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Assessment Pollutant Road-Side Soil and Farmland through Accumulation of Lead (Pb) due to Vehicular Traffic Activity along National Highway-4 from Nelamangala to Dabaspet, Karnataka, India

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Abstract: Background: Accumulation of lead (Pb) due to vehicular traffic activities on the road-side soil and farmland is a potential environmental hazard affecting the eco-system. Environmental pollution of heavy metal like lead (Pb**)** from automobiles has attained much attention in the recent past. Aim and Objectives: The present research was conducted to study the lead (Pb) concentration in road-side soil and farmland along a National Highway-4 from Nelamangala to Dabaspet. 35 soil samples were collected from the left and right side of the highway. Samples were collected at a distance of 10m and 200m away from the road edge. Amount of lead (Pb) level in soil was analyzed by using X-ray florescence spectrophotometer (model XRF-α-4000) and soil physiochemical properties of the soil were also determined. The results of the physiochemical analysis showed that the pH values in all sampling sites ranged from 3.55 to 6.58 and 3.65 to 6.36 at 10 m and 200 m away from the road respectively, indicating the acidity of soil. The total organic carbon values ranged from 0.00264% to 0.773% and 0.088% to 0.715% at 10m and 200m away from the road respectively, indicating the presence of organic matter and micro-biological activities in the soil sample. The conductivity values ranged from 0.002mS/gm to 0.026mS/gm and 0.002mS/gm to 0.036mS/gm at 10m and 200m away from the road respectively, indicating significant presence of some soluble inorganic salts. The road-side soil and farmland soil samples also had significantly high contents of Lead (Pb) and its level increased with increasing traffic activities.

Keywords: Environmental pollution, Road-side soil, Heavy metal, Lead (Pb), Traffic activity.

INTRODUCTION

The pollution of soil by heavy metal (Pb) from automobiles is a serious environmental issue. Lead belongs to the group of heavy metal which is extensively used by man. Lead is a most troublesome toxic metal, government agencies have taken many prevention steps to control lead in the environment, but still large scale incidents of metal poisoning have occurred[1].This metal is released during different operations of the road transport such as combustion, component wear and tear, fluid leakage and corrosion of metals. Lead (Pb) is the major metal pollutant of the road-side environment and is released from fuel burning, wear out of layers, leakage of oils, corrosion of batteries and metallic parts such as radiators etc[2]. Exhaust emissions and combustion of fossil-fuels were identified as primary sources of atmospheric metallic burden and it is now well established that a variety of motor vehicles introduce a number of toxic metals into the environment, most of which are released adjacent to roadways and among these toxic metal lead (Pb) is the most toxic pollutant of the road-side soil and farmland ecosystem. Lead (Pb) emission from motor vehicles produce elevated concentration of element in road-side vegetation[3]. Several studies have shown that metals such as Lead (Pb), cadmium (Cd), Nickel (Ni) amongst others are responsible for certain diseases and have a lethal effect on man and animals[4].

Recently it was claimed that lead (Pb) in urban areas could be over 1000ppm. In addition, FAO/WHO recommended tolerable intake of ingested Lead (Pb) for adults to be 3000µgm per week, which is equivalent to an average daily uptake of 430µgm and 130µgm for children[5]. Several studies have revealed that 60-80% of heavy metal toxins found in body, in urban areas are as a result of consuming contaminated food rather than air-pollution. The principle target organ-system of lead poisoning are the blood, brain, neurosystem, kidney and reproductive system acute exposure to lead leads to shock, and sever-anemia, Lead is transferred to animals and human beings through the food chain system of soil-plant-animal-human[6,7].

A major part of metal pollutants are deposited on adjacent road-side soil, they may be transported to other parts of the environment and their concentration and distribution in a different road verge zone (border, slope, verge, and ditch) were determined[8].

