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Assessment of Soil Parameters and Microbes in Amaravathi River Bed Area, Karur District, Tamil Nadu, India

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Abstract

In the present study, the physico-chemical properties of soil samples of agricultural region collected from Amaravathi River basin were analyzed. Parameters like soil pH, turbidity, total dissolved solids, total hardness, total alkalinity, calcium, magnesium, nitrate, sulphate, chloride, fluoride, phosphate, iron, manganese, biological oxygen demand and chemical oxygen demand for the soil samples were carried out. Different values were observed in the different physico-chemical parameters due to the soil quality in different sampling locations. Values of pH, Chloride, Fluoride, Sulphate, BOD and COD concentration in the soil samples also show wide variations. Microbiological characteristics of soil samples were carried out among which, bacillus and pseudomonas species were the predominant bacteria genera isolated.

Keywords: *Amaravathi River; Karur; Microbes; Physico-chemical properties.*

1. INTRODUCTION

Soil is a dynamic medium created of minerals, organic matter, water, air and living organisms like bacteria and earth worms, and its continuous properties charging due to farming factors such as parent material, time, climate and the organisms (Nwachokorm *et al.* 2009**)**. Healthy soil consists of approximately 40 % mineral, 23 % water, 23 % air, 6 % organic material and 8% living organisms. A study of soil profile supplemented by physical, chemical and biological properties of the soil will give full picture of soil fertility and productivity. Good productive soil builds the foundation for any successful cropland (Galal M. Zaiad, 2001). The worldwide significant decline in soil productive capacity through physical, chemical, biological properties and contamination is by inorganic and organic chemicals (Abu Ahmed Mokammel Haque, 2007). Soil as a module of the terrestrial ecosystem fulfills many activities that are important for plant growth. The qualities that are used to assess the ability of soil to fulfill storage of plant available water, supply of possible oxygen to roots, storage of nutrients essential to plant growth, provision of favorable conditions of seeding establishment and these functions include pH, cation exchange capacity and soil depth (Nwachokorm *et al.* 2009**)**.

The most unadorned and widespread difficulties facing the agriculture department is the degradation of soil quality due to salinity. Almost 40% of the land surface in world is pretentious by salinity related problems (Pandeeswari and Kalaiarasu, 2012). India is a leading country using large number of fertilizers instead of manures to this crop productivity increases

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but the quality of soil decreases. Pollution in soil and water is strictly related to human activities such as industry, burning fossil fuels, mining and metallurgical processes and their waste disposals (Ladwani Kiran, 2012). It is real time to carry out the physico-chemical analysis of soil and river sediments.

Micro organisms in the soil contribute to the improvement and maintenance of soil quality. The dynamic nature of soil organisms makes them sensitive to nature or management – related soil changes and thus makes excellent assessors of soil quality. Soil microbes perform some beneficial functions as well as some deterimental impacts to environment. In the study area, adverse effects on soil health and soil quality arise from nutrient imbalance in soil, excessive fertilization, soil pollution from industrial units and soil loss processes. The aim of the study therefore was to provide the baseline data of soils for its management for sustainable agriculture.

2. GEOLOGY OF THE STUDY AREA

Amaravathi River is a tributary of Cauvery River in Coimbatore and Tiruppur, Tamil Nadu, South India. The 175 km long Amaravathi River begins at the Kerala/Tamil Nadu border at the bottom of Manjampatti Valley between the Annamalai Hills and the Palani hills in Indira Gandhi Wildlife Sanctuary and National Park in Tiruppur. It descends in a northerly direction through Amaravathi Reservoir and Amaravathi Dam at Amaravathinagar. It is joined by the Kallapuram River at the mouth of the Ajanda valley in Udumalaipettai, and it merges with the river Cauvery at Thirumukkudal, about 10 km from Karur. Amaravathi River irrigates over 60,000 acres of agricultural lands in Coimbatore, Erode and Karur districts and fulfills the drinking water requirements of these regions. The Amaravathi River and its basin, especially in the vicinity of Karur, are heavily used for industrial processing water and waste disposal and as a result are severely polluted due to large amount of textile dyeing and bleaching units.

