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Multivariate statistical analysis of soil parameters to establish baseline level around proposed Jaitapur Nuclear Power Plant (JNPP), Maharashtra, India

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Abstract

In this paper Multivariate statistical analysis and correlation coefficient analysis were used to analyse the soil data and to prepare the baseline of soil parameter around proposed Jaitapur Nuclear Power Plant (JNPP). Result indicates that the soil is reach in iron content. The other trace metals from soil are above trace level with a slight positively skewed distribution. The mean trace metal concentration around proposed JNNP can be arranged in decreasing order as Cu> Cr> Pb> Zn> Ni> Mn> Co> Cd> As> Ba. The study reveals that all the physico-chemical parameters are within the normal permissible range and do not show any significant seasonal changes with the exception of Salinity, EC and Na concentration. It is confirmed from paired t-test that all the parameters along with Salinity, EC and Na concentration maintain its original distribution.

Keywords: Physico-Chemical Parameters; Multivariate Statistical Analysis; Baseline

Introduction

Sampling technique is the method of selecting or collecting a proper representative of the population. Soil sampling is most difficult in soil analysis, since the selection of small fraction of soil as true representative from huge mass is important Jain et al. [1]. Mostly farmers are concern with the chemical composition of the soil. A different crop absorbs different nutrients which upsets the balance of the soil. Hence most of the farmers regularly rotate their crops. The soil science professionals are interested in studying the physical, chemical and biological parameters which affects the soil quality. For others, quantifying soil quality is difficult because of its natural differences observed in soil orders. The difference in these opinions is due to the evolving process of soil evaluation Karlen et al. [2]. While other define soil quality using some biological parameters, because soil is unique in habitats where a wide diversity of biota is observed. Soil quality can be further refined in terms of various functions, like recycling of nutrients, partitioning of rainfall and buffering, that soil performs in ecosystem Warkentin [3]. Walter C. Lowdermilk [4] give emphasis on that, nation, farmer or landowner should save the physical body of soil resources rather than its fertility. Whereas he also maintain soil fertility purely in farmer's hand.

Soil consists of sand, silt, clay and organic matter which affect soil parameters like pH, water holding capacity and mineral composition. The availability of micro nutrient, macro nutrient and soil pH affects the growth and crop production Hornick [5]. The perception of Soil Science Society of America (SSSA) Ad hoc committee on soil quality (S-581) was related to the intrinsic value of soil which focuses primarily on the unique and irreplaceable characteristics of soil resources. They recommend that soil quality should be evaluated on the basis of how well a soil functions within and across ecosystem. Soil functions can be categorised using physical, chemical or biological properties Karlen et al. [2]. Soil quality parameters may include microbial biomass, enzymes, water holding capacity, saturated hydraulic conductivity, electrical conductivity, particle bonding, pH, salinity, organic carbon, nutrients or mineral concentrations and many more. Donald [6] Ponnamperuma [7] Chemically, soil pH is defined as the log10 of hydrogen ions (H+), which refers to the soil acidity or alkalinity. Ability of soil to carry electrical current is measured by electrical conductivity, whereas salinity measures salt content in soil Smith et al. [8, 9].

Soil fertility is the ability of soil to provide consistent and sustain plant growth. It is affected by concentration of organic

carbon, available Nitrogen, phosphorus, potassium and water. Nitrogen is important for plant growth, phosphorus acts as limiting nutrients for energy storages and potassium affects all division of plant by carbohydrate formation and translocation of sugar Ball et al. [10], Jain et al. [1]. National Power Corporation of India Limited (NPCIL) has planned to install a Nuclear Power Project at Jaitapur, district Ratnagiri in Maharashtra state. It is projected to have a 9900MW power capacity. This presented an issue for various nongovernmental organizations because of the potential adverse effects of radiation and different types of pollution. Given the scenario mentioned above, it is vital to collect baseline data related to quality of some environmental parameters like water, soil, air, sediments and background radiations. This study investigates the variation in soil quality parameters in different seasons. Physical, Chemical and biological parameters were studied throughout the winter, summer, and post-monsoon seasons. Samples were collected from 15 villages around proposed nuclear power plant within the territory of 30km.