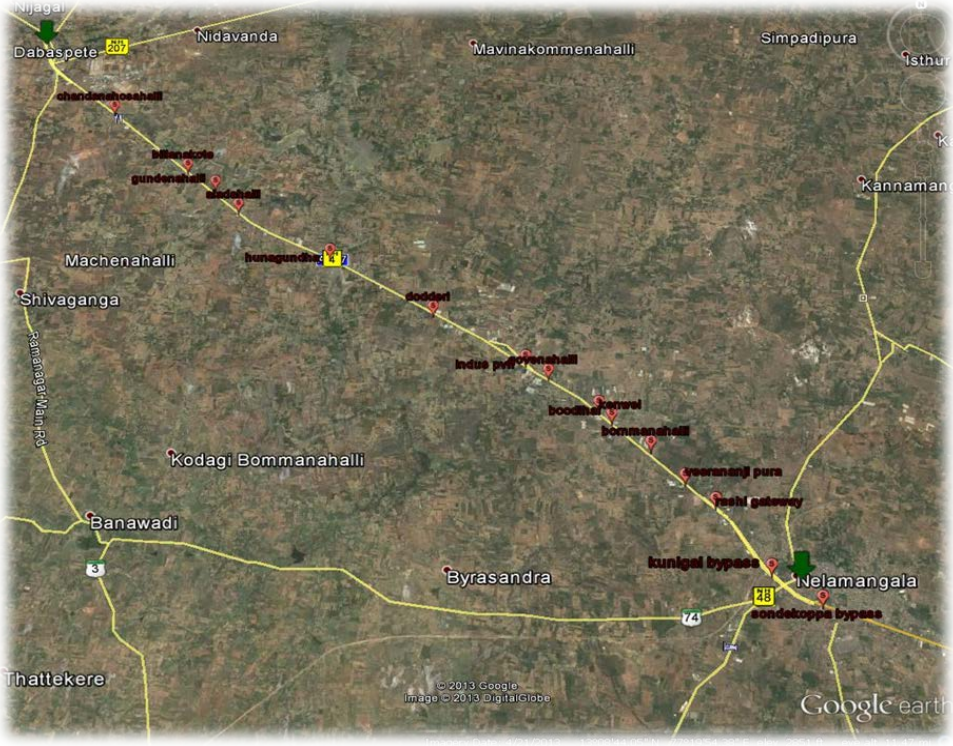
There is no doubt that leafy vegetables grown in the neighborhood of major motorways can contain significant trace of lead (Pb) due to airborne metal particulates derived from motor vehicle emissions. The distributions of the metal lead (Pb) in the road-side soil and farmland are strongly but inversely / directly correlated with the distance away from the roadside[9].

The tremendous increase in the number of motor vehicles onthe highway is leading to the increasingly high level of heavy metal lead (Pb) in the highway environment ecosystem. This research consists of a study of the distribution of lead (Pb) in road-side soil and farmland sampled at two different distances from the centre of traffic flow along the highway[10].

MATERIALS AND METHODS

Study Area: The study area consisted of 35-40 road-side sites on National Highway-4 between Nelamangala and Dabaspet along both the sides of the road. The geographical co-ordinates of the study area are from 13° 6' 7" N **(**latitude**)** and 77° 23' 23" E **(**Longitude**)** (Nelamangala) to 13° 13' 42" N and 77° 14' 30" E (Dabaspet). The road is one of the oldest tarmacs in this area and carries an

average density of traffic. A typical road verge can be divided into four different arbitrary zones, Border, Verge, Slope and Ditch/hedge. The border is the narrow zone adjacent to the road and it is heavily disturbed. The verge is next to border and usually 1-3m wide. The slope, where present, is 1-3m in height with 30-35 degrees inclination. The ditch is the last zone and usually had a hedge along it. The soil sampling along the roadside verges was therefore carried-out according to the different zones in the road-side verges depending on its condition. During the survey, however, it happened sometimes not all the four zones (particularly slope) were present at each site. The main socioeconomic activity along this road is farming.



