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Research Article

STUDY OF IMPACTS OF INDUSTRIES ON SOIL CHARACTERISTICS OF MYSORE CITY INDIA

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ABSTRACT
Industrial activities lead to deterioration of soil by physically, chemically and biologically. Determination of physico-chemical properties in soil provides information relating to pollution levels. In the present study an attempt has been made to study the physic-chemical properties of soil collected from industrial area of Mysore city, Karnataka. The soil samples were collected from three different sites of Mysore industrial area during different periods of the year. The collected samples have been analyzed to determine their physic-chemical characteristics. The soil samples showed that, pH 6.2-7.921, EC ranges from 74 µs/cm to 96µs/cm, Lime content ranges from 1.2mg/kg to 7.91mg/kg, and Sodium shows a range of 1.6ppm to 9.9ppm.

Key Words: *Metals, Soil, industries, sequential extraction, speciation*

INTRODUCTION
Soil is a natural body consisting of layers (soil horizons) of mineral constituents of variable thicknesses, which differ from the parent materials in their morphological, physical, chemical, and mineralogical characteristics. Soil is composed of particles of broken rock that have been altered by chemical and mechanical processes that include weathering and erosion.

Especially the industries are developing in major cities and metropolitan city of the country. Due to industrialization, the economy of the country will be increase through giving job opportunities to the people. But in the mean while, biodiversity of the surrounding area of the industry would be destroyed. In major industrial areas, soil gets contaminated by the industrial activities.

Soil pollution is caused by the xenobiotic chemicals and other alteration in the natural soil environment. This type of contamination typically arises from the rupture of underground storage tanks, application of pesticides percolation of contaminated surface water to subsurface strata, oil and fuel dumping, leaching of wastes from landfills or direct discharge of industrial wastes to the soil (Synder, 2005). The most common chemicals involved are petroleum, hydrocarbons, solvents, pesticides, lead and other heavy metals (Davenport *et al.,* 2005). Occurrence of this phenomenon is correlated with the degree of industrialization and intensities of chemical usage.

Treated sludge, known in the industry as biosolids has become controversial as a fertilizer to the land. As it the byproduct of sewage treatment, it generally contains contaminants such as organisms pesticides and heavymetals (Synder, 2005). There is also a controversy surrounding the contamination of fertilizers with heavy metals (Davenport *et al.,* 2005).

Heavy metal pollution is a problem associated with areas of intensive industries. However roadways and automobiles now are considered to be one of the largest sources of heavy metals to the soil. Zinc, copper cadmium and lead are four of the most common heavy metals released from road transportation, accounting for at least 90% of the total metal (Khalid farooq akbar *et al.,* 2006).Contaminated or polluted soil directly affects human health through direct contact with soil or via inhalation of soil contaminants

which have vaporized and potentially greater threats are posed by the infiltration of soil contamination into groundwater aquifers used for human consumption.

MATERIALS AND METHODS

The study area Mysore is having more than 9 lakh populations and was capital of former state and $11^{o}6^{1}$ lattitude and $77^{o}7^{1}$ longitude and general elevation is little more than 1800 feet above sea level. The climate of the city is moderated throughout the year with temperature during summer ranging from 30^{o}C to 34^{o}C. The rainy season is from June to October. The winter season starts from November to February. The source of water for domestic purpose is mainly from the Cauvery River and ground water.

Mysore is one of the growing cities of Karnataka and it is largely due to presence of industrial resources and a well developed communication network. Mysore has a rich and vibrant history and heritage and hence attracts a huge number of tourists. Also Mysore is now active center for production and industrilisation. The city has been growing as a country parallel to Bangalore, with a large presume of software companies and the population is growing at a faster rate due to the influx of many industrial and commercial activities.

In recent year's industrialization has become main cause of city's growth. There is diversity in industrial landscape of Mysore with haphazard distribution. The industrial areas are distributed all over the city and its surroundings with lack of order and regulation in industrial location. A large number of small and medium scale industries exist in and around the Mysore city. Most of all medium scale industries like engineering chemical, pharmaceutical food brewery, textile, steel and metal smelting etc.