Jaitapur is a small village situated in Rajapur Tehsil of Ratnagiri District, Maharashtra. It lies on the Arabian sea coast. Various industries have planned to construct their plants around this area. Jaitapur Nuclear Power Project has also been proposed by the Nuclear Power Corporation of India Limited (NPCIL) which is the India's biggest proposed power plant having a capacity of nearly 9900MW. This project is located at 16.55^0N; 73.35^0E and this area is a part of Konkan in Western Ghats of Maharashtra. Also many other industries like thermal power, mining of aluminum etc are being constructed in this Konkan region. This Konkan region is famous for mango production and export especially Devagad hapus, jackfruits, cashew and cashew nuts , rice ragi, kokam fruits and other bi products of these fruits. Hence it is necessary to study the soil-water chemistry of this konkan area. For our study we have selected an area of about 30 km distance which covers Devagad and Rajapur Tehsil from Sindudurg and Ratnagiri district respectively.

Soil pollution is an important issue in developing and developed countries due to change in soil use pattern. Pollutant activities add different kinds of contaminants and heavy/trace metals to soil which are hazardous due to their persistence and toxicity Adriano [11]. Heavy/trace metal concentration affects the soil quality, ground water and food web, which directly affect human health Lu et al. [12], Nicholson et al. [13], Mico et al. [14]. To determine the water and soil quality, a detailed study regarding their physical and chemical parameters is essential and it includes various parameters as per the literature and manuals of various national agencies James et al. [15], Klein et al. [16], Kopp et al. [17], Kunze et al. [18]. By considering these points we have planned to study the soil chemistry of this area, as there are no any reports related to assessment of soil were found. Our study will be helpful to assess the impact of these industries after their post operations. Hence this pre-operational study has been undertaken which will play an important role in establishing the baseline level of soil parameters.

Methods and Materials

The basic aim of the proposed study was to carry out comprehensive assessment of soil samples to establish the baseline data on physical and chemical parameters and trace metals present around the proposed Jaitapur Nuclear Power Plant (JNPP) environment up to a distance of 30Km from the site. To fulfill this aim we have prepared the sampling frame of all the villages within the territory of 30km from JNPP. 15 villages are randomly selected as sampling positions around proposed nuclear power plant within the territory of 30km and located using GPS positions (Table 1). The base map (Figure 1) was prepared from these sampling locations. Soil sampling from these selected locations was done by following the proper scientific methods with maximum standards for three seasons of winter, summer and post monsoon. The soil samples were tested for the following parameters-pH, EC, Salinity, Silicon, Organic carbon, N, P, K, Ca, Mg, Na and Boron. In addition trace metals from soil were analyzed in post monsoon season using inductively coupled plasma mass spectrometer (ICP/MS). Multivariate statistical analysis has been carried for the data obtained from soil analysis Facchinelli A et al. [19,20].

Table 1: Sampling sites and their GPS positions.

Sr. No.	Locations	Name	GPS Position	
1.	Devgad	S1	N- 160 22'43.4"	E- 730 24'02.9"
2.	Nadan	S2	N- 160 26'29.0"	E- 730 24'52.0"
3.	Baparde	S3	N- 160 26'26.8"	E- 730 28'34.8"
4.	Thakarwadi	S4	N- 160 30'33.8"	E- 730 22'19.2"
5.	Vijaydurg	S5	N- 160 33'34.5"	E- 730 20'05.3"
6.	Pural	S6	N- 160 27'48.4"	E- 730 23'04.0"
7.	Hatiwale	S7	N- 160 35'40.9"	E- 730 32'27.1"
8.	Ansure	S8	N- 160 33'44.5"	E- 730 24'27.0"
9.	Mithgawane	S9	N- 160 35'06.5"	E- 730 22'19.9"
10.	Madban	S10	N- 160 25'47.1"	E- 730 20'43.3"
11.	Jaitapur	S11	N- 160 37'36.2"	E- 730 38'17.8"
12.	Nate	S12	N- 160 38'17.8"	E- 730 21'25.2"
13.	Rajapur	S13	N- 160 39'19.6"	E- 730 30'47.1"
14.	Ambolgarh	S14	N- 160 38'35.6"	E- 730 19'44.8"
15.	Bhalawali	S15	N- 160 43'24.1"	E- 730 24'23.7"

