Effect of cement dust on soil chemical properties in the vicinity of a Cement Factory, RamnagarChandauli

ABSTRACT

The present study was carried out to assess the effect of cement dust deposition on the chemical properties of soil in the vicinity of Jai Laxmi cement factory, Ramnagar, Chandauli. Soil samples were collected and analyzed and compared with control site and standard soil classification. Comparison of soil chemical parameters revealed that cement dust from factory effect the soil quality surrounding cement factory. pH was found to be neutral to slightly alkaline near cement factory. EC was in non-saline range. Soil organic carbon and soil SOM was in medium range. NPK was also high in affected range than the control site. At present it may not be that serious but if this trend continues soil properties of a vast area is likely to be change indirectly affecting flora, fauna and human being.

Keywords: Chemical properties, soil quality, cement dust, modernization, NPK, SOM

1. INTRODUCTION

In today's world, day by day, many small-scale and large-scale industries are setting up and affecting and degrading different environmental components such as air, soil, water, vegetation, and human health (**VimleshRawat** and **RatnaKatiyar**, **2015)**. The word soil is derived from the Latin word 'solum' which means 'floor' or 'ground'. Soil provides numerous regulatory services, since it is the second global carbon sink, and nutrient cycling **(Rakshit A. *et.al.*, 2016)**.

Soils contain 3.5% of the earth's carbon reserves, compared with 1.7% in the atmosphere, 8.9% in fossil fuels, 1.0% in biota, and 84.9% in oceans **(lal R., 2004)**. It is the interface at which all forces acting on the Earth's crust meet to produce a medium of unconsolidated material, acting as an environment for further changes and developments, keeping pace with the evolution of the global Earth system as a whole**(Ibrahim** and**Mirsal A., 2008)**.

Cement is the most widely used concrete material throughout the world. The cement industry is one of the 17 most pollutingindustries listed by the CPCBof India. **(Kumar *et al.*, 2008)**. Despite its profitability, the cement industry faces many challenges due to environmental pollution and health issues as a result of the effluent that enter the environment as a by-product.

These include emissions of airborne pollution in the form of dust, and gases; soil pollution by settling of dust and effluents discharge from the industry; noise and vibration when operating machinery and during blasting in quarries; and cement dust when inhaled can potentially contribute to different breathing and Interstitial lung diseases**(Syed Sana *et al.*, 2003).**

Cement dust deposition on the soil surface changes the Physico-chemical properties of soil as it causes a shift of pH towards the alkaline range, which generally reduces the absorption of mineral substances from the soils. Interference of alkaline cement dust with soil may mediate both the synthesis and decomposition of soil organic matter and therefore influences the soil N, P, and K, and soil water-holding capacity. It also affects the microbial activity of soil **(VimleshRawat**and**Ratna Katiyar,2018).**

Cement dust is a localized air pollution problem in the vicinity of a cement factory. Dust particles from the limestone mines, coal yards, and cement clinkers are emitted into the air, together with dust from various processes such as crushing and clinkerisation. The heavy encrustation of cement dust is formed on the plants growing in cement polluted areas. **(NarahariChapagain**and **Min Raj Dhakal, 2011).**

2. AIM AND OBJECTIVE

2.1.Aim

The present study was conducted to assess the soil chemical properties andeffect of cement dust on the soil quality in the surroundings area of the Jai Laxmi Cement factory, situated at the industrial region of Ramnagar, Chandauli. Assessment of chemical properties of soil leads to the managing of resources while working with particular soil of a region.

The specific analysis of this factor and different parameters testing related to this study is much needed to check the effects of cement dust from factory on soil because soil is our life-supporting system andplays a vital role in the earth's ecosystem. Besides all the goodness, the soil quality is degrading day-by-day due to rapid urban-industrial growth and improper use and management of soil.

Therefore, the study attempts to analyse the impact of these industrial activities and its interferences on the soil quality present in the vicinity of Jai Laxmi cement factory, RamnagarChandauli.

Objective

To study the chemical parameters of soil in the vicinity of the Jai Laxmi cement factory, RamnagarChandauli.

To Compare the affected soil sample with the standard soil classification.