Mysore is having industrial areas which have been majorly devided in to 3 regions, namely:

Metagalli industrial area
Hebbal Industrial area
Hootagalli Industrial area

Metagalli Industrial area is consisting of industries like tyre manufacturing, Aluminium industries, Electrical appliance industry and metal industry. This industrial area, is having medium and large scale industries.

In Hebbal industrial area small scale industries and medium scale industries are more in number compared to large scale industries like Electrical appliance manufacturing industries, textile industry metal product industries etc.

Hootagalli industrial area is smaller in its size as compared to Metagalli and Hebbal industrial areas. Here the industries like textile, heavy earth movers manufacturing industry and very few small scale industries are situated.

In the present study, sampling locations are included in all the 3 major industrial areas of Mysore city. Sampling station from 1 to 5 belongs to the Hootagalli and Hebbal industrial area and remaining 5 samples are belonging to different industries of Metagalli industrial area. The samples were collected during Monsoon, Pre-Mansoon, Post-Monsoon season of 2010-11.

RESULTS AND DISCUSSION

The results of physico-chemical analysis are shown in Table 1, 2&3 respectively. The pH range of all the soil samples in all the industrial area are in normal range of from 6.2 to 7.921 (Figure 1). High pH value above 8.5 is often caused by carbonates and bicarbonates concentration known as Alkalinity (T.A.Bander *et al.,* 2003) High carbonates and bicarbonates cause calcium and magnesium ions to form insoluble minerals leaving sodium as the dominant ion in sample.

Electrical conductivity

Electrical conductivity (EC) is a measure of ions present in water. The conductivity of a solution increases with the increases amount of ions. In the agricultural field electrical conductivity plays an important role, because of salinity aspect. The conductivity test does not indicate fairly reliably the degree with which a salinity problem is likely to occur. Salinity restricts the availability of water to plants

by lowering the total water potential in the soil Salinity also has an impact on crop physiology and yield with visible injury occurring at high salinity levels. Usually, the yield of crops is independent of salt concentration when salinity is below some threshold limit, later yield gradually decreases to zero as the salt concentration increases to the level of which cannot be tolerated by a given crop. In the present study, EC of industrial zone soil shows a range from 74 to 92µs/cm during monsoon season, 75-96µs/cm in Post monsoon, and 75-96µs/cm in pre monsoon (Figure 2).

Table 1: Physico-chemical characteristics of Industrial zone soil during Monsoon 2010

	pH	EC (µs/cm)	Lime content (mg/kg)	OC (%)	OM (%)	Na (ppm)	K (ppm)	Ca (mg/kg)	Mg (mg/kg)
P1	6.8	80	2.58	0.486	0.8778	5	7.2	100	60
P2	6.5	76	1.25	0.0972	0.1675	3.5	12	120	36
P3	6.2	74	1.5	0.1215	0.2094	5	6.8	180	120
P4	7.8	92	7.5	0.7533	1.2986	1.6	3.5	100.2	84
P5	7.2	84	6.0	0.1701	0.2932	3	17	108	80
P6	6.7	77	2.58	0.6075	1.0473	3.1	12.2	180	70
P7	6.6	76	1.25	0.3625	0.6283	4.6	12.2	84	80
P8	7.0	81	4.75	0.243	0.4189	3	12.1	84	80
P9	7.5	86	5.75	0.2916	0.5027	9	10	310	132
P10	6.9	80	4.25	0.8019	1.3824	3.5	12.5	160.3	120

Table 2: Physico-chemical characteristics of Industrial zone soil during Post-Monsoon season of 2010.

