

Variation in Physico-chemical properties of forest soil around a thermal power plant

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ABSTRACT

The present study was conducted to investigate the influence of thermal power air pollutant dispersal on physico-chemical properties of forest soil around a power plant. The data were collected randomly from the four different sampling sites around a National Thermal Power Plant. The soil samples were analyzed for the various physico-chemical properties such as soil pH, soil organic carbon (SOC), nitrogen (N), phosphorus (P), potassium (K) contents. The analysis of the data showed that the soil physico-chemical parameters varied significantly between distances, directions and seasons at different site around the thermal power plant. It is quite evident from the data of present study that effect of thermal power pollutants decreased with increase in distance from the thermal power plant.

Keywords: Forest soil, Physio-chemical parameters, Soil pollution, Thermal Power Plant.

Journal of Economic Literature (JEL) Classification Number: Q23

Mathematics Subject Classification: 62P12, 62F99

1. INTRODUCTION

Soil is a complex mixture of mineral nutrients, organic matter, water, air, and living organisms influenced by various environmental factors such as climate, parent materials, organisms, and time factors (AKC et al, 2013). Physico-chemical characteristics of soils vary in space and time because of variations in many factors such as topography, climate, weathering processes, vegetation cover, microbial activities, and other biotic and abiotic factors. The standard methods are used for the analysis of soil quality, which is based on the combination of soil properties that reflect the status of soil quality compared to individual parameters (Andrews et al., 2004 and Amacher et al., 2007). Soil quality analysis can be an important tool for planners and decision-makers to combat soil quality

degradation by introducing the appropriate intervention of the land use pattern of the soil management. The present study aims to study the influence of air pollutants dispersal of a thermal power plant on nearby and distant forest soils.

2. MATERIALS AND METHODS

2.1 Study Area

The present study was carried out at four sites with five replicates on the basis of wind direction and distance from the National Thermal Power Plant, Sipat, Bilaspur, Chhattisgarh, Central India. Four study sites were located around the power plant at the distance of 3km and 10km in north east and south west direction, as the wind blows in north-east direction for more than eight months of a year and in south west direction for four months in a year. The climate of the study site is tropical hot. The annual ambient temperature of the study sites varies between 15°C and 44°C. Thus, it has hot summer, moderate winter, and rainy monsoon season. Average annual rainfall is 1280mm year⁻¹ and relative humidity varies between 60% and 75%.



Figure 1: Sampling locations around the National Thermal Power Plant, Sipat, Bilaspur, Chhattisgarh, Central India. (**Source:** State Forest Department, Bilaspur, Chhattisgarh)

2.2 Soil Sampling and analysis

Soil samples from four different sites were collected from 3 and 10km distance around NTPC, Sipat. Soil samples (approx 500 gm each) were collected from each quadrat (1×1m), and each sample from different quadrates of a site was put in separate labelled bag. Soil samples were analyzed for different physical and chemical parameters.

2.3 Methodology

Soil samples were collected at different depths from 0-10cm, 10-20cm, 20-30cm and were mixed together to make a composite sample. The composite samples were analyzed for physio-chemical

parameters. Soil pH was measured using the soil water suspension ratio 1:2.5 w/v with the help of digital pH meter. Organic carbon in soil was determined by the Walkley and Black method (1934). The available nitrogen was determined by auto jeltech method. Phosphorus was analyzed by extraction with sodium bicarbonate and using spectrophotometer. Soil moisture was determined using gravimetric method and soil potassium was estimated using the flame photometer.

2.4 Statistical analysis

The data of the one year study (from 2020 to 2021) was pooled for three seasons two distance and two directions and analyzed statistically using one way analysis of variance (ANOVA).

3. RESULTS

The result showed that the soil parameters namely; pH, SMC, SOC, N, P, K varied with change in the season direction and distance. The Changes in soil chemical properties are depicted in figures 2 and 7. The soil reaction (pH) was ranged from 6.1 to 7.8. At the distance of 3km maximum pH (7.6) was found in north-east direction and minimum (6.3) was found in south-west direction. At the distance of 10 km maximum value of pH (7.8) was found in south-west direction and minimum (6.1) was found in north-east direction.