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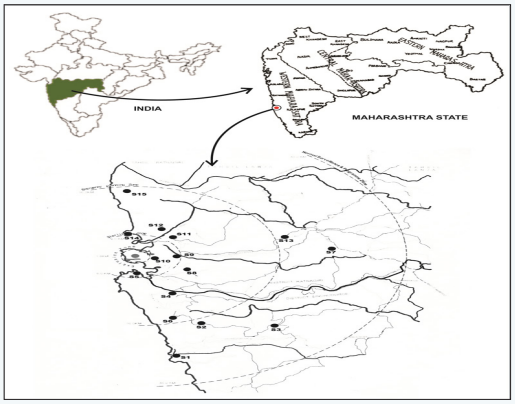

Figure 1: Base map of JNPP and locations of soil sampling sites.

Results and Discussion

General descriptive statistics of soil parameter

The physicochemical characteristics along with the standard deviation, skewness, kurtosis and p-value of Shapiro-wilk test of normality for winter, summer and post monsoon seasons is carried out and presented in (Table 2). The pH is determined to express the soil capacity. The accepted range of values are characterized in three categories - normal 6.5- 7.8, acidic < 6.5, alkaline 7.8-8.5 and alkali > 8.5 (01). From results, pH value varies from 5.85 to 7.89, 5.56 to 7.3 and 6.0 to 7.12 (mean; 6.948, 6.841 and 6.728) for winter, summer and post monsoon season respectively, which is close to neutral. These pH values are best for the growth of many crops like corn, wheat, soya bean etc but due to other climate condition primarily mango and ragi are cultivated.

Table 2: Physico-chemical properties of soil samples of winter, summer and post monsoon seasons from 15 villages near JNPP.

	pH	EC	Salinity	Si	O.C.	N	P	K	Ca	Mg	Na	B
WINTER SEASON												
Min	5.85	0.098	0.7	0	0.27	103.48	44.43	336	12.5	14.5	3.69	0.082
Max	7.89	0.564	1.2	0.953	0.52	376.32	71.62	2128	67.5	48.2	27.93	1.41
Median	7.08	0.28	1	0.222	0.4	254.01	51.32	1008	25.75	23	13.36	1
Mean	6.948	0.295	0.953	0.275	0.393	252.222	54.209	1097.6	26.777	24.88	13.265	0.946
Std. Dev.	0.605	0.115	0.173	0.225	0.083	70.261	8.949	533.703	13.944	8.108	6.509	0.346
Skewness	-0.277	0.575	0.079	2.191	-0.1	-0.366	0.875	0.782	1.823	1.823	0.579	-0.932
Kurtosis	-0.915	0.963	-1.11	5.92	-1.007	0.234	-0.163	0.088	4.616	4.41	0.432	1.498
P-Value	0.785	0.74	0.183	0.002	0.334	0.987	0.068	0.261	0.007	0.009	0.761	0.22
SUMMER SEASON												
Min	5.56	0.123	0.8	0.112	0.25	175.2	44.4	403	14.8	14.8	4.19	0.69
Max	7.3	0.618	2	0.51	0.62	375	70.1	2513	70.5	30	24.15	1.5
Median	7	0.322	1.2	0.211	0.39	238	50.12	1214	27.2	23	13	0.95
Mean	6.841	0.363	1.273	0.234	0.399	249.48	53.419	1213.733	27.74	23.533	12.936	0.983
Std. Dev.	0.401	0.125	0.367	0.096	0.103	62.428	7.748	616.394	14.157	4.777	5.783	0.235
Skewness	-2.551	0.151	0.634	1.703	0.448	0.834	0.707	0.648	2.095	-0.37	0.443	0.74
Kurtosis	7.945	0.273	-0.699	4.276	0.137	-0.264	-0.522	-0.124	5.703	-0.774	-0.387	0.175
P-Value	0.000	0.925	0.228	0.007	0.609	0.104	0.046	0.529	0.002	0.402	0.83	0.426
POST MONSOON SEASON												
Min	6	0.112	0.7	0.138	0.29	151.33	45	299	13	14.3	4.22	0.75
Max	7.12	0.425	1.3	0.5	0.49	333.51	69.98	2308	57.1	34.9	27	1.18
Median	6.98	0.29	0.9	0.275	0.39	240.98	57.12	976	25.1	23.9	14	0.97
Mean	6.728	0.277	0.98	0.267	0.387	253.553	55.695	1093.333	25.713	24.367	14.259	0.956
Std. Dev.	0.384	0.085	0.186	0.1	0.049	63.676	7.291	540.401	11.321	5.539	6.593	0.127
Skewness	-0.774	-0.033	0.182	0.886	0.093	-0.136	0.602	1.074	1.505	-0.101	0.439	-0.102
Kurtosis	-0.959	-0.429	-0.894	0.78	0.624	-1.697	0.099	1.127	3.273	-0.282	-0.326	-0.601
P-Value	0.009	0.863	0.266	0.214	0.974	0.046	0.191	0.119	0.032	0.954	0.783	0.701

