

AIR POLLUTION IN PESHAWAR (RATE OF DUSTFALL)

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Rate of dustfall measurements were under taken in urban area of Peshawar at four sites during the period 1993-1998. The average rate of dustfall has increased from 1993 to 1998 and the overall average rate of dustfall was found to be 27.65 tons/km² month. It was observed that dustfall varied from place to place and from month to month. Meteorological conditions have marked effect on the rate of dustfall pollution. Chemical analysis of the dustfall indicated that it has contribution from particulate emission from automobile exhausts, construction activities, soil and sand particles of the surrounding area.

Key words: Dustfall, Pollutant, Meteorological conditions.

Introduction

Particulate matter (dustfall), a typical air pollutant include dust, dirt, soot, smoke and liquid droplets. These are emitted directly into the atmosphere. Particles in the air are a very important source of air pollution. There are 2×10^6 dust particles in every cubic foot of air (Imdad, 1996). With every breath man inhale 2×10^4 to 7×10^4 dust particles. The nuisance caused by dustfall is a common feature in urban areas of arid zone. it affects human health which include irritation, dental carries, cardiovascular diseases, asthma, etc. (Encyclopedia, 1954; Stoke and Seager, 1972). As well as children and elderly are most likely to be sensitive to the effects of particulates. Dustfall causes a wide range of damage to materials especially paint surfaces are very susceptible to particulate damage before the paint is dry (Johnson *et al* 1977). It also contributes to the chemical decay of marbles, limestone, dolomite, stone work and concrete structure if it carries acid and soluble salts (Nat. Res. Comm., 1979). Besides human beings and materials, plants are not free from ill effects of dustfall pollution, it affects photosynthesis in plants and low rate of photosynthesis reduces the total and reducing sugar contents in the leaves and also decrease carbohydrates (Vora *et al* 1986).

Assessment of pollution especially atmospheric aerosols have received increased attention by governmental, scientific and industrial communities because of correlation between high level of particulate pollution and its ill effects on health, material and plants. Considerable work has been carried out in developed as well as in developing countries (Paul *et al*, 1956; Prinz *et al* 1982; Okubo and Miyazzaki, 1987; Radermacher

et al 1986; Radermacher *et al* 1989). In Japan there are more than twelve hundred dustfall collecting station whose results are reported regularly every year (Air Observation Board Japan, 1985) and Japan has succeeded in bringing down the level of dustfall in the atmosphere by taking certain important measures through enforcement of atmospheric pollution control legislation (Air Observation Board Japan, 1985).

In Pakistan, very little attention has been paid to the atmospheric pollution in general and dustfall in particular. Very small data is available for some cities of Pakistan like Karachi, Islamabad and Lahore (Environ. Profile of Pak. 1986; Beg *et al* 1991; and Khan *et al* 1991).

Rapidly increasing population, large number of factories built close to the populated areas, ever increasing motor vehicles on roads and conversion of green lands into townships etc. have also spoiled the environment of Peshawar and has become a focus of interest for the researchers. Keeping in view the above facts the present investigations were carried out because no study has been done in this area before. This paper describes the rate of dustfall, its chemical composition and the quantity of dustfall in urban areas of Peshawar.

Materials and Methods

Dustfall measurements were carried out by a recommended standard method (Robert 1986). Dustfall containers/collectors of standardized shape, i. e., 22-24 cm mouth diameter, 20 cm base diameter and 25 cm height were used.

Dustfall collectors (Fig 1) were installed at four locations/sites, i. e., near General Bus stand, main G. T. road (city area), Sunehri Masjid road (cant area) and Jamrud road (Speen Jamat) Peshawar as shown in Fig 2. The selection of locations/sites

