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Research Paper

Impact of heavy metals found in soil alongside Highway: A short review

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ABSTRACT:*In this paper,the impact of vehicular traffic can consequently be undisputedly recognized on heavy metal contamination of roadside soil. Road traffic and maintenance pollutes the roadside soil by chromic heavy metals. Some of these pollutants can be scattered into the air or stored on the roadside. By the vigor-pollutant site near the highway, this review article highlights the influence of heavy metal contamination along the highway roadsides due to heavy traffic vehicle emission.*

KEYWORDS: *Heavy Metals, Soil, Highway*

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I. INTRODUCTION

Soil is the outer layer of the Earth's crust, serving multiple vital functions including the production of food and wood, transport, filtration and absorption of many macro and micro nutrients. The soil structure has, however, been altered in recent years owing to numerous natural and anthropogenic activities [1].Organic carbon influences many soil characteristics including colour, capacity to hold nutrients, nutrient turnover and stability, which in turn influences water relations, aeration, and workability. Soil organic matter plays a crucial role in the processing of nutrients and can greatly improve soil structure. The bulk density depends on many variables such as sedimentation; aggregation and the volume of SOC present in the soil but are strongly associated with the organic carbon content [2-5].Soil research offers reliable evidence to the extent of sampling on the chemical, physical and biological properties of soils, but analytical results are of no value because they are precise, timely, and capable of practical interpretation [6]. Different uses include study of modal profiles from soil resource surveys, evaluation of plant-available soil nutrient status, interpretation of research results, calculation of requirements for crop fertilizers, identification of polluted areas, measurement of soil salinity and acidity, etc. Soil science has its origins by pioneers such as Daubney, Davey, Liebig and Hilgard [7-8] in the early to mid-nineteenth century. The method was later developed by Carl Schmidt of Dorpat, and Bernard Dyer. For examples, Dyer used a 1% citric acid solution to remove soil for phosphorus and potassium, as its acidity correlates relatively well with that in typical crop root-fur sap [9-10]. On the other hand many researchers have been involved in studying soil heterogeneity, ranging with the study [11-13]. Most of the publications in this area, based on laboratory soil samples study, find more soil conservation properties such as mechanical structure, humus content etc. In particular, soil contamination has been reported to increase at alarming rates in developing countries like India [14].The underlying layer is polluted not only by chemical discharges or effluents but also by vehicle pollution on roadsides. Although the toxins generated by automobiles migrate into the air they eventually touch and accumulate in the environment of the earth. So the surface soil seems to be the ideal source for automotive emissions research [15].

II. HEAVY METALS IN THE SOIL ALONGSIDE HIGHWAY

ChaochengZhenghas been studied theheavy metal content analyzed in six segments of the Huning-Jinghu highway, suggesting that road traffic has polluted agricultural land in different degrees, especially Pb and Cd contaminants. Spatial studies revealed 330 m of gross heavy metal pollution on both sides of the highway. In six areas of the expressway, heavy metals grow through soil on all sides of the highway as traffic volume increases. Nevertheless, the content of heavy metals in the soil in the spatial highway distribution revealed a major difference, the content of Cd, Cr, Zn and Cu decreased gradually overall with distance to highway, whereas the content of Pb and increased with distance to highway [16].

Olajire and Ayodele (1997) and Soylak et al. (1999) have been highlighted the heavy metals like Cu, Cd and Ni on highways are higher than other commercial areas. Nonetheless, in the high and low traffic density areas, no significant difference was found between their mean concentrations. The Fe and Mn amounts in samples of soil were shown to be independent of the highway size, whereas urban-soil quality of Pb, Ni, Zn, Cu and Cd depends on the proximity to the roads and traffic densities [17-18].

Saw AungZaw Aye et al. have been reported the copper in Yogyakarta Region unsaturated soil concentrated primarily in amorphous ferrous oxide 81.72%, crystalline iron oxide 8.92%, and the remaining copper distributed in exchangeable, carbonate, recycled and residual fractions. Therefore, copper was predominantly adsorbed by iron oxide in unsaturated soil in the sample region. Approximately ninety percent of non-residual copper was influenced by anthropological activities. Although copper concentration is high in a non-residual fraction, Fe oxide may serve as effective adsorbents and control excessive copper mobilization in soil in the research area. Under unsaturated water, copper can be used as poor bio-availability product. Copper may have been poisoned by anthropological operations, but low-risk soil due to weak bio-availability. This should be known that if copper accumulation improves iron oxide adsorption ability, it will influence the urban atmosphere and potential impact on human health [19].