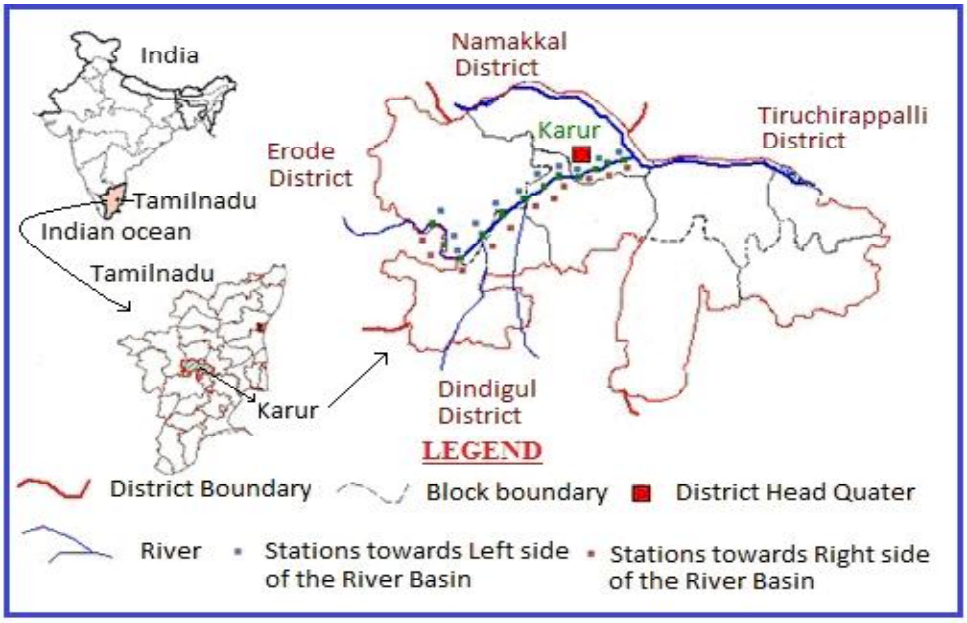

Fig. 1: Map of the study area showing sampling sites

Table 1. Physico-chemical Characteristics of the Soil Samples

Sample Id	Turbidity	pH	EC	TDS	TH	TA	Ca	Mg	Cl	F	SO_4	PO_4	NO_3	Fe	Mn	BOD	COD
SL 1	2.3	7.40	987	563	236	256	105	56	245	1.0	146	0.06	46	0.08	0.05	340	274
SL 2	1.6	8.02	831	500	275	196	46	45	268	1.2	126	0.1	49	0.05	0.03	290	251
SL 3	1.9	7.85	945	516	253	245	80	50	236	1.5	203	0.04	52	0.1	0.06	365	245
SL 4	3.5	7.20	871	465	274	268	96	52	265	1.3	158	0.07	58	0.15	0.1	285	269
SL 5	2.8	8.12	1020	584	195	189	75	60	250	1.1	194	0.01	49	0.1	0.08	316	236
SL 6	2.6	7.53	1198	624	214	178	109	56	276	0.09	186	0.02	47	0.06	0.03	386	283
SL 7	2.1	8.00	964	575	256	232	55	53	296	1.2	175	0.06	46	0.3	0.07	341	249
SL 8	3.4	7.50	702	319	217	275	64	50	257	0.05	137	0.08	51	0.1	0.06	374	261
SL 9	2.5	7.34	1247	652	248	261	39	59	271	1.6	215	0.02	45	0.5	0.05	322	273
SL 10	2.6	7.78	831	460	210	150	65	49	260	1.5	120	0.01	52	0.2	0.05	300	260
SL 11	1.4	8.27	887	535	185	253	91	54	266	1.4	164	0.05	54	0.2	0.09	289	342
SL 12	3.2	8.54	1062	584	274	200	49	49	258	1.5	193	0.01	46	0.1	0.06	347	212
SR 13	2.0	7.25	774	540	200	210	65	52	280	1.5	155	0.03	32	0.4	0.3	360	275
SR 14	3.6	7.95	719	450	190	182	59	65	230	1.9	167	0.01	48	0.2	0.07	245	260
SR 15	2.5	8.23	863	500	215	200	77	55	245	1.0	142	0.02	55	0.1	0.1	265	245
SR 16	3.2	7.13	876	490	222	215	60	46	260	1.3	150	0.02	36	0.06	0.09	270	272
SR 17	2.6	7.67	793	460	205	210	68	59	235	1.2	145	0.01	54	0.09	0.05	250	256
SR 18	3.0	7.97	907	510	212	190	75	38	270	1.6	160	0.03	45	0.02	0.06	240	230
SR 19	2.5	7.45	920	530	215	200	65	61	240	0.7	162	0.05	42	0.3	0.08	260	259
SR 20	2.4	8.11	887	495	230	195	83	45	245	1.0	148	0.02	37	0.2	0.03	254	235
SR 21	2.5	8.39	902	515	180	180	70	57	260	0.9	150	0.03	52	0.08	0.1	271	250
SR 22	2.3	8.26	975	500	200	190	70	50	272	1.0	140	0.01	45	0.3	0.03	280	240
SR 23	2.7	7.78	918	520	200	192	64	50	250	1.4	143	0.01	44	0.1	0.05	244	264
SR 24	3.0	8.35	964	525	205	105	80	42	225	0.8	163	0.02	50	0.2	0.07	236	270
RS 25	3.4	7.38	1112	600	250	230	96	36	259	2.0	150	0.09	63	0.3	0.02	342	196
RS 26	2.3	7.54	853	450	192	180	62	54	163	3.2	137	0.03	45	0.1	0.08	298	245
RS 27	3.6	7.72	1005	560	236	215	85	57	296	1.3	162	0.01	74	0.09	0.07	316	278
RS 28	3.2	7.43	1264	610	257	230	46	76	278	2.6	141	0.04	39	0.3	0.05	350	256
RS 29	3.0	7.25	1037	570	165	190	52	27	249	1.0	153	0.02	67	0.08	0.07	379	223
RS 30	2.5	7.21	930	550	199	255	31	65	251	1.8	140	0.01	48	0.4	0.02	341	296
RS 31	2.6	7.82	897	580	186	196	75	48	271	1.2	210	0.07	85	0.1	0.05	326	267
RS 32	2.8	7.65	955	540	240	237	82	39	237	1.7	184	0.02	69	0.6	0.09	384	215
RS 33	3.2	8.34	923	500	257	247	41	73	310	1.4	208	0.06	41	0.5	0.04	265	183
RS 34	3.5	8.12	1010	565	186	154	24	82	284	2.1	195	0.01	78	0.2	0.03	421	249
RS 35	2.6	7.88	863	480	146	249	39	51	244	1.1	178	0.03	49	0.4	0.01	356	160
RS 36	2.8	7.98	978	504	214	168	57	70	186	2.4	185	0.07	52	0.2	0.03	372	274

