

Vulnerability to Fire Hazard and capacity assessment

Case study of Delhi

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Abstract:

Fires cause the greatest loss of life and property whether it is the case of forest fires, urban fires or rural fires. Urban fires have devastating impacts on communities. Unplanned urbanization and uncontrolled population has intensified the problem further. The number of fire incidents in Delhi is increasing day after day. Community participation is imperative to mitigate such disasters at community level. In order to strengthen the resilience of a community towards fire hazards, before they become disasters, a comprehensive risk and vulnerability assessment of fire Hazard is essential to assess structural, non-structural and community capacity. In this study, medium and serious incidences of fire outbreaks over last three years have been selected and plotted on a Map of Delhi to know which zone is highly vulnerable and then to analyze the existing fire control capacity. Firstly, a hazard map was created on the basis of attributes such as fire scenario, type of building and location of risk prone fire sources in the study area. Each of them was assigned a value using The Analytic Hierarchy Process. Then the following vulnerability analyses were conducted namely Fire vulnerability and critical facilities vulnerability. To accomplish these vulnerability analyses, data from various sources has been collected from Delhi Fire Service. Each of the vulnerability analysis includes certain specific steps which ultimately lead to a vulnerability map using ESRI ARCGIS technology, the data was processed and maps were prepared. After preparing the hazard map, it was overlaid with each of the maps like, maps of critical facilities, economic activities, etc. On the basis of some parameters and attributes, it was evaluated that which areas are highly vulnerable to fire in various aspects from every intersected map. Finally the overall vulnerability to fire hazard and capacity was assessed.

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Dr. Mukta Girdhar specializes in Disaster Management, Geographic Information System and Remote Sensing. She has over twelve years of experience in imparting education in the field of Disaster Management and GIS. She has guided several dissertation related to disasters besides publishing and presenting many research papers in national and International Journals. She has undergone many training courses at national and International levels and is familiar with ArcGIS, MapInfo, Erdas Imagine, and Illwis softwares.

Introduction and Background

Delhi's fourteen million residents live in a brewing crucible of hazards. In the city, road accidents and fires occur each day. This is not the terminus of hazards faced by the residents of the city. Cinema halls char the spectators, while industrial gas leakages poison already polluted lungs of the residents, houses collapse burying families and bomb blasts and train accidents make frequent news headlines. Scientists have made an addition to this by confirming that the city falls in a vulnerable seismic zone and is prone to floods as well. It is very rarely realized that these hazards are characteristics of decaying urban processes.

Hazards are a process. They can be variable, worse, and mild or less offensive, their condition may thus deteriorate, improve or acquire a whole lot of new features. Urban areas are the seed-beds of new and complex socio-environmental arenas fostering unprecedented permutations and combinations of old and new hazards. The city is not a static or homogeneous entity because its land use, population density, civic amenities and other features show a sharp change and contrast. These processes are also not random in space. Floods and other hazards take place at particular places, as they have specific origins. Fires erupt only where the areas provide an opportunity to blaze. Hazards thus, are not distributed evenly.

In Delhi, the economies are concentrated and the teeming sea of millions are getting crammed up in overly congested areas. Such a concentration of humans in numbers as well as activities make the common man vulnerable to various kinds of risks arising from any kind of emergency situation out of the complicated urban life. Emergency situations require a quick and focused response as human life and property may be involved. It is recognized now that the greater proportion of poor quality housing, inadequate planning, monitoring and control in metropolitan cities, which become overpopulated, lead to a greater number of fires and other urban disasters.