	pH	EC (µs/cm)	Lime content (mg/kg)	OC (%)	OM (%)	Na (ppm)	K (ppm)	Ca (mg/kg)	Mg (mg/kg)
P1	7.0	81	3.1	0.5103	0.8797	5	6.9	120.2	72
P2	6.9	80	1.6	0.1956	0.3372	3.9	13.1	140.28	36
P3	6.3	75	2.23	0.171	0.295	5.6	7.6	200.4	132
P4	7.9	96	7.69	0.7336	1.2648	2.1	3.9	160.3	72
P5	7.3	85	5.96	0.2445	0.4216	3.6	16	100.2	12
P6	6.76	78	3.26	0.6603	1.138	3.4	13.1	204	160.3
P7	6.69	76	2.32	0.4646	0.801	5.1	16.9	100.2	96
P8	7.1	81	5.61	0.3423	0.5902	3.4	13.6	96	80.11
P9	7.6	87	5.91	0.3912	0.6475	9.2	10.8	336	147
P10	6.96	84	4.67	0.8315	1.4335	3.9	14.6	156	120.2

Organic Carbon and Organic matter.

Soil carbon is the last major pool of the carbon cycle. The carbon that is fixed by plant is transferred to the soil via dead plant matter including dead roots, leaves and fruiting bodies. Carbon is taken out of the atmosphere by plant photosynthesis about 60gt annually is respired or oxidized from soil (Lal Rattan *et al.*, 2008).

Soil carbon is primarily composed of biomass and non-biomass carbon sources. Some of the substrates carbon will bound to the mineral soil becoming encapsulated in soil aggregates or chemical complexing. Soil organic carbon improves the physical properties of soil. It increases cation exchange capacity and water holding capacity of sandy soil and it contributes to the structural stability of clays soil by helping to bind particles in to aggregates (Leeper, G.W.; Uren, N.C. 1993). Soil organic matter of nutrients, cations and trace elements are important for plant growth. It prevents the nutrient leaching and if integral to the organic acids that make minerals available to plants. It also buffers the soil form strong changes in pH (Andre Leu, 2007). It is widely accepted that the carbon content of soil is a major factor in its overall health.

The results of organic carbon and organic matter of study area, shows a highest range of 0.8019% in monsoon season at sampling station no. P10 and least amount of 0.0972% at sampling station number P2. In post monsoon the organic carbon ranges from 0.171% to 0.8315% at P3 and P10 sampling station respectively. The low amount of organic carbon and organic matter were recorded of 0.096% at P3 and maximum of 0.576% at P4 in pre monsoon (Figure 4&5). Due to lack of fertility in the soil, the organic carbon would differ from season to season with the additional factor of moisture content in soil.

