American Journal of Water Resources, 2019, Vol. 7, No. 1, 30-41
Available online at http://pubs.sciepub.com/ajwr/7/1/5
Published by Science and Education Publishing
DOI:10.12691/ajwr-7-1-5

Land Use Pattern Impact on Biogeochemistry of Soil in Auraiya District of Uttar Pradesh, India

Deepak Singh[1], Yogesh Kumar[2], Usha Mina[1,*]

[1]School of Environmental Sciences, Jawaharlal Nehru University, New Delhi, India
[2]Amity University, Uttar Pradesh, India
*Corresponding author: praush2@gmail.com

Received December 03, 2018; Revised January 18, 2019; Accepted February 02, 2019

Abstract The natural resources on the Earth are limited and these resources should be used judiciously for sustainability. One of the important natural resource is the soil, use by the people for various purposes. When its utilization and consumption is skewed, then it affects the soil quality. To fulfill the needs of the people of the region, there is need for the proper management of this particular resource. The present study tries to characterize the soil of Auraiya district, which has undergone major change in land use pattern in last two decades. The different biogeochemical parameters studied in the present study are important from the point of view to know the level of degradation of the soil of the region. The present study characterizes the biogeochemical soil quality parameters of five representative villages of the Auraiya district located in state of Uttar Pradesh, India. The land use pattern of Auraiya district shows that its land is utilized for agriculture, residential colony and industrial set up. The different biogeochemical soil parameters studied are pH, Electrical Conductivity, Water Holding Capacity, macronutrients namely, Nitrogen, Phosphorus and available Potassium, micronutrients like Aluminium, Manganese, Iron, Boron and microorganism (bacteria) named *E.coli* population load. The correlation matrix result showed that the pH has inverse relationships with all other parameters except Mn and EC. The WHC is negatively related with EC, N, P, Al and Fe levels. The available Nitrogen in the soil has inverse relationship with the pH which may be due to the volatilization loss of nitrogen. The content of the *E.coli* was high during the winter season at Ranipur village. Among the seasonal variation in the soil quality parameters shows that there is variation during these periods. The studied sites are mainly under agriculture practice but the water used by the farmers of the areas comes from the rivers, canals, lakes, underground water etc. These water resources receive different types of pollutant from the industrial units, commercial places and solid waste from the municipal bodies located nearby. This polluted water when used gets mixed with soil and interferes with the soil nutrients contents. The variation in soil quality parameters between villages indicate that villages and the adjoining area are subjected to major land use change, due to which the soil quality parameters and nutrients content have declined. To achieve and maintain the soil resource, sustainability, there is need for short and long term strategies for sustainable development planning so that the needs of people is fulfilled with degrading the soil resource.

Keywords: *land use pattern, soil biogeochemistry, agriculture, E. coli*

Cite This Article: Singh Deepak, Kumar Yogesh, and Mina Usha, “Land Use Pattern Impact on Biogeochemistry of Soil in Auraiya District of Uttar Pradesh, India.” *American Journal of Water Resources*, vol. 7, no. 1 (2019): 30-41. doi: 10.12691/ajwr-7-1-5.

1. Introduction

The increase in population of any country leads to the increase in the stress and pressure on the natural resources. The major impact occurs on the land resources of the region. To fulfil the needs of food and shelter of the population, the regional government tries to convert the land use pattern of the region. The areas under the forest are converted into the agricultural cropland, land of residences, commercial and industrial areas by cutting down the trees of the region. Sposito [1] found that to fulfil the need originating from soil and other natural resources, there are three main constraints like water use, land use and soils ability to sustain agricultural crops. This leads to the change in the pattern of land use and land cover as per the need of the region which is a dynamic process and changes with the time [2]. The land use and land cover changes lead to direct or indirect impact on all the three spheres constituting biosphere i.e., lithosphere, atmosphere and hydrosphere in one way or the other [3,4,5]. Many studies carried out all over the world have found that there occurs major changes in the physical, chemical and biological characteristics of the soil and alteration in the biogeochemical cycles of the biosphere which may lead to the formation of wasteland [6-17]. The degradation of soil properties and changes may have long standing impact on the countries mainly based on agricultural economy [6].