In the past, the absence of proper regulations, legislation and planning particularly in the matter of fire protection and related activities resulted in an increase in losses due to fire. Due to the rapid increase in population, industrialization, rapid rise in new colonies, construction of high rise buildings, the fire risk in the cities has been tremendously increasing. With the cities growing in size and complexity day by day they need to be managed more and more efficiently. Aspects like planning and management of fire services should form a part of Urban Management as a whole. To combat such a dangerous and widespread challenge, technology can become a powerful ally in the fight against fire and can help combat any kind of emergency

Data Collection

| Station wise fire incident reports and other calls in Delhi Fire Service year 2013 | | | | |
|---|---------------|---------------|---------------|--------------|
| Station Name | Apr-13 | May-13 | Jun-13 | Total |
| Connaught Circus | 82 | 115 | 78 | 275 |
| SPM Marg | 34 | 53 | 37 | 124 |
| Moti Nagar | 44 | 73 | 47 | 164 |
| Rani Jhansi Road | 33 | 67 | 41 | 141 |
| Safdar Jung | 62 | 91 | 64 | 217 |
| Mathura Road | 63 | 91 | 64 | 218 |
| Shahdara | 28 | 66 | 26 | 120 |
| Roop Nagar | 87 | 179 | 147 | 413 |
| Shanker Road | 15 | 30 | 19 | 64 |
| Laxmi Nagar | 15 | 50 | 27 | 92 |
| Chanakya Puri | 67 | 89 | 44 | 200 |
| Bhikaiji Cama Palace | 82 | 108 | 59 | 249 |
| Nehru Place | 102 | 147 | 112 | 361 |
| Parshad Nagar | 43 | 50 | 54 | 147 |
| Kirti Nagar | 17 | 27 | 13 | 57 |
| Teliwara | 8 | 10 | 10 | 28 |
| Wazir Pur | 28 | 59 | 34 | 121 |
| Darya Ganj | 12 | 19 | 9 | 40 |
| Geeta Colony | 61 | 121 | 84 | 266 |
| Rakab Ganj | 28 | 20 | 16 | 64 |
| Keshav Puram | 71 | 119 | 90 | 280 |
| Naraina | 20 | 22 | 16 | 58 |
| Janak Puri | 80 | 156 | 103 | 339 |
| Okhla | 7 | 8 | 5 | 20 |
| Narela | 16 | 41 | 23 | 80 |
| Jwala Puri | 54 | 80 | 44 | 178 |
| Rastrapati Bhawan | 3 | 1 | 0 | 4 |
| Sector-16 Rohini | 43 | 67 | 41 | 151 |
| Najafgarh | 73 | 118 | 55 | 246 |
| Sector-5 Rohini | 82 | 141 | 102 | 325 |
| Bhorgarh | 64 | 80 | 25 | 169 |
| Bawana | 84 | 84 | 22 | 190 |
| Jahangir Puri | 86 | 156 | 77 | 319 |
| Gokul Pur | 50 | 67 | 53 | 170 |
| Shastri Park | 39 | 63 | 42 | 144 |
| Paschim Vihar | 11 | 27 | 20 | 58 |

| | | | | |
|-------------------|-------------|-------------|-------------|-------------|
| Paiwalan | 23 | 45 | 36 | 104 |
| Okhla-1 | 39 | 54 | 27 | 120 |
| Dwarka | 44 | 68 | 51 | 163 |
| Hari Nagar | 27 | 73 | 39 | 139 |
| DSIDC Bawana | 22 | 33 | 20 | 75 |
| Jwala Heri | 3 | 11 | 7 | 21 |
| Tikri | 11 | 13 | 10 | 34 |
| M Puri | 25 | 31 | 23 | 79 |
| Tahir Pur | 30 | 62 | 41 | 133 |
| Sarita Vihar | 24 | 42 | 29 | 95 |
| Delhi Secretariat | 4 | 5 | 2 | 11 |
| CBD Shahdara | 25 | 46 | 22 | 93 |
| Mayur Palace | 19 | 39 | 22 | 80 |
| Kalyan Vas | 31 | 41 | 28 | 100 |
| Udyuog Nagar | 3 | 8 | 2 | 13 |
| Mandawli IP | 39 | 53 | 45 | 137 |
| HQ | | | | |
| Total | 2063 | 3319 | 2107 | 7489 |

Analysis and Interpretation

Data is plotted with fire outbreak incidences along x-axis and name of the fire stations along y-axis. The data is plotted for the months in which number of fire outbreaks have been highest, namely April, May and June of 2013. After plotting the data we were able to conclude that;

- Fire outbreaks in the month of May were almost 40 percent more than April and June.
- The highest number of calls were recorded in the following fire stations, namely, Roop Nagar, Jahangir Puri, Janak Puri, Nehru Placee, Rohini Sector-5, Geeta Colony, Keshav Puram, Najafgarh, Cannought Place and Bhikaji Cama.
- Study also shows that the above areas are also industrially and officially oriented.