3. MATERIALS AND METHODOLOGY

3.1.Study Area:

The study was carried out in the month of January-April the study was conducted for the chemical properties of soil quality assessment near ***Jai Laxmi Cement Co. (Pvt) Ltd***, RamnagarChandauli. The study area has been taken within a 1 km radius of Jai Laxmi Cement factoryRamnagarChandauli, to assess the soil's chemical parameters analysis.

Comment [M1]: Add the geographical location map

Based on the distance from the cement factory and the predominant wind direction. Five locations were selected from the center of the cement factory.

Sampling Sites:

For affected soil samples, 4 sites were selected from each direction of the Jai Laxmi Cement factory i.e., ***Puraini*** (site-1) from the North, ***Jiwanathpur*** (site-2) from the East, ***Katariya*** (site-3) from the West, and ***Sengar***(site-4) from the

Southeast direction of cement factory under the vicinity of 1km radius. The control soil sample is unaffected by cement dust and effluents from where a single field is chosen from ***BHU*** (site-5).

Comment [M2]: Insert the detailed map of the samples

3.2.Methodology for Soil Collection:

Soil samples were collected from the mentioned experimental site from January to April month, using clean trowels in clean plastic bags, sealed tightly as well as labeled properly after the collection of the soil samples.

From each field three spots were dug till approx 0-15 cm of topsoil, and the soil from all three places was mixed thoroughly to represent the heterogeneity of soil as soil is frequently ploughed for Agri-purposes, and one sample was taken from each field randomly by trowel. For the control soil sample that is unaffected by cement dust and effluents, a single field is chosen, and a single sample from that field is acquired by the same methodology for testing the respective parameters.

3.3.Technique Used for Analysis:

Soil pH and Electrical Conductivity weredetermined in the soil and weremeasured by the pH meter and Digital Conductivity Meter given by **Jackson, (1958)** and **Wilcox, (1959)**, respectively. Parameters like Soil Organic Matter and Soil Organic Carbon technique used for the analysis was by Rapid Titration Method given by **Walkey**and **Black, (1947)**. For Soil Total Nitrogen, Phosphorus, and Potassium Content the technique used for analysis was Available Nitrogen by **Subbiah**and **Asija,(1956)** for nitrogen analysis. The calorimetric method by **Olsen et. al. (1954)** for Phosphorus Content and the Flame Photometric Method by **Toth**and **Prince, (1949)** for the test of Potassium.

4. RESULT AND DISCUSSION

4.1. pH:

The table 1 and figure 1 given below depicts the data accumulation of the pH of soil sample taken from the study area The lowest value recorded was 6.24 in the month of April, at Katariya i.e., site-3 and the highest value recorded was 7.81 in the month of April, at Puraini i.e., site-1.

In the surface soil of affected sites, at the site-1 the pH range interpretation is of slightly alkaline, for site-2, range interpretation is of slightly acidic, for site-3 the interpretation of range is slightly acidic to neutral, for site-4 the range interpretation of pH is slightly alkaline. The soil range interpretation for the control site, i.e., site-5 is in a neutral range generally because the respective land is an organic farm.

The variations in the range of pH can be because of the deposition of chemicals from various different industries located in the area. The pH ofthe alkaline range can be due to liming effect of the cement dust as it contains $CaCO_3$resulting in the alkalinity of soil**(Oludoye O.O. &Ogunyebi L.A., 2017)**. While the field is commercial Agri field addition of fertilizers can also be a reason for varied pH. The pH of soil samples varied from neutral to slightly alkaline in the sites near the cement plant and slightly acidic away from the factory. A similar result was found by **Lamare, R.E., & Singh, O.P., (2020)**.

STUDY AREA	MONTH				MEAN
	JANUARY	FEBRUARY	MARCH	APRIL	
Puraini (Site-1)	7.59	7.71	7.76	7.81	7.71
Jiwanathpur (Site-2)	6.37	6.84	6.32	6.57	6.52
Katariya (Site-3)	6.81	6.73	6.95	6.24	6.68
Sengar (Site-4)	7.36	7.31	7.35	7.34	7.34
BHU (Site-5)	7.07	7.05	7.24	7.09	7.11

Table 1: Effect of Jailaxmi Cement Factory, on soil pH at the study site in different months.