The available N ranged from 179.2 to 244 kg/ha. At the distance of 3km maximum N (244 kg/ha) was found in north-east direction and minimum was found 185.5 kg/ha in south-west direction. At the distance of 10 km maximum value of N (237.7 kg/ha) was found in north-east direction and minimum (179.2 kg/ha) was found in south-west direction. Available P ranged from 10.45 to 12.76 kg/ha. At the distance of 3km maximum (12.76 kg/ha) P was found in north-east direction and minimum 10.08 kg/ha was found in south-west direction. At the distance of 10 km maximum value of P (18.5 kg/ha) was found in south-west direction and minimum (10.45 kg/ha) was found in north-east direction. Available K was ranged from 241.5 to 327 kg/ha. At the distance of 3km maximum (327 kg/ha) K was found in north-east direction and minimum (250 kg/ha) was found in south-west direction. At the distance of 10 km maximum value of K (319.75 kg/ha) was found in north-east direction and minimum (241.5 kg/ha) was found in south-west direction.

The SMC varied from 10.5% to 16.7%. At the distance of 3km maximum (13.8%) SMC was found in north-east direction and minimum (10.5%) was found in south-west direction. At the distance of 10 km maximum value of SMC (16.7%) was found in north-east direction and minimum (13.3%) was found in south-west direction. The soil organic carbon varied from 0.4% to 0.5%. At the distance of 3km maximum SOC (0.5%) was found in north-east direction and minimum (0.4%) was found in south-west direction. At the distance of 10 km maximum (0.5%) value of SOC was found in north-east direction and minimum (0.4%) was found in south-west direction.

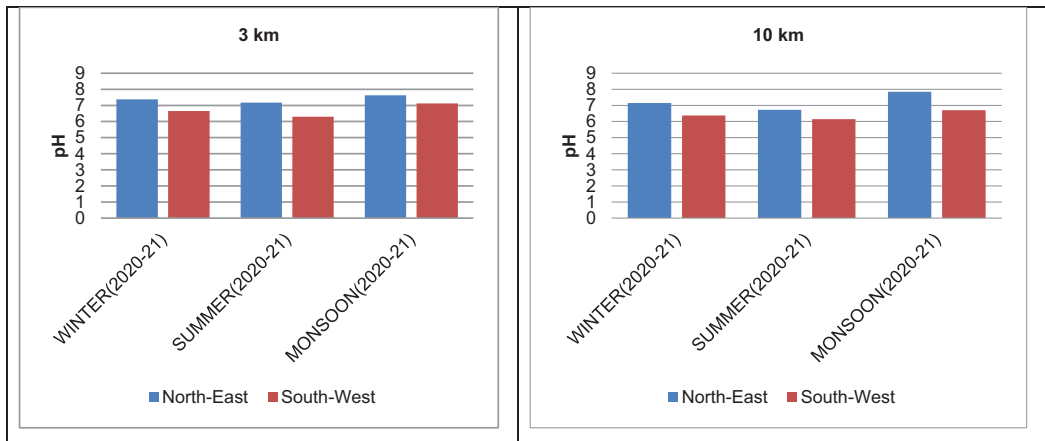


Figure 2: Variation in soil pH at different distance, direction and season around a thermal power plant

