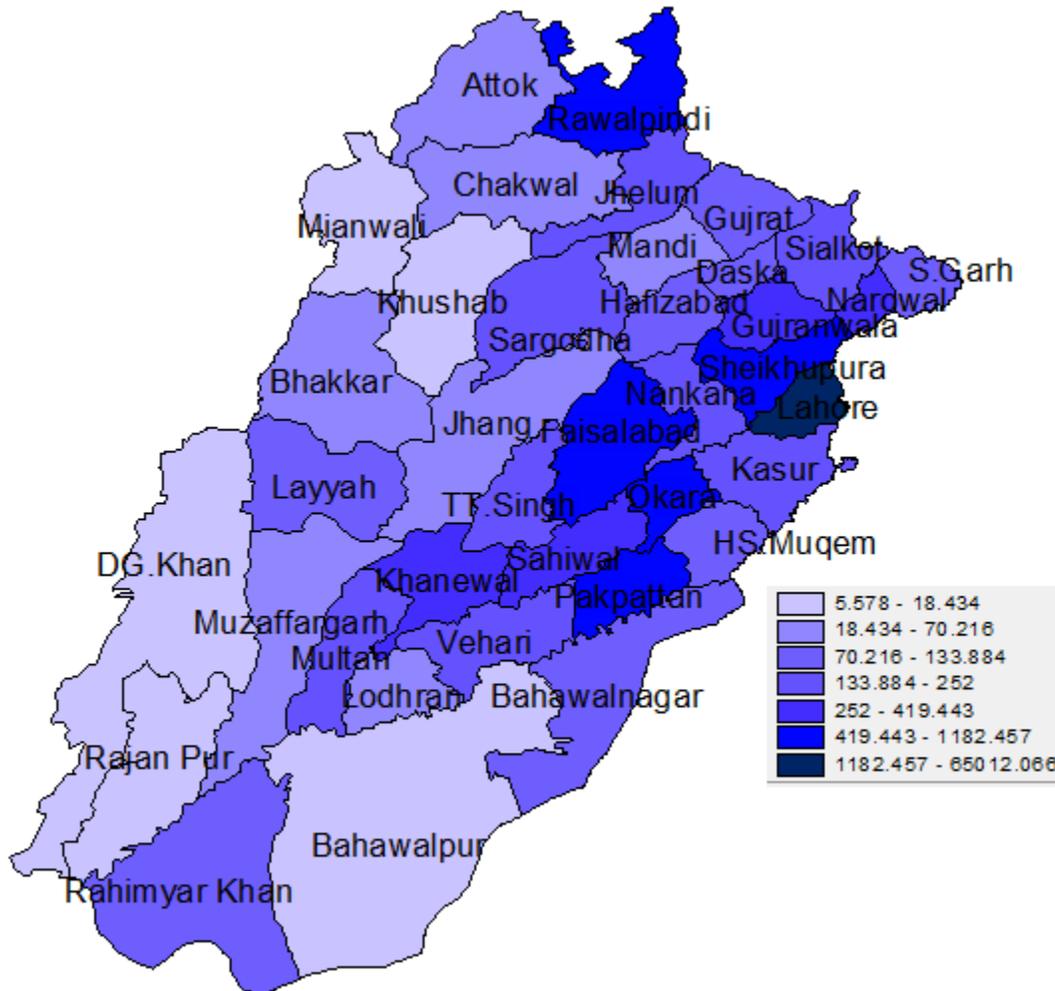


**Geographical Pattern and Intensity of Dengue in December**

**Figure 11:** *Geographical Pattern and Intensity in December*

#### 4.11 Geographical Pattern and Intensity of Dengue in December

Figure 12 shows the current situation of geographical pattern and intensity of Dengue in December. Overall condition looks to be under control except for five to six cities. 66% the geographical area is under control and threshold level. In December temperature is much lower like below ten centigrade, in these conditions Dengue move back to its Den up to the next spell and Dengue reduce to minimize level. In the above thematic map Lahore, Narowal, Faisalabad, Sahiwal, Khanewal, Multan, Gujranwala and Rawalpindi proved to be hotspot areas in the month of December.

