International Journal of Engineering Research and General Science Volume 3, Issue 3, Part-2 , May-June, 2015
ISSN 2091-2730

# Assessment of Characteristics of Urban Area Soil around Bellandur Lake, Bangalore, Karnataka, India

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**Abstract-** The main aim in this study is to assess the level of Characteristics of urban area soil focuses on heavy metals parameters around Bellandur Lake. The samples of soil collected at different locations around the Bellandur Lake and one sample at unpolluted area have been analyzed for viz. pH, % CaCO3, Ca, Mg, $Cl^-$, F, Na, K, SAR, Fe, Cu, Zn, As, Cd, Cr, Hg, Ni and Pb using pH meter, titrimetric method, flame photometric method, spectrophotometric method and atomic absorption spectrophotometer. These values assessed with respect to reference soil taken from unpolluted soil profile. The concentration of all the parameters is high compared to the soil sample taken from unpolluted area. All the parameter values were higher on top layer soil and decreases in subsequent in bottom layer.

**Keywords-** Soil, Heavy metals, Sewage water, Contamination, Urban Lake, Pollution, Deteriorate

## INTRODUCTION

In many developing countries, the expansion of urban centers is of considerable importance for socio- economic growth and this continuously modifies the physical, chemical and biological composition of our living environment. Thus, many people living within these urban centers are often exposed to such unnatural environment since they depend on resources from water, soil and air. Heavy metals are considered as the most important form of pollution of the aquatic environment because of their toxicity and accumulation by marine organisms. Very small amount of certain heavy metals are essential for life and it has been stated that they are more important than vitamins since they cannot be synthesized by living matter. Copper, zinc and chromium, although essential at low levels, are very toxic at higher concentrations. Heavy metals are stable and persistent environmental contaminants since they are not biologically degraded like many organic pollutants; thus, they tend to accumulate, particularly in sediments in association with organic and inorganic matter and involve adsorption, complex formation and chemical combination. Some trace metals are necessary in small amounts for individual metabolic processes, being assimilated by marine organisms. Rapid urbanization and industrialization with improper environmental planning often lead to discharge of industrial and sewage effluents into rivers and lakes. The lakes have a complex and fragile ecosystem, as they do not have self-cleaning ability and therefore, readily accumulate pollutants [1]. Wastewater disposal is becoming a problem in developing countries as large quantities of municipal waste and industrial effluent are being produced due to increased urbanization and industrialization respectively [2]. The problems associated with heavy metals in waste and storm water drainage entering the natural urban aquatic ecosystems have been well documented and studied. Heavy metals are widespread pollutants of great environmental concern as they are non degradable, toxic and persistent with serious ecological ramifications on aquatic ecology. The urban aquatic ecosystems are strongly influenced by long term discharge of untreated domestic and industrial wastewaters, storm water runoff, accidental spills and direct solid waste dumping [3].The contamination of soils directly influences public health, because soils exert a direct impact on human health due to the fact that individuals easily come into contact with them [4].

Soil pollution with heavy metals has become a critical environmental concern due to its potential adverse ecological effects. Heavy metals occur naturally at low concentrations in soils. However, they are considered as soil contaminants due to their widespread occurrence, acute and chronic toxicity. These metals are extremely persistent in the environment. They are non-biodegradable, non thermo-degradable and thus readily accumulate to toxic levels. Since they do not break down, they might affect the biosphere for a long time. It is known that heavy metals form an important polluting group. They have not only toxic and carcinogenic effect but also tend to accumulate in living organisms. Heavy metals are the stable metals or metalloids whose density is greater than 4.5 $g/cm^3$, namely Pb, Cu, Ni, Cd, Zn, Hg and Cr etc. They are stable and cannot be degraded or destroyed, and therefore they tend to accumulate in soils. There are several sources of heavy metals in the environment: 1) air which contains mining, smelting and refining of fossil fuels, production and use of metallic commercial products and vehicular exhaust, 2) water having domestic sewage, sewage and industrial effluents, thermal power plants and atmospheric fallout and 3) soil like – agricultural and animal wastes, municipal and industrial sewage, coal ashes, fertilizers, discarded manufacture goods and atmospheric fallout [5].