The Electrical Conductivity (EC) is used to estimate total soluble salts in aqueous soil extract. Soil is considered to be normal if EC < 0.8 dsm^{-1}. It is injurious to crops if EC >2 .5 dsm^{-1} and critical for salt tolerant crops if EC lies between 1.6 to 2.5 dsm^{-1}. EC varies from 0.098 to 0.564, 0.123 to 0.618 and 0.112 to 0.425 (mean; 0.295, 0.363 and 0.227) for winter, summer and post monsoon seasons respectively, both skewness and kurtosis values are positive for winter and summer seasons and negative for post monsoon season. Salinity varies from 0.7 to 1.2, 0.8 to 2.0 and 0.7 to 1.3 (mean; 0.953, 1.273 and 0.98) for winter,

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summer and post monsoon seasons respectively, shows non-saline nature. Skewness is near to symmetric and kurtosis shows non-saline uniform nature. SW p-value suggests EC and Salinity is not normally distributed. SW p-value for pH shows normal behaviour in summer and post monsoon seasons only.

The concentration of major nutrients in soil like Si, N, P, K, Ca, Mg, Na and B are also analysed. K, N and P have highest average concentration as 1097.6, 252.222 and 54.209ppm with standard deviation 533.703, 70.261 and 8.949 respectively in winter. 1213.733, 249.48 and 53.419ppm with standard deviation 616.394, 62.428 and 7.748 respectively in summer and 1093.333, 253.553 and 55.695ppm with standard deviation 540.401, 63.676 and 7.291 respectively in post monsoon season. The minimum average concentration is found for Si and B as 0.275 and 0.946 with standard deviation 0.225 and 0.346 respectively in winter, 0.234 and 0.983 ppm with standard deviation 0.096 and 0.235 respectively in summer, 0.267 and 0.956 with standard deviation 0.1 and 0.127 respectively in post monsoon season. Whereas Ca, Mg and Na have average concentration 26.777, 24.88 and 13.265ppm with standard deviation 13.944, 8.108 and 6.509 respectively in winter, 27.74, 23.553 and 12.936ppm with standard deviation 14.157, 4.777 and 5.783 respectively in summer and 25.713, 24.367 and 14.259ppm with standard deviation 11.321, 5.539 and 6.593 respectively in post monsoon season.

General descriptive statistics of trace metals concentration

Table 3: Physico-chemical properties of trace metals from soil samples using inductively coupled plasma mass spectrometer from 15 villages near JNPP.

	Fe	Cu	Cr	Zn	Pb	Ni	Ba	Co	As	Cd	Mn
N of cases	15	15	15	15	15	15	15	15	15	15	15
Minimum	19.74	1818	250.6	219.6	329.9	49.48	5.997	33.81	11.6	21.34	65.4
Maximum	65.51	5869	1442	734.7	633	207.4	44.05	149	74.41	46.79	161.52
Median	35.23	2949	776.4	346.4	426.1	99.2	28.73	88.82	19.2	29.48	105.4
Mean	36.371	2992.933	798.26	389.933	446.7	112.739	25.477	94.695	27.307	31.805	108.193
Standard Dev	11.366	1042.318	406.513	148.573	85.76	53.6	12.386	38.406	18.979	8.424	24.366
Skewness (G1)	1.021	1.445	0.332	1.001	0.697	0.48	-0.203	0.165	1.766	0.611	0.535
Kurtosis (G2)	1.88	3.186	-1.079	0.57	0.008	-1.208	-1.252	-1.329	2.186	-0.791	0.563
SW P-Value	0.258	0.036	0.249	0.166	0.567	0.13	0.285	0.214	0.001	0.176	0.84