In India, there has been major change in the land use and land cover after the country shifted from the restricted economic phase to the liberal economic phase in the 1991 [18]. After this, the country saw major transformation in terms of industrialisation, liberalisation and agricultural processes and pattern. On working for the needs of the people for their growth and development, the state of Uttar Pradesh, India, also took the same line of economic development. In the process, state of Uttar Pradesh took decision with regard to major change in land use and land cover during the last three decades. In the transformation, the district of Auraiya was also included in the process of industrialization and expansion of urban area for establishment of residential colonies for which forest and agricultural land use was converted [18]. The present study tries to see the impact of land use and land cover changes on the soil quality parameters for which, five villages [(Ranipur (S1), Peeparwaha (S2), Bahadurpur (S3), Achanakpur (S4) and Kachhpura (S5)] of district of Auraiya located in the state of Uttar Pradesh, India were selected. The district lies between 26.21° to 27.01°N latitude and 78.45° to 79.45°E longitude. The district was created in the year 1997 which is located on the central Gangetic river plain basin. The total area of the district is 2016 Km^2, having total number of villages 848 and 3 tehsils. The total population of Auraiya is 1,379,545 and having population density of 684 peoples per Km^2 [19,20,21]. The total rail line in the district is 31 Km and the total road length is 2385 Km of which 77 Km belongs to National Highways, 95 Km to State Highways, 77 to main District Highway and 2170 belongs to other district and rural roads [20].

The average precipitation in the Auraiya is 792mm which receives mainly from the south west monsoonal winds. The district has different types of soils like, clay, loam, sandy loam and sandy soils. The soils of the Auraiya are also affected by increased salinity, sodicity, ravines etc as shown in Table 1. The Agriculture department of Auraiya has divided the district into four types of Agro-ecological Zones which is mainly based on the occurrence of type of soil, topography, type of irrigation available and pattern of agriculture. In low lying plain beds of clay, the water collects during the rainy season and generally rice crop is easily grown in these areas. The annual temperature range varies from 2.2°C to 44.4°C. The Auraiya has mainly an agriculture based economy. Of the total area of 2,06,126 hectares, there is 4321 hectares of forest cover, 5,865 hectares is non-agricultural land. The net cultivable land is 1,41,218 hectares, of which 76,349 hectares of land is the area sown more than once in a year while 1,10,275 hectares of land is the net irrigated area. The average holding size of the land by the farmers is 0.84 hectares having cropping intensity of 164 %. The Figure 1 shows the location of the Auraiya district in state of Uttar Pradesh, India [19,21].