Meie Wang, and Haizhen Zhang, collected and studied the soil samples from 45 roads in three different categories in Xihu District, Hangzhou City, and investigated potential factors affecting heavy metal concentrations. Our results showed that Cu, Zn, Pb, Cr, and Cd found CVs more than 90%. According to related geo-chemical history values, Cu, Zn, and Pb concentrations were elevated. A multivariate study has established strong distinctions among heavy metals. It could be inferred that Cu, Zn, Pb, Cr, and Cd may have accumulated due to human activity in roadside soils in the studied region, while no strong pollution was indicated based on Chinese soil quality standards. The Correlation research indicated that pH and soil organic matter were the two most significant factors affecting the concentration of heavy metals in roadside soil, as these two variables may explain almost 100% of the variation in deposition of Cu, Zn, Pb and Cd. A minor association was observed between the age of roads or the form of roadside vegetation cover and the concentrations of the major anthropological heavy metals like Cu, Pb, Cd, Cr, and Zn, although these influences were widely considered to have an effect on the deposition of heavy metals in roadside areas. Nonetheless, the highest Pb, Cd, and Cr in heavy traffic sites and significant differences in Cu, Pb, Cd, and Zn concentrations across different road categories indicated the contribution of traffic strength. The highest traffic rate CUR had the highest concentrations of Cu, Zn, Pb, and Cd comparative to supplementary two path groups [20].

SubrotoDutta and AbhaSisodia, The latest research was conducted to examine amounts of Pb and Cd in soil along a major highway with high traffic density. Soil samples along the highway were obtained from ten locations on the National Highway-8 between Kishangarh Toll to Bagru Toll in Ajmer and tested for two heavy metals (Pb and Cd) using a spectrophotometer to detect flames. Physicochemical influences, assumed to influence metal mobility in the research region dust, such as pH, TOM, electrical conductivity, organic carbon, etc. The general decline in these metals concentrations at distance from the highway shows their connection to the heavy traffic [21].

Dolan et al. Heavy metals are typical car contaminants and are well established in soil and plants in their deposition patterns. Pollution of heavy metals from vehicle products is a serious environmental problem. Such metals are emitted during road transport operations such as oxidation, part tear, solvent contamination and metal corrosion. Lead, cadmium, copper and zinc are the main metal contaminants in roadside habitats and are emitted from fuel burning, tires, oil leaks, and metal parts such as radiators [22].

Voegborlo R. B. and Chirgawi M. B., have been used atomic absorption spectrophotometry calculated the amounts of some heavy metals in soil and vegetation along a major road in Libya. The concentrations in soil and plants of Pb, Cd, Ni, Zn, Cu, Cr, and Mn decreased with distance from traffic. Concentrations of metals have also deteriorated with soil profile size, suggesting the aerial deposition of motor vehicles as a source of the metals. There was a very strong ($p < 0.05$) inter-relation between the metals in the soil indicating that these metals were a common source. More than the other elements, Pb and Zn were reported to have been accumulated. The average values were 30-65% of those for citrus lemon leaves in general. In most instances, a quick washing of water removes 20 to 40 percent of the metals, which implies that a large but not prominent fraction is in the form of particulate matter, which is easily removed [23].

Dierkes C. and Geiger W. F. (2000),studied the pollutant soil retention ability. Highway drainage produces large amounts of heavy metals and hydrocarbons that endanger soil and groundwater by green backgrounds. Soils were examined for distance and depth to identify degradation with plumage, copper, cadmium, and hydrocarbons. The amounts of toxins in roadside soils were found to rely on the age and circulatory intensity of the embankments. The highest levels were found in the upper few centimeters of the field and up to two meters from the road [24].