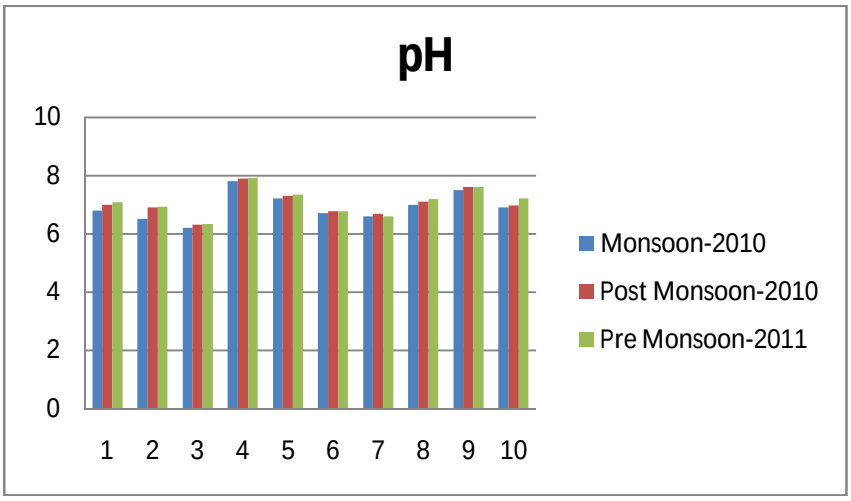

Figure 1: Seasonal variation of pH

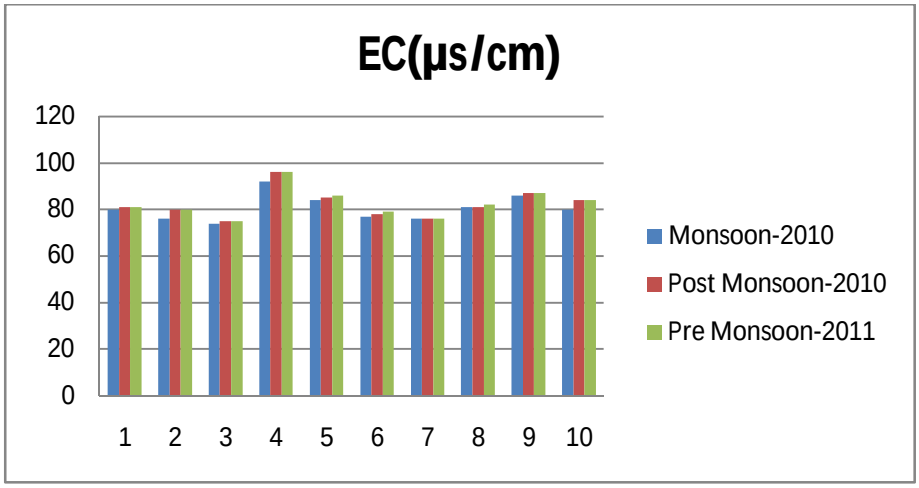

Figure 2: Seasonal variation of electrical conductivity

Table 3: Physico-chemical characteristics of Industrial zone soil during Pre-monsoon season of 2011.

	pH	EC (µs/cm)	Lime conten (mg/kg)	OC (%)	OM (%)	Na (ppm)	K (ppm)	Ca (mg/kg)	Mg (mg/kg)
P1	7.08	81	3.46	0.312	0.537	5.8	8.4	146.1	81.6
P2	6.92	80	1.82	0.101	0.174	4.3	16.1	161.3	48.4
P3	6.32	75	2.32	0.0906	0.165	5.9	8.1	210.7	161.6
P4	7.921	96	7.81	0.576	0.99	2.3	4.5	190.3	98.1
P5	7.35	86	5.98	0.096	0.165	4.9	21.3	106.1	44.0
P6	6.78	79	3.42	0.412	0.710	5.0	15.6	210	176.9
P7	6.6	76	2.21	0.297	0.512	6.0	22.3	98.4	72
P8	7.19	82	5.86	0.196	0.337	4.1	15.9	94.3	72
P9	7.6	87	6.03	0.197	0.339	9.9	11.7	372	240
P10	7.2	84	5.91	0.516	0.889	4.8	17.1	186.4	131