Soil is one of the vital resources on living planet Earth. The comprehensive understanding of temporal variability, physicochemical parameters and affect on the environment is becoming an essential task in soil science and field of environment. In these areas, nutrient loading and physiochemical characteristics adversely affect water bodies and extreme extension causes sever eutrophication.

Inherent soil physicochemical properties influence the behaviour of soil and hence, knowledge of soil property is important. Soil physicochemical properties deteriorate to the change in land use. The waste material discharges from industrial activities causes adverse effects on soil and soil organic matter. The presence of heavy metals and residues from town and industrial wastes has been found to be the causes of pollution in soil. It needs some physicochemical analysis to know the status of this adverse impact on soil quality. Soil pollution usually originates from the industries, chemical fertilizers, use of sewage sludge, city compost and other industrial wastes. The industrial effluents and water drainage from spoil and rubbish heaps either washes direct to nearby fields and entire the local streams, river and ultimately into the soil. Once pollutants enter and are incorporated into the soil, the concentration in soil continuously increasing and accumulating, which is toxic to all forms of life like plant, microorganisms and human being [6].

The present study focuses on with the Characteristics of Urban Area Soil parameters around Bellandur Lake viz. pH, Calcium Carbonate, Calcium, Magnesium, Chloride, Fluoride, Sodium, Potassium, Sodium adsorption ratio, Iron, Copper, Zinc, Arsenic, Cadmium, Chromium, Mercury, Nickel and Lead.

## STUDY AREA

Bangalore, the capital of Karnataka, has a history of over 400 years. The origin of Bangalore city can be traced back to 1537 when it was founded by Late Magadi Kempegowda. Bangalore is the principal administrative, cultural, commercial and industrial centre of the state of Karnataka. The city of Bangalore is situated at an altitude of 920 meters above mean sea level. Geographically it is located on 12.95º N latitude and 77.57º E longitude. The population of Bangalore as per the 2001 census was 5,686,844 while it was 163,091 in the beginning of the last century (1901). As per provisional reports of census of India, population of Bangalore in 2011 is 84, 25,970 and is the third densely populated city in India having density of 11,000 per square kilometers. [7]

The earliest history of creation of lakes in and around the city is traced to the founders of Bangalore–the Kempe Gowdas –by damming the natural valley systems by constructing bunds. Most of the lakes and tanks were manmade for purposes of drinking water, irrigation and fishing needs and they have also favorably influenced microclimate of the city. [8]

Bellandur Lake, the largest in Bangalore city spreads across an area of 892 acres. It is located at latitude of 12°58′ N and longitude of 77°35′ E at an altitude of 921 m above mean sea level and has a catchment area of 110.94 sq.miles or 287.33 sqm. The water storing capacity of Bellandur lake is 17.66 million cubic feet, being 3km in length and 2.75km in Width. It is one of the largest man-made lakes in Southeast Asia, located about 20 km from the city towards the south-east of Bangalore city. The tank is a receptor from three chains of tanks. One chain, originates in the north, from Jayamahal, covers the eastern portion and has been referred to as the eastern stream. Another chain originates from the central part of the city, from around the K.R.Market area and covers the central portion and is called the central stream. The other chain, that reaches the tank is through the southwestern region and is called the western stream. Due to urbanization in 1980s, there was breakage of chains of tanks feeding the lake. The breakage in chains, unchecked industrial, residential as well as commercial development, resulted in insufficient rainwater reaching the tank and excess untreated sewerage and effluents laden water flow to the tank. [8]

Figure 1. Satellite view of Bellandur Lake and its surrounding

Satellite view of Bellandur tank and its surrounding shown in Figure 1.Research work has been carried out to study the Characteristics of Urban Area Soil around Bellandur in Bangalore city.