Chon et al., (1995) The dispersion trends and characteristics of heavy metal emissions attributable to urbanization and industrialization were collected from Seoul, Korea and examined for Cu, Pb, Zn and Cd. Iron quantities in most soils and dusts surpassed global levels. The soil and dust pollution index is > 1 in most of the Seoul region, which is consistent with the city's industrialization and urbanization index. Soils are contaminated with Cu, Zn, Cd, particularly Pb. This means that soil contamination in Seoul is primarily caused by vehicle emissions. The soil pollution index is highest in the Kuro region, where Cu and Zn contamination induced by indigenous brass and bronze industrial unit.From selective analyzes, metal concentrations separates the Seoul region into power, traffic, and urban areas: Zn > Cu >Pb [25].

Mafuyai G. M. et al., (2015), Five main roadside dusts are testified for Cu, Pb, Ni, Zn, Fe, Cd, Mn, and Cr pollution. The concentration of metal in dusts suggested Cu varied from 24.5–67.0 mg / kg, Pb 25.0–66 mg / kg, Ni 1.23–3.88 mg / kg, Zn 35.0–123 mg / kg, Fe 48.5–125 mg / kg, Cd 1.54–2.58 mg / kg, Mn 1.15–2.58 mg / kg and Cr 1.13–2.79 mg / kg. Traffic volume greatly influences the deposition of heavy metals in soil dust, and the metals showed a significant decrease in roadside dust with increasing distance from the lane. Four approaches were used to determine the level of contamination. These four approaches reported that ABW, YGW, and GJR are pollution-impacted sites relative to MMW and BRR. The finding indicates various sources of pollution, including human activities, vehicle emissions and lithogenic concentrations of road construction metals present in some of the sites analyzed [26].

Al-Khashman, O. A. (2004), has been reported the Roadside dust usually generated from anthropogenic practices by modifying natural concrete, liquid or gaseous content with polluting sources such as water-borne material from the surrounding soil and cliffs, dry and wet atmospheric precipitation, biological contributions, road surface wear, road coat loss, car wear such as tires, engine, brake linings, etc.[27]

Y. Nazzal, HabesGhrefat and Marc A. Rosen, (2014), are reported here of an analysis of the content of metals in roadside dust samples of four major highways in the superior Toronto Area (GTA) in Ontario, Canada. Heavy metals Pb, Zn, Cd, Ni, Cr, Cu, Mn and Fe are studied. The calculation of soil chemistry composition variations uses multivariate geo-static analysis, including Correlation Analysis (Ca), Principal Component Analysis (PCA) and Hierarchical Cluster Analysis (HCA). The correlation coefficient indicates that most of the pairs are associated with the Zn-Cd, Mn-Cd, Zn-Cr, Pb-Zn and Ni-Zn cases. PCA indicates that the importance of three is less than one and implies that the sources of pollution are manufacturing and traffic. Among two main groups, HCA classifies heavy metals. Geostatic research allows for the isolation and detection of specific pollute origins for geological and anthropogenic causes of differences in roadside dust material [28].

Webster et al. (1994), have been applied multivariable geological surveys, not just on the visual inspections of concentration charts, but also on the quantitative analysis of the spatial variation in the elements and their interactions on various space scales. To order to provide a more objective evaluation of the origin of some heavy metals to topsoil, In order to connection the heavy metal concentration to geology and land use, multivariate approaches were also used to compare results of main component analyzes conducted on the concentration data with the experimental indicator Variogram used for other categorical statistics [29].

Pagotto C. et al. (2001), have been studied the concentrations of lead, copper, cadmium, zinc, nickel and chromium metals were measured in road dust and roadside soils from a French major highway. The observed concentrations fall rapidly with distance and profundity, the soil samples revealed no nickel and chromium emissions. The geochemical phases on which heavy metals like lead, copper, zinc, cadmium and chromium were preferentially set and the possible mobility of various metals under certain physical and chemical conditions were evaluated. Chromium, found mostly in residual form, was predominantly normal in the samples analyzed and was not extremely mobilized. Cadmium was the simplest exchangeable item for differences in physical and chemical environments, but the amounts involved remained small. Lead and copper weren't highly mobile. Only dramatic situations such as those created by unintentional spillage of acid or complexes mobilized them quantitatively. Only in zinc, which is very responsive to acid pH, was a significant risk of mobilization to be expected [30].