All the values are expressed in mg/L except pH and EC in ìS/cm.

Amaravathi watershed (Fig. 1) in Karur district lies between 10º 77' and 10º 95 N' and 77º 92' and 78º 23 E'. The lithology of the study area is characterized with older Pre-Cambrian basement and younger alluvia. Rocks of the khondalite group including garnet-sillimanite schists and gneisses, calc-granulites with crystalline schists and gneisses, calc-granulites with crystalline limestone pockets and quartzite are well exposed. Quartz of very fine quality is found in many places, especially in the village of Vaduvanampalli near Kodiyur and Kothapalayam near Aravakurichi. A major portion (90 %) of the soil of the Amaravathi basin is red sand. Karur has average annual rainfall of 25.04 in inches and average number of rainy days in a year is 40.

3. MATERIALS & METHOD

3.1 Soil Sampling

Soil samples were collected from thirty six different places (including river bed soil) of Amaravathi river basin area of Karur district. Soil samples were collected from a depth of 5-10 cm during January 2013 into labeled sterile polythene bags and taken in ice-packed coolers to the laboratory for physico-chemical and microbiological analysis. For chemical measurements, the soil samples were air-dried and then sieved through a 2 mm sieve.

3.2 Physico-Chemical Analysis of Soil Samples

Aqueous extract of the samples were prepared by mixing 80 g of the air dried sample with 400 ml double distilled water in 500 ml beaker. Using hot plate magnetic stirrer the mixture was stirred for 30 minutes at 40 °C, and then the mixture was allowed to settle for one hour. Filtrates of soil-water slurry (1:5 w/v) were used for chemical analysis. The same procedure was adopted for each sample. Soil pH and electrical conductivity (EC) and total dissolved solids (TDS) were determined by using combined water quality multi-parameter probe Elico PE 138 (Jackson, 1973). The sum of the calcium (Ca) and magnesium (Mg) contents in the extract was determined by the Eriochrome Black-T titration method and the Ca content was then subtracted from the sum to determine the Mg content. Total alkalinity (TA) was determined by titrating with 0.1 N HCl using methyl orange as indicator. Chloride (Cl) content of the soil samples was determined by Mohr's method (Washington, 1954). Turbidity and sulphate (SO_4^{2-}) were estimated using Nepholometer. Fluoride (F) was estimated colorimetrically by SPADNS [2-(p-sulphophenylazo)1, 8-dihydroxynapthalene-3, 6-disulphonic acid trisodium salt), $C_{16}H_9N_2O_{11}S_3Na_3$]. Nitrate ($NO_3^-$) was analyzed by spectrophotometric determination at 520 nm. A value for biochemical oxygen demand (BOD) was obtained using the Winkler's titration method. Chemical Oxygen Demand (COD) was determined by dichromate open reflex method. Iron (Fe) and manganese (Mn) were analyzed using the Atomic Absorption Spectroscopy (AAS).

3.3 Microbiological Analysis of the Soil Samples

The soil microbiological analysis of the samples were carried out according to the methods of Rabah (2008) and Oyeleke and Manga (2008). The bacterial isolates were identified and characterized using standard biochemical tests (Cheesebrough, 2006). The tests employed include gram stain, motility, catalase, oxidase, methyl red, nitrate, Voges-Proskaeur, indole production, urease activity and citrate utilization tests.