## SAMPLING AND ANALYSIS

Soil samples for investigations were collected from six different locations selected around the banks of the Bellandur lake and one location selected at downstream of Bellandur lake, total 14 samples were collected during March 2014. The criterion of selection of sampling points was based upon inflow and outflow regions of the lake. Sampling locations are shown in Figure 2 and 3. At all the sampling locations two samples approximately 1000gm of soil was collected from each site were taken one from the top layer and another at to a depth of over 30cm. Sampling tools were washed and dried with water before the next sample was collected. These soil samples were brought in polythene bags to laboratory for the analysis of characteristics of soil parameters. Soil was collected as per standard procedure given in literature [3, 6].

Soil samples were air dried and then ground in to fine powder using an agate mortar and pestle to pass through a 0.5mm sieve. The powdered samples were stored in polythene covers at room temperature for further analysis of characteristics of soil samples. The soil samples were analyzed for properties using standard analytical methods. All laboratory equipment used for the heavy metal analysis was washed in 3% $HNO^3$ and rinsed at least twice with distilled water. One gram of each soil sample was placed into a 200 ml flask. Then, 0.2 ml of sulfuric acid, 1 ml of nitric acid and 5 ml of perchloric acid were added. The soil and acid mixture was heated to 180°C for 3 h on a hotplate. After cooling, 1 gram of ammonium chloride and 20 ml of 0.5 N HCl were added. Samples were reheated to 180°C for one hour and evaporated to approximately 10 ml. After cooling, the extracts were filtered into 100 ml plastic bottles through a filter paper and 1 ml of lanthanum chloride was added. The samples were analyzed using pH meter, Titrimetric method, Flame photometric method, Spectrophotometric method and Atomic absorption Spectrophotometer [9, 10, 11, 12].

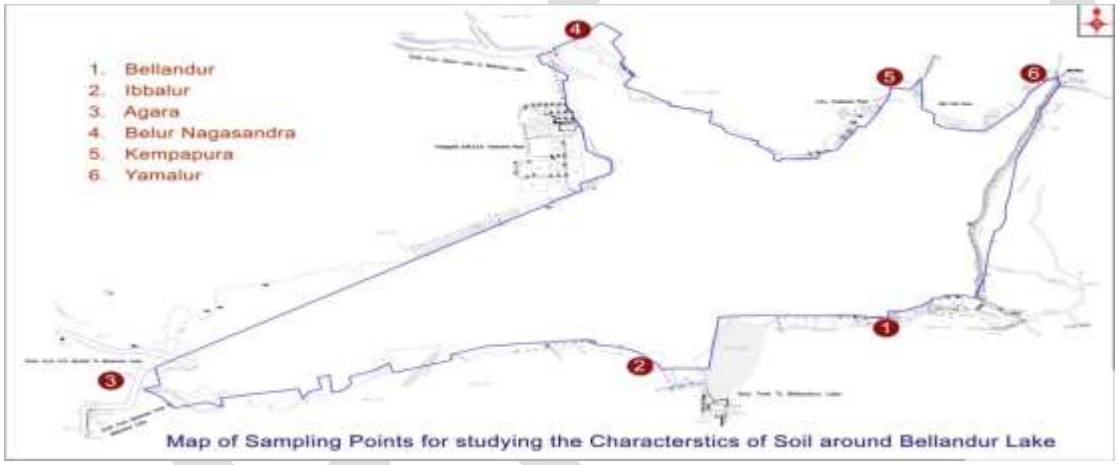


Figure 2. Sampling locations around Bellandur lake


Figure 3. Sampling location of Kadubeesanahalli (S. No.7)

## RESULTS AND DISCUSSION

The data analysed for the Soil samples from six different locations around the Bellandur lake namely Bellandur(1), Ibblur(2),

Agara(3), Belur Nagasandra(4), Kempapura(5), Yamalur (6) and one sample from unpolluted soil from Kadubeesanhalli(7) is represented in Table-1 and the different sampling locations is represented in Figure 2 and 3.