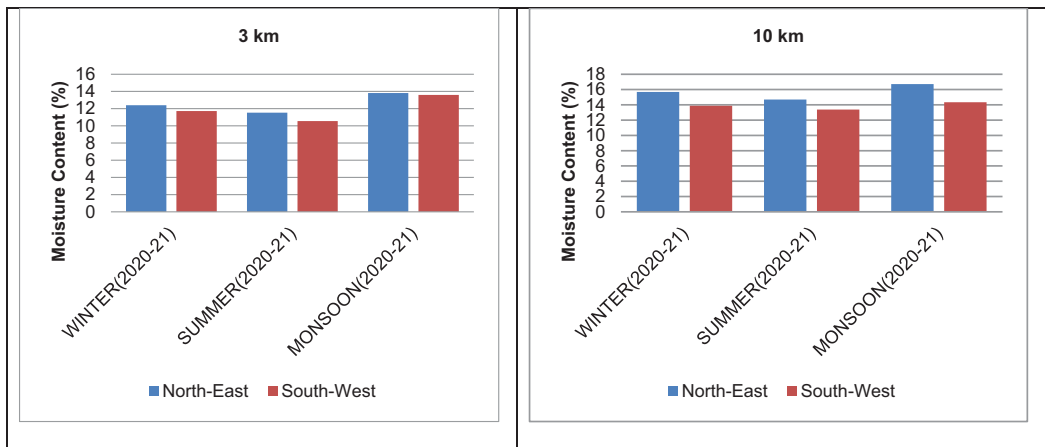


Figure 3: Variation in soil moisture content at different distance, direction and season around a thermal power plant

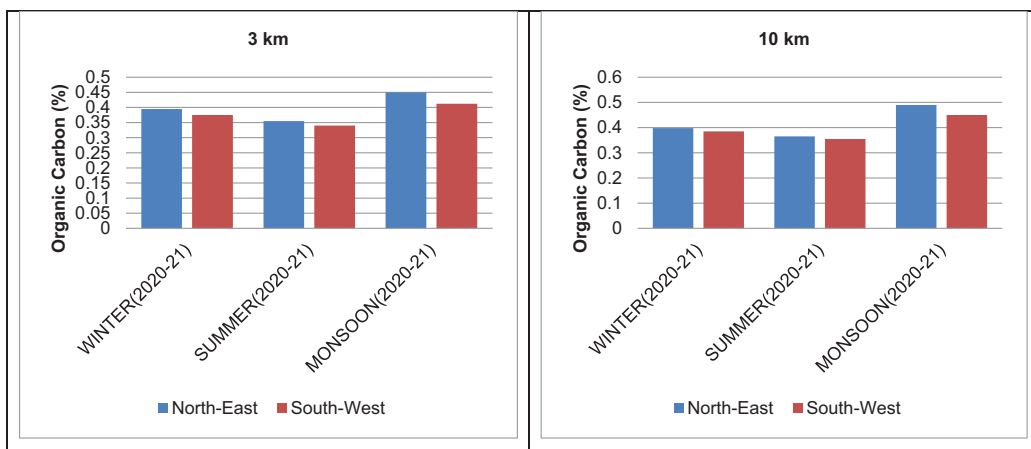


Figure 4: Variation in soil organic carbon at different distance, direction and season around a thermal power plant

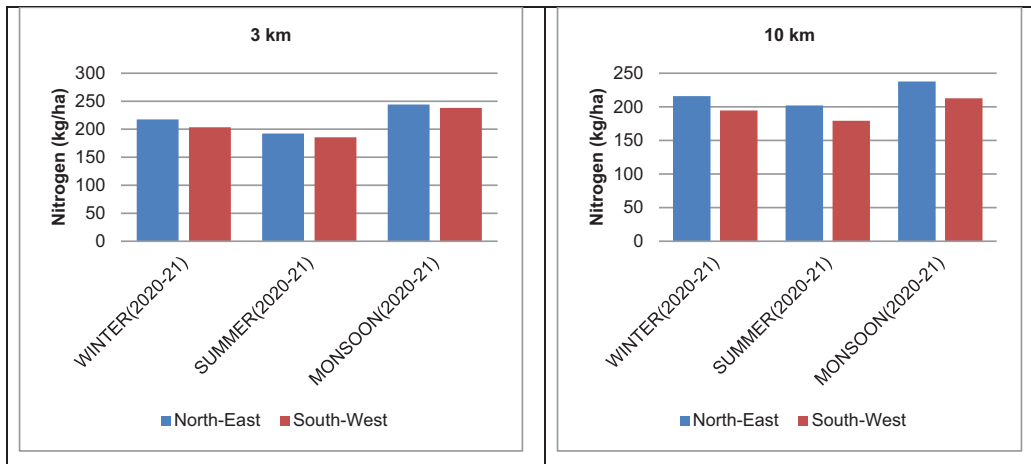


Figure 5: Variation in soil nitrogen at different distance, direction and season around a thermal power plant