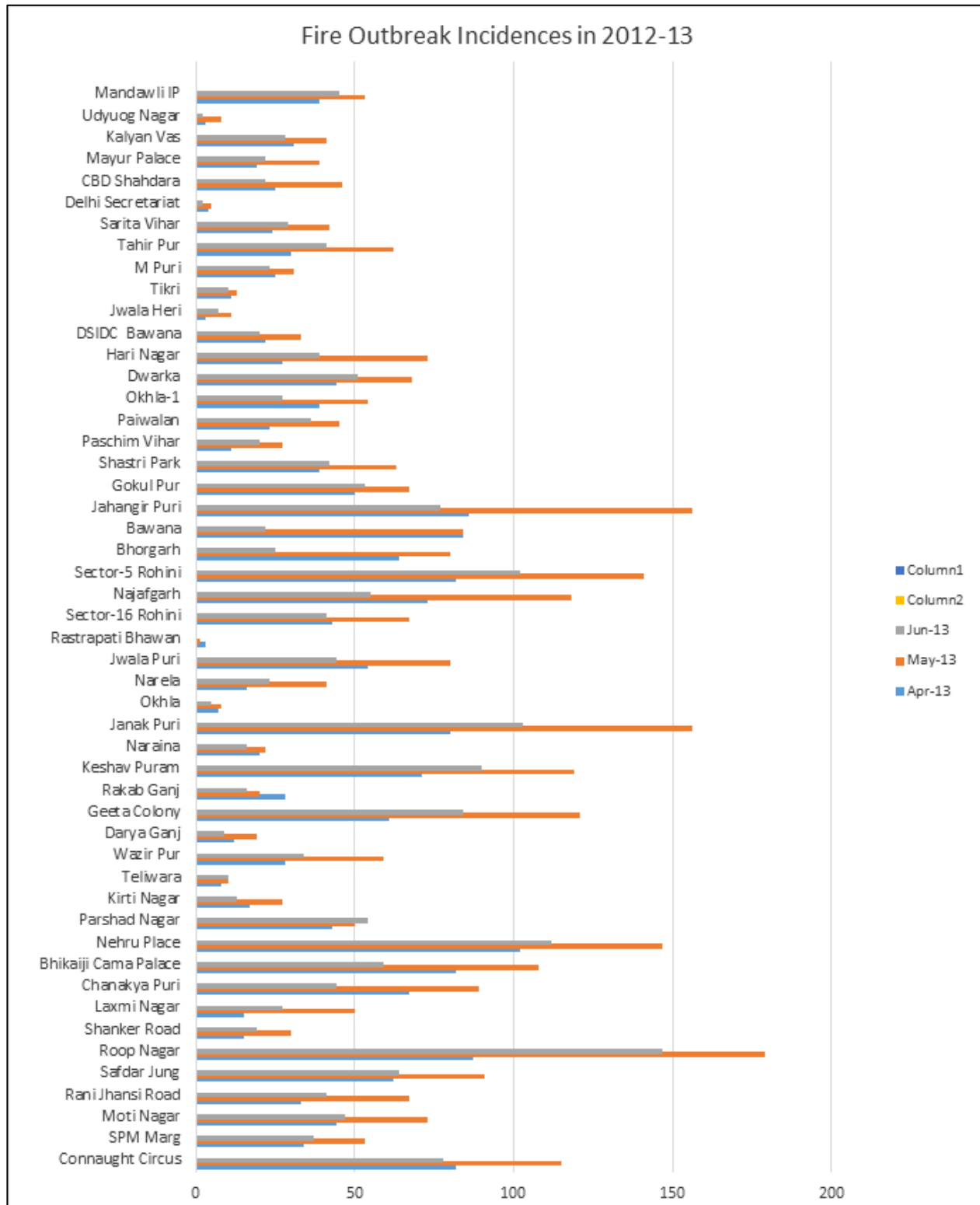


Fig 4: Plotting of No. of fire outbreaks v/s name of fire stations.