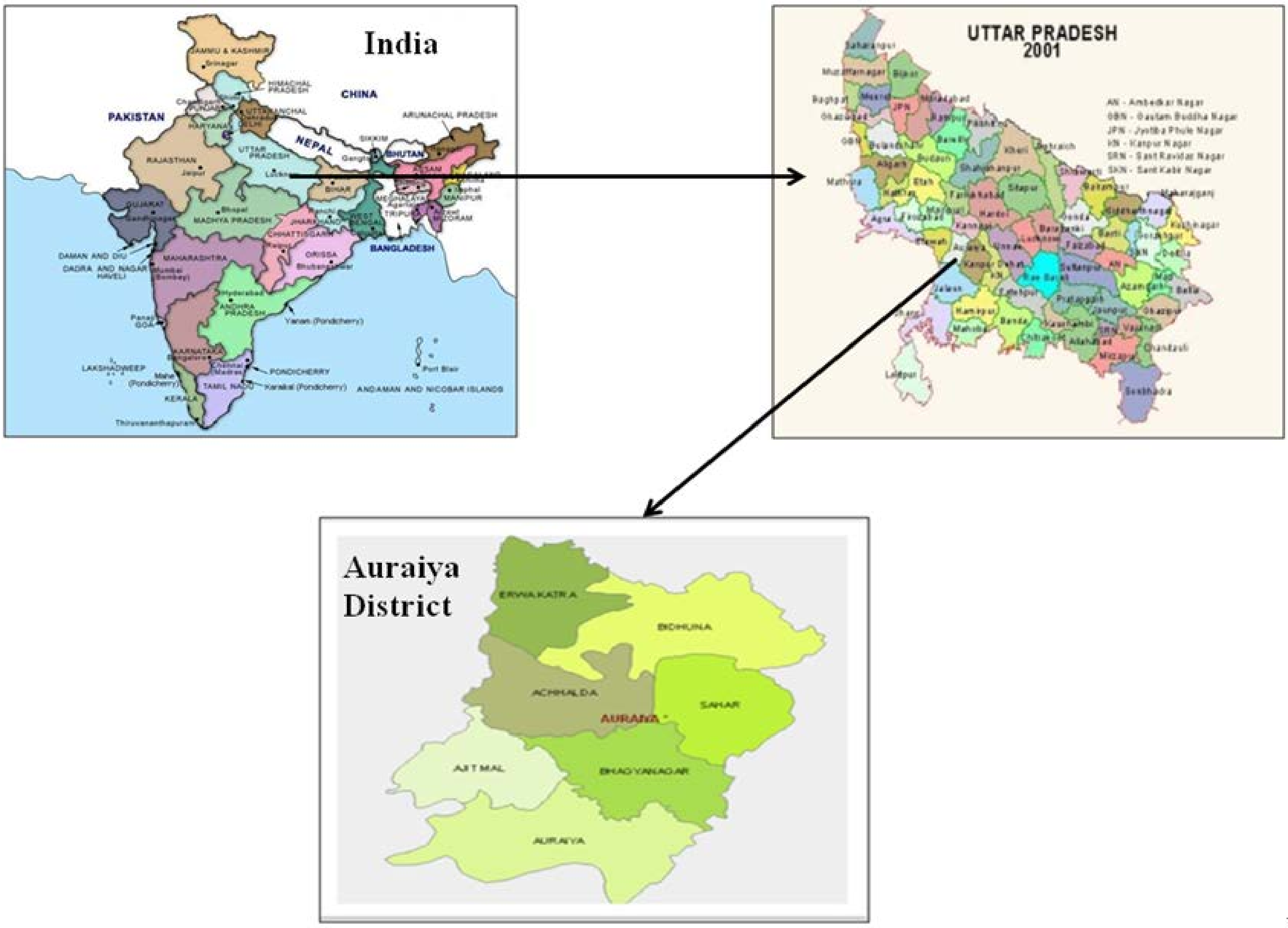


Figure 1. Map showing location of Auraiya district in the state of Uttar Pradesh of India (Map taken from Census of India, Krishi Vigyan Kendra, Auraiya district) [19,21]

Table 1. Showing the type of soil and its characteristics in Auraiya. [19,21] (Table taken from Census of India, 2011 and Krishi Vigyan Kendra, Auraiya district website)

S.No	Soil type	Characteristics
1	Clay	Salinity, sodicity and ravines are the main reason for degradation of soil. A low lying bed of clay filled with water is used for growing rice.
2	Clay Loam	The soils of the area are affected by salinity, high levels of sodium and ravine topography. Here also the low lying areas filled with water of monsoon rain are used for growing rice crops.
3	Loam	The soils are broadly affected by salinity, high concentration of sodium and ravines topography. In this soil also the monsoonal water is collected in the low lying areas filled with water is used for growing rice.
4	Sandy	The salinity, sodicity and ravines are the main problems of the soil of this area and low lying beds are filled with water are used for growing the rice crops.
5	Loam	Higher levels of salinity, sodicity and ravines are the main problems of the soil. Rice is grown in the water filled low lying areas.

As per the Krishi Vigyan Kendra, Auraiya [19] is divided into seven types of farming systems which are:- (1) Paddy-wheat -fallow (2) Bajra-Wheat-fallow (3) Maize-Toria-Wheat-fallow (4) Paddy-Wheat-Dhaincha, Paddy-Wheat-Moong (5) Okra-vegetable Pea-Colocasia/Cucurbits (6) Paddy-Wheat-Fodder Jowar (7) Paddy-Barseem. The 4,321 hectares of land is covered with forest where the main trees grown are the Kanji (*Millettia sps*), Mahua (*Madhuca sps*), Babool (*Acacia sps*), Semal (*Bombax sps*), Mango (*Mangifera sps*), Neem (*Azadirachta sps*), Jamun (*Syzygium sps*). Table 2 shows the data related to area, production and productivity of major crops cultivated in the district during the 2014-15.

From the point of view of natural resources of the district, it can be divided into four parts from the point of natural features. The north-eastern part has river Sengar which flows across the city from west to east parallel to the major river Yamuna. It has tehsils Bharthana and Etawah on the banks of Sengar River. The southern portion which lies south of the Sengar River have Highlands besides which overlooks the Yamuna River which covers the areas coming under the major portion of the Auraiya tehsil. Across the Yamuna, where there is confluence of the rivers Sindh, Kuwari, Chambal and Yamuna, there lies a highland and broken landform topography which is called as Janibrast. These four parts of the district has marked variation in the topography. The River systems of the Auraiya and Etawah districts consists of mainly river Yamuna along with its two large tributaries i.e., the river Chambal and Kuwari, and the river Sengar and its tributary Sirsa. Along with it, small tributaries like river Rind, Arind and its tributaries, river Ahneya, Puraha and Pandu. The Auraiya also have some important Lakes located in Durmangadpur, Mundai, Hardoi, Barauli, Auton, Yakubpur, Tirhwa, Dhupkari or Thulpia and Manaura in tehsil Bidhuna [19,20,21].