Sampling: Samples were collected from Nelamangala-Dabaspet highway about 23km from the nearest rural centre (Nelamangala). This highway carrying an average of 10^x motor vehicles per day. 35-40 sites were selected for the study along both sides of highway. At each site two samples of soil were collected at two different distances from the road edge (10m and 200m).

Soil samples randomly distributed, round the observation point were taken with the aid of stainless steel ditch auger at a depth of 0-15cm and width of 15-30cm circumference on the surface of the soil and samples were kept in labelled polyethylene bags. Soil samples were air-dried before chemical analysis.

Sample Preparation and Analysis: Each soil sample was air-dried in the laboratory, soil samples were gently ground using an acid washed porcelain pestle and mortar and then passed through a 0.2mm nylon sieve and stored in plastic bags until analysis. The soil sample for metal analysis was digested using concentrated nitric acid. The digested samples were analysed for metal using X-ray Florescence Spectrophotometry (XRF-α-4000).

Soil pH was measured in a soil: water suspension (1:10) using an electric digital pH meter and electric conductivity of soil was determined using conductivity cell (Deluxe Water and Soil analysis kit-model-191E).

Acidity of soil NaOH v/s sample(1:10)], % of calcium carbonate (NaOH v/s HCl and sample), % of oxidized organic carbon, % of total organic carbon and % of organic matter (FAS v/s $K_2Cr_2O_7$, conc. H_2SO_4, conc. Ortho phosphoric acid, water and sample) was determined by volumetric titration method using diphenylamine as indicator.

RESULT AND DISCUSSION

The main aim of this study was to determine the change in the physical properties and contamination of Lead (Pb) in road-side and farmland around National Highway-4 from Nelamangala to Dabaspet due to vehicular traffic activity. The range of the physiochemical properties and the contamination level of Lead (Pb) in the soil samples is presented in the following tables.

Table 1: Ranges of Physiochemical Parameters and Level of Lead (Pb) on both Right and Left Side of Road at Different Distance

Distance	pH	EC mS/gm	% of $CaCO_3$	% of Total Organic Carbon	Lead (Pb) in PPM
10 m	3.55-6.5	0.002-0.026	96-104	0.00264-0.773	17-49
200m	3.65-6.3	0.002-0.036	96-105	0.088-0.715	16-40
Average	4.734	0.0117	99.77	0.3766	23.58

Soil pH ranged from 3.55 to 6.58 at 10m away from the road and 3.65-6.36 at 200m away from the road. This range indicated that the samples taken 200m away from the road edge were more acidic than the samples taken 10m away from the road and the average was 4.73, this indicated that the soil around the our study area was slightly acidic. Electric conductivity of soil was ranged from 0.002mS/gm to 0.026mS/gm at 10m away from the road and 0.002mS/gm to 0.036mS/gm at 200m away from the road and average was 0.0117mS/gm, this indicate that the presence of some salts in the soil. The percentage of calcium carbonate ranged from 96 to 104 at 10m away from the road and 96 to 105 at 200m away from the road and average was 99.77.

The Total organic carbon ranged from 0.00264 to 0.773 at 10m away from the road and 0.088 to 0.715 at 200m away from the road edge and average is 0.3766, which indicated the presence of some soluble organic matter was our study area. Lead (Pb) level in soil sample ranged from 17ppm to 49at 10m away from the road edge and 16ppm to 40ppm at 200m away from the road edge and average was 23.58. This indicated that the high level of lead (Pb) was accumulated in soil samples in the study area than the standard level (10ppm).

Physiochemical Properties and Lead (Pb) Level in Soil Samples: The present investigation showed that the concentration of lead (Pb) and some of the physiochemical properties of soil sample collected in road-side are given in the following tables.