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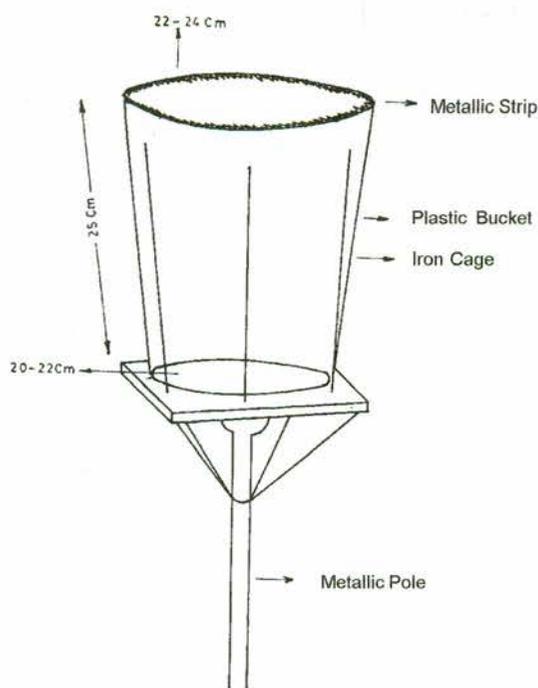


Fig 1. Dustfall collector.

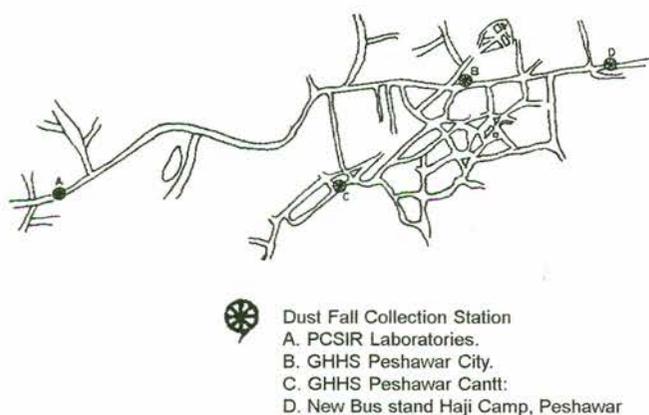


Fig 2. Map of Peshawar.

for the present study has an important bearing with respect to the number of motor vehicles which is the only main source of transportation in Peshawar. After a period of one calendar month corrected to 30 ± 2 days the collectors were taken off, covered with plastic lid and brought the laboratory. The samples were analysed by standard chemical and physical method (Scott, 1956).

Results and Discussion

Dustfall measurements were carried out for a period of six years from January 1993 to December 1998. Data on monthly rate of dustfall at individual site is recorded in Tables 1-4. Meteorological parameters obtained are listed in Table 5.

Chemical composition of the dustfall of the different sites is shown in Table 6.

Dustfall at main G.T. Road (city area). The average rate of dustfall at city area from 1993 to 1998 ranged from 19.60 to 24.21 tons/km² month and the overall average rate was found to be 21.99 tons/km² month. It increased by 21% from 1993 to 1998. Each years maximum dustfall was recorded in the month of June and the minimum was recorded in the month of January/February. Most of the dustfall were contributed by the traffic mobility in the vicinity of the study points. Several bus stops of public transport and private vehicles are present which provide pick and drop facility to passengers. Thousands of vehicles passes every hour. One entrance of not only fruit and vegetable mandi, but guruh mandi also opens near this study point that is the main causes of the slow moving traffic. At the back of the station, very old residential of the inner city are situated and these have a very small share in dustfall due

Table 1
Monthly rate of dustfall at main G. T. Road (City area), tons/km² month

| Months/Year | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 |
|-------------|----------------|----------------|----------------|----------------|----------------|----------------|
| January | 13.25 | 15.50 | 14.80 | 16.35 | 17.00 | 16.20 |
| February | 15.60 | 14.40 | 16.30 | 18.25 | 20.00 | 17.50 |
| March | 18.62 | 20.87 | 21.25 | 22.95 | 21.75 | 20.15 |
| April | 21.50 | 22.17 | 23.35 | 25.65 | 24.00 | 27.25 |
| May | 23.22 | 27.10 | 25.00 | 28.35 | 33.00 | 32.35 |
| June | 25.00 | 28.50 | 29.60 | 31.50 | 37.00 | 36.10 |
| July | 23.45 | 22.50 | 25.30 | 27.80 | 26.25 | 31.20 |
| August | 24.67 | 20.90 | 23.45 | 26.00 | 26.00 | 25.25 |
| September | 20.75 | 18.81 | 22.10 | 23.55 | 29.00 | 28.10 |
| October | 18.00 | 16.62 | 20.00 | 22.20 | 21.00 | 24.50 |
| November | 16.87 | 15.30 | 17.80 | 18.95 | 17.50 | 20.15 |
| December | 14.30 | 14.84 | 15.00 | 16.80 | 15.80 | 14.10 |
| Average | 19.60± 4.07 | 19.79± 4.74 | 21.16± 4.55 | 23.19± 4.88 | 24.02± 6.55 | 24.40± 6.91 |