Table 2. Area, Production and Productivity of major crops cultivated in the district 2014-15. (Table taken from Census of India and Krishi Vigyan Kendra, Auraiya district, website) [19,21]

S.No.	Name of Crop	Area (Hectares)	Production (100)	Productivity (100/hectares)
1	Paddy	6100	14792	27.69
2	Wheat	14584	24.75	28.03
3	Bajra	6400	8000	12.50
4	Gram	5000	5000	10.00
5	Mustard	6100	5490	9.00
6	Sugarcane	1000	-	567.65

From the industrial point of view, the Auraiya is considered to be backward districts. Only few Block areas belonging to the Dibiyapur, Bidhuna, Achhalda and Auraiya are the industrial areas which are moderately developed from the point of industrial establishment while three areas are mini industrial areas. Among the small and medium scale industries like rice mills, pulses mills, desi ghee mills, bricks making units are very well established along with it, some wooden furniture, steel furniture, product manufactured from cement are also moderately established. The Uttar Pradesh State Industrial Development Corporation (UPSIDC) [20] is in the process to develop Dibiyapur town of Auraiya into a 'Plastic city' in an area of 314 acres of which 225 acres will be used for industrial purposes while remaining land will be used as a residential land. With regard to minerals, district is not so wealthy; the main available land resource is the mud which is mainly used in the manufacturing of the bricks which supplies to the nearby areas of the district.

The total number of industrial units registered in the district of Auraiya is 2558. The major employment giving industries in the region are the small scale industries where the estimated average daily worker employed is more than 30 thousands while it is more than 3 thousand in the medium and large scale industries. The district has different types of industries which are mainly based on agricultural products viz., cotton textiles, woolen textiles, silk products, furniture made of wood, paper and paper based products, jute and jute based products, mineral based industries, small and medium engineering units, electrical goods, plastic based products, petroleum derived products, transport related equipments and parts, repairing and servicing industries [20,21].

The industrial establishment and development started during the year 2006-07 and it continuously increased in area and number. The Auraiya also has two major industries which are public sector undertakings: first is the Gas Authority of India Ltd. (GAIL) which is located in the block of Pata of Dibiyapur town. GAIL is a public sector Navratna company involved in transmission and marketing business of gas in India. Gail has petro-chemical complex in Auraiya. Table 3 show the development and establishment of industries in last decade [20,21].

The second major industry of the Auraiya is the National Thermal Power Plant (NTPC) which is located in Auraiya block of Dibiyapur tehsil in Auraiya district. The thermal power plant use gas for the production of the electrical energy. The gas is used as fuel for the thermal power plant is made available from the nearby GAIL gas producing industry. This thermal power plant uses the water for the power plant from the Auraiya-Etawah canal [20].

Table 3. Showing the trend of establishment and development of the industries in last decade(Table taken from DIC Centre, Auraiya, Ministry of MSME, GOI, 2016) [20]

S.No.	Year wise trend of industrial units registered	Total number of registered industrial units	Total employment (Persons)	Investment (Million INR)
1	2006-07	145	575	11.73
2	2007-08	46	133	12.070
3	2008-09	121	343	21.91
4	2009-10	162	537	59.60
5	2010-11	168	545	96.40
6	2011-12	161	335	50.20
7	2012-13	82	214	70.90
8	2013-14	333	1423	10.10
9	2014-15	306	3313	75.70
	Total	1624	7418	408.65

2. Methodology

2.1. Sampling Procedure

The sampling was carried out in five selected villages i.e., Ranipur, Peeparwaha, Bahadurpur, Achanakpur and Kachhpura of the Auraiya district. The soil samples were collected from these villages from two depths 0-15 cm and 15-30 cm. The soil samples were collected during the four month representing the four specific seasons occurring in Auraiya. The selected months are January (Winter), April (Summer), September (Monsoon) and October (Autumn). The samples are brought back to the laboratory for further analysis to check the soil quality parameters. The soil quality parameters monitored are - pH, EC (Electrical conductivity), Water Holding Capacity (WHC), macronutrients namely, available Nitrogen (N), available Phosphorus (P) and available Potassium (K), micronutrients namely, Manganese (Mn), Aluminium (Al), Iron (Fe) and Boron (B). Along with them the *E.coli* count in the soil was also measured.

