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Estimate of dust suspended at different heights and its impact on different land use system

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Abstract
Strong atmospheric winds may cause wind dispersal through natural or anthropogenic phenomenon present in surrounding atmosphere primarily affects Earth's climate by scattering and absorbing short-wave and long-wave radiation, which initially impacts surface temperatures which is considered as one of the major instinct for climate change. This study clearly shows that dust load estimates found increasing vertically measurement height. The higher dust accumulation is seen in the region with higher vehicular movement. The lowest duct accumulation is observed at the lowest height from the ground surface and increased as the height increased. The movement of dust load was studied in different season. In pre-monsoon season an average of 236 per cent dust was found, where as in post monsoon the average was 186 per cent. In both season residential area recorded the lowest dust and highest was recorded from the road side.

Keywords: Land use, seasons, dust accumulation, vehicular movement

Introduction
The changes in global climate and increase in ground level ozone are predicted to have serious implications on living and non-living things in the existing ecosystem, especially in tropical countries in terms of increased natural perturbations that eventually influence food security, health, and the economy projected by food and agriculture organization (FAO). The aftermaths of this nature are quite evident in recent years with prolonged dry spells, heat waves, and increased frequency of floods and droughts in most parts of the world (Nicholls *et al.* 2012) [5]. Dust is one of the natural or anthropogenic phenomenon present in surrounding atmosphere primarily affects Earth's climate by scattering and absorbing short-wave and long-wave radiation, which initially impacts surface temperatures which is considered as one of the major instinct for climate change. The surrounding dust particles modify the environmental cycle through the absorption and scattering of both incident and reflected radiation (Lacis and Mishenko, 1995) [3]. The impact of dust particles not only have problem with surface temperature but also, living organisms on Earth, they interact with biotic and abiotic components directly or indirectly. Dust not only has impact with sole life but also affects rainfall through its interaction and implications to the hydrological cycle and the global monsoon systems, leading to disturbance in distribution of water resources (Prusty *et al.* 2003) [7].

It is very important to consider the issue that cause serious impact on environment. Generally, the exposed surface at different heights with flat surface help in depositing of dust in it, if we consider trees absorbs large quantities of dust particles from the surrounding environment, particularly on the leaves in the tree canopy, and therefore considered as natural air filters. Thus, air quality in urban areas can be improved by planting a tree. However, the amount of dust deposition in aerodynamic surface of leaf is possible due to different morphological characteristics of leaf like wax content, leaf area, leaf shape, plant height, leaf texture, presence or absence of plumose structures, *etc*. Stomatal frequencies are also related to the efficiency of the dust-collecting capacity of plants on the upper and lower surfaces of the leaf (Das and Pattanayak, 1977) [1]. Though the tree canopy helps in reducing the dust in the atmosphere, it also has some negative impacts on plant physiology. The accumulation of dust on plant leaves influences the leaf morphology and biochemical characteristics and exerts stress on plant physiology. Though the tress help in removing dust particle from the surrounding environment it is very important to note that how far the dust travels vertically and the regions where the dust activities are more. In this study the attempt was made to understand the impact of dust on environment, major concerned region where the dust activity

is more and height the dust travel along the vertical movement.

Materials and Method

The study was conducted in five different landscapes of Ward number four (Yelahanka New town), Bangalore, Karnataka, India in the year 2022. In this region of Bengaluru city, five different landscapes, namely; Avenue Trees, Residential Area, Industrial area, Lake and park were studied. Two kilometre walk stretch of each of the landscapes was sampled, while in the case of a lake, the entire lake was assessed and three parks were enumerated which cover a length of two kilometres.

In order to study the dust produced in different land-use systems observations were recorded in these five different landscapes using the glass slide technique. Observations were made in five spots of each land-use system.

The dust production in a place with high vehicular movement and at a place with no or minimum vehicular movement is measured to assess the possible exposure of trees to dust was also evaluated to understand the seasonal concentration of dust, observation was recorded during the month of February 2022 (Pre mansoon) and July 2022 (Post mansoon). Highway No. 75 (Bangalore-Hyderabad connecting highway) which is close to the University of Agriculture Sciences campus is selected and considered as a high dust-producing region, and the farmlands within the campus about five Kilometres away from the Highway are the two sites selected to represent the above-mentioned situations.

Glass slide method

Glass slides used for microscopic studies were washed thoroughly to ensure no dust particles were present in. The glass slide is smeared with a thin layer of petroleum jelly and weighed, which is considered as initial weight (w_1). The glass slide is then placed in the experimental site for 24 hours and was quickly transferred to the laboratory for further analysis. The glass slide with dust present is reweighed (w_2). The difference in weight between W_2 and W_1 is the quantity of dust accumulation (Navjot Singh *et al*. 2016) [4].

$$W = \frac{W_2 - W_1}{A}$$

Where, W = Dust content (mg/cm^2),
W_1 = Weight of beaker without dust
W_2 = Weight of beaker with dust
A = Total area of glass slide in cm^2

Single factor ANOVA is used to know the significant differences of dust deposition at different heights at different landscapes. It is carried out in MS Excel 2010.