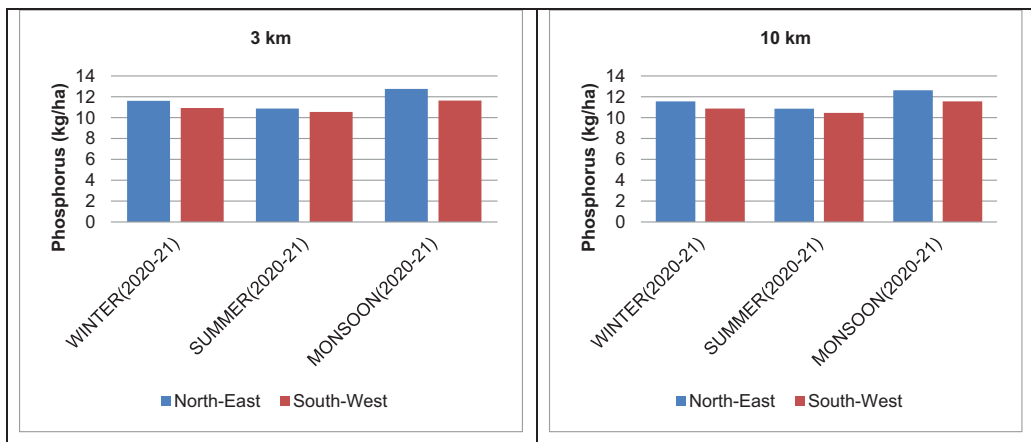


Figure 6: Variation in soil phosphorus at different distance, direction and season around a thermal power plant

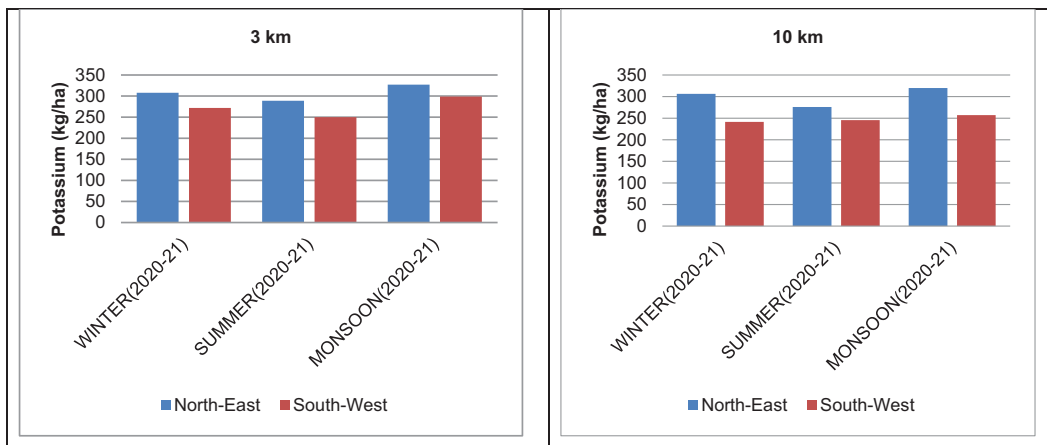


Figure 7: Variation in soil potassium at different distance, direction and season around a thermal power plant

The data of the one year study (from 2020 to 2021) was pooled for three seasons and analyzed for seasonal variations, concerning rainy, winter, and summer season. The results showed a significant difference in physico-chemical properties in different seasons. Physico-chemical characteristics of soil during different season were exhibited. Most of the soil parameters tested were slightly higher in summer season than the monsoon seasons.

Results showed a clear cut trend of maximum values of all the physio-chemical parameters at the distance of 10km and minimum at the distance of 3km from the thermal power plant. Similarly north-east direction showed higher values of physio-chemical parameters as compared to south-west direction and higher values of the soil parameters were recorded generally during monsoon season as compared to winter and summer seasons.

With respect to the distance pH, N,P,K, was found maximum and organic carbon and moisture content was found minimum at the distance of 3km in comparison of the 10km distance , it was because of the dispersal of air pollutants in soil through rain water. With respect to the direction pH, N,P,K, soil organic carbon and moisture content was found maximum in north east direction. It may be because of the dispersion of air pollutants in north east direction because wind is blowing in this direction for the period of more than eight months of a calendar year.

