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Evaluation of soil quality and its impact on mangroves forest Indus delta, Pakistan.

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Abstract:

The geochemical and texture of forests soil on different aspects have been widely studied, but the adverse effects of environmental degradation poses deterioration on mangroves forest soil of different mangroves species has not been broadly in the literature. The aim of the research was to find out the reasons for the change in forests density along with the extinction of mangroves species and to determine the detrimental impacts of forest soil on mangroves of Keti Bunder, Indus delta, Pakistan. The field study of the Indus delta has been conducted during the year 2021-22. The soil samples were collected from each root zone at different depths (25, 50, and 70 cm) of mangroves species (*A.marina, R.mucronata, C.tagal,* and *A.corniculatum*) that presently exist in Pakistan. To evaluate the soil quality, some physical and chemical parameters (pH, Salinity, TDS, TOC, Calcium, Magnesium, Sodium, Potassium, Nitrate, Phosphate, Iron, and Chromium) were used to evaluate the adversity of the pollution. The statistical results have also been calculated by using Descriptive and Principal Component Analysis to find out the level of parameters dispersed in soil and their effects that may cause extinction of mangroves species from Pakistan.

Keywords: Species extinction, Adverse impacts, Soil quality, Physico-chemical, Indus delta.

1. Introduction

Woody mangrove forests attract multiple species of land and sea. The mangroves are serving as catalysts in intertidal zone of tropical and sub-tropical regions of the world (Naidoo, G. 2009; Zhou et al., 2010). Mangroves are referred as floristically diversified shrubs and trees have been classified as halophytic, which absorbed excess salt by their roots, stems, and leaves (Tomlinson, P. B. 2016). Mangroves forests perform an integral role to steady the shoreline from harsh weather, maintain water quality, flood control, and conserve habitat to floral and faunal species. Furthermore, wood of mangroves is a major source for production of charcoal, boats, huts, construction work, and is also used to produce paper, rayon, toxicants and herbal medicines (Bandaranayake W.M., 2002). These forests are important to give rise the economy and perform productive role by export raw forestry material, export wood, herbal medicines. In spite of all these beneficial services, the forests are under drastic stress due to excessive siltation and sedimentation problem, land erosion, anthropogenic and natural disasters i.e. cyclones and tsunamis (Duke *et al*., 2007). However, the evidence precedent that mangroves forests are declining gradually, not just in developing world but in developed nations too (Ferreira, A. C., & Lacerda, L. D. 2016).

The coastal lines of Pakistan have also witnessed the tremendous declining of deltaic mangroves which have been shrunk from 345,000 ha (1980) to 158,000 ha (2001) rapidly. During this period, it was estimated that loss of mangroves patches was 187,000 ha which is equal to 8,905 loss annually (FAO, 2005). Some of the mangrove species

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found in the past were die down and now only four species (*Avicennia marina, Rhizophora mucronata, Ceriops tagal* & *Aegiceras corniculatum*) out of eight are being reported (Stewart, R.R. 1972).

Furthermore, in house extinction of mangroves species were due to fast pace urbanization, anthropogenic pollution, over grazing, lack of public awareness, construction of dams and barrages for agricultural purpose and hyper salinity due to lack of fresh water (WWF-Pakistan 2006; Kogo *et al*., 1986), but due to clearing of mangroves covers this may lead to contribute the increased rate of atmospheric carbon dioxide as mangroves are good carbon sequestration after ocean. However, it observed that soil is an integral factor towards carbon sequestration, and thus have ability to capture anthropogenic pollutants that can posed the deadly impacts on ecology of aquatic and terrestrial habitat. The contamination in mangroves forests soil can come from ultimate sources as of industrial discharge, urban wastewater, mining and agricultural runoff which poses serious threats to declining the mangroves directly or indirectly (Caccia, V.G., *et al*., 2003). From the last few years, many researchers investigated the mangroves propagules size variation, height, number of leaves their growth patterns, their sustainability even in high saline conditions along with heavy metals contamination are being reported at different coastal areas of Karachi (Khattak, M. I. *et al*, 2012). Recently, the study estimated that Karachi being generated 472 MGD wastewater, from which only 15 percent of this estimated volume has been treated poorly then it discharges into seawater which cause adverse effects on marine life and forest (Published in Dawn, October 25th, 2020).