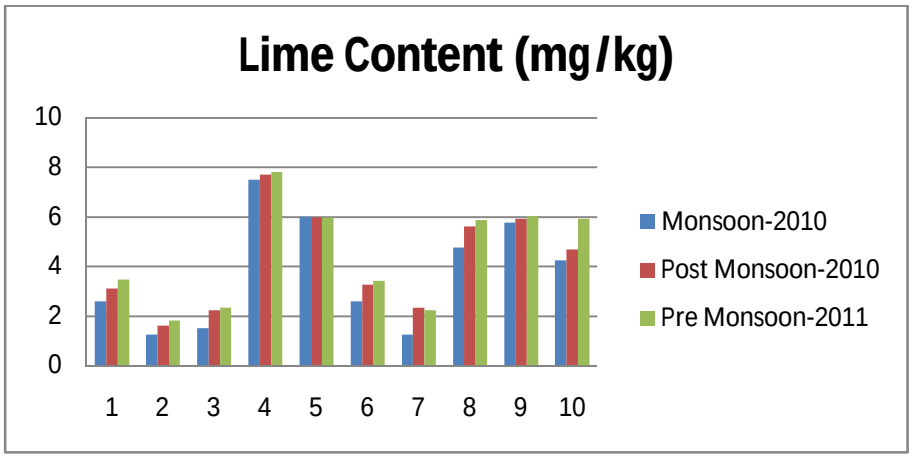

Figure 3: Seasonal variation of lime content

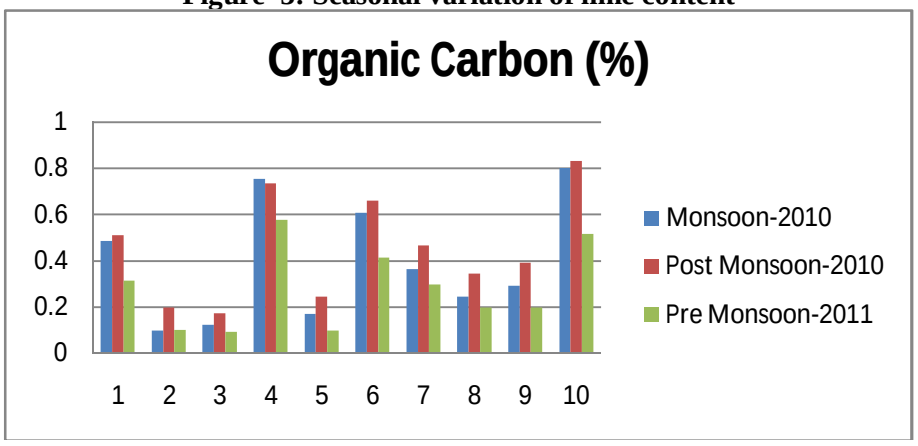

Figure 4: Seasonal variation of organic carbon

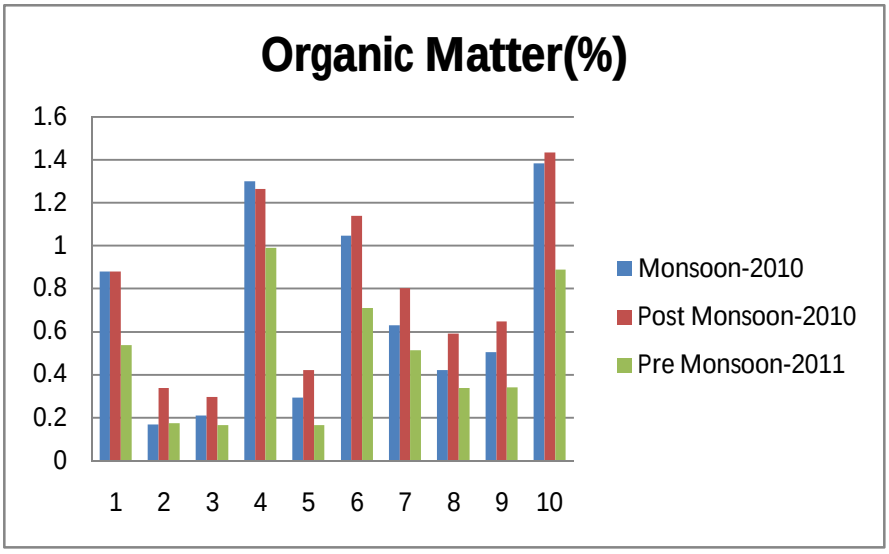

Figure 5: Seasonal variation of organic matter

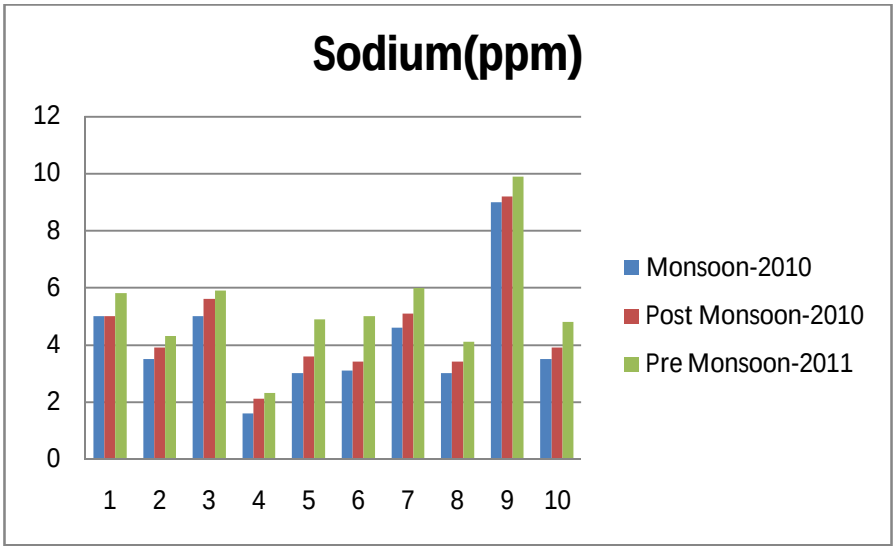

Figure 6: Seasonal variation of sodium

Sodium (Na)

Sodium is a component of sodium chloride (NaCl), a very important compound found everywhere in the living environment. Sodium is a compound of many foodstuffs for instance of common salt. It is necessary for humans to maintain the balance of the physical fluids system. Sodium is also required for nerve and muscle functioning. Sodium is an element, that regulates blood volume and blood pressure, maintains the right balance of fluids in the body, transmits nerve impulses and influences the contraction and relaxation of muscle. The minimum requirement for sodium is 1,500 mg/day (The American Heart Association 2010).

In the present study, the sodium content of all the samples ranges from 1.6 to 9ppm in monsoon season, 2.1 to 9.2ppm in Post monsoon season and 2.3 to 9.9ppm in pre monsoon season (Figure 6). Comparing with Monsoon, pre monsoon and post monsoon season, the samples of post monsoon season soils having slightly higher concentration than monsoon and pre monsoon season it may be due to erosion of soil by rain and dissolving nature of sodium in water.