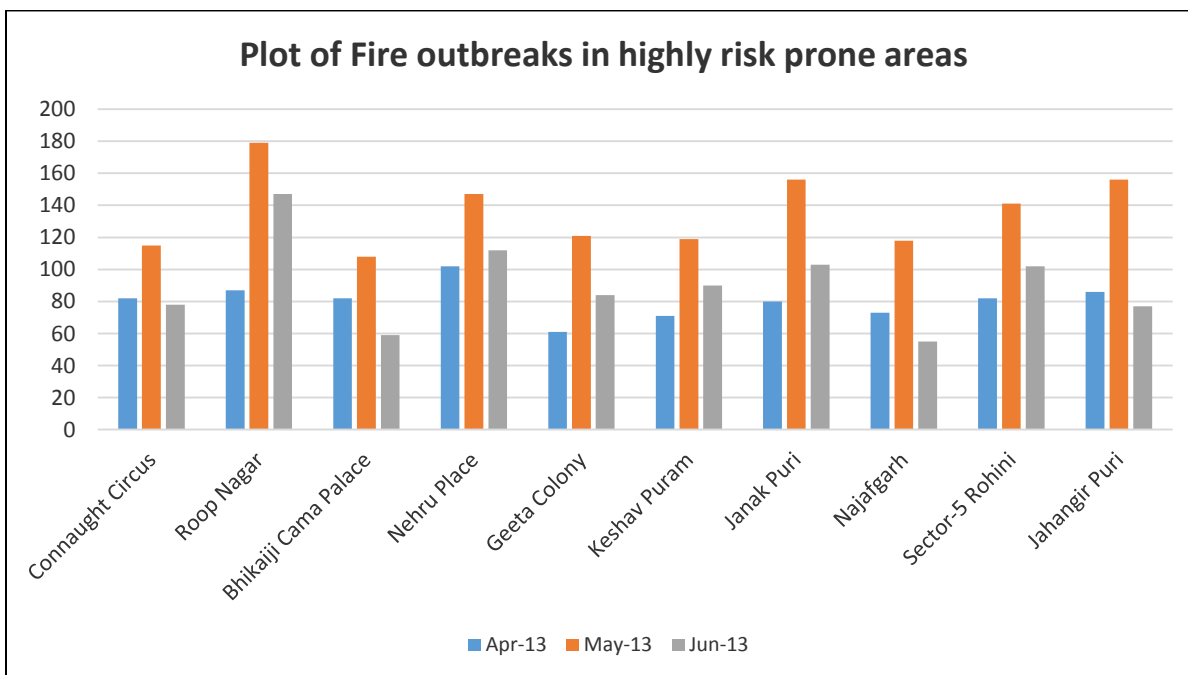


Fig 5: Detailed plot of the highly prone areas.

The data for the highly prone areas has been re-plotted with names of fire stations along x axis and number of incidences along y axis. From the above data plotting, we conclude that;

- Roop Nagar fire station has recorded the highest number of fire outbreaks.
- On the basis of incidences recorded, the above highly incidence prone fire stations can be classified as:

Category 1 (More than 160 incidents reported):- Roop Nagar

Category 2 (No. of incidents between 140 to 160):- Jahangir Puri, Janak Puri and Nehru Place

Category 3 (No. of incidents reported less than 140):- Rohin Sector-5, Geeta Colony, Keshav Puram, Najaf Garh, Cannought Place and Bhikaji Cama Place.