Scientifically, the soil is a major medium that help to provide nutrition and supplying of healthy characteristics which enhanced forests performance for aquatic and terrestrial ecology and keep stable environmental conditions. So, it is become important to identify the trace and heavy metals properties in forest soil because the mangrove sediments are considered as source and sink of heavy metals. Few studies observed the pollution of heavy metals on mangroves forest (Banerjee, K. *et al*., 2012), but there is still lack of detailed research, gaps and shortcoming on mangroves soil, its adverse impacts on plant species their distribution and rate of declination. However, some keen researches and directions are still needed. Therefore, the major emphasized of the study was to evaluate the soil quality and its adverse impacts on mangroves forests, Indus delta, Pakistan. Furthermore, the aims of the research were to highlight some specific parameters that can retard the growth of plant and has been discussed the reasons of species extinction, along with how to overcome the drastic ecological destruction from Pakistan.

2. Materials and Methods:

2.1 Study Site Area

Pakistan is located within subtropical regions of the world having arid and semi-arid climatic conditions. The coastal belt of Pakistan Indus delta is located between the North 24°10.147′ and East 67°39.6157′. The selected study site is mangroves forests of Keti Bunder district Thatta Sindh shares the geographical location in between 24° 8' 41" North, 67° 26' 59" East. The coastal pocket of Pakistan is expanding from 990-1050 Km and widened approximately about 490-500 Km from which 350 Km shared with Sindh and rest of with Balochistan.

Mangroves forests of Sindh province is largely constituent in district Thatta and Badin, which covered 97% of the total mangroves patches found in Pakistan and only 3% shared with Balochistan, the most dominated species out of

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four is *Avicennia marina*, and the specie of *Rhizophora mucronata* is going rare, but the two species *Ceriops tagal* and *Aegiceras corniculatum* are at the verge of extinction from Pakistan.

2.2 Sampling of Soil

Keti Bunder along the coastal line of Indus delta was selected as all the four types of mangroves species exist here only. The samples of soil were collected to follow the grid sampling (Dinkins, C. P. et al., 2008). The samples were collected from roots of dense mangroves stands, three replicate depths (25cm, 50cm, and 70cm) of each stand (*A.marina, R.mucronata, C.tagal & A.corniculatum*) have been collected, one site sampling of degraded wetland area was chosen to study as a controlled hypothesis with same replicate depths. The samples were collected with the help of hand shovel digging equipment, with 2Kg of soil and a total 15 number of samples have been collected. Geotagging software was used to record the exact coordinates of the stands, five different sites representing five localities surveyed.

2.3 Samples Preparation

After samples reached to laboratory, the collected soil samples were dried into hot air oven at 36-40°C under constant temperature. The dried soil was then proportioned, weighted of about 2mm sieved soil each, using wood pestle for soil disaggregated. The weighted samples then transferred into petri plates to add the mixture of concentrated nitric acid (HNO_3) and hydrochloric acid (HCl) in the ratio of 1:3 in soil for digestion of samples. Addition of (HNO_3) oxidize sulphide material and destroyed organic matter, and the process react with (HCl) to formed aqua regia, the aqua regia extraction used to recovery of metals like, Cd, Cu, Pb, Zn, Cr etcetera. The samples were then heated to remove excess amount of acid used, then cool the samples in room temperature.