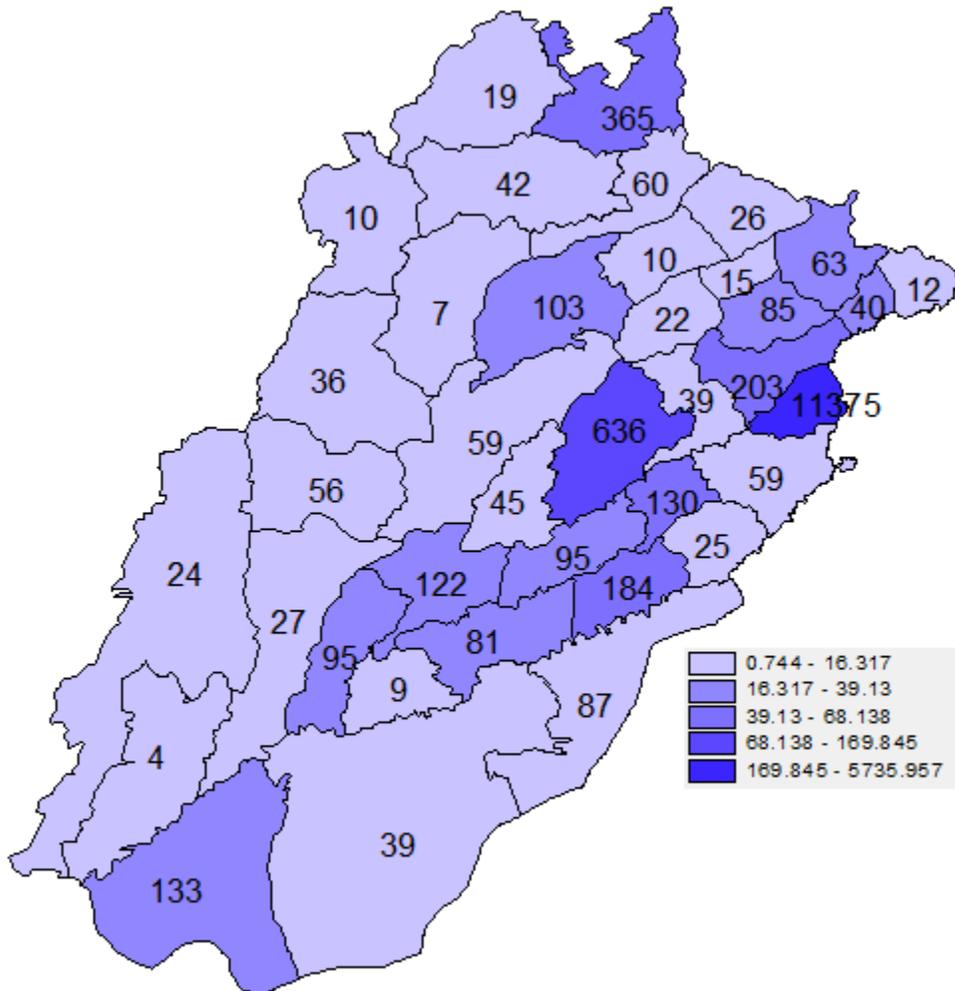


**Geographical Pattern and Intensity of Dengue Virus among Males, March to December**

**Figure 12:** *Geographical Pattern and Intensity from March to December*

#### 4.12 Geographical Pattern and Intensity of Dengue from March to November

Figure 13 presents the summary of Dengue Outbreak from March to December. The thematic map shows that 18% geographical area is hotspot area comprised of these cities like Lahore, Sheikhupura, Faisalabad, Pakistan, Rawalpindi, Khanewal and Okara are hotspot areas. In this summary 13% geographical area remains at a marginal level. Over all 69%, the geographical area was at high level with respect to the intensity of Dengue Fever. Bahawalpur, Rajan pur, DG. Khan, Khushab and Mianwali are outskirts areas of Punjab here is less transportation of public so these areas remain almost at a marginal level.