Ahmed A. Elnazer et al. (2015) have been studied the roadside soil pollution of Pb, Cd and Zn, 34 soil samples were obtained along the Alexandria-MarsaMatruh highway in Egypt and tested using atomic absorption. Contamination of these metals was assessed using geo-accumulation index, contamination factor (CF), pollution load index (PLI), single ecological risk index, and possible ecological risk index (PERI). Pb, Cd, and Zn measured 38.2, 2.3 and 43.4 μg/g respectively Specifies soil contamination of Pb and Cd and Zn. Shows the roadside soils have low risk from Pb and Zn and strong risk from Cd. In many samples, 62% show low PERI risk correlated with metal penetration and the remaining samples (38%) are high PERI. For Pb and Cd material, the bioavailable fraction was 72.5 and 37.5 percent. These findings show the remarkable impact of vehicle and agricultural practices on soil Pb and Cd material [31].

Zhang Hui et al. (2017) have been detail studied of soil survey in roadside soils along the Shenyang-Dalian Highway of Liaoning Province, China, measured heavy metal pollution. Pb, Cu, Cd, Ni, and Zn were studied using atomic spectrophotometry. The average concentrations of Pb, Cu, Cd, Ni, and Zn in roadside soils were respectively 43.8, 26.5, 0.119, 32.1, and 71.3 mg / kg, and all concentrations surpassed baseline values. Under various land-use styles, specific heavy metal consumption trends were noticed. In agriculture, 25 m from the roadside soil, a peak metal accumulation prevailed, while in forest and orchard soil all heavy metals reduced with distance from the roadside, which adhered to the exponential rule. Heavy metal amounts were slightly higher in 1999 than 2007, except for Cd. Concentrations of soils along the Shenyang-Dalian Highway is modest or small relative to roadside soils in other cities worldwide. Generally, this review indicates that heavy metal exposure in such soils is relatively small and we propose paying more attention to Pb emissions in roadside soils along Shenyang-Dalian Highway [32].

Adedeji, Oludare H. et al. (2013) this research studied the concentration of eight critical heavy metals in selected urban center roadside soils in Ijebu-North Local Government Area Ogun County, SW, Nigeria. Thirty-six hybrid soil samples were obtained along the roadside dependent on road lengths. In some chosen areas, physiochemical properties and concentrations of heavy metals Cd, Cr, Cu, Fe, Mn, Pb and Zn were calculated using atomic absorption spectroscopy. Accumulation of heavy metals in top soils is seriously affected by amount of traffic and all heavy metals demonstrated a substantial reduction in roadside soils with growing distance from lane. Metal rates in roadside soils observed Zn >Pb> Fe > Cu > Mn > Cd > Cr. Zinc concentration was 156.09 mg /kg in Ijebu-Igbo / Oru / Ago-Iwoye roadside soils, which is witnessing high traffic volume, while it ranged from 10-47 mg/kg for Ijebu-Igbo / Bajowa / Akanran road with low traffic volume. Pb concentration of 26.7 mg/kg was observed in: Ijebu-Igbo / Oru / Ago-Iwoye route, particularly in the city center. Concentrations of all heavy metals were below EU standards [33].

Rozanski S. et al. (2017) have been assessed the effect of highway traffic on the overall content and bio-availability of Zn, Cu, Ni, Cd, Cr and Pb in surrounding soils as well as the effects of acoustic screens on spatial metal delivery. The content contained 40 soil samples from fifteen testing points 5, 10, 25 and 50 m away from the road acoustic panel and four points between the panel and highway. Furthermore, below the metal fence were five testing sites. Selected soil physico-chemical activities were determined: soil structure, soil pH, TOC and $CaCO_3$ content. After digestion in aqua-regia and bioavailable types in 1 molar diethylene-triamine-penta-acetic acid, AAS calculated overall heavy metal content in soils. This work noticed low effect of road traffic on heavy metals in soils [34].