All location shows high concentration (mean 36.371%) of Fe but it is not a major concern because Fe is not contaminant element, Fe is important in plant nutrition and essential as crop micronutrient. The standard statistical analysis (mean, standard deviation, skewness, kurtosis, SW p-value) is carried out to describe the heavy/trace metals contents in the soil presented in (Table 3). The average concentration of Cu, Cr, Zn, Pb, Ni, Ba, Co, As, Cd and Mn was found to be 2992.933, 798.26, 389.933, 446.7, 112.739, 25.477, 94.695, 22.307, 31.805 and 108.193 ppb respectively. Among the 11 metals studied on the basis of decreasing concentration heavy/trace metals can be arranged as Cu > Cr > Pb > Zn > Ni > Mn > Co > Cd > As >Ba. All skewness coefficient values are greater than zero except for Ba showing slightly positively skewed behaviour of heavy/trace metal concentration. Also SW p-values confirms that out of all only Cu and As are normally distributed.

Paired t-test analysis

To identify the change in mean behaviour of soil parameters due to season change is analysed with the help of paired t-test and presented in (Table 4). The mean behaviour of EC rises from 0.2947 to 0.3633 (p-value 0.012) significantly in winter to summer season change and falls down from 0.3633 to 0.2771 (p-value 0.006) significantly in summer to post monsoon season change. Which does not differ significantly (p-value 0.176) from last winter which means that average EC remains unchanged. Average behaviour of salinity rises from 0.9533 to 1.2733 significantly (p-value 0.012) from winter to summer season change and falls down from 1.2733 to 0.9800 significantly (p-value 0.021) in summer to post monsoon season change. Which does not differ significantly (p-value 0.597) from last winter, hence mean salinity remains stagnant. The mean concentration of Na does not change significantly (p-value 0.381) in winter to summer season change, but rise significantly (p-value 0.022) from 12.94 to 14.26 in summer to post monsoon season change, hence differ significantly (p-value 0.021) from last winter also. All other parameter does not show any significant change during all season changes. Hence the natural behaviour of soil remains unchanged.

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Table 4: Two Sample Paired t-test analysis: P- value Table.

Parameter	Winter to Summer	Summer to Post Monsoon	Post Monsoon to Winter
pH	0.403	0.258	0.176
EC	0.012	0.006	0.330
Salinity	0.012	0.021	0.597
Si	0.316	0.081	0.826
O. C.	0.886	0.732	0.788
N	0.810	0.783	0.918
P	0.791	0.358	0.164
K	0.121	0.199	0.923
Ca	0.276	0.074	0.234
Mg	0.582	0.704	0.857
Na	0.381	0.022	0.021
B	0.654	0.565	0.900

Correlation analysis of soil parameter and trace metals

The inter-element relationship in soil matrix provides information of soil parameters, heavy/trace metal sources and pathways in the geo-environment. Correlation matrix was useful to confirm some association between soil parameters as well as heavy/trace metals. To know the significance of association, two tailed test of significance was carried out for winter, summer and post monsoon samples. According to the values of Pearson correlation coefficient, in winter season (Table 5), significant positive correlation (p- value < 0.05) exists between Mg and Ca ($r = 0.696$, $p = 0.04$), pH and EC ($r = 0.554$, $p = 0.032$), EC and Na ($r = 0.588$, $p = 0.021$), P and Si ($r = 0.624$, $p = 0.012$) and B and O.C. ($r = 0.603$, $p = 0.017$). Salinity shows significant negative correlation with Si ($r = -0.527$, $p = 0.043$) and P ($r = -0.564$, $p = 0.029$). In summer season (Table 6), salinity shows only significant positive correlation with electrical conductivity (EC) ($r = 0.0724$, $p = 0.017$). All other correlation coefficient are week or insignificant. In post monsoon (Table 7), season sample a significant positive correlation exists between P and Si ($r = 0.698$, $p = 0.004$), Na and EC ($r = 0.638$, $p = 0.011$), Na and N ($r = 0.523$, $p = 0.046$), Na and Ca ($r = 0.598$, $p = 0.018$), whereas Mg shows significant negative correlation with Ca ($r = -0.595$, $p = 0.019$) and Na ($r = -0.600$, $p = 0.018$).