Table 2
Monthly rate of dustfall at Jamrud Road (Speen Jamat), tons/km² month

| Months/Year | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 |
|-------------|----------------|----------------|----------------|----------------|----------------|----------------|
| January | 15.39 | 17.05 | 17.95 | 18.75 | 17.15 | 19.35 |
| February | 17.75 | 15.70 | 18.20 | 19.80 | 20.25 | 16.50 |
| March | 21.20 | 22.50 | 22.75 | 23.50 | 22.10 | 20.25 |
| April | 24.42 | 23.69 | 25.00 | 26.45 | 28.35 | 27.85 |
| May | 28.05 | 29.37 | 30.30 | 31.65 | 35.35 | 34.45 |
| June | 32.00 | 33.50 | 34.60 | 35.85 | 38.25 | 37.50 |
| July | 28.47 | 27.50 | 29.95 | 32.55 | 31.50 | 34.00 |
| August | 29.45 | 25.32 | 26.00 | 30.75 | 28.20 | 32.35 |
| September | 22.80 | 22.50 | 24.35 | 25.20 | 27.40 | 26.15 |
| October | 20.62 | 19.60 | 21.25 | 22.60 | 24.25 | 23.25 |
| November | 18.62 | 18.20 | 20.00 | 21.20 | 22.15 | 21.15 |
| December | 16.87 | 16.47 | 14.25 | 17.45 | 19.25 | 22.75 |
| Average | 22.97± 5.48 | 22.61± 5.54 | 23.72± 5.89 | 25.48± 6.00 | 26.14± 6.42 | 26.32± 6.90 |

to domestic activities. This station is expected to be the most polluted place compared to other station (Table 3 and 4) because of high traffic mobility, presence of large shopping areas, entertainment places and daily influx of large number of people from the adjoining villages. The main reason for the low amount is the distance between the collector and the source of dust. The collector is almost 180 feet away from the source, i.e., main road. Also small size particulates remain suspended in air for quite some time, and most of the dust blown in the ambient air falls down before reaching the collector.

Dustfall at Jamrud Road (Speen Jamat). The monthly average rate of dustfall ranged from 22.97 to 26.06 tons/km² month from 1993 to 1998 and the overall average was found 24.53 tons/km² month. It increased by 12.73% from 1993 to 1998. This station is located on Jamrud road in front of the famous "Speen Jamat" and university town main shopping

Table 3
Monthly rate of dustfall at Sunehri Masjid Road (Cant area), tons/km² month

| Months/Year | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 |
|-------------|----------------|----------------|----------------|----------------|----------------|----------------|
| January | 19.20 | 21.20 | 22.75 | 21.95 | 20.00 | 24.50 |
| February | 20.65 | 18.25 | 23.00 | 25.70 | 24.25 | 25.20 |
| March | 23.75 | 25.85 | 24.35 | 27.80 | 26.50 | 29.50 |
| April | 28.25 | 27.60 | 29.55 | 30.90 | 34.50 | 27.25 |
| May | 32.00 | 36.75 | 37.00 | 38.45 | 43.50 | 39.75 |
| June | 39.50 | 41.45 | 42.80 | 44.50 | 47.50 | 45.50 |
| July | 35.75 | 34.00 | 37.90 | 35.85 | 40.75 | 42.25 |
| August | 37.50 | 32.25 | 35.00 | 38.20 | 39.00 | 37.50 |
| September | 30.35 | 28.80 | 31.30 | 33.65 | 32.00 | 33.50 |
| October | 27.00 | 25.80 | 28.25 | 29.75 | 27.25 | 29.10 |
| November | 23.45 | 23.60 | 26.10 | 27.50 | 26.00 | 27.85 |
| December | 21.75 | 20.50 | 23.95 | 34.80 | 23.25 | 23.75 |
| Average | 28.26± 6.83 | 28.02± 6.94 | 23.16± 6.67 | 31.59± 6.65 | 32.04± 8.91 | 32.15± 7.41 |