Mmolawa K. B. et al. (2011) Heavy metal pollutant assessment: Al, Co, Cu, Fe, Pb, Mn, Ni and Zn was conducted along major roadside soils in Botswana between latitudes 18°S to 27°S and 20°E to 29°E using enrichment factor ratios, contamination factor, pollution load index and geoaccumulation index (I_{geo}) methods. The sites were classified into five areas named FN (Francistown-Nata), NM (Nata-Maun), MG (Maun-Ghanzi), GK (Ghanzi-Kang) and TS (Tshabong-Sekoma). The four emission measurement approaches showed that FN, NM, and MG areas are emissions-impacted relative to GK and TS areas. Multivariate findings indicate multiple causes of contamination, including human activity, automobile waste, and lithogenic events. Al, Cu, Fe, Mn, Zn and Co is of mixed pollutant nature, with Fe and Mn being primarily lithogenic and Pb and Ni automotive pollutants [35].

Caroline Ewen et al. (2009) In the middle of the town and the bypass motorway areas of Thessaloniki, northern Greece, and seventy five roadside dust samples were collected. Samples were taken from arterial, main, local, and ring roads to equate and contrast heavy metal rates, namely Cu, Zn, Cd, Mn, and Pb. Flame Atomic Absorption Spectroscopy was utilized for quantitatively assess both total element and geochemical fractionation concentrations within the two particulate fraction sizes <75 μm and 75-125 μm. Acid digestion using Aqua Regia was used for complete elemental analysis; a process tested using qualified reference compounds. Fractionation experiments included a three-stage sequential extraction process on five selected samples. The resulting solutions were tested for lead and zinc levels to evaluate fractionation across various geochemical fractions, while determining bioavailability. Jamming or stop-start traffic conditions were shown to have affected and raised rates of heavy metal accumulation along inner-city roads relative to rates seen on the existing relief ring road [36].

Yang Jie et al. (2016) have been tested the road and foliar dust samples obtained for the purposes of research into the origins of and distribution characteristics of the nine heavy metals V, Pb, Cd, Cu, Zn, Ni, Cr, Fe and Mn for four districts in the City of Panzhihua, China, which have been renowned for their V-Ti production area. The results suggest that foliar samples were smaller and heavier than ground soil. Lead and vanadium was significantly enriched, below Zn, Ni, Cr, Fe, Mn showed moderate enrichment and less than Cd and Ni was minimal enrichment were the same toxicity tests for heavy metals. As the primary pollution factor, statistical analysis showed the Pb emerged in the waste combustion and the combustion of the plumage coal. Fugitive pollution and road movements were sources of Zn, Ni, Cr, Fe, V and Mn. Corrosion of alloys used in aircraft, vehicle or other metal structures and components are possible source for Cu. Cd origins varied from other heavy metals. The major anthropogenic cause of heavy metal in Panzhihua powders is transportation and manufacturing practices, and the contamination of heavy metals in the agricultural area should be given greater consideration [37].

Choudhary M. P. and Kushwah Y. K. (2016) have been reported in the present study, of heavy metals in soil along the national highway-12 between Kota:Deoli (Tonk) by selecting ten sampling locations at a distance of about 10-12 Km between two consecutive locations for a period of six months from December 2015 to May 2016. The soil samples are analyzed for toxic metals like Lead, Manganese, Cadmium, Zinc, Iron and other parameters like pH and electric conductivity. It has been found that the concentrations of the heavy metals found in these samples along the national highway are beyond the permissible limits prescribed by the Indian Standards [38].

VuralAlaaddin (2013) has been demonstrated in his study is to understand heavy metal accumulation due to dense traffic load, industrialization, urbanization or geological features of the region. The assessment of the heavy metal accumulation of the soils is based on the Geo-accumulation Index and Enrichment Factor, and that of plants, is based on the Bioaccumulation Factor. According to the Geo-accumulation Index, soil samples were uncontaminated for Cr, Co, Cu, Rb, and Sr elements, un-contaminated to moderately contaminated for V, Ni, Ba, and Zn, and moderately to heavily-heavy contaminated for As. The contamination of soil samples changes from moderate–heavy-extremely contaminated grade for Pb. According to the Enrichment Factor; soil samples show, no enrichment-moderately-severe enrichment for V. Considering the Zn element, enrichment is in minor to severe enrichment. On the other hand, element enrichment is severe to very severe enrichment for As and that of Pb is minor to an extremely severe enrichment level. The data revealed that the soil in the study area is significantly contaminated for Zn, As, and Pb [39].