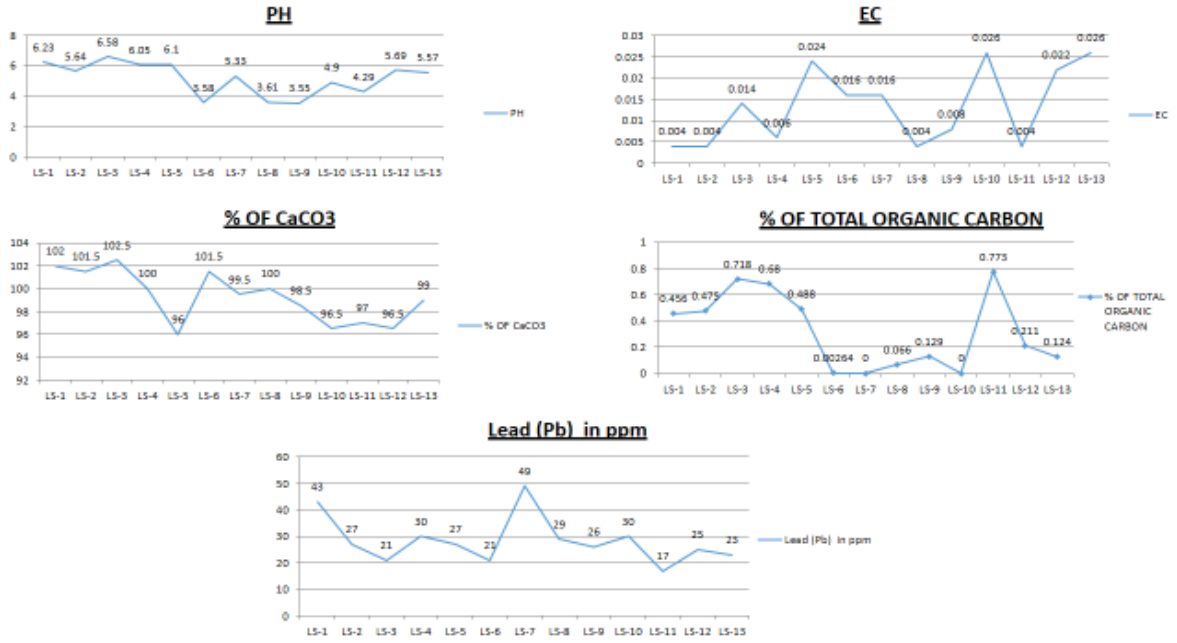
The following table gives the data about the concentration level of the lead (Pb) and some physiochemical parameters in soil samples collected at the southeast direction at 10 meters away from the road edge along the national highway-4 from Nelamangala to Dabaspet.

The first column indicates the sampling number and LS indicates the samples collected at the left side of the road. The highest concentration level of lead (Pb) is found to be 49ppm at site LS-7 and lowest

concentration is 17ppm at site LS-11, the average lead (Pb) concentration level is 28.3ppm at 10m away from the left side of the road edge.

Table 2: Physiochemical Properties and Lead Level in Left Side Soil sample (10m Away from the Road)

Samples	pH	EC	% of CaCO3	% of Total Organic Carbon	Lead (Pb) in PPM
LS-1	6.23	0.004	102	0.456	43
LS-2	5.64	0.004	101.5	0.475	27
LS-3	6.58	0.014	102.5	0.718	21
LS-4	6.05	0.006	100	0.68	30
LS-5	6.1	0.024	96	0.488	27
LS-6	3.58	0.016	101.5	0.00264	21
LS-7	5.33	0.016	99.5	<LOD	49
LS-8	3.61	0.004	100	0.066	29
LS-9	3.55	0.008	98.5	0.129	26
LS-10	4.9	0.026	96.5	<LOD	30
LS-11	4.29	0.004	97	0.773	17
LS-12	5.69	0.022	96.5	0.211	25
LS-13	5.57	0.026	99	0.124	23