The pH value is higher 8.85 at location no.3 and lowest 8.06 at location no.2 decreases with depth at all locations. The % of CaCO3 is higher 15.4 at location no.4 and lowest 5.0 at location no.6 decreases with depth at all locations. Ca value is higher 153.00 mg/kg at location no.5 and lowest 126.20 mg/kg at location no.6 decreases with depth at all locations. Mg value is higher 35.40 mg/kg at location no.4 and lowest 26.30 mg/kg at location no.6 decreases with depth at all locations. $Cl^-$ value is higher 54.30 mg/kg at location no.4 and lowest 35.90 mg/kg at location no.6 decreases with depth at all locations. F is absent at all locations. Na value is higher 30.30 mg/kg at location no.4 and lowest 21.70 mg/kg at location no.6 decreases with depth at all locations. K value is higher 3.10 mg/kg at location no.4 and lowest 2.10 mg/kg at location no.6 decreases with depth at all locations. SAR value is higher 2.90 at location no.3 and lowest 2.40 at location no.6 decreases with depth at all locations. Fe value is higher 1.70 mg/kg at location no.2 and lowest 1.30 mg/kg at location no.1 decreases with depth at all locations. Cu is present at location no. 1 is higher 0.40 mg/kg and lowest 0.08 mg/kg at location no.3 , are decreases with depth and in remaining locations are BDL. Zn is present at location no. 1 is higher 0.90 mg/kg and lowest 0.20 mg/kg at location no.3 , are decreases with depth and in remaining locations are BDL. As, Cd, Cr, Hg, Ni and Pb were found is below detectable limit in all 14 samples. Characteristics of soil were detected higher concentration in the top and decreases in the next 30 cm deep. The concentration of all the metals is high compared to the soil sample taken from unpolluted area is represented in Table-1.]