Table 1: One way analysis of variance (ANOVA) of soil Physico-chemical characteristics data.

	df	F Value					
		pH	Moisture	C	N	P	K
Distance	1	NS	33.34***	NS	NS	NS	4.69*
Direction	1	67.93***	10.84***	NS	10.94***	11.26***	77.86***
Season	2	16.79***	11.75***	45.32***	80.11***	55.98***	10.33***

df = Degree of freedom, * Indicates significance at $P < 0.05$, ** at $P < 0.01$, *** at $P < 0.001$ NS= Non Significant

The Statistical analysis (ANOVA) was done to find out whether the effect of distance, direction and season on physico-chemical characteristics of the soil is significant or not significant. This analysis showed that pH was found statistically significant between the directions (North-East and South-West) as well as between the three different seasons but it did differ significant less between the near (3 km) and far (10 km) distances from thermal power plant (Table 1). The statistical analysis (ANOVA) showed that moisture content varied significant between the directions (North-East and South-West) as well as between the three different seasons and between the 3 km and 10 km distance (Table 1). The statistical analysis (ANOVA) showed that organic carbon did not vary significantly between the directions (North-East and South-West) as well as between the near (3 km) and far (10 km) distance sites but vary significantly between the three different seasons (Table 1). The statistical analysis (ANOVA) showed that nitrogen was found to vary significantly between the directions (North-East and

South-West) as well as between the three different seasons and between the near (3 km) and far (10 km) distance sites (Table 1). The Statistical analysis (ANOVA) showed phosphorus did not vary significantly by between the directions (North-East and South-West) as well as between the three different seasons in year but did not vary significantly between the near (3 km) and far (10 km) distance sites (Table 1). The Statistical analysis (ANOVA) showed that potassium did not vary significantly between the directions (North-East and South-West) as well as between the three different seasons and between the near (3 km) and far (10 km) distance sites (Table 1).

Between two directions North East direction was found to maximum exhibit values of all soil parameters as compared to the of South East direction. At the distance of 3km the availability of (N, P, K) parameters was found maximum and at the distance of 10 km the values of pH, SMC, SOC parameters were also found to be maximum. All the parameters showed maximum values in monsoon season followed by winter season and summer season.

4. DISCUSSIONS AND CONCLUSION

The variation in pH might be because of rise/fall in temperature which results in increment/decline in CO₂ evolution, microbial action and natural aggregation/decay in soils (Sivansan *et al.*, 1993). The increase in pH may be due to the accumulation of litter, which on decomposition is known to produce weak organic acids in soil (Babu M *et al.*, 2007). In the present study, the pH range was maximum in the rainy season and minimum in the winter season. The present available nitrogen was found maximum in the winter season which could be because of a higher amount of available organic material (Shourkaie *et al.*, 2007). According to the previous investigations, the soil nutrients are generally accessible in the spring and late-spring when temperature and moisture are good, and mineralization is quick (Grogan *et al.*, 2003; Ahmad *et al.*, 2011). Contrary to the above in present study available nitrogen is higher during winter. This might be due to the moderate winter conditions in this region similar to the spring season of the area where severe winter season is experienced by the soils. The lower values of available phosphorus occur in the rainy season which might be due to the leaching and soil erosion (Mohd, 2015).

In the far sight location (10km) due to dense and less infiltration of sunlight which might be responsible for little loss of moisture through evaporation (Faruqi *et al.*, 2013). The moisture content was maximum in the rainy season and minimum in the summer season, may be due to the less precipitation received during summer season. The maximum percentage of organic carbon was found in the rainy season and the minimum percentage of organic carbon was found in the winter season. It was due to the thick litter deposition, impacts and low mineralization caused by relatively lower temperatures under the shade of dense trees and, therefore, due to the slow rate of decomposition of organic matter (Moore, 1981; Mary *et al.*, 2006).

The present study provides a comprehensive analysis of physio-chemical properties of the soils around a thermal power plant and showed that effect of dispersal of thermal power pollutants on forest soils decreased with the increase in distance from the thermal power plant.

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