Table 5: Correlation Matrix: Analysis of soil parameters for the sampling 1st in winter.

Parameters	pH	EC	Salinity	Si	O.C.	N	P	K	Ca	Mg	Na
EC	0.554										
	0.032										
Salinity	-0.156	-0.288									
	0.578	0.299									
Si	-0.387	-0.081	-0.527								
	0.154	0.775	0.043								
O.C.	0.178	0.109	0.064	-0.183							
	0.527	0.699	0.821	0.514							
N	-0.468	-0.07	-0.004	0.111	-0.177						
	0.078	0.803	0.989	0.695	0.528						
P	-0.209	-0.158	-0.564	0.627	0.34	-0.139					
	0.455	0.573	0.029	0.012	0.215	0.623					
K	-0.149	-0.387	-0.043	-0.036	0.457	0.278	0.376				
	0.596	0.154	0.88	0.898	0.087	0.316	0.168				
Ca	0.123	0.024	0.321	-0.222	0.004	-0.058	-0.002	-0.135			
	0.663	0.933	0.243	0.427	0.989	0.839	0.994	0.632			
Mg	0.044	0.09	0.16	-0.104	-0.289	-0.254	-0.031	-0.454	0.696		
	0.876	0.75	0.569	0.712	0.296	0.36	0.913	0.089	0.004		
Na	0.278	0.588	0.17	-0.314	-0.043	0.067	-0.298	-0.312	0.498	0.334	
	0.316	0.021	0.544	0.254	0.878	0.813	0.281	0.258	0.059	0.223	
B	-0.064	0.028	0.198	0.114	0.603	0.145	0.257	0.4	0.342	-0.255	0.255
	0.82	0.922	0.48	0.687	0.017	0.606	0.355	0.14	0.212	0.359	0.359

Normal: Correlation Coefficient value; Italic: P-value; Bold: Significant values

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Table 6: Correlation Matrix: Analysis of soil parameters for the sampling 2nd in summer.

Parameters	pH	EC	Salinity	Si	O.C.	N	P	K	Ca	Mg	Na
EC	0.394										
	0.147										
Salinity	-0.042	0.724									
	0.882	0.002									
Si	-0.185	-0.239	-0.336								
	0.509	0.392	0.221								
O.C.	-0.126	-0.098	-0.016	0.172							
	0.656	0.729	0.955	0.539							
N	-0.195	-0.156	-0.253	-0.122	-0.378						
	0.487	0.58	0.364	0.665	0.165						
P	0.316	-0.263	-0.302	0.014	-0.421	0.457					
	0.252	0.343	0.274	0.959	0.118	0.086					
K	-0.011	0.126	0.231	-0.022	-0.439	0.192	0.391				
	0.97	0.655	0.407	0.939	0.101	0.494	0.149				
Ca	0.31	-0.128	-0.367	0.192	0.115	-0.12	0.315	-0.076			
	0.262	0.65	0.178	0.493	0.683	0.67	0.253	0.788			
Mg	0.273	0.301	-0.15	-0.24	0.055	-0.069	-0.212	-0.092	0.234		
	0.326	0.276	0.594	0.389	0.845	0.808	0.447	0.744	0.401		
Na	0.505	0.439	-0.014	-0.299	0.079	-0.083	-0.087	-0.377	0.44	0.464	
	0.055	0.101	0.959	0.279	0.781	0.769	0.758	0.167	0.101	0.082	
B	-0.049	-0.133	-0.238	0.205	-0.18	0.069	0.086	0.266	0.225	-0.071	0.231
	0.864	0.636	0.392	0.463	0.52	0.807	0.759	0.338	0.421	0.8	0.407

Normal: Correlation Coefficient value; Italic: P-value; Bold: Significant values

Table 7: Correlation Matrix: Analysis of soil parameters for the sampling 3rd in post monsoon.