2.4 Samples analysis

Three methods are normally used to analyzed the characteristics of soil, these methods are gravimetric method, titrimetric method and wet digestion method, each method have been used to determined specific elements. To find the presence of heavy metals, digestion method was used (US-EPA, 3050-E) to evaluate the samples. The samples diluted with distilled water to quantify the heavy metals (Fe, Na, K and Cr) by using Perkin Elmer Atomic Absorption Spectrophotometer (AAS-700) under the methods of (APHA-3500 and ASTM D-4191). Some elements were then analyzed to follow the methods (gravimetric and titrimetric) for (TOC, TDS, salinity, NO_3, Mg and Ca), and pH were then determined (ASTM D-1293) by electrometric determination using the glass electrode sensor, respectively. The observed data were then analyzed by statistical standard methods using Minitab software to find out accurate correlation between selected and with controlled data samples.

3. Results and Discussions

3.1 Analytical Results

The evaluation of soil quality uses some soil indicators such as physical and chemical characteristics of mangroves soil by using Principal Component Analysis to determine Minimum Data Set (MDS) as shown in table 1 below.

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Table 1: Findings of PCA at 25 cm depth of mangroves forest soil.

Variable	**PC1**	**PC2**	**PC3**	**PC4**
Eigen Values	**7.4339**	**2.1529**	**1.8039**	**0.6092**
Proportion	0.619	0.179	0.15	0.051
Comulative	0.619	0.799	0.949	1
pH @ 25°C	0.04	**0.576**	0.161	**-0.61**
TDS ppm	0.255	-0.183	**0.489**	-0.161
Salinity PSU	0.255	-0.183	**0.486**	-0.136
Calcium ppm	**0.321**	-0.271	-0.186	-0.146
Magnesium	**0.349**	-0.148	-0.0165	-0.261
Iron µmol g^{-1}	**0.308**	0.047	**-0.351**	**-0.331**
sodium ppm	**0.338**	-0.213	-0.165	0.057
Potassium ppm	**0.338**	-0.213	-0.165	0.057
Chromium mg/kg	-0.244	**-0.456**	0.245	0.035
Total Carbon Wt.%	0.294	0.273	-0.225	**0.417**
Nitrate ppm	0.295	0.251	0.293	**0.317**
Phosphate ppm	0.294	0.253	0.294	**0.318**

The Eigen Values of Principal Component Analysis (PCA) are (greater than 1 or >1). The loadings of variables close to -1 to1 indicate that the variable were strongly influenced the component, as highlighted in boldface and the loading close to 0 referred that variables has weaken influenced the component. On the bases of PCA that have arranged all main indicators which were influenced on the soil and its selected properties. In PC1 the proportion influenced has 0.619, which means 61.9% of PC1 which indicate 34.08% has an effects of (Ca, Mg, Fe, K and Na) these variables on soil quality. In PC2 the proportion is 0.179 means 17.9% of PC2 has recorded individual effects of (pH and Cr) have 51.6% influenced on soil. In PC3 the proportion is 0.150 means 15.0% of PC3 has recorded, but individual indicators (TDS, Salinity and Fe) observed 44.2% influenced on the soil. In PC4 the proportion is 0.051 mean 5.1% of PC4 has recorded, but the individual indicators (pH, Fe, TOC, N and P) observed 39.86% influenced on the soil of selected species of mangroves for the depth of 25cm.

In figure 1, loading plot Mg, K, Ca, TDS, Salinity and Na have large positive loadings on Principal Component 1. The presence of all the essential nutrients and salts ions have an evidence of halophytic nature of mangroves. But the cluster of these nutrients make a strong relation among each other and notify towards the growth of mangrove trees and shrubs have highly been influenced by their positive correlation. In other cluster Nitrate and Phosphate were at the same position have witnessed that their presence marked by anthropogenic activities mixed with forests soil and due to agricultural run-off and untreated wastewater may develop the correlation between Nitrate and Phosphate. And Total Organic Carbon tends towards acidic soil due to the decomposition of mangroves foliar. While Fe and pH positioned at positive component 1, but on the other side Chromium was at negative loading on component 1, it means

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the Cr have liability over all properties of soil and posed serious threats to the soil and plant nourishment mentioned in table no 6.