For the estimation of different parameters of soil quality, available standard methods were used. For the pH measurement, pH meter was used which works on the principle of Potentio-metric method which measure the potential difference between the two electrodes which is made up of glass and calomel electrode. Soil pH was determined by using glass electrode pH meter in 1:2:5 soil-water suspensions after stirring it for 30 minutes.

The Electrical Conductivity is used to measure the amount of salts present in soil. The soil samples used for pH determination were allowed to settle down the soil particles for 24 hours. The conductivity of supernatant liquid was determined by Electrical Conductivity Meter [22].

The Water Holding Capacity which is the defined as the water retained between field capacity and wilting point in soil which was measured by using the standard method available called Kien Box method.

The available Nitrogen was determined by the alkaline $KMnO_4$ method as described by Subbiah and Asija [23]. Available Phosphorus in the soil was extracted by 0.5M $NaHCO_3$ (pH 8.5) as described by Olsen et al. [24] and Phosphorus in the extract was determined by the ascorbic acid method as described by Watanabe and Olsen [25]. Soil Potassium was extracted by shaking with neutral normal ammonium acetate for five minutes at a constant temperature (25°C) as described by (Hanway and Heidal [26] and then Potassium in the extract was estimated by Flame Photometer. Hot water soluble boron was extracted by boiling soil-water suspension 1:2 for five minutes and determined by Azomethine-H colorimetric method [27,28] for quantifying the available Boron. The Manganese was extracted by using 0.005M Diethylene tri-aminepenta acetic acid (DTPA), 0.01M calcium chloride dehydrate and 0.1M Triethanolamine-buffered at pH 7.3 [28] concentrations were analyzed by AAS (Model Elico, No. 4141).

For the measurement of the *E.coli*, M-endo method was used. The M-endo method is a membrane-filtration method that determines the concentration of total coliforms and *E.coli*. In this method, 5.1 g of dehydrated M-endo medium mixed with 100 ml of the 2% ethenol solution in a flask. This solution is then heated up till the medium approaches the boiling point and promptly remove it from the heat and cool the medium to temperature of about 45-50°C and then pour 6 to 7 ml in 50 mm bottom petridish. Quickly placed the top petridish loosely on bottom petridish to allow condensation and then close the petridish by pressing firmly on the top so as to prevent it from drying and store it in the darkness in a refrigerator.

The Aluminium content of the soil sample is determined by atomic absorption spectrophotometer (AAS). The dissolved Aluminium in the soil is filtered and the sample is directly aspirated to the atomizer for total recoverable Aluminium. A pre-treatment with conc. HCL is carried out prior to aspiration of the sample.

2.2. Statistical Analysis

The statistical analysis was performed using SPSS 16 ver.16. The data were presented as means ± standard deviations. The correlation matrix and descriptive statistics were also carried out to reach the relationship between soil quality parameters viz., pH, EC, WHC, N, P, K, Al, Mn, Fe and Boron.

3. Results and Discussion

For the statistical analysis of the data, the correlation matrix and descriptive statistics was carried out using SPSS software. The Table 4 show the correlation matrix between soil quality parameters i.e., pH, EC, WHC, N, P, K, Al, Mn, Fe and Boron.

The correlation coefficients between the physico-chemical parameters of soil indicated that there are inverse relationships between all studied soil properties with pH ($p \leq 0.05$) except with Mn and EC levels significant at 5% level. This result is mainly due to high values of EC, where sodium is a dominant cation and which affects other soil properties.

Table 4. Showing Descriptive statistics and Pearson's correlation matrix for soil quality parameters in Auraiya district

	pH	EC	WHC	N	P	K	Al	Mn	Fe	B
pH	1									
EC	0.49	1								
WHC	-0.05	0.49	1							
N	0.66*	0.15	0.53*	1						
P	-0.60*	0.04	0.73*	-0.01	1					
K	0.76*	-0.49	-0.39	0.54*	0.62*	1				
Al	0.54*	0.17	0.80*	0.60*	0.63*	-0.05	1			
Mn	0.48	0.23	-0.22	0.03	0.51*	0.10	0.68*	1		
Fe	0.84*	-0.06	0.57*	0.80*	0.31	0.40	0.89*	0.56*	1	
B	-0.37	0.15	-0.40	0.33	0.83*	0.66*	-0.12	0.12	0.17	1

Note:- *correlation is significant at $p \leq 0.05$ *level*, correlation is non-significant
pH: potential of Hydrogen ion; EC: Electrical Conductivity; WHC: Water Holding Capacity; N: available Nitrogen; P: available Phosphorus; K: available Potassium; Al: available Aluminium; Mn: available Manganese, Fe: available Iron; B:available Boron.