Table 4
Monthly rate of dustfall at near new busstand, tons/km² month

| Months/Year | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 |
|-------------|----------------|----------------|----------------|----------------|----------------|----------------|
| January | 20.85 | 23.25 | 22.85 | 24.95 | 23.00 | 23.10 |
| February | 23.85 | 21.60 | 25.30 | 23.85 | 26.00 | 29.20 |
| March | 27.30 | 29.45 | 28.40 | 30.60 | 33.00 | 27.00 |
| April | 32.50 | 31.00 | 33.80 | 36.50 | 35.00 | 38.50 |
| May | 39.75 | 41.75 | 43.90 | 44.80 | 46.00 | 41.25 |
| June | 45.00 | 48.80 | 47.50 | 48.85 | 48.50 | 48.00 |
| July | 41.25 | 40.30 | 42.25 | 47.75 | 43.00 | 45.10 |
| August | 43.00 | 38.65 | 40.35 | 39.00 | 42.00 | 40.25 |
| September | 35.20 | 34.20 | 36.20 | 37.70 | 38.50 | 41.25 |
| October | 30.50 | 29.35 | 30.85 | 33.50 | 32.00 | 31.10 |
| November | 26.35 | 25.75 | 27.45 | 29.45 | 28.00 | 32.20 |
| December | 22.80 | 22.25 | 24.95 | 23.75 | 25.00 | 26.15 |
| Average | 32.36± 8.39 | 32.19± 8.67 | 33.65± 8.30 | 34.89± 8.70 | 35.00± 8.64 | 35.22± 8.15 |

centre. From Table-2 it is observed that high rate of dustfall occurred at this point compared to city area (Table-1), but not as bad as cant and near Bus stand areas (Table 3 and 4). Although the location is quite near to Peshawar University and Hayat Shaheed Teaching Hospital (clean and green places), Hayatabad Industrial Estate is a few kilometers from this point. Moreover, several illegal bus stops have been made by private vehicles that provide pick and drop facilities. The shoulders of the roads have been encroached by different vendors. This being the congested area (Hayat Teaching Hospital, University area, PCSIR laboratories, Suzuki stops for Palosai/Regi etc) and extensive traffic mobility on road make this location unique.

Dustfall at Sunehri Masjid Road (cant area). This station is very close to cant. commercial area and Saddar Bazar due to which heavy parking is seen every time. Main vegetable, fish, milk, meat and poultry markets are situated here. A few hotels and restaurants with huge number of shops of furniture, general utilities, automobiles workshops are present near this point where miscellaneous activities are going on throughout the day. From 1993 to 1998, the monthly average rate of dustfall ranged from 28.26 to 32.05 tons/km² month (Table 3) and overall average rate of dustfall was found to be 30.37 tons/km² month. It increased by 12.10% from 1993 to 1998. This road is quite narrow and heavy load of traffic supplemented with traffic jam is observed very often. Private and public transport stops at both sides of the road encroachment by vendors and slow moving traffic contribute more to the dustfall. Animal dung is one of the major dust sources being collected at this point. Horses in tongas and donkeys in carts are being used to bring in and take out vegetables from the markets are also the sources of dustfall pollution. Traffic police is quite active in this area but their efforts become less fruitful due to heavy load of traffic on both sides of roads and lack of co-operation and traffic sense in drivers/public.

Dustfall near new Bus stand Peshawar. This collector was installed on the roof of a petrol pump near new Bus stand Haji camp Peshawar. The monthly average rate of dustfall from 1993 to 1998 varied from 32.36 to 35.00 tons/km² month with overall average was found to be 33.38 tons/km² month. Dustfall increased by 8.12 % from 1993 to 1998. This is the most polluted place. Dustfall rate is very high, all types of vehicles such a buses, coasters, flying coaches, wagons, rickshawa etc. always present at this point. All the urban and rural transport of Peshawar, traffic between Peshawar and other cities/towns of the country and also Afghanistan passes at this point. The high level of dustfall can be associated with dust generated by traffic mobility inside the Bus stand and on G. road. Other factors like occasional traffic congestion, pres-