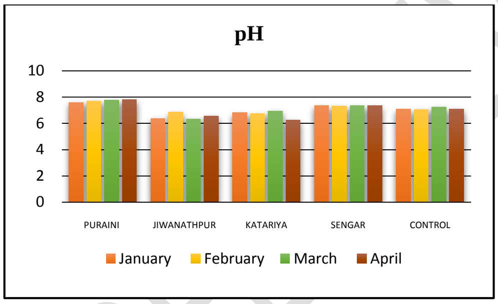

Figure 1: Effect of Jailaxmi Cement Factory, on Soil pH at study sites in different months.

4.2.Electrical Conductivity:

Table2 andfigure 2 given below depicts the data accumulation of the electrical conductivity of soil sample taken from the vicinity of the study area of Jai Laxmi Cement Factory, Chandauli. The lowest value recorded was 0.32 dSm^{-1} in the month of march at the control site i.e., site-5 and the highest value recorded was 0.99 dSm^{-1} in the month of March, at the affected site i.e., site-1.

In the surface soil of affected sites, at the site-1 the EC range is from 0.48-0.88, for site-2, the range is0.45-0.54, for site-3 the range is from 0.51-0.84, for site-4 the range of EC is 0.46-0.79. The soil EC range for the control site, i.e., site-5 is from 0.32-0.56.

The study of electrical conductivity of soil sample stated that the soil type of the affected area and the unaffected area is non-saline soil as the value is below 1.0 dSm^{-1} with the salt percentage of approx 0-0.1 % as per the limits suggested by **Jaiswal, (2011)**. It shows that the soil contains soluble salts in a very minute amount.

STUDY AREA	MONTH				MEAN
	JANUARY	FEBRUARY	MARCH	APRIL	
Puraini (Site-1)	0.88	0.48	0.99	0.69	0.76
Jiwanathpur (Site-2)	0.45	0.49	0.54	0.43	0.47
Katariya (Site-3)	0.84	0.51	0.89	0.76	0.75

Sengar (Site-4)	0.79	0.46	0.58	0.68	0.62
BHU (Site-5)	0.52	0.41	0.32	0.56	0.45

Table2: Effect of Jailaxmi Cement Factory, on Soil EC at the study site in different Months.

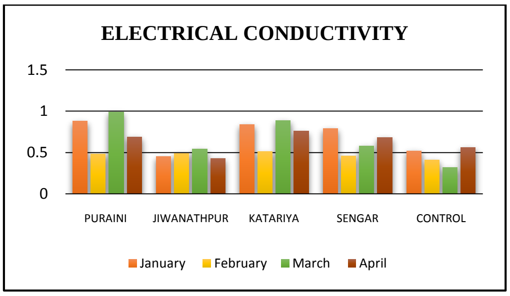

Figure 2: Effect of Jailaxmi Cement Factory, on Soil EC at study sites in different Months.

4.3.Soil Organic Carbon:

Table3 and figure 3 given belowdepict the data accumulation of the percent organic carbon of soil samples taken from the vicinity of the study area of Jai Laxmi Cement Factory, Chandauli. The lowest value recorded was 0.28 % in the month of March, site-4 i.e., Sengar and the highest value recorded was 0.69 % in the month of March, site-2, i.e., Jiwanathpur.

The concentration of soil organic carbon is greater in the surface soil of the affected soil site i.e., site-2, the value ranges from 0.39-0.69 which is in the medium range according to the range limits given by **Jaiswal, (2011)**. Most of the affected soil sample is in the medium range of percent organic carbon limit. The control site i.e., site-5 is also in the medium range being an organic Agri farm.

The high to medium range of organic carbon content in the soils is due to the luxuriant availability of organic matter like litter, and grasses along with long-term deposition of organic matter **(Kavitha and Sujatha, 2015)**. High temperature and good aeration in the soil increase the rate of oxidation of organic matter resulting reduction of organic carbon content **(Meena et. al. 2006).**

STUDY AREA	MONTH				MEAN
	JANUARY	FEBRUARY	MARCH	APRIL	
Puraini (Site-1)	0.55	0.54	0.52	0.46	0.51
Jiwanathpur (Site-2)	0.39	0.67	0.69	0.51	0.56
Katariya (Site-3)	0.48	0.31	0.57	0.34	0.42
Sengar (Site-4)	0.37	0.48	0.28	0.33	0.36
BHU (Site-5)	0.44	0.34	0.49	0.42	0.43

Table3: Effect of Jailaxmi Cement Factory, on Soil Percent Organic Carbon at the study site in different months.