Parameters	pH	EC	Salinity	Si	O.C.	N	P	K	Ca	Mg	Na
EC	0.297										
	0.282										
Salinity	0.018	0.438									
	0.948	0.103									
Si	-0.006	-0.138	-0.156								
	0.984	0.623	0.58								
O.C.	-0.284	0.025	-0.149	0.127							
	0.305	0.929	0.596	0.652							
N	0.164	0.346	0.445	0.202	-0.091						
	0.56	0.206	0.097	0.47	0.747						
P	0.31	-0.102	-0.279	0.698	0.139	0.204					
	0.262	0.717	0.313	0.004	0.622	0.466					
K	0.069	-0.246	-0.032	-0.128	0.175	0.198	0.243				
	0.806	0.376	0.911	0.65	0.534	0.48	0.383				
Ca	0.344	0.342	0.344	-0.145	-0.244	0.261	0.272	-0.129			
	0.209	0.213	0.21	0.607	0.38	0.348	0.326	0.646			

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Mg	-0.066	-0.012	-0.33	0.395	0.067	-0.029	0.139	0.148	-0.595		
	0.815	0.965	0.229	0.145	0.812	0.918	0.622	0.598	0.019		
Na	0.427	0.638	0.474	-0.213	0.059	0.523	-0.041	-0.151	0.598	-0.6	
	0.112	0.011	0.075	0.445	0.835	0.046	0.884	0.591	0.018	0.018	
B	0.406	-0.298	0.221	0.115	-0.068	-0.081	0.322	-0.012	0.325	-0.325	0.037
	0.133	0.28	0.429	0.683	0.81	0.774	0.242	0.967	0.237	0.237	0.895

Normal: Correlation Coefficient value; Italic: P-value; Bold: Significant values

Table 8: Correlation Matrix: Analysis of trace metals from soil samples using inductively coupled plasma mass spectrometer.

Metal	Fe	Cu	Cr	Zn	Pb	Ni	Ba	Co	As	Cd
Cu	0.142									
	0.613									
Cr	0.806	0.13								
	0	0.644								
Zn	0.047	0.61	-0.052							
	0.868	0.016	0.855							
Pb	0.407	0.834	0.415	0.679						
	0.132	0	0.124	0.005						
Ni	-0.465	0.354	-0.487	0.578	0.234					
	0.08	0.196	0.065	0.024	0.401					
Ba	0.172	0.636	0.109	0.598	0.586	0.587				
	0.541	0.011	0.7	0.019	0.022	0.021				
Co	-0.387	0.05	-0.42	0.339	-0.001	0.696	0.493			
	0.154	0.858	0.119	0.217	0.997	0.004	0.062			
As	-0.096	-0.073	-0.321	0.428	0.105	0.13	-0.196	0.118		
	0.734	0.796	0.243	0.112	0.708	0.643	0.484	0.676		
Cd	0.364	-0.201	0.029	-0.058	-0.072	-0.433	-0.34	-0.239	0.285	
	0.182	0.473	0.918	0.837	0.799	0.107	0.215	0.391	0.303	
Mn	0.444	-0.024	0.416	-0.116	0.13	-0.57	-0.059	-0.205	-0.086	0.172
	0.097	0.933	0.123	0.679	0.645	0.027	0.834	0.464	0.759	0.54

Normal: Correlation Coefficient value; Italic: P-value; Bold: Significant values

Correlation analysis of trace metals

Correlation analysis is carried out and presented in (Table 8), Positive correlation between heavy/trace metals exits due to, that pairs in the soil samples suggesting that they are from same source. Negative correlations between heavy/trace metals indicate that the heavy/trace metal pairs are derived from different origin and that they do not associate in their geochemical dynamics. In heavy/trace metals, Fe have highest concentration at every sample point but shows significant positive correlation with Cr (r = 0.806, p = 0.001) only. The maximum correlation occurs between Pb and Cu (r = 0.834, p = 0.00), Pb also shows positive correlation with Zn (r = 0.679, p = 0.005) and Zn is positively correlated with Cu (r = 0.610, p = 0.016). Ba shows positive correlation with Cu (r = 0.636, p = 0.011), Zn (r = 0.598, p = 0.019), Pb (r = 0.586, 0.021) and Ni (r = 0.587, p = 0.021). Ni shows positive correlation with Zn (r = 0.579, p = 0.024) and Co (r = 0.696, p = 0.004) and Negative correlation with Mn (r = -0.570, p = 0.027).