Results

Dust accumulation pattern in the atmosphere

The dust accumulation pattern was different under conditions of with and without vehicular movement (Table 1). The higher dust accumulation is seen in the region with higher vehicular movement. The lowest duct accumulation is observed at the lowest height from the ground surface and increased as the height increased. The maximum dust accumulated at 2m height (31.78 mg/cm^2) and the minimum dust was recorded at 1m height (25.11 mg/cm^2) without vehicular movement. The maximum dust was recorded from the ground surface at 4 m height (42.44 mg/cm^2) and the minimum dust was recorded at 1m height (36.22 mg/cm^2) with vehicular movement. It is important to understand the distance travelled by dust particles where once they are suspend into the air by vehicular movement, wind, fire, *etc*. The major contributing factors that affect this are: size of the particle, wind velocity, height at which the dust is suspended. Particle size considerably the most determine factor due to the terminal settling velocity. Travel of dust movement is influenced and is highly dependent on this particle size. Dust is a commonly occurring natural phenomenon being observed in all the areas irrespective of geographical location and in larger concentration it is found mainly on cities and developmental areas like near industries, construction sites, road side, playing ground *etc.* (Elabdin and Islam, 2008) [2]. Usually, strong raising winds can be considered as one of the acceptable reason for the dust particles to get suspended in the atmosphere. These winds at different altitudes vary depending upon specific regional characteristics and wind speeds. The intensity of dust storms decreases the visibility. Dust in the atmosphere can reach a height of 5 km or more in the atmosphere (Elabdin and Islam, 2008) [2].

The higher dust accumulation in higher vehicular density region is obviously because of higher emissions from the vehicles. Our results are in agreement with the findings of Samal and Santra (2002) [8] who noticed more dust due to more vehicular activities adjacent to roadside. The results are also in conformity with the findings of Spatt and Miller (1981) [9] who reported that the dust arising from vehicular traffic settled in greatest quantities near the road with the amount rapidly decreasing away from the road.

Table 1: Average dust accumulation at two different locations on five different heights at study site

Sl. No.	Heights	Dust accumulation (mg/sq cm)	
		Without vehicular movement	With vehicular movement
1	1 meter	25.11	36.22
2	2 meter	31.78	38.22
3	3 meter	26.67	40.22
4	4 meter	28.22	42.44
5	5 meter	29.33	40.44
	SEM = 0.040		

Table 2: Average seasonal dust accumulation in five different land use systems (values in the parenthesis is the increase over non dust producing areas)

Sl. No.	Land Use System	Dust accumulation (mg/ cm^2)	
		Pre-monsoon	Post-monsoon
1	Industrial area	31.00 (360%)	24.28 (217%)
2	Lake	24.85 (277%)	17.28 (154%)
3	Avenue trees	44.85 (401%)	27.71 (248%)
4	Residential area	18.28 (163%)	15.28 (137%)
5	Parks	24.43 (218%)	18.42 (164%)
	Average	28.68 (236%)	20.59 (186%)

Seasonal dust accumulation showed considerable variations among the five land use systems and with the post and pre-monsoon seasons. Seasonal average dust accumulation of 28.68 mg/cm^2 was recorded during pre-monsoon season from different landscapes of the city. The lowest of 18.42 mg/cm^2 was observed during post monsoon season from residential area (Table 2). In pre-monsoon season an average of 236 per cent dust was found, where as in post monsoon the average

was 186 per cent. In both season residential area recorded the lowest dust and highest was recorded from the road side, followed by Industrial area, lake, parks and least was in residential area in pre monsoon, whereas in post monsoon it is Industrial area, parks, lakes and least dust accumulation was in residential area. Spatt and Miller (1981) [9] reported that the dust arising from vehicular traffic generated from day to day traffic activity will accumulate and stays in the atmosphere. Irrespective of season, dust deposition on the roadside is found to vary in different time of the day mainly depending on the vehicular movement.

In the studied landscapes before the rainfall, the highest concentration of dust was seen while in post rainfall it was comparatively less. This is because rain water will wet the surface soil and reduce the movement of dust into the atmosphere. Rain can reduce dust emission, but this can only happen if the topmost soil layer is wet. How effectively rain can suppress dust emission depends on how frequently strong winds occur while the top layer of the soil is wet (Okin, 2022) [6]. The impact of rain on dust emission is highly dependent upon regional climate. In certain regions, the dusty season and the rainy season occur during different parts of the year where rain will have significant effect on dust emission. In other regions, storms that bring rain also bring winds, and rain has the potential to strongly effect dust emission. In addition, the natural rainfall occurs in an open area within which airborne particle like dust easily be diffused by strong winds. It remains unknown whether strong winds strengthen or weaken the rainfall and dust removal. Therefore, the synergistic action of strong winds and heavy rainfall on dust removal might influence removal of dust in the atmosphere (Xu *et al*., 2017) [10].

Conclusion

Dust is a very common meteorological phenomenon observed in all developmental areas like near industries, construction sites, roadside, playing grounds, *etc*. It is found that dust accumulated on the roadside with vehicular movement was highest compared to the roads with no vehicular movement. Similarly, dust produced during pre-monsoon periods was more compared to post-monsoon. The high intensity of vehicular movement in the cities generates dust and gaseous pollutants which are harmful to human health. From the dust profile at different areal heights, it is found that the highest dust is found at higher areal heights from the ground. This indicates that dust produced generally moves vertically upwards and if trees are planted the tree canopy at these heights would withhold them and help in reducing dust pollution on the roads where people will be moving.

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