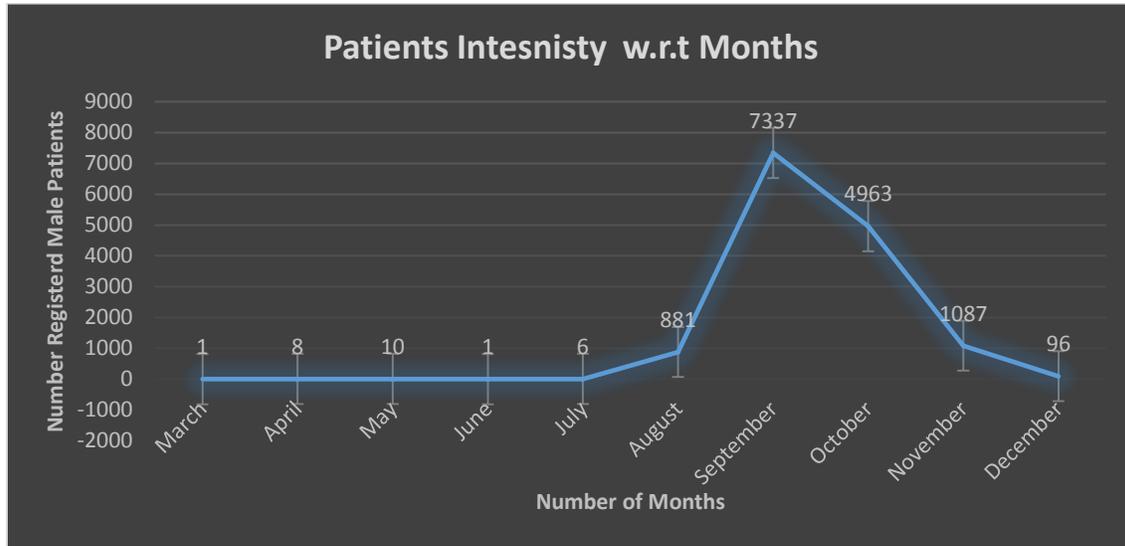


**Geographical Pattern and Intensity of Dengue Virus among Males, March to December**

**Figure 13: Geographical Pattern and Intensity whole summary**

#### 4.13 Geographical Pattern and Intensity of Dengue from March to November

Figure 14 shows the whole outbreak summary in numerical form by representing the number of registered patients in each geographical area. Lahore city consistently remains in the scene from March to December and register a maximum number of the patient as 11375 and proved a launching pad for Dengue Fever in Punjab Pakistan. Faisalabad remains on the second number while Rawalpindi remains on the third number. So these three cities proved hotspot areas during this Dengue outbreak.



**Figure 14:** Dengue registered Male Patients from March to December

Figure 15 shows the summary of registered patients during different months from March to December. Graph reflects that outbreak spell is from August from December Strat. Monsoon rain starts in the month of August which lower down the temperature, it is a suitable environment for Dengue while in December temperature is lower down and remains below ten centigrade which compel the Dengue move to its den.

## 5. Result and Discussion

We come to know through this research study that fourteen thousand and five hundred men's patients suffered by Dengue Fever during this outbreak from March to December. It is observed that 79% patients were only from Lahore the capital city of Punjab province. Research results show that outbreak holds a seasonal pattern which follows the meteorological factors like temperature, humidity and rain fall. As the monsoon season starts in August like that way Dengue start its activities while in December the temperature is lowered down and Dengue stop its activities and wait for the next spell with a suitable environment. Most of the people were victimized by Dengue Fever in the month of September and October. Dengue flight is confined to a maximum 3km area and the geographical spread of the virus is due to the transportation of Patients from one to other geographical location. Information embedded in these thematic maps can assist the health authorities and Government official to be alert from the hotspot cities proved in this research study and take preventive action along with a precautionary measure to avoid from any outbreak in future. These research results can also help the authorities how to

manage the factors which may cause the outbreak. In future we can develop online dengue surveillance system to be aware from current intensity and geographical flow of dengue outbreak. So that run time decision making can be done.

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