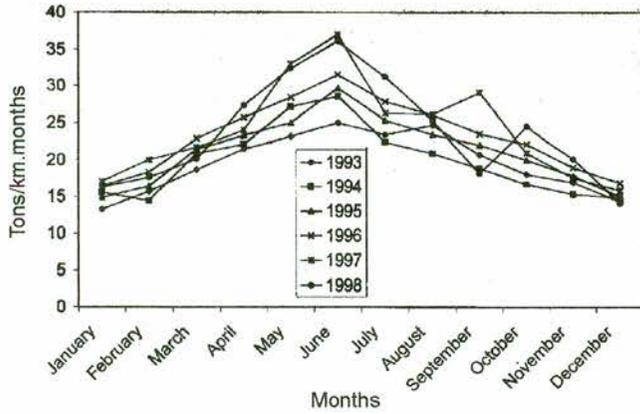


Fig 3. Monthly rate of dustfall at mian G.T. Road (City area).

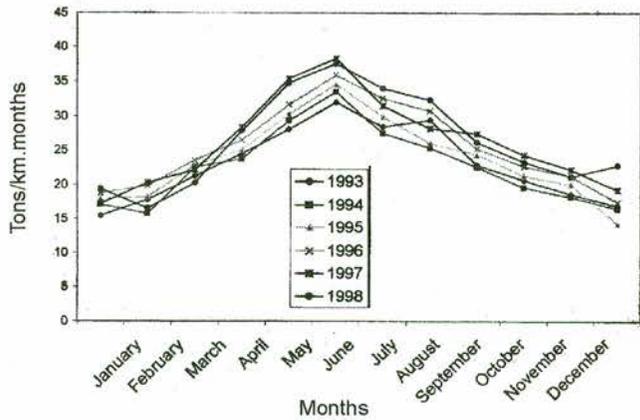


Fig 4. Monthly rate of dustfall at Speen Jamat.

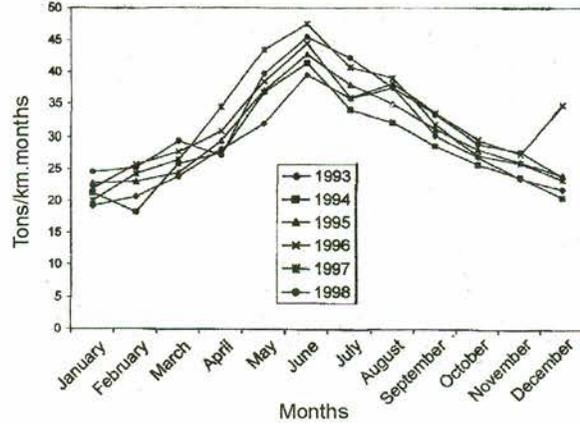


Fig 5. Monthly rate of dustfall at Sunehri Masjis Road.

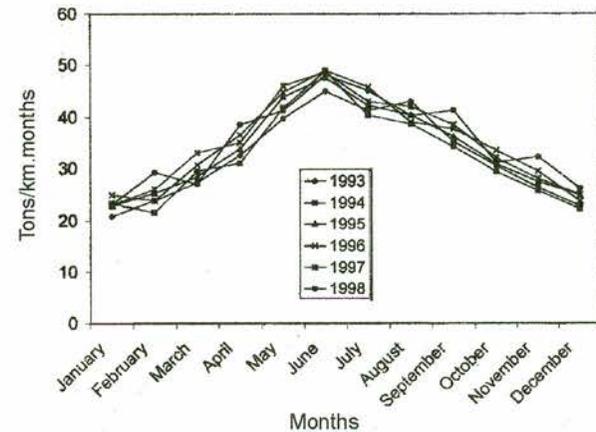


Fig 6. Monthly rate of dustfall at near bus stand, Haji camp.

ence of slum area on one side, construction of buildings, roads, lack of proper arrangement in the bus stand, lack of adequate space with regard to the number of vehicles, lack of awareness about air pollution among drivers/conductors, muddy condition of the area etc. add more and more to the atmospheric dustfall pollution.

General observation on dustfall at Peshawar. From the six years data, it is observed that dustfall is usually high in summer (May to August and low in winter (November to February)). At all four locations the highest dustfall was recorded in the month of June and the lowest in the month of January/February. Monthly rate of dustfall is represented in Figures 3-6 and there are two maxima one in the month of June and the other in August. Furthermore, dustfall varied from place to place and from time to time. Dustfall is site specific. The variation is of great importance as it can give some idea about the local factors which can contribute to the atmospheric dustfall.