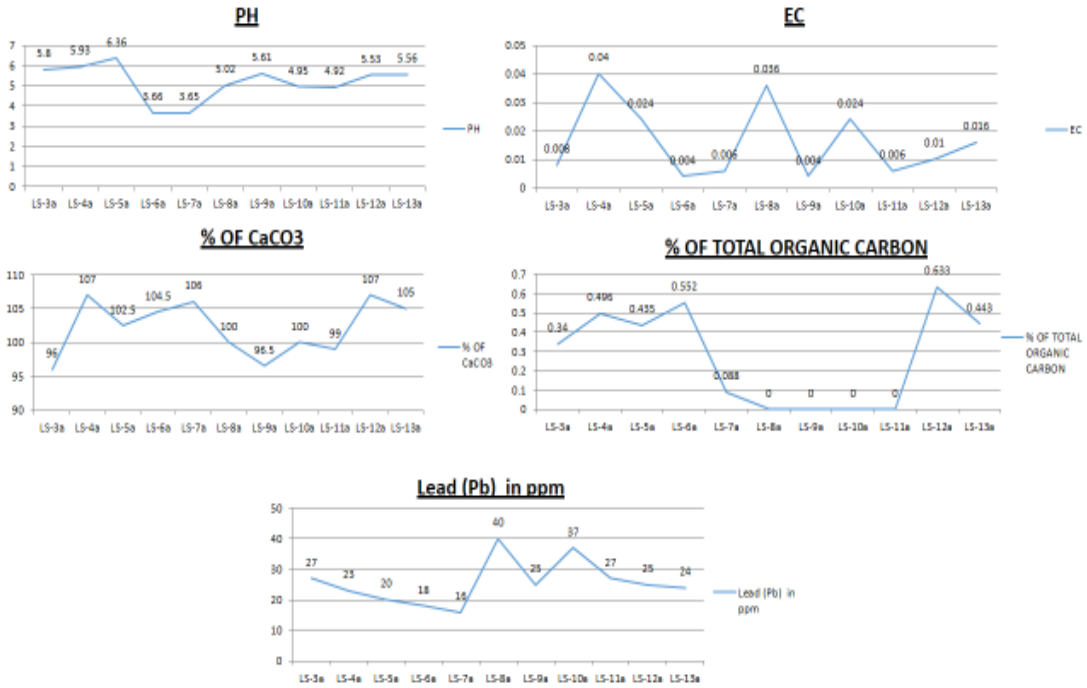


The following table gives the data about the concentration level of the lead (Pb) and some physiochemical parameters in soil samples collected at the southeast direction at 200 meters away

from the road edge. The first column indicates the sampling number and LS-a indicates the samples collected at the left side of the road. The highest concentration level of lead (Pb) is found to be 40ppm at site LS-8a and lowest concentration is 16ppm at site LS-7a, the average lead (Pb) concentration level is 25.6ppm at 200m away from the left side of the road edge.

Table 3: Physiochemical Properties and Lead Level in of Left Side Soil Sample (200m Away from the Road)

Samples	pH	EC	% of $CaCO_3$	% of Total Organic Carbon	Lead (Pb) in PPM
LS-3a	5.80	0.008	96	o.340	27
LS-4a	5,93	0.04	107	0.496	23
LS-5a	6.36	0.024	102.5	0.435	20
LS-6a	3.66	0.004	104.5	0.552	18
LS-7a	3.65	0.006	106	0.088	16
LS-8a	5.02	0.036	100	<LOD	40
LS-9a	5.61	0.004	96.5	<LOD	25
LS-10a	4.95	0.024	100	<LOD	37
LS-11a	4.92	0.006	99	<LOD	27
LS-12a	5.53	0.01	107	0.633	25
LS-13a	5.56	0.016	105	0.443	24