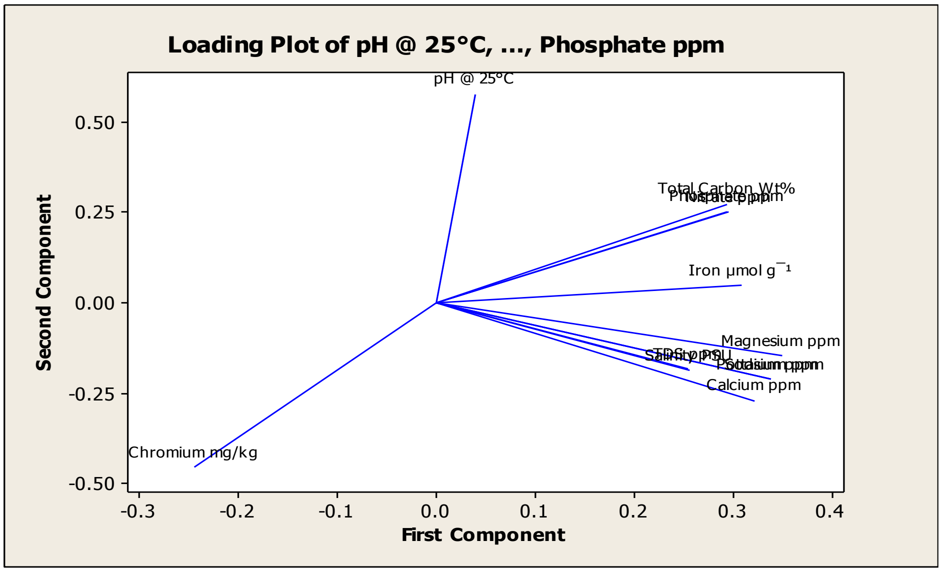

Figure 1: Loading plot of mangroves soil properties at the depth of 25cm.

Table 2: Findings of PCA at 50cm depth of mangroves forest soil.

Variable	PC1	PC2	PC3	PC4
Eigen Values	**7.2639**	**2.775**	**1.1239**	**0.8365**
Proportion	0.605	0.231	0.094	0.07
Comulative	0.605	0.857	0.93	1.000
pH @ 25°C	0.148	-0.116	**-0.555**	**-0.739**
TDS ppm	0.261	**0.375**	0.216	-0.276
Salinity PSU	0.261	**0.375**	0.2	-0.292
Calcium ppm	**0.346**	0.122	-0.139	0.285
Magnesium	**0.352**	0.167	-0.053	0.157
Iron µmol g¯¹	0.258	**-0.404**	-0.088	0.259
sodium ppm	**0.345**	0.201	-0.067	0.14
Potassium ppm	**0.345**	0.201	-0.067	0.14
Chromium mg/kg	-0.248	**0.431**	0.185	0.019
Total Carbon Wt.%	**0.346**	-0.156	-0.224	0.097
Nitrate ppm	0.238	**-0.323**	**0.491**	-0.187
Phosphate ppm	0.237	**-0.232**	**0.491**	-0.187

In 50cm depth the soil properties were then evaluate by using PCA to determine the individual influenced on soil quality. In PC1 of depth the proportion is 0.605 which mean 60.5% has been recorded, but the individual effects of

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(Ca, Mg, Na, K and TOC) have observed 34.68%. In PC2 of 50cm depth the proportion is 0.231 means 23.1% has recorded, and the effect of each indicator (TDS, Salinity, Fe, Cr, Na and P) have found 44.62% influenced on soil. In PC3 the proportion is 0.094 means 9.4%, and the indicators influenced (pH, N and P) have observed 51.23%. In PC4 the proportion is 0.070 means 7.0% has recorded, and the only parameter of pH have highest influenced 73.9% has been noted for soil quality.