Climatic variables influence the severity of air pollution in general and dustfall in particular. These vary tremendously

from day to day, from season to season and from location to location. So meteorological factors such as temperature, wind velocity and rainfall obtained are recorded in Table 5 (Meteor. Obs. 1993-98). From climatic data (Table 5), it is observed

Table 5
Climatic data of Peshawar

| Months | Temperature°C | | Humidity % | Rainfall (mm) | Wind Velocity km/h |
|-----------|---------------|---------|------------|---------------|--------------------|
| | Maximum | Minimum | | | |
| January | 16.98 | 1.62 | 29.83 | 11.74 | 2.61 |
| February | 19.12 | 3.89 | 31.19 | 34.66 | 3.14 |
| March | 21.85 | 8.51 | 35.56 | 69.97 | 3.25 |
| April | 26.86 | 12.89 | 32.97 | 66.31 | 3.40 |
| May | 34.67 | 18.72 | 27.62 | 21.26 | 4.18 |
| June | 38.60 | 22.38 | 32.35 | 16.42 | 4.47 |
| July | 36.12 | 24.90 | 51.09 | 78.62 | 4.85 |
| August | 28.81 | 24.57 | 49.88 | 43.64 | 4.46 |
| September | 33.85 | 21.00 | 39.47 | 26.52 | 3.70 |
| October | 28.37 | 14.02 | 30.38 | 26.90 | 2.98 |
| November | 24.89 | 9.38 | 30.24 | 82.00 | 2.74 |
| December | 20.71 | 2.76 | 30.89 | 18.50 | 2.42 |

Table 6
Chemical analysis of dustfall

| Constituents | Main G.T. road (city area) | Jamrud road (speen jamat) | Sunehri Masjid road(cant area) | Near new bus stand area |
|---|-------------------------------|------------------------------|-----------------------------------|----------------------------|
| Loss on ignition % | 22.36 | 17.63 | 22.58 | 18.71 |
| Silica as SiO ₂ | 43.55 | 45.50 | 41.16 | 46.29 |
| Alumina as Al ₂ O ₃ | 11.12 | 11.38 | 13.83 | 12.89 |
| Iron as Fe ₂ O ₃ | 3.12 | 3.69 | 4.38 | 5.30 |
| Calcium as CaO | 15.59 | 17.14 | 13.33 | 13.59 |
| Magnesium as MgO | 1.33 | 2.01 | 1.60 | 1.10 |
| Sodium as Na ₂ O | 0.76 | 1.04 | 0.84 | 0.90 |
| Potassium as K ₂ O | 0.41 | 0.78 | 0.35 | 0.38 |

that all the climatic factors show very wide day to day and month to month variation. The most common wind direction is from north to west and the next common south to west.

Wind velocity at Peshawar is low in winter ranges from 2.74 to 2.61 Km/h in November to February. It is high in Summer (May to August) 4.18 to 4.46 Km/h, and it was highest in the month of July, i. e., 4.85 km/h. High and strong winds are dust raising in character. All the meteorological variables are temperature dependent and temperature is high in summer.

The dustfall samples were analysed for loss on ignition, silica, oxides of aluminum, iron, calcium, magnesium, sodium, and potassium. From chemical analysis results (Table 6), it is seen that dustfall of all the sites have the same origin. It is mainly consists of SiO₂ : 41.16-46.29; Al₂O₃ : 12.89-13.83; Fe₂O₃ : 3.12-5.30; CaO : 13.33-17.14; MgO : 1.10-2.01; Na₂O : 0.76-1.04; K₂O : 0.35-0.78 and loss on ignition (carbon) : 17.63-22.59%. This indicates that dustfall is mainly calcium aluminosilicate from the Earth's crust, which originates from wind blown soil and road dust. All urban atmospheric dust has SiO₂ : 45%; Al₂O₃ : 6%; Fe₂O₃ : 13%; lime : 3%; and loss on ignition (carbon) 24% (Zutshi, *et al*, 1970). The grey color dust shows that it is a mixture of soot, smoke, unburnt fuels, vehicular traffic aerosoles and many other undetermined constituents.

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