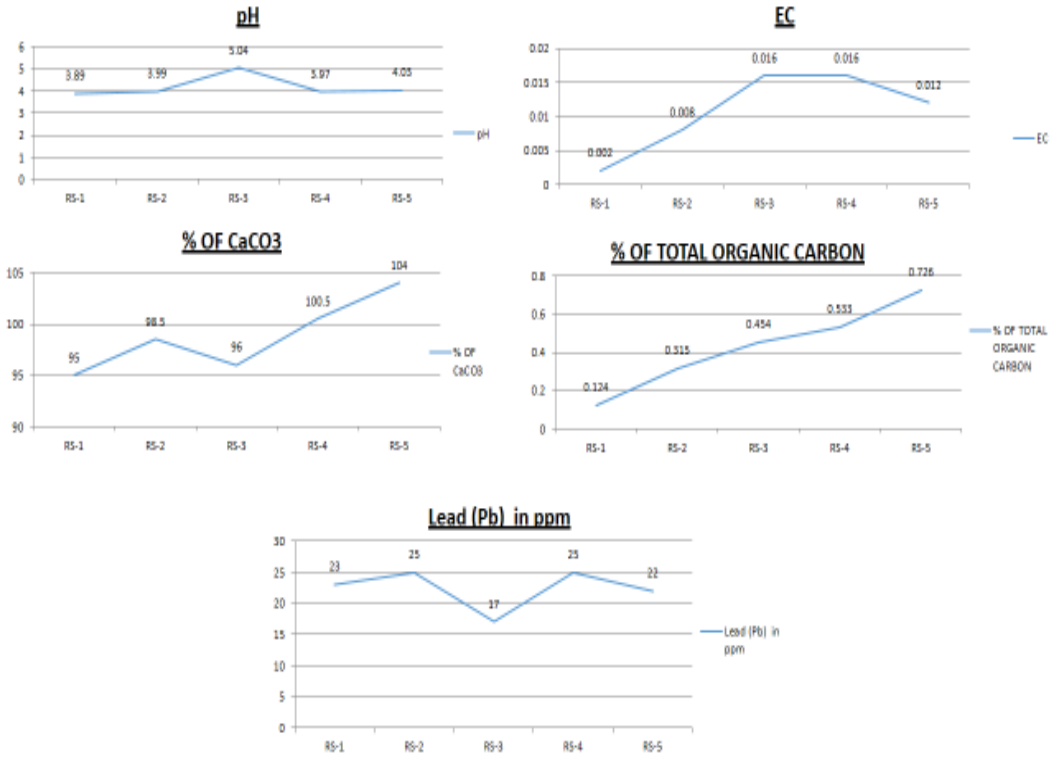


The following table gives the data about the concentration level of the lead (Pb) and some physiochemical parameters in soil samples collected at the north-west direction at 10 meters away from the road edge, we collect only 5 soil samples in this region, because there is no available space

for sample collection due to industrial activity and road construction. The first column indicates the sampling number and RS indicates the samples collected at the right side of the road. The highest concentration level of lead (Pb) is found to be 25ppm at two sites RS-2 and RS-4, and lowest concentration is 17ppm at site RS-3, the average lead (Pb) concentration level is 22.4ppm at 10m away from the right side of the road edge.

Table 4: Physiochemical Properties and Lead Level of Right Side Soil Samples (10m Away from the Road)