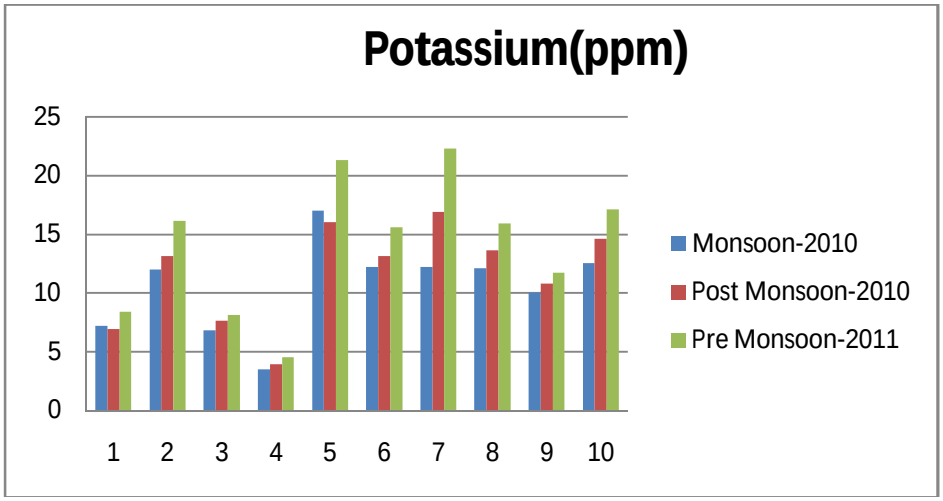

Figure 7: Seasonal variation of potassium

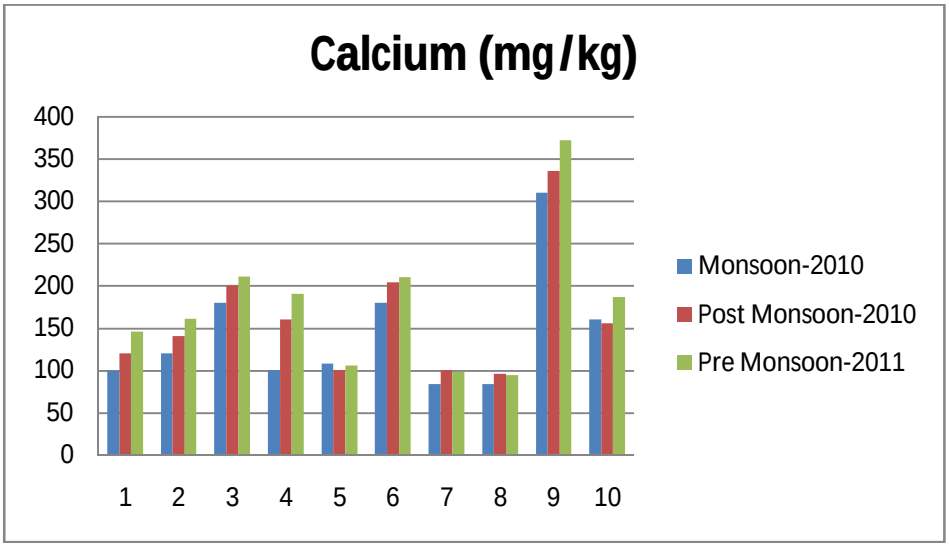

Figure 8: Seasonal variation of calcium

Potassium

Potassium ions are an essential component for plant growth and they are present in all soil types **(Greenwood 1997**) They are used as a fertilizer in agriculture horticulture and hydrophonics culture in the form of KCl, sulpate (SO_4), and 90% of the potassium is supplied as KCl (Greenwood 1997).

Potassium is not an integral part of any major plant component but it plays a key role in a vast array of physiological process vital to plant growth from protein synthesis to maintenance of plant – water balance. Potassium is a macro nutrient that is present in high concentration in soils but it is not bioavailable because it is bound to other compounds. Heavy crop production in agricultural field depletes soils of potassium and agricultural fertilizers can consume 95% of global potassium chemical production (Greenwood 1997) Elemental potassium does not occur in nature, due to rapid reaction rate with water (Holleman, Arnold *et al.*, 1985)

In our study, the soil of industrial area is showing increased quantity of potassium when compared to sodium. The value in summer season shows comparatively higher than rainy season. It ranges from 3.5 to 12.5ppm in monsoon, 3.9 to 16.9ppm in post monsoon and 8.1 to 22.3ppm in pre monsoon season

(Figure 7). It clearly indicates that the solubility of potassium in rainy season is slightly higher than in dry season. In rainy season, the potassium occurring in soil will be easily dissolved in water and eroded off.

Calcium

Calcium is usually present in adequate amounts in soils. Calcium is a component of several primary and secondary minerals in the soil which are essentially insoluble for agricultural considerations. Calcium is also present in relatively soluble forms as a cation adsorbed to the soil colloidal complex. The ionic form is considered to be available to crops. Calcium is not considered a leachable nutrient. Many soils have higher levels of Ca and higher pH in the subsoil.

In the present study Calcium ranges from 84 to 180mg/kg in monsoon, 96.2 to 336mg/kg in post monsoon and 94.3 to 372mg/kg in pre monsoon (Figure 8). It affects on the pH also, in the sense the cation present in the soil increase the soil pH.