Cumulative Analysis and Interpretation for 2010-2013

The Average data for each month from 2010 to 2013:

| <u>FIRE STATION NAME</u> | <u>APRIL</u> | <u>MAY</u> | <u>JUNE</u> |
|--------------------------|--------------|------------|-------------|
| Connaught Circus | 86.33333 | 104.3333 | 61.66667 |
| SPM Marg | 40.33333 | 54.66667 | 39.66667 |
| Moti Nagar | 50 | 76.33333 | 42 |
| Rani Jhansi Road | 52 | 59.33333 | 42.33333 |
| Safdar Jung | 72.66667 | 66.66667 | 59.33333 |
| Mathura Road | 72.66667 | 82.33333 | 57.66667 |
| Shahdara | 38.33333 | 58.33333 | 32.66667 |
| Roop Nagar | 85.33333 | 149.3333 | 112.3333 |
| Shanker Road | 23.66667 | 28.66667 | 24.33333 |
| Laxmi Nagar | 34 | 56 | 33 |
| Chanakya Puri | 73 | 74 | 51.66667 |
| Bhikaiji Cama Palace | 93.66667 | 111.3333 | 59.66667 |
| Nehru Place | 126 | 149 | 103.3333 |
| Parshad Nagar | 45.66667 | 58.33333 | 54 |
| Kirti Nagar | 20.66667 | 24 | 20.33333 |
| Teliwara | 9.666667 | 10.33333 | 11 |
| Wazir Pur | 38.66667 | 58.33333 | 34 |
| Darya Ganj | 13.66667 | 19 | 11.66667 |
| Geeta Colony | 62 | 96.66667 | 64.33333 |
| Rakab Ganj | 25 | 15.33333 | 11.33333 |
| Keshav Puram | 69 | 108.6667 | 80 |
| Naraina | 22.66667 | 24.66667 | 16 |
| Janak Puri | 98.33333 | 143.6667 | 92.33333 |
| Okhla | 9 | 11.33333 | 7.666667 |
| Narela | 24.33333 | 34 | 20.33333 |
| Jwala Puri | 54 | 70 | 40.33333 |
| Rastrapati Bhawan | 3.333333 | 1 | 0 |
| Sector-16 Rohini | 46 | 60 | 36.66667 |
| Najafgarh | 87.66667 | 93.66667 | 55.33333 |
| Sector-5 Rohini | 97.66667 | 119.3333 | 94 |
| Bhorgarh | 59.66667 | 52.66667 | 27.66667 |
| Bawana | 63.66667 | 65.33333 | 24.33333 |
| Jahangir Puri | 82.66667 | 108.6667 | 61 |
| Gokul Pur | 52.33333 | 58.66667 | 39.66667 |

| | | | |
|-------------------|----------|----------|----------|
| Shastri Park | 55.33333 | 59.33333 | 47.66667 |
| Paschim Vihar | 13.33333 | 21 | 17 |
| Paiwalan | 33.33333 | 38 | 30 |
| Okhla-1 | 39 | 55.66667 | 29 |
| Dwarka | 50.66667 | 63.33333 | 42.66667 |
| Hari Nagar | 34 | 57.33333 | 39 |
| DSIDC Bawana | 21.33333 | 24 | 15.33333 |
| Jwala Heri | 6.333333 | 10 | 5.666667 |
| Tikri | 10.66667 | 9.666667 | 7.666667 |
| Mangol Puri | 26 | 27.66667 | 18 |
| Tahir Pur | 46.66667 | 46 | 40.66667 |
| Sarita Vihar | 30.66667 | 37.33333 | 21.33333 |
| Delhi Secretariat | 3.5 | 5 | 1.5 |
| CBD Shahdara | 25.5 | 40.5 | 26 |
| Mayur Palace | 17 | 28.5 | 19 |
| Kalyan Vas | 31 | 41 | 28 |
| Udyuog Nagar | 3 | 8 | 2 |
| Mandawli IP | 70 | 77 | 68 |
| Badli | 1 | 1 | 1 |