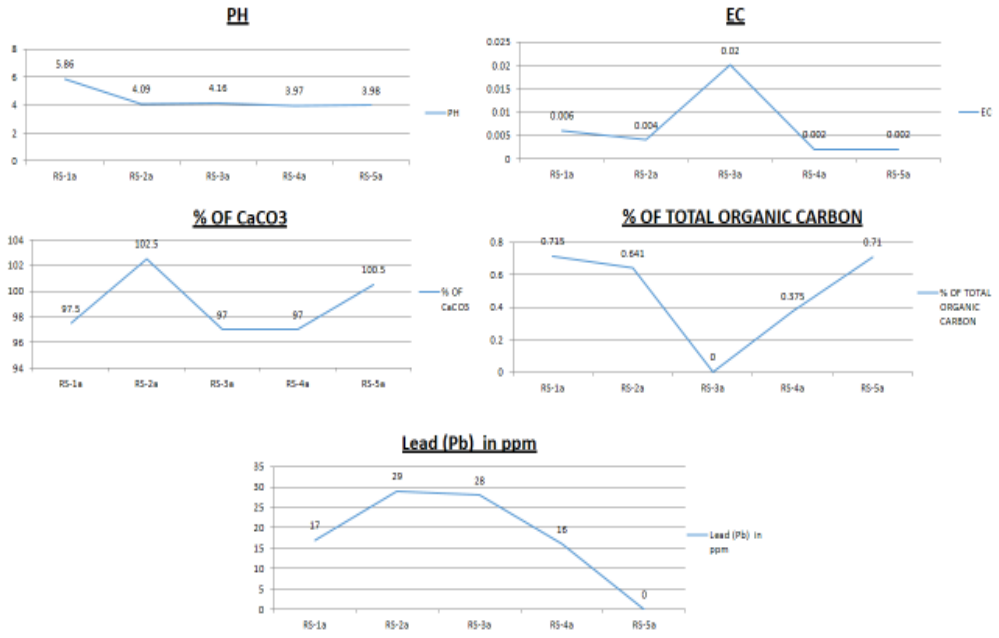
Samples	pH	EC	% of $CaCO_3$	% of Total Organic Carbon	Lead (Pb) in ppm
RS-1	3.89	0.002	95	0.124	23
RS-2	3.99	0.008	98.5	0.315	25
RS-3	5.04	0.016	96	0.454	17
RS-4	3.97	0.016	100.5	0.533	25
RS-5	4.03	0.012	104	0.726	22



The following table gives the data about the concentration level of the lead (Pb) and some physiochemical parameters in soil samples collected at the north-west direction at 200 meters away from the road edge. The first column indicates the sampling number and RS-a indicates the samples collected at the right side of the road. The highest concentration level of lead (Pb) is found to be 29ppm at site RS-2a and lowest concentration is 16ppm at site RS-4a, the average lead (Pb) concentration level is 18ppm at 200m away from the right side of the road edge.

Table 5: Physiochemical Properties and Lead Level of Right Samples (200m Away from the Road)

Samples	Ph	Ec	% of CACO3	% of Total Organic Carbon	Lead (Pb) in PPM
RS-1a	5.86	0.006	97.5	0.715	17
RS-2a	4.09	0.004	102.5	0.641	29
RS-3a	4.16	0.02	97	<LOD	28
RS-4a	3.97	0.002	97	0.375	16
RS-5a	3.98	0.002	100.5	0.71	<LOD



CONCLUSION

The above graph shows that the high contamination level of lead (Pb) in soil samples taken from both left and right side of the road at 10m away from the road edge, because lead (Pb) can enter the environment through the exhausts of vehicles. The mass of lead (Pb) when compared to other heavy metals, so the large particles of lead will drop to adjacent to the roadside immediately and pollute the road-side soil. Lead (Pb) is insoluble in water; the movement of lead (Pb) on the soil surface is very slow by water flow due to its heavy mass. So, the concentration of lead (Pb) is very high in soil samples collected at 10m away from the road.

On comparing left and right side samples, the left side samples have a high level of lead (Pb) than the right side samples. In our contemplation, it may be due to industrial activity, traffic density and topography of this area. Our study area consists of high level of lead (Pb) concentration than its standard level (i.e. 10ppm). If the contamination of lead (Pb) goes on like this, the entire area will be polluted by lead poisoning and vanish the echo-system. We concluded that, there is only one natural way to control the lead contamination in road-side soil and lead poisoning that is bio-remediation. Bio-remediation is a growing some plant and tree which absorb the lead concentration in the soil and maintain its function.

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