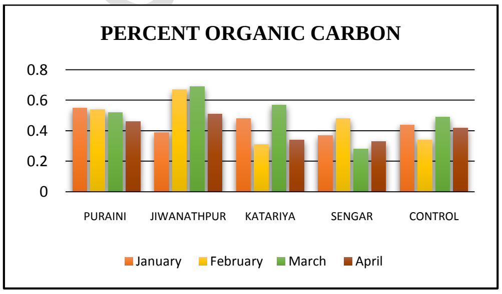

Figure 3: Effect of Jailaxmi Cement Factory, on Soil Percent Organic Carbon at study sites in different months.

4.4.Soil Organic Matter:

The table4 and figure 4 given belowdepicts the data accumulation of the percent organic matter of soil sample taken from the vicinity of the study area of Jai Laxmi Cement Factory, Chandauli. The lowest value recorded was 0.41 % in the month of January, site-5 i.e., BHU and the highest value recorded was 1.18 % in the month of march, site-2, i.e., Jiwanathpur.

Soil organic matter showed a similar trend to that of soil organic carbon. The concentration of soil organic matter is greater in the surface soil of affected soil site i.e., site-2, the value ranges from 0.62-1.18. Most of the affected soil sample is in the medium range of percent organic matter limit. The control site i.e., site-5 is also in medium range being an organic agri farm. Value range of control site-5 is from 0.41-0.84. Soil organic matter typically comprises just 1% -5% of soil mass and the data range is approx in this value range.

More organic matter is present near the surface of soil on the topsoils. It is one of the main reasons that topsoils are more productive than subsoils. The amount of organic matter in soil is the result of all the additions and losses of organic materials that have occurred over years. Anything that adds large number of organic residues to a soil may increase SOM, on the other hand anything that decomposes organic matter rapidly or to be lost through erosion may deplete organic matter **(Fred Magdoff**and **Harold Van Es, 2021).**

STUDY AREA	MONTH				MEAN
	JANUARY	FEBRAURY	MARCH	APRIL	
Puraini (Site-1)	0.94	0.93	0.89	0.79	0.88
Jiwanathpur (Site-2)	0.62	1.15	1.18	0.87	0.95
Katariya (Site-3)	0.82	0.53	0.91	0.58	0.71
Sengar (Site-4)	0.63	0.82	0.48	0.56	0.62
BHU (Site-5)	0.41	0.58	0.84	0.72	0.72

Table4: Effect of Jailaxmi Cement Factory, on Soil Organic Matter at the study site in different months.

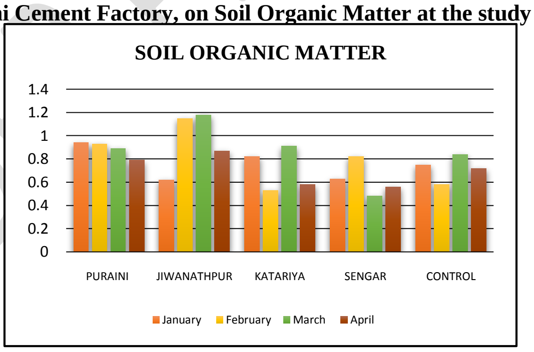

Figure 4: Effect of Jailaxmi Cement Factory, on Soil Organic Matter at study sites in different months.

4.5.Total Nitrogen:

The table5 and figure 5 given belowdepicts the data accumulation of the nitrogen content of soil sample taken from the vicinity of the study area of Jai Laxmi Cement Factory, Chandauli. The lowest value recorded was 22.5 kg/h in the month of March, site-5 i.e., BHU and the highest value recorded was 213 kg/h in the month of March, site-4, i.e., Sengar.

The concentration of soil nitrogen content is highest in the surface soil of affected soil site i.e., site-4, the value ranges from 147.7-213.7 which is in the low range according to the range limits given by **Subbiah**and**Asija, (1956)**. All the soil samples of the affected sites are in the low range of nitrogen content limit i.e., < 250. The control site i.e., site-5 is in the lowest range of nitrogen content.

The high range of nitrogen can be seen in the site-4 and site-2, of the affected site and other affected sites are in the 50-90 range values of nitrogen. Site-5 consist of the least amount of nitrogen because of the general practice of monoculture patterns which leads to decrease in fertility of soil thus decreasing the components necessary in the soil. Whereas the affected soils are in the industrial area and those being the commercial agri fields therefore, there's great possibility of least amount of addition of nitrogen rich chemical fertilizers.