4. RESULTS & DISCUSSION

4.1 Soil Physico-chemical Properties

The physico-chemical properties of the soil samples analyzed are presented in table 1. The turbidity was measured in the NTU units and the turbidity of the soil samples were ranged from 1.4 to 3.6 NTU. The pH in soil is the measure of hydronium ion activity in the soil solution. Soil pH influences many facts of crop production and soil chemistry, as well as availabilities of nutrients and toxic substances, activities and nature of microbial populations, and activities of certain pesticides (Pandeeswari and Kalaiarasu, 2012). The pH of soil samples was ranged from 7.13 to 8.54 which

indicate that the soils are alkaline. Under alkaline conditions, the solubility of minerals decreases to the point that nutrient deficiencies occur. Soil EC is an easily measured yet reliable indicator of soil quality, crop performance, nutrient cycling, and biological activity and can serve as a quick indicator of plant-available nitrate-N (Johnson, 2005). EC of all the soil samples were ranged from 702 to 1247 μS/cm. Soil with EC below 400 μS/cm are considered marginally or non-saline, while soils above 800 μS/cm are considered severely saline. The soils under analysis were found severely saline except SL8, SR 13, SR 14 and SR 17 are considered as moderately saline. TDS value ranges from 319 to 652 mg/L, higher concentration is due to leaching of salts and also domestic sewage percolate to the soil.

The value of total alkalinity is observed from 105 to 268 mg/L and increase in TA is because of mineral dissolution. Total hardness is varying from 146 to 268 mg/L and is due to the presence of calcium and magnesium. Calcium and magnesium content in the soil solution ranging between 24 to 109 mg/L and 27 to 82 mg/L respectively. Except station SL1 and SL 6, Ca is in the safe range. Increase and decrease in Ca content may be their uptake by living organisms and their release on decomposition. Chloride is the most recent addition to the list of essential elements. Although chloride (Cl) is classified as a micronutrient, plants may take up as much chloride as they do secondary elements such as sulphur (Solanki, 2012). The concentration of chloride is between 163 and 310 mg/L. Fluoride shows the wide variation from 0.09 to 3.2 mg/L, above 1.0 mg/L is not considered as safe. Sulphate and Phosphate are macronutrient elements essential for plant growth. Sulphate and phosphate ranges from 120 to 215 mg/L and 0.01 to 0.1 mg/L respectively.

Nitrogen exists in the soil system in many forms and transforms very easily from one form to another. The in and out route that N follows in the soil system is collectively called “nitrogen cycle” and is biologically influenced. The concentration of nitrate in soil samples range from 32 to 85 mg/L. Availability of Fe and Mn content shows no marked variations and were not recorded in excess amount; these concentrations are shown in table 1. BOD is the method determines the amount of oxygen required by aerobic microorganisms to decompose the organic matter in a sample. The amount of oxygen consumed in the dilution water should range from 236 to 421 mg/L. The high values of BOD indicated the presence of an excess of biodegradable organic matter from the municipal and agricultural sewage. COD varied from 160 to 342 mg/L at the different sampling sites. The high values of COD indicate soil pollution which is related to sewage effluents discharged from town, industry or agricultural practices.

Table 2. Frequency of occurrence of microorganisms isolated from soil samples

Bacteria isolates	Frequency of occurrence (%)
Bacillus subtilis	21
Bacillus cereus	13
Escherichia coli	27
Staphylococcus aureus	21
Pseudomonas fluorescens	4
Klebsiella pneumoniae	10
Staphylococcus epidermis	4

4.2 Microbial Isolates from Soil Samples

The bacterial cultures were isolated and identified by pure culture technique, gram staining method and biochemical test methods. Bacterial cultures was isolated from thirty six soil samples, identified and maintained by sub-culturing them in nutrient broth. More than twenty five bacterial species were isolated and the dominant species are taken for account. The results of the percentage frequency of occurrence of the microbial isolates were presented in Table 2. From the results Escherichia coli (27 %) had the highest frequency of occurrence. This was followed by Bacillus subtilis and Staphylococcus aureus (21 % each) and Bacillus cereus (13 %). The lowest frequency of occurrence of 4 % was observed in Pseudomonas fluorescens and Staphylococcus epidermis respectively.

5. CONCLUSION

The present work concludes that the dyeing effluent from the industry and agricultural wastes causes the pollution problems in the surrounding environment of the sampling region. The nutrient status of the samples showed that the soil quality of the surrounding field was poor and the physicochemical characteristics of the soil also show wide variation. Soil management practices alter the physicochemical properties of soil, and the soil microbial community may respond to these changes in ways that affect the ability of the soil to resist soil-borne diseases. Soil microbial diversity drops when the soil is subjected to intensive exploitation during agricultural production. Efficient maintenance and caring of the influential soil properties are major concern in intensive crop cultivation for improving soil productive capacity, food safety and environmental quality.

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