WHC at the studied site is in the range of 18 - 65%. WHC of a soil is mainly dependent on its texture and organic matter content. Soils with a high percentage of silt and clay particles holds more water and nutrients compared to soils with more percentage of sandy particles. Results of the study indicates that WHC is negatively correlated with pH, K, Mn and B and positively correlated with EC, N, P, Al and Fe levels in soil respectively. Similar relationships were also reported by Deb et al. [29].

The crops need the nitrogen for its growth and development which is the most important nutrient among the three macro-nutrients viz., nitrogen, phosphorus and potassium. The most of the nitrogen present in the soil is in form of bound with the organic compounds which constitutes more than 95% while rest is present in the inorganic form [30,31]. In some soils, it is present in the bound ammonium form which is frequently and easily available to the plants. In present study, available nitrogen levels indicated inverse relationship with soil pH (Table). The significant and negative correlation was found between soil pH and available nitrogen which indicates that increase in soil pH decreases the available nitrogen to the plants which might be due to phenomenon of volatilization loss of nitrogen and rise of soil pH. Khokar et al., Patil et al. and Yadav and Meena [32,33,34] have also found similar observations with regard to the nitrogen in soil. Ashok et al. [35] carried out wide and comprehensive study with regard to the nutrient present in the soil of the district Auraiya. The main objective of the study was to examine the reasons behind the decline in the productivity and production of wheat in the southern part of the Uttar Pradesh. The total of seven blocks were selected from where 168 samples of soils were collected which were representative samples of the different types of soil groups present in wheat growing regions of district Auraiya. In their study, they found that the main reason for the decline was the higher levels of nitrogen deficiency.

The range of available phosphorus levels in the study area was 3.1-10.3 mg/kg of soil. Soil pH and EC are negatively and positively correlated with available phosphorus level respectively, in soil. It has been reported that soil pH adversely affect available phosphorus levels in soil which may be due to conversion of soluble phosphorus to insoluble calcium and magnesium phosphate thus reducing its availability to the plant with the rise in soil pH [33,36].

Potassium is considered as a structural element of soil minerals which is present in between the clay mineral lattice and is adsorbed on outer surfaces of small sized soil particles and in the soil solution. For the proper absorption of the potassium by the plant, the potassium should be present in the solution or soluble form and exchangeable forms. Results of the study indicate that increase in soil pH thus decreasing the solubility of iron complexes. The correlation matrix table shows that the potassium is negatively correlated with EC and WHC while positively correlated with other soil quality parameters. The results are in accordance with the observations of Bhat et al. and Waghmare et al. [37,38].

The growth and development of plant needs another micronutrient called Boron. Boron is needed for the different physiological and biochemical functions by the plants. The plants respond to the boron depends on the species of the crops, type of the soil and environmental conditions [39-45]. In the present study at the different sites, the levels of boron were in the range of 0.6-1.3 ppm. The Boron was found to have positively correlated with phosphorus, and potassium while negatively correlated to the pH and EC. With regard to metals present in the soil, the Aluminium has positive correlation with pH, WHC, N and P. In case of Mn which has positive correlation with pH, P and Al while Iron is found to have positive correlation with pH, WHC, N, Al and Mn.

3.1. Analysis of Soil Quality Parameters

The land of Auraiya is mainly used for purposes like development of agriculture, forest, industries and residences. The water resources of the area available in the form of surface and ground water are being used for irrigation. Approximately, 82% (1193.55 Km^2) land of the total area is covered by various methods of irrigation, out of which, 54.36% area is irrigated by groundwater while remaining area is irrigated by surface water resources. The Etawah branch of Lower Ganga canal system passes through the area. A substantial length (826 km) of canal network contributes to irrigation in the area [46]. The soil quality parameters pH, EC, WHC, N, P, K, Mn Al, Fe and

B were analyzed for two depths 0-15 cm and 15-30 cm of soil. Samples were collected were brought back to the laboratory for the further analysis.