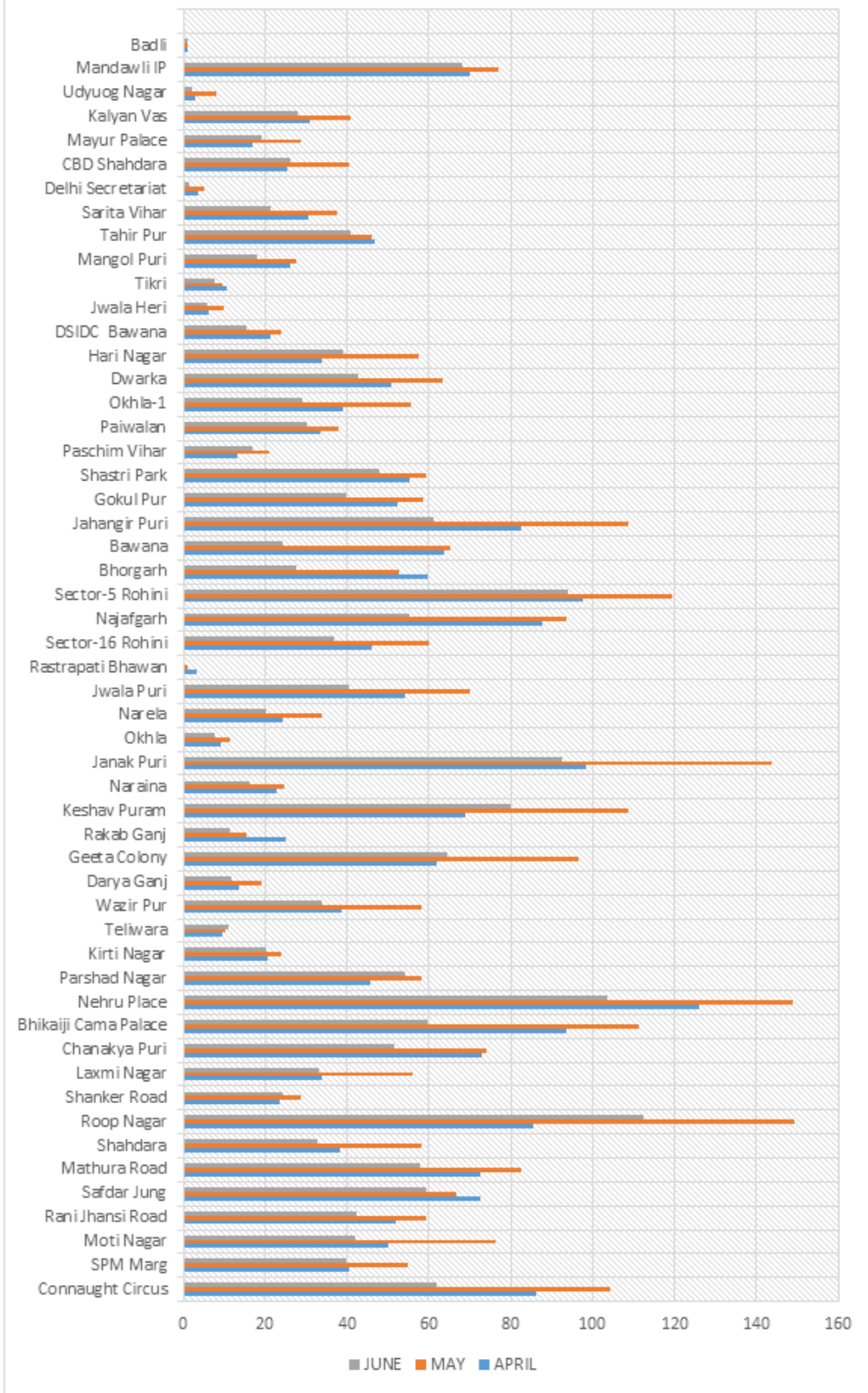
Graphical Plot of the above Data

The above data was graphically plotted for all three months, namely, April, May and June, with no. of fire outbreak incidences along x-axis and name of the fire stations along y-axis. The average data is plotted over the years 2010-2013, for the months in which number of fire outbreaks have been highest, namely April, May and June. After plotting the data we were able to conclude that;