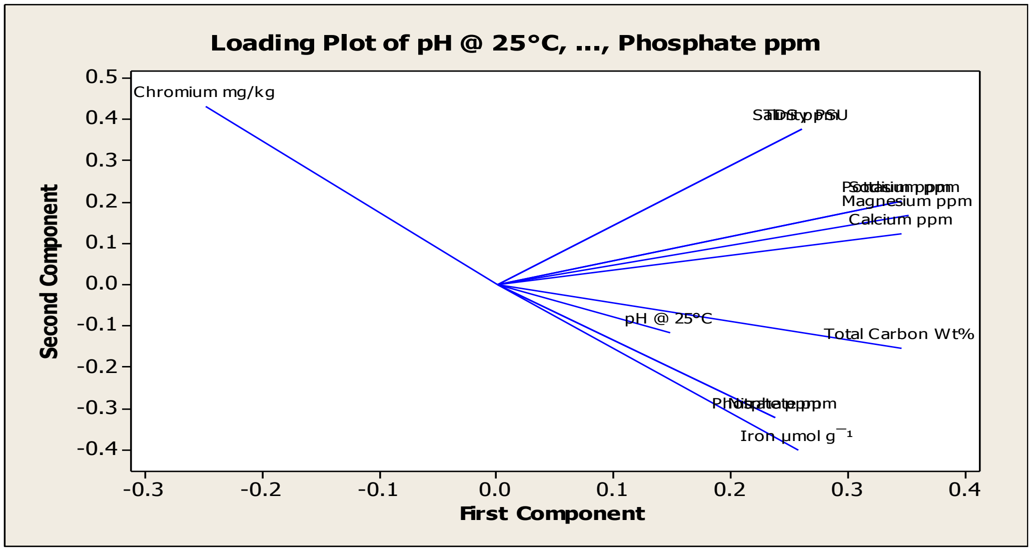

Figure 2: Loading plot of mangroves soil properties at the depth of 50 cm.

Table 3: Findings of PCA at 70cm depth of mangroves forest soil.

Variable	PC1	PC2	PC3	PC4
Eigen Values	**5.1681**	**1.4168**	**1.5997**	**0.8153**
Proportion	0.431	0.368	0.133	0.068
Comulative	0.431	0.799	0.932	1.000
pH @ 25°C	**0.336**	-0.038	**0.024**	**0.708**
TDS ppm	**-0.394**	0.153	**-0.068**	**0.325**
Salinity PSU	**-0.406**	0.098	-0.07	0.348
Calcium ppm	**-0.327**	0.098	-0.07	0.325
Magnesium	**-0.4**	**-0.304**	0.053	0.182
Iron µmol g^{-1}	**0.18**	**0.359**	**0.331**	**0.326**
sodium ppm	**-0.39**	0.073	**0.344**	-0.181
Potassium ppm	**-0.39**	0.073	**0.338**	-0.093
Chromium mg/kg	0.314	**-0.249**	**0.344**	-0.184
Total Carbon Wt.%	-0.088	**0.446**	0.224	-0.024
Nitrate ppm	0.048	**0.415**	**-0.364**	-0.139
Phosphate ppm	0.049	**0.415**	**-0.363**	-0.138

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In figure 2, loading plot a cluster of Ca, Mg, K and Na formed with positive correlation as shown in table no 02. In this plot Nitrate and Phosphate stands together due to the wastewater run-off, but pH and Total Organic Carbon showed an evidence of soil acidity thus Fe, TDS and Salinity were at the same position in Component 1, but stands different in Component 2. However, Chromium stands alone in both 1 and 2 components in loading plot but having negative position in first component and stands positive in component 2.

In the PCA of 70cm depth of forests soil the data has been arranged to find out the influenced on mangroves species. In PC1 the proportion is 0.431 means 43.1% of the data has recorded, but the influence of (pH, TDS, Salinity, Ca, Mg, Na and K) have observed 36.67%.

In PC2 the proportion is 0.368 mean 36.8% has recorded, and the influenced on each parameter (Ca, Fe, Cr, TOC, N and P) have found 37.55% of the soil quality. In PC3 the proportion is 0.133 mean 13.3% has observed, but the influenced of each parameter (Fe, Na, K, Cr, N and P) of PC3 have effects of 33.39%. In PC4 the proportion is 0.068 mean 6.8% of influenced on the indicators of Principal Components have parameters (pH, TDS, Salinity and Fe) having 42.67% effects of soil quality which could influenced on the growth of mangroves plants.