Table 1. Analytical results of characteristics of soil sample

| Parameter | Location | Unit | Bellandur(1) | Ibblur(2) | Agara(3) | Belur Nag asandra(4) | Kempapura(5) | Yamalur (6) | Kadubees anhalli(7) |
|---|---|---|---|---|---|---|---|---|---|
| pH | Top | - | 8.23 | 8.06 | 8.85 | 8.18 | 8.69 | 8.30 | 7.86 |
| | 30cm deep | - | 7.69 | 7.12 | 7.41 | 7.05 | 7.21 | 7.54 | 7.60 |
| %Caco3 | Top | % | 7.10 | 7.60 | 10.00 | 15.40 | 9.80 | 5.00 | 3.30 |
| | 30cm deep | % | 5.30 | 4.90 | 4.20 | 5.00 | 3.70 | 3.50 | 3.00 |
| Calcium | Top | mg/kg | 135.30 | 133.90 | 150.10 | 176.40 | 153.0 | 126.20 | 110.00 |
| | 30cm deep | mg/kg | 125.70 | 127.80 | 120.40 | 120.60 | 118.60 | 114.50 | 102.90 |
| Magnesium | Top | mg/kg | 27.60 | 27.00 | 30.20 | 35.40 | 30.60 | 26.30 | 21.90 |
| | 30cm deep | mg/kg | 25.90 | 25.10 | 24.50 | 24.70 | 23.90 | 22.80 | 20.40 |
| Chloride | Top | mg/kg | 43.50 | 44.80 | 50.60 | 54.30 | 50.10 | 35.90 | 25.90 |
| | 30cm deep | mg/kg | 38.20 | 37.00 | 30.30 | 32.50 | 26.70 | 28.40 | 21.30 |
| Fluoride | Top | mg/kg | Ab | Ab | Ab | Ab | Ab | Ab | Ab |
| | 30cm deep | mg/kg | Ab | Ab | Ab | Ab | Ab | Ab | Ab |
| Sodium | Top | mg/kg | 25.60 | 24.70 | 28.10 | 30.30 | 26.90 | 21.70 | 10.20 |
| | 30cm deep | mg/kg | 22.40 | 23.00 | 20.50 | 21.00 | 16.60 | 16.70 | 8.00 |
| Potassium | Top | mg/kg | 2.60 | 2.50 | 2.70 | 3.10 | 2.70 | 2.10 | 1.20 |
| | 30cm deep | mg/kg | 2.20 | 2.30 | 2.00 | 2.00 | 1.60 | 1.40 | 0.70 |
| SAR | Top | - | 2.80 | 2.70 | 2.90 | 2.90 | 2.80 | 2.40 | 1.20 |
| | 30cm deep | - | 2.50 | 2.60 | 2.40 | 2.40 | 1.90 | 2.00 | 1.00 |
| Iron | Top | mg/kg | 1.30 | 1.70 | 1.40 | 1.60 | 1.50 | 1.60 | 2.00 |
| | Bottom | mg/kg | 1.20 | 1.50 | 1.30 | 1.50 | 1.30 | 1.40 | 1.80 |
| Copper | Top | mg/kg | 0.40 | BDL | 0.08 | BDL | BDL | BDL | BDL |
| | 30cm deep | mg/kg | 0.10 | BDL | 0.06 | BDL | BDL | BDL | BDL |
| Zinc | Top | mg/kg | 0.90 | BDL | 0.20 | BDL | BDL | BDL | BDL |
| | 30cm deep | mg/kg | 0.70 | BDL | BDL | BDL | BDL | BDL | BDL |
| Arsenic | Top | mg/kg | BDL | BDL | BDL | BDL | BDL | BDL | BDL |
| | 30cm deep | mg/kg | BDL | BDL | BDL | BDL | BDL | BDL | BDL |
| Cadmium | Top | mg/kg | BDL | BDL | BDL | BDL | BDL | BDL | BDL |
| | 30cm deep | mg/kg | BDL | BDL | BDL | BDL | BDL | BDL | BDL |
| Chromium | Top | mg/kg | BDL | BDL | BDL | BDL | BDL | BDL | BDL |
| | 30cm deep | mg/kg | BDL | BDL | BDL | BDL | BDL | BDL | BDL |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Mercury | Top | mg/kg | BDL | BDL | BDL | BDL | BDL | BDL | BDL |
| | 30cm deep | mg/kg | BDL | BDL | BDL | BDL | BDL | BDL | BDL |
| Nickel | Top | mg/kg | BDL | BDL | BDL | BDL | BDL | BDL | BDL |
| | 30cm deep | mg/kg | BDL | BDL | BDL | BDL | BDL | BDL | BDL |
| Lead | Top | mg/kg | BDL | BDL | BDL | BDL | BDL | BDL | BDL |
| | 30cm deep | mg/kg | BDL | BDL | BDL | BDL | BDL | BDL | BDL |

**Note:** BDL - Below Detectable Limit.

The variation in the heavy metal concentration in soil at different locations is due to variation in heavy metal sources and concentration of heavy metals present in polluted water where the water is used continuously for irrigation for several years. The soil pollution also takes place due to atmospheric fall out, emissions from vehicular exhaust, land application of municipal solid waste, sewage sludge, fertilizers, pesticides etc., [13]. Hence the metal concentration is high around the Bellandur lake, compared with unpolluted area of Kadubeesanhalli area.

## CONCLUSION

This paper proposes the determination of urban area soil parameters around Bellandur Lake especially concentrated on heavy metals. The study reveals that the irrigation was carried out with polluted water containing variable amount of heavy metal increases the concentration in soil samples. The concentration of all the metals is high compared to the soil samples taken from the unpolluted area. The presence of heavy metals in soil is one of the key components of human exposure to metals through the food chain. The heavy metals can be removed by plants and it is an effective method in cleaning up of contaminated soil. The presence of heavy metals has merit attention especially for developing countries where newly establishing industries and extensive urban growth continue to raise heavy metals in soil.

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