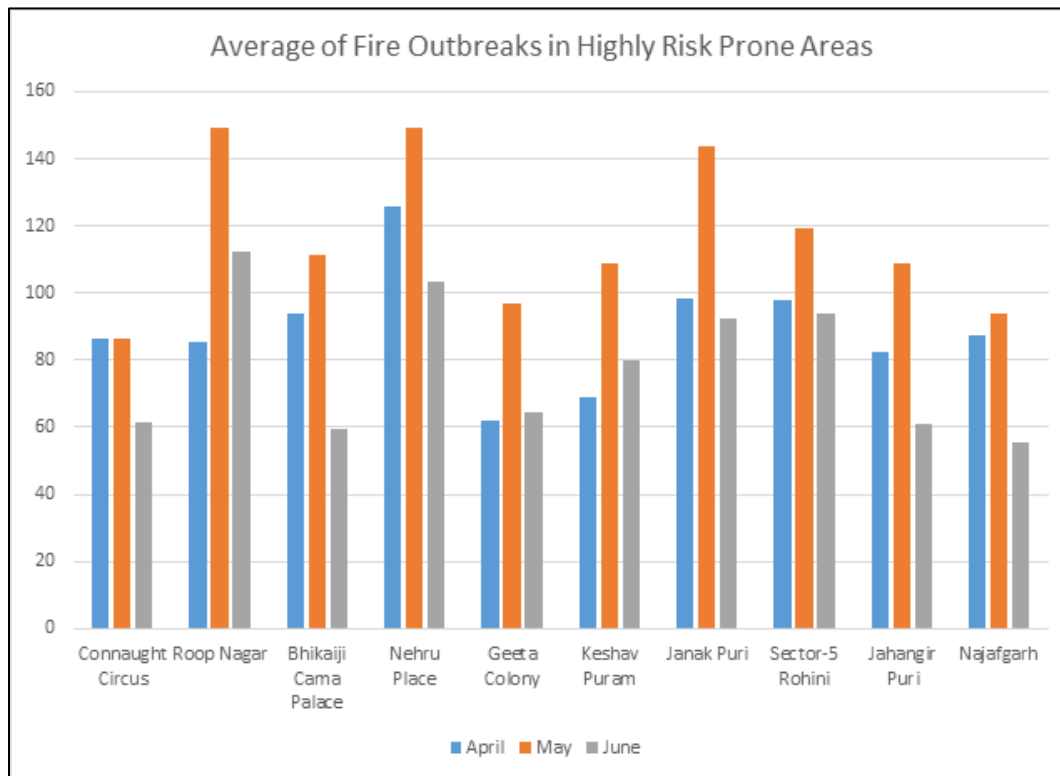
- Fire outbreaks in the month of May were almost 40 percent more than April and June.
- The highest number of calls were recorded in the following fire stations, namely, Roop Nagar, Jahangir Puri, Janak Puri, Nehru Placee, Rohini Sector-5, Geeta Colony, Keshav Puram, Najafgarh, Cannaught Place and Bhikaji Cama.

The conclusions from the plot of average data for fire outbreak incidences over the years 2010-2013 were found same as the conclusions of the plot for 2013. Hence the result was cross verified.

Average Fire Incidences from 2010-2013



From the above plot, the highly risk prone areas were selected and re-plotted in detail to reaffirm the categorical division of the areas on the basis of no. of fire outbreak incidences.



The data for the highly prone areas has been re-plotted with names of fire stations along x axis and number of incidences along y axis. From the above data plotting, we conclude that;

- Roop Nagar, Janak Puri and Nehru Place fire stations have recorded the highest number of fire outbreaks.
- On the basis of incidences recorded, the above highly incidence prone fire stations can be classified as:

Category 1 (No. of incidents more than 160):- In the average plot over 2010-2013, no fire station comes under this category. However the plot for 2013 showed Roop Nagar under this category.

Category 2 (No. of incidents between 140 to 160):- Roop Nagar, Janak Puri and Nehru Place. However, for the plot of 2013, this category also included Jahangir Puri.