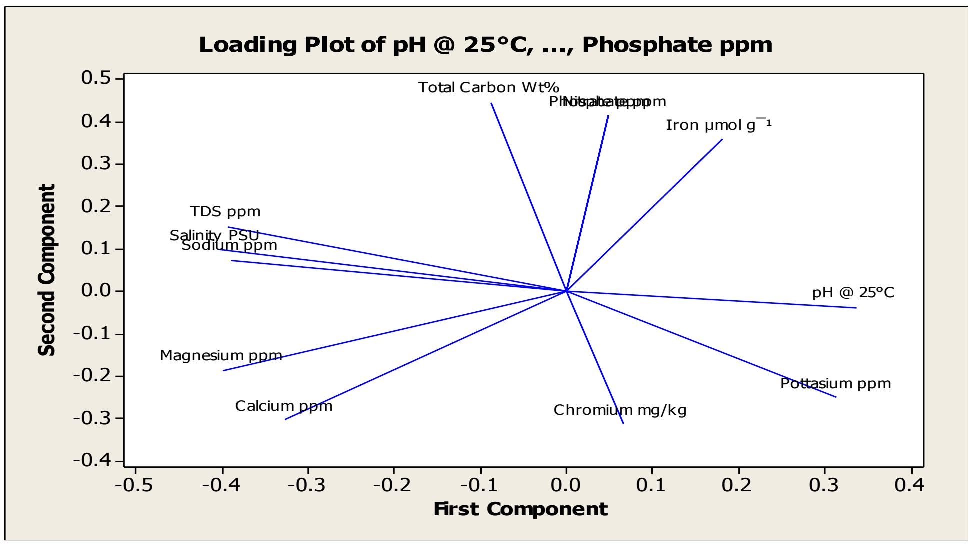

Figure 3: Loading plot of mangroves soil properties at the depth of 70 cm.

In this loading plot of 70 cm depth of soil have found dispersed parameters in figure no 3. In this plot half of the parameters stands at positive side while rest of all lies at negative side in both components 1 and 2. Only one cluster formed of salts ions which are TDS, Salinity and Sodium, these three parameters having strong negative correlation, and apart from that, Ca and Mg stands at negative side it means all the salts were together in all the depths. Moreover, Chromium and TOC have positive relation as shown in table no 06. Furthermore, Nitrate and Phosphate are together in all depths but Potassium stands alone in this site followed with Fe and pH. This type of dispersion of parameters have witnessed that all the nutrients, salts and metals are dispersed when reached to the end of the depth, the reason of this dispersion due to tidal influence and hence continuous contact with soil posed dispersion of soil properties in deepest layer of soil in roots zone of the forests.

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3.2 Discussions

The experimental results of mangroves forest soil revealed the presence of physical (pH, Salinity, TDS and TOC) chemical (Nitrate, Phosphate, Magnesium, Calcium, Potassium, and Sodium) and heavy metals (Iron and Chromium). The findings of forest's soil have witnessed the characteristic differences among each collected samples of mangroves species.

The properties of soil pH in all the sites were slightly acidic in all depths (pH< 7), the values showed increase (6.9000±0.1732) to decrease (6.800±0.283) ordered from the depths 25cm, 50cm, and 70cm as shown in table 04. The soil acidity and basicity is based on the rainfall patterns in which mixing of fresh water changes the soil properties. But the acidity of soil caused was due to the forests foliar decomposition. The presence of soil Total Organic Carbon (TOC) has an evidence of acidic pH, the mangroves litter decomposed by different processes and due that decomposition the soil changed the characteristics from alkaline to acidic. Furthermore, the presence of TOC has been responsible for the solubility of nutrients and salts ions for the plants. The TOC showed the higher values in top most layer of the soil (18.20±18.12) at 25cm depths, but the results found increased when soil depth increased at the depth of 70cm (16.51±9.55) as shown in table 04.