STUDY AREA	MONTH				MEAN
	JANUARY	FEBRUARY	MARCH	APRIL	
Puraini (Site-1)	56.5	81.7	66.1	72.3	77.4
Jiwanathpur (Site-2)	191.7	135.1	198.4	163.4	172.1
Katariya (Site-3)	84.8	72.3	50.2	78.7	71.5
Sengar (Site-4)	197.4	147.7	213.7	185.4	186.3
BHU (Site-5)	28.2	40.8	22.5	28.2	29.9

Table5: Effect of Jailaxmi Cement Factory, on Soil Nitrogen Content at the study site in different months.

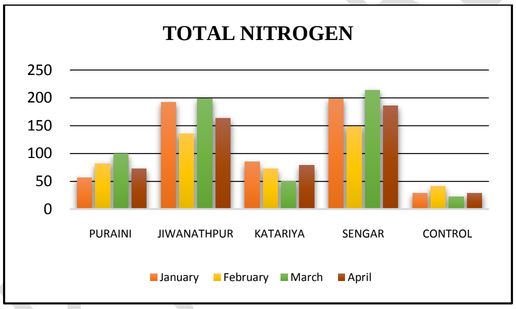

Figure 5: Effect of Jailaxmi Cement Factory, on Soil Nitrogen Content at study sites in different months.

4.6.Potassium Content:

The Table6 andfigure 6 given belowdepicts the data accumulation of the potassium content of soil sample taken from the vicinity of the study area of Jai Laxmi Cement Factory, Chandauli. The lowest value recorded was 22.9 kg/h in the month of February, site-5 i.e., BHU and the highest value recorded was 231.2 kg/h in the month of March, site-3, i.e., Katariya.

The concentration of soil potassium content is highest in the surface soil of the affected soil site i.e., site-3, the value ranges from 180.6-231.2 kg/h which is in the medium range according to the range limits given by **Jaiswal, (2011)**. All the soil samples of the affected sites are in the medium range of potassium content limit i.e., from 101-250. The control site i.e., site-5 is in the lowest range of potassium content which is from 0-50.

The medium range of potassium can be seen in the highest range in site-3 and site-2, of the affected site and other affected sites are also in the medium range. Site-5 consist of the least amount of potassium because of the general practice of monoculture patterns which results in continuous drain of nutrients from soil reserve over the years without replenishments causing deficiency of potassium in the control site. Whereas the affected soils are in the industrial area and those being the commercial agri fields therefore, there's great possibility of addition of potassium content in the form of different chemical fertilizers.

STUDY AREA	MONTH				MEAN
	JANUARY	FEBRUARY	MARCH	APRIL	
Puraini (Site-1)	101.4	129.1	168.4	89.8	122.1
Jiwanathpur (Site-2)	123.5	172.9	218.9	151.5	166.1
Katariya (Site-3)	231.2	180.6	188.5	196.4	199.1
Sengar (Site-4)	168.4	179.6	196.4	134.7	169.1
BHU (Site-5)	31.8	22.9	36.2	35.7	47.2

Table6: Effect of Jailaxmi Cement Factory, on Soil Potassium Content at the study site indifferent months.

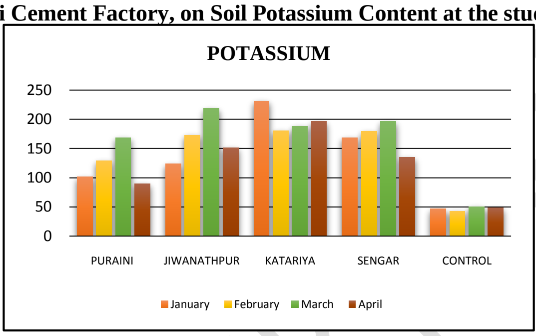

Figure 6: Effect of Jailaxmi Cement Factory, on Soil Potassium Content at study sites in different months.

4.7.Phosphorus Content:

The table 7 and figure 7 given belowdepicts the data accumulation of the phosphorus content of soil sample taken from the vicinity of the study area of Jai Laxmi Cement Factory, Chandauli. The lowest value recorded was 10.06 kg/h in the month of January, site-2 i.e., Jiwanathpur and the highest value recorded was 109.6 kg/h in the month of march, site-3, i.e., Katariya.