Conclusion

The study is carried out for the development of baseline data of soil parameter. Result of soil parameter analysis shows that most of the parameters are in the normal range. It is also observed that amount of potassium is higher (563.5ppm) than the normal value. Other elements like N, P, Na and B content are in normal appreciable range. The organic carbon (O.C.) content is less than the normal value. EC and salinity increases

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significantly in winter to summer season change and decrease significantly in summer to post monsoon season change. 'Na' decreases significantly in summer to post monsoon season change and increases in post monsoon to winter season change. EC, Salinity and Na along with all other soil parameters do not show significant changes over the three seasons. Hence the soil behavior remains unchanged over all seasonal changes. From the trace metal analysis it is observed that soil is reach in iron content and other metals like Cu, Cr, Zn, Pb, Ni, Ba, Co, As, Cd and Mn were also found in trace level.

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References

1. Jain SA, Jagtap MS, Patel KP (2014) Physico-Chemical Characterization of farmland Soil used in some villages of Lunawada Taluka. Dist: Mahisagar (Gujarat) India. International Journal of Scientific and Research Publications 4(3): 1-5.
2. Karlen DL, Mausbach MJ, Doran JW, Cline RG, RF Harris et al. (1997) Soil Quality: A Concept, Definition, and Framework for Evaluation. Soil Sci Soc Am J 61: 4-10.
3. Benno P Warkentin (1995) The changing concept of soil quality. Journal of Soil and Water Conservation 50(3): 226-228.
4. Lowdermilk WC, (1999) Conquest of the land through 7,000 years. US Department of Agriculture, Natural Resources Conservation Service.
5. Hornick SB (1992) Factors affecting the nutritional quality of crops. American Journal of Alternative Agriculture 7(1-2): 63-68.
6. Donald LS (2003) Environmental Soil Chemistry, (2nd edn) Academic Press USA.
7. Ponnamperuma FN (1972) The chemistry of submerged soils. Advan Agron 24: 29–96.
8. Smith JL, Doran JW (1996) Measurement and use of pH and electrical conductivity for soil quality analysis. Soil Sci Soc Am Spec Publ 49: 169-185.
9. Stanley EM (2001) Fundamentals of Environmental Chemistry "Front Matter". CRC Press LLC.
10. Ball BC, Campbell DJ, Hunter EA (2000) Soil compactibility in relation to physical and organic properties at 156 sites in UK. Soil and Tillage Research 57(1/2): 83-91.
11. Adriano Domy C (2001) Trace elements in Terrestrial Environments. Biogeochemistry, Bioavailability and Risks of Metals. Springer-Verlag New York.
12. Lu X, Wang L, Li L.Y, et al. (2010) Multivariate statistical analysis of heavy metals in street dust of Baoji, NW China. J Hazard Mater 173(1-3): 744-749.
13. Nicholson FA, Smith SR, Alloway BJ et al. (2003) An inventory of heavy metals inputs to agricultural soils in England and Wales. Sci Total Environ 311(1-3): 205-219.
14. Mico C, Recatala L, Peris M, Sanchez J (2006) Assessing heavy metal sources in agricultural soils of an European Mediterranean area by multivariate analysis. Chemosphere 65(5): 863-872.
15. James BR, Bartlett RJ (2000) Handbook of Soil Science (Sumner ME ed.), CRC Press Boca Raton FL pp B169-B194.
16. Klein C, Hurlbut CS, (1985) Manual of Mineralogy. (20th edn), John Wiley and Sons New York.
17. Kopp JF, Kroner RC Trace Metals in Waters of the United States. US Environmental Protection Agency Washington DC.
18. Kunze GW, Dixon JB, (1986) Methods of Soil Analysis, Part 1, Physical and Mineralogical Methods (Klute A. ed.) (2nd edn), Am Soc Agron Madison WI.
19. Facchinelli A, Sacchi E, Mallen L, (2001) Multivariate Statistical and GIS-based approach to identify heavy metal sources in soils. Environmental Pollution 114(3): 313-324.
20. Ruqia Nazir, Muslim Khan, Mohammed masab (2015) Accumulation of heavy metals (Ni, Cu, Cd, Cr, Pb, Zn, Fe) in the soil, water and plants and analysis of physic-chemical parameters of soil and water collected from Tanda Dam Kohat. Journal of Pharmaceutical Sciences and Research 7(3): 89-97.

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