The pH of the soil is the main parameter which controls many important chemical and biological processes in the soil. Plants need different types of nutrient from the soil for its growth and development. The availability of nutrients to the plants is affected by the variation in the pH of the soil. At Ranipur, the pH values were 7.7 and 8.1 at the 0-15 cm and 15-30 cm depth, respectively having standard deviation (SD) of 0.3. The lower soil was found to be more basic compared to the upper layer soil. The Peeparwaha site has upper soil more basicity compared to the lower one having the values of pH 7.8 and 7.4, respectively. At Bahadurpur, the upper and the lower soil found to have same basicity having value of pH 8.1. The site of Achanakpur have same trend as that of the Ranipur having lower soil more basic compared to the upper soil. At Kachhpura site, the upper and lower layers of soils have found to have very less difference in the pH values of upper layer having pH of 7.9 and lower 7.8.

Water Holding Capacity of the soil is an important property who values decide which type of crop is suitable for the soil. The soils having more clay have better WHC while soils richer in sand have poor WHC. The WHC has range from 29.2 to 42.6 % having lowest value at Peeparwaha (at depth 15-30 cm) and highest at Achanakpur (at depth 15-30 cm).

Salinity is a soil property referring to the amount of soluble salt present in it. It is generally a problem of soil in arid and semi-arid regions. Electrical conductivity (EC) estimates the amount of total dissolved salts (TDS) or the total amount of dissolved ions present in the water. The electrical conductivity (EC) for the site Ranipur at the depth of 0-15 cm was found to be lowest while highest EC was at the depth of 15-30 cm at Peeparwaha having the values of 467.5 and 640.9 µmho/cm, respectively.

With regard to the macronutrients, the range of N was found to be between 55.0-185.3 mg/kg. The content of the N was highest and lowest value was found to be at Kachhpur and Peeparwaha, respectively. The phosphorus content in the soil was in the range of 3.1 to 10.3 mg/kg having highest concentration at Kachhpur while lowest at Bahadurpur. Potassium is an important macronutrient whose level in the soil was between the 55.3 and 150.9 mg/kg found at Achanakpur and Peeparwaha, respectively.

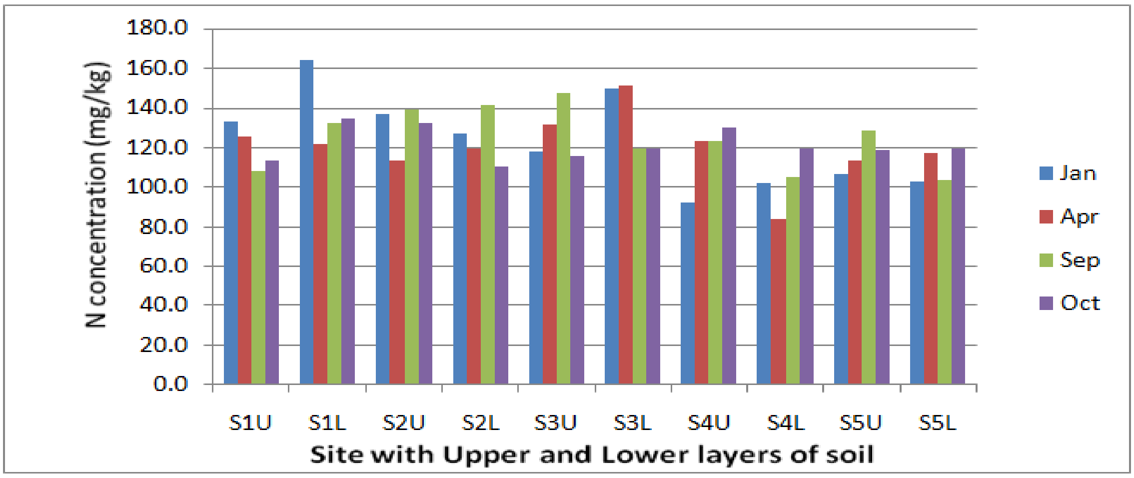
Although the micronutrient is available in low concentration but are important from the point of growth and development of plant. The four measured micronutrients are Mn, B, Al and Fe. Manganese in the soil was found to be in the range of 1.1 - 1.4 with highest values at Achanakpur and lowest at Bahadurpur. Boron is found (range 0.5 - 0.8 mg/kg) to be highest at the Bahadurpur and lowest at three sites viz., Ranipur, Peeparwaha and Kachhpura. In case of Aluminium, it varied in range of 0.004 to 0.012 mg/kg and the highest values are at Peeparwaha and lowest at Achanakpur, Ranipur and Kachhpur. Iron content at the studied sites varied in the range of 0.28 to 0.34 mg/kg. Iron was found to be highest in concentration at Bahadurpur and lowest at Ranipur, Peeparwaha and Achanakpur.