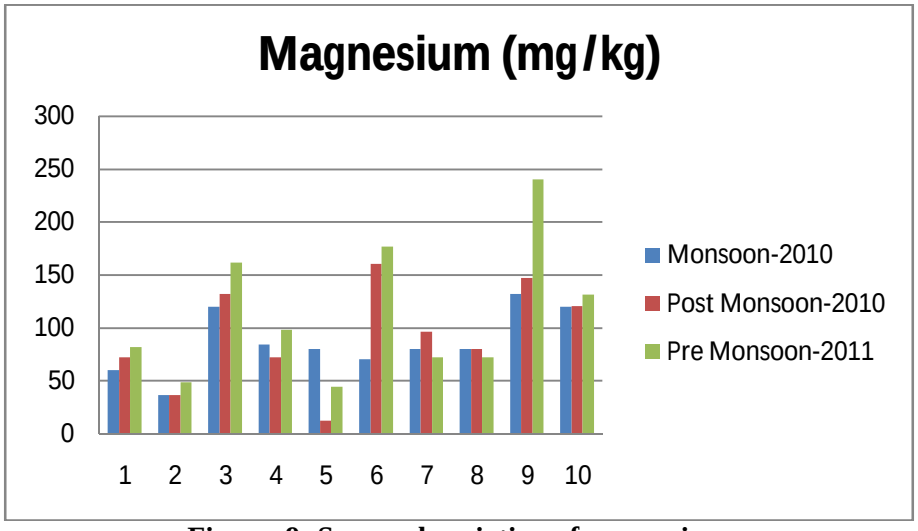

Figure 9: Seasonal variation of magnesium

Magnesium

Magnesium an alkaline earth metal and the eighth most abundant element in the Earth's crust and ninth in the known universe as a whole. Magnesium is a component of several primary and secondary minerals in the soil which are essentially insoluble for agricultural consideration. These materials are the original source of the soluble unavailable forms of Mg. Magnesium is also present in relatively soluble forms and is found in ionic form (Mg^{++}) adhered to the soil colloidal complex. The ionic form is considered to be available to crops. Magnesium is a constituent of most agricultural lime as well as specific fertilizers. Magnesium containing materials applied to the soil may serve two functions such as nutrient and neutralizer as $MgCO_3$ in soil acidity.

Due to magnesium ion's high solubility in water it is the third most abundant element dissolved in seawater (Anthoni, J Floor *et al.*, 2006). In the study area the magnesium content is vary from a minimum of 36mg/kg to maximum of 180mg/kg in monsoon season, 12mg/kg to 160mg/kg in post monsoon and 44 mg/kg to 240mg/kg in pre monsoon (Figure 9).

CONCLUSION

Life on earth exists in a very delicate balance, where soil, air and water sustain not only human life, but the entire eco-system. Any imbalance in this eco-system due to environmental pollution results in contamination and sets off a chain of disruption that affects all patterns of existence. Soil pollution is a reality today with as severe repercussions as water and air pollution. Soil pollution facts need to be

understood, and more importantly controlled. The effects of pollution on soil are quite alarming and can cause huge disturbances in the ecological balance and health of living creatures on earth.

Seasonal variation acts up on a number of factors that influences the availability of organic material present in the soil. The factors affecting the availability are includes the rain, run-off of rain water. In the present study, soil sample of monsoon were comparatively shows a lower values than pre-monsoon and post-monsoon. The present study of physico-chemical analysis of soil samples of Mysore city industrial area have shown optimum pH in all the soil samples. Calcium and Magnesium has a lower ranges in monsoon compare to post monsoon and pre monsoon with a range of 80mg/kg to 240mg/kg and 36mg/kg to 372mg/kg respectively. The organic matter and organic carbon (%) recorded showed minimum quantities. Increasing soil carbon can reduce the 25% of greenhouse gases created by agriculture and assist in ameliorating climate change. Increasing soil carbon will ensure good production outcomes and farm profitability. Soil carbon, particularly the stable forms such as humus increases farm profitability by increasing yields, soil fertility, soil moisture retention, aeration, nitrogen fixation, mineral availability, disease suppression, soil tilth and general structure. It is the basis of healthy soil (Andre Leu, 2007). Here, the organic carbon (%) showed a value of 0.09 % to maximum of 0.83%, which clearly indicates that, soil fertility has reduced.

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