HuaZhanget et al. (2012) have been discussed heavy metal accumulation influence of railways on the Tibetan plateau on the surface. The findings suggest that rail transport greatly affects concentrations of Zn, Cd and Pb in the soil, with enrichment rates varying from nil to major contamination, and that the amounts of arsenic, cadmium, and copper are being tested in a representative region along the Haergai-Delingha railway and cobalt and vanadium in top soils. The region impacted was twenty meters from the station. The ground at Delingha was the most heavy-metal led rock, and the Cd extents on the soils were the strongest along the railway between Qinghai and Tibet [40].

ShakyaPawan Raj and PradhanangaAchut Ram, the Lead, cadmium and mercury were examined by atomic absorption spectrophotometer in roadside dust samples got from ten main sampling sites alongside Arniko Highway, Kathmandu Valley, Nepal. Dust analyses found elevated amounts of heavy metals compared with baseline values. The metal concentrations ranged between 69.09-471.40 mg/kg for Pb, 1.56-6.15 mg/kg for Cd, and 0.59-1.89 mg/kg for Hg, respectively, with average concentrations of 245.36 mg/kg, 2.89 mg/kg and 1.04 mg/kg for the same components. Such values were associated with findings from different cities or countries worldwide. The pollution indices such as pollution factor, degree of pollution and heavy metal geo-accumulation index revealed different degrees of contamination in roadside dust around the locations. The study showed road pollution, vehicles and other anthropogenic practices are possible causes of metal acquaintance [41]. In the view of the above literature survey, here the researcher has been decided to do the further research on the heavy metal contamination in the soil nearby highway roadsides on national highway-3 shown in the map (figure-1)

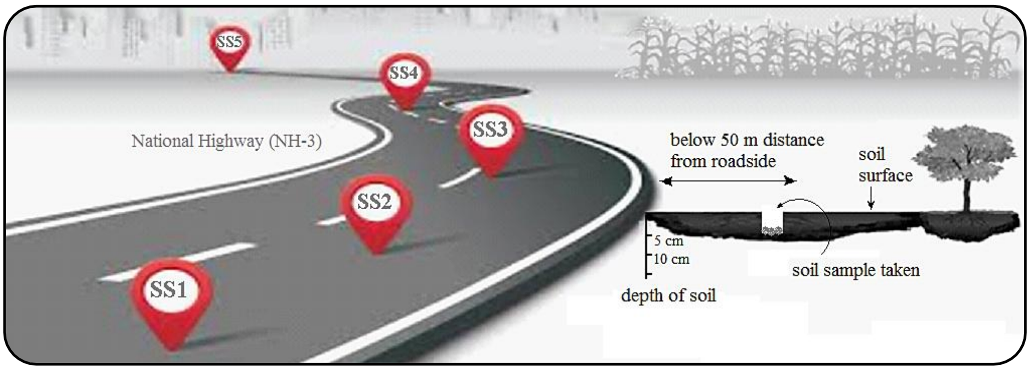

Fig.1: Soil sampling distance and digging map along road sides of NH-3

III. RESULT AND DISCUSSION

This review study revealed that the pollutants steadily rise on roadside soil along highway. The most possible cause of this emission is that automobile traffic is recorded this way relative to the background levels of high heavy metals and oil hydrocarbons. In certain instances, contaminant amounts stay below the limits established by certain international bodies, such as WHO, EU, FAO, etc. High heavy metals and petroleum hydrocarbon have life-threatening threats, as previous researcher's worldwide study confirms our findings, so the need for the hour is continuously tracking certain parameters. Dumping unregulated and illegal lubricants, plastics and e-wastes can be stopped for greater human experiences. This study has shown that road traffic has affected on soil heavy metal quality. Increased concentrations of heavy metals in near-road soil could contribute to long-term in the ecosystem.

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