The TDS (Total Dissolved Solids) showed higher values of Mean ± St. Dev in upper surface of soil at 25 cm depth (730.4±157.7), but the results found decreased as depths of soil increased. Higher TDS in the soil is due to the agricultural run-off, industrial discharged, xenobiotic chemicals and untreated domestic wastewater caused the unhealthy soil environment (United States. Environmental Protection Agency. Office of Emergency, & Remedial Response. 1989). But there is no evidence observed in the literature of TDS adversity for mangroves and its soil.

The soil salinity and sodium are related to each other but results found difference in salinity and sodicity values followed depths (25 cm > 50 cm > 70 cm), the salinity decreases as depth of the sites increases, as shown in table no 1 below. The results were fluctuated due to some factors i.e. the rate of dilution and evaporation, the salinity changed into brackish water due to the influence of rainfall, and freshwater run-off. The research revealed that salinity from (0-5 PSU) showed higher survival of mangroves forests than that of increased salinity from (>5 PSU), and most of the mangroves showed better growth in slight to moderate (25 PSU) salinity.

Table 4: Descriptive statistics of all species of physical parameters. Mean±StDev.

Depths	pH @ 25°C (6.5-8.5)	TDS ppm (>450)	Salinity PSU (5-25)	Sodium ppm	Total Carbon Wt.%
Soil Sites (25cm)	6.9000±0.1732	730.4±157.7	0.6340±0.1333	433.9±89.2	18.20±18.12
Soil Sites (50cm)	6.860±0.230	602.6±91.2	0.5220±0.0776	364.2±92.4	13.28±6.74
Soil Sites (70cm)	6.800±0.283	569.0±71.5	0.4860±0.0643	307.6±87.0	16.51±9.55

The main category is of macronutrients (Ca, Mg, N, P and K) and the presence of Nitrate, Phosphate, Calcium and Magnesium salts have been accumulated in the forest soil. These essential nutrients were correlated with each other and neutral results of pH has an evidence of strong relation among them. Furthermore, the amount of all these

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macronutrients witnessed the halophytic nature of mangroves. The results found higher values at the depth of 25cm, but the values decreased as depth of soil goes downward as mentioned in table no 5.

Soil is one of the crucial sink for accumulation of Nitrogen and Phosphorus but Phosphate ions are unavailable and immobilized directly, until the microorganism breakdown Phosphate and resealed Phosphorus from Phosphate rocks and utilized it as plant nutrients (Ramos e Silva, C.A., *et al.*, 2007). It was also found that concentration of calcium, magnesium and potassium is due to the tidal influence with mixing of forests nutrients with estuaries. Potassium is also important to regulate osmotic processes of mangroves even in hyper saline conditions, but the deficiency of potassium may cause adverse effects on photosynthetic function, it also indicate the presence of clay in soil along with higher organic matter if higher potassium in plants. Furthermore, it has not been observed any satisfactory evidence reporting in literature on the adverse effects and deficiencies of base saturations (Calcium, Magnesium and Sodium) of mangroves forests. But on other terrestrial species of plants showed adverse effects on rate of photosynthesis and growth of plants due to lack of calcium and magnesium salts (McLaughlin, S. B., *et al*. 1990; Shortle, W. C., & Smith, K. T., 1988).

Table 5: Descriptive statistics of all species of chemical nutrients. Mean ± St. Dev.

Depths	Calcium ppm	Magnesium ppm	Potassium ppm	Nitrate ppm	Phosphate ppm
Soil Sites (25cm)	386.4±43.1	184.76±17.21	419.2±45.1	44.28±16.89	33.20±12.66
Soil Sites (50cm)	366.8±47.9	168.7±23.4	384.0±46.7	40.26±15.16	30.16±11.34
Soil Sites (70cm)	315.6±102.4	160.36±15.30	331.2±89.5	37.78±15.27	28.30±11.45