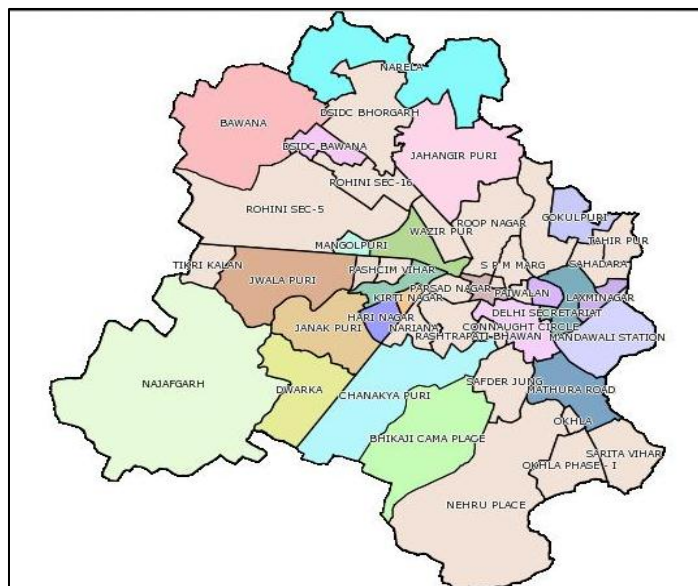
Category 3 (No. of incidents between 140 to 100):- Sector-5 Rohini, Bhikaji Cama, Jahangir Puri, Keshav Puram

Category 4 (No. of incidents reported less than 100):- Geeta Colony, Najaf Garh and Cannaught Place. Hence, from the graphical interpretation, it is observed that the above highly risk prone areas need special attention in the context that their fire handling capacity needs to be improved. Moreover, there is a lot that can be learned from the above data. By assessing the above data, we were able to pin point the risk prone areas. This study can help us take preventive measures from beforehand and be prepared with mitigative strategies. Also, by understanding the main factors causing these fire outbreaks, we can take steps to control those factors. For example, if an area is affected due to shot circuits and other such electricity oriented issues, or at industrial places, mock drills and informative sessions can be conducted to help at these places. Moreover, by understanding the traffic situations of an area, the area can be equipped with a greater number of small mobile fire stations at lesser distances. So that in advent of a fire outbreak, the nearest mobile van can reach the place as soon as possible without getting caught in traffic so that it can prevent the fire from becoming serious.

Fire Vulnerability Map

The fire vulnerability map of Delhi was prepared by integrating three attribute maps together. These are Fire stations, Fire incidences and Jurisdiction zones. Each attribute is expressed as a map and then all the attribute maps were integrated to make fire vulnerability maps.

Delhi Map along with the Fire Stations



Delhi Map along with the highly incidence prone fire stations.

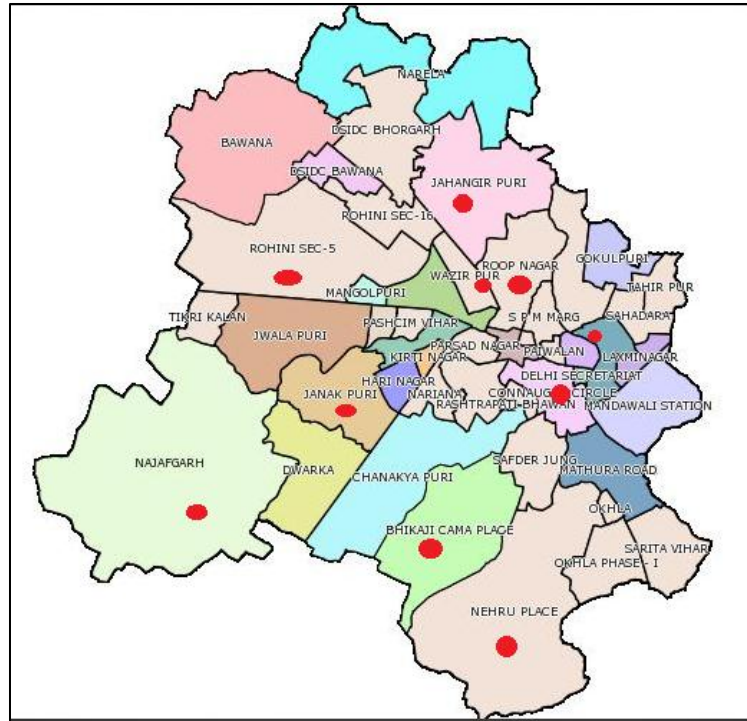


Fig 7: The highly prone fire areas marked in red on Delhi Map.

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