The concentration of soil phosphorus content is highest in the surface soil of affected soil site i.e., site-3 and site-1, the value ranges from 40.44-109.6 kg/h and 39.94-69.09 kg/h respectively which is in the high range of phosphorus i.e., >40 according to the range limits given by **Jaiswal, (2011)**. Rest all the soil samples of the affected sites are in the medium range of potassium content limit i.e., from 26-40. The control site i.e., site-5 is in the lowest range of 12.26-25.11 of phosphorus content which is from 11-25.

The highest range of phosphorus can be seen site-3 and site-1, of the affected site and other affected sites which are site-2 and site-4 are in the medium range. Site-5 consist of the lowest amount of phosphorus because of the general practice of monoculture patterns which results in continuous drain of nutrients from soil reserve over the years without replenishments causing deficiency of phosphorus in the control site. Whereas the affected soils are in the industrial area and those being the commercial agri fields therefore, there's great possibility of addition of potassium content in the form of different chemical fertilizers.

STUDY AREA	MONTH				MEAN
	JANUARY	FEBRAURY	MARCH	APRIL	
Puraini (Site-1)	69.09	48.87	39.94	57.34	53.81

Jiwanathpur (Site-2)	10.06	12.59	49.46	26.41	24.63
Katariya (Site-3)	40.44	71.38	109.6	97.07	79.62
Sengar (Site-4)	25.07	39.02	14.05	37.02	28.90
BHU (Site-5)	12.26	25.11	15.78	21.97	18.78

Table7: Effect of Jailaxmi Cement Factory, on Soil Phosphorus Content at the study site in different months.

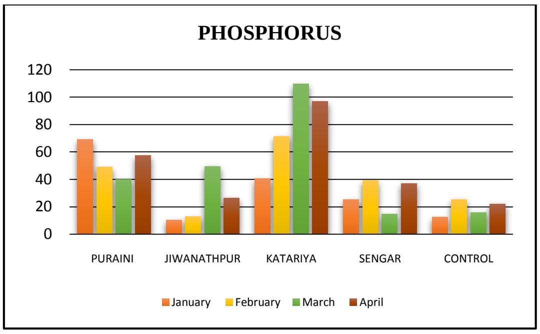

Figure 7: Effect of Jailaxmi Cement Factory, on Soil Phosphorus Content at study sites in different months.

5. SUMMARY &CONCLUSIONS

5.1.Summary

Based on the result of the study,the affected area site-1 (Puraini) records the highest pH, with a mean value of 7.71 and EC with a mean value of 0.76 dSm^{-1}. Site-2 (Jiwanathpur) is highest in percent organic carbon and soil organic matter with the mean value of 0.56%, 0.95%, respectively and the lowest value records for soil pH with value of 6.52. Site-3 (Katariya) records the highest value for soil potassium content and soil phosphorus content with the mean value of 199.7 kg/h and 79.6 kg/h, respectively. Site-4 (Sengar) records highest value for total nitrogen content with mean value of 186.3 kg/h. and the lowest value records for soil organic carbon and SOM with value of 0.42%. and 0.62% respectively. Site-5 (BHU) records lowest value for soil EC, total Nitrogen content, potassium content and phosphorus content with the value of 0.45 dSm^{-1}, 29.92 kg/h, 47.02kg/h and 18.7 kg/h., respectively.

The soil samples were compared with standards of soil classification and based on the present study, The reason mainly can be the wind direction which results in settling dust and effluents discharged from the cement industry on sites over the years.

5.2. Conclusion:

The result of various chemical parameters analyzed revealed that the soil sample from the Control site possess better soil quality as compared to the soil collected from the different affected soil sites located in the vicinity of the cement factory. The normal soil pH is generally acidic but due to continuous deposition of cement dust on soil the pH of soil tends to be from neutral to slightly alkaline range. At different affected sites the highest value is recorded for different parameters as per the distance from the cement factory and the direction of the wind due to which cement dust is deposited on soil surface.

The effect of dust deposition on soil is more in the areas nearer to the cement plants. It is thus concluded that if such trend of dust deposition continues, soil properties of a vast area around the cement plants are likely to change in terms of its chemical properties. These changes will in turn have multiple deleterious effects particularly on agriculture, flora, and fauna of the area in the near future.

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