As of all the nutrients of soil Iron is also an essential parameter for the healthy process of photosynthesis and the plants growth, but the high concentration of Iron may cause breakage of plants tissue. The values of Iron in mangroves soil showed higher concentration in the end depth of 70cm (108.02±11.98), which is exceeded from the given permissible limits of iron in plants recommended by WHO is 20mg/kg, reported the values by (Shah, A., *et al*., 2013). The values of Iron revealed different approach from rest of all parameters it was followed clockwise sequence as depth of soil increased the values of Iron increased, thus the highest concentration was at the last depth of samples collected. The possible sources of iron contamination are steel mills located in Karachi. Moreover, the reason of iron contamination in deepest surface of soil may attributed to the geochemical process of rocks weathering related to wave action and vegetation, industrial and domestic discharge and from by-products.

Chromium is considered a toxic element and has been categorized as carcinogenic metal for International Agency for Research on Cancer. Therefore, it is need of hour to study this metal thoroughly and find out its mutagenic effects on soil and plants. Chromium occur in two valences trivalent and hexavalent, but the hexavalent chromium (IV) having high soluble ion which posed adverse effects and paralyzed metabolic process of plants and retard soil fertility due to its persistent nature if accumulated from environment. The mutagenic chromium may come into water, air and soil from various anthropogenic processes i.e. effluent discharged by dyeing of textiles and tanning industries, electroplating, leather processing and steel production. Another source of chromium could be weathering of rocks

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with discharge of soil leached and it transferred into aquatic environment which cause reduction in aquatic life as well as intertidal plants like mangroves and its fauna by the process of bioaccumulation. The presence of chromium in soil may retard the bioavailability of fertile nutrients which could beneficial for mangroves growth and nourishment. The values of Cr in soil indicate the adversity in all level of depths but it showed drastically increase at the initial layer of soil at 25cm (1262.8±45.3), and it decreased with depth of soil increased. The values found above the permissible limits (10 and 50 mg/kg in natural soil) and (350 mg/kg for agricultural soil) recommended by USEPA.

Table 6: Descriptive statistics of all species of heavy metals. Mean±StDev.

Depths	Iron µmol g^{-1} (20mg/kg)	Chromium mg/kg (350 mg/kg)
Soil Sites (25cm)	93.30±8.87	1262.8±45.3
Soil Sites (50cm)	98.80±12.53	1219.2±61.0
Soil Sites (70cm)	108.02±11.98	1139.2±77.9

4. Conclusion

The goal of this research was to investigate the properties of soil in at Keti Bunder along Indus coastal delta and to assess its impact on declination of mangroves forests. The soil samples were collected from the roots zone at different depths of the mangroves species in Keti Bunder, Indus delta. And for that soil evaluation, 12 parameters from the different groups (chemicals, macronutrients and heavy meals) were selected to analyze the characteristics of the soil, and to find out the reasons of die down the species and their extinction from the country since after 1990's.

1. Most of parameters (pH, TDS, salinity, Ca, Mg, Na, K, P, N, TOC) were found under safe permissible limits as recommended by WHO for soil quality.

2. Only two parameters (Iron and Chromium) were exceeded noted to the level from the set limits by US-EPA (350 mg/kg in agricultural soil and 10mg/kg) in natural soil.

3. It was also evidenced that the entire region is endanger due to various operational effluent discharged such as civic waste, industrial, municipal, transportation and port activities they all give rise the pollution of soil and water which are also discharging their effluent directly into the aquatic bodies.

4. Furthermore, overharvesting by local community and overgrazing by their domestic livestock are actively responsible for reduction in mangroves forests.

5. The reduction of freshwater flow from river Indus may also create the problem of siltation, which thus increased coastal erosion and hyper salinity has also been increased, thus the survival of salt-tolerant *Avicennia marina* in the Delta provides evidence of higher levels of salinity in and around the mangrove forests region.

This may cause directly and indirectly deteriorating the soil quality and making it imbalanced for mangroves and its related aquatic and terrestrial ecosystem which resulting deterioration of the environmental conditions along the coastal area consequently extinction of some species (*Ceriops* and *Aegiceras*) of the mangroves.

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