Table 5. Soil quality parameters measured at two depths [(0-15) cm and (15- 30) cm] of the selected sites (Mean ± SD)

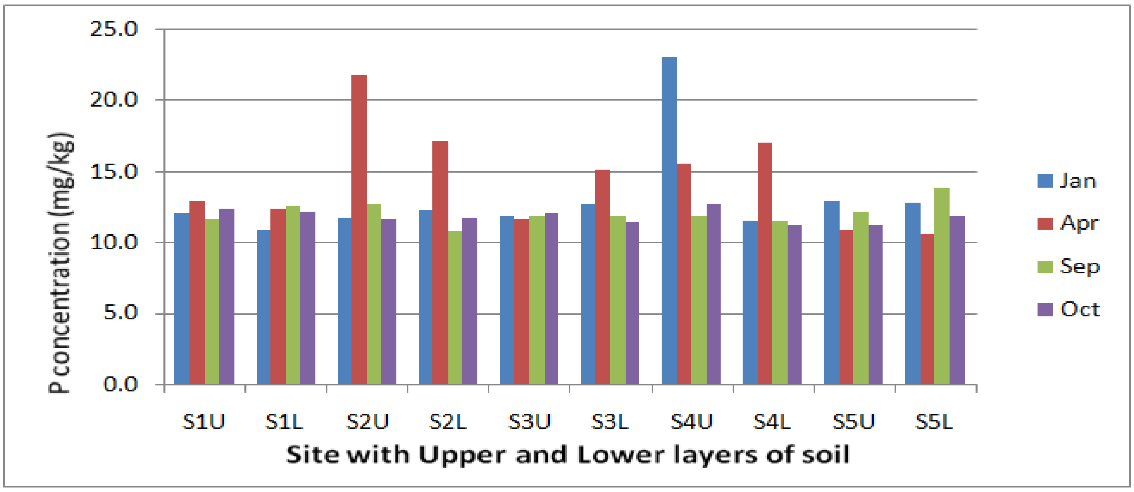
S.No	Site	Depth	pH	W.H.C(%)	EC(µmho/cm)	N(mg/kg)	P(mg/kg)
1	Ranipur	(0-15) cm	7.7 ± 0.3	34.7 ± 4.1	467.5 ± 47.4	92.2 ± 25.3	5.7 ± 0.5
		(15- 30) cm	8.1 ± 0.3	37.0 ± 3.1	480.5 ± 46.0	63.9 ± 8.4	4.9 ± 1.0
2	Peeparwaha	(0-15) cm	7.8 ± 0.4	32.5 ± 1.6	492.7 ± 22.7	55.0 ± 16.7	9.0 ± 1.5
		(15-30) cm	7.4 ± 0.4	29.4 ± 0.9	640.9 ± 10.2	142.1 ± 13.9	6.8 ± 0.8
3	Bahadurpur	(0-15) cm	8.1 ± 0.5	38.4 ± 3.2	619.0 ± 40.3	160.5 ± 5.5	3.5 ± 0.7
		(15-30) cm	8.1 ± 0.4	39.7 ± 1.1	547.9 ± 26.3	145.3 ± 33.4	3.1 ± 2.3
4	Achanakpur	(0-15) cm	7.6 ± 0.7	42.1 ± 1.3	458.1 ± 104.2	162.4 ± 5.9	6.6 ± 0.6
		(15-30) cm	7.9 ± 0.5	42.6 ± 3.6	474.2 ± 72.6	155.5 ± 13.8	6.1 ± 1.7
5	Kachhpura	(0-15) cm	7.9 ± 0.6	40.6 ± 2.9	542.2 ± 26.6	162.2 ± 21.4	4.8 ± 0.3
		(15-30) cm	7.8 ± 0.5	38.4 ± 3.1	468.9 ± 74.7	185.3 ± 27.3	10.3 ± 1.7
S.No	Site	Depth	K(mg/kg)	Mn(mg/kg)	B(mg/kg)	Al (mg/kg)	Fe(mg/kg)
1	Ranipur	(0-15) cm	92.0 ± 4.0	1.3 ± 0.0	0.5 ± 0.1	0.004 ± 0.0007	0.28 ± 0.01
		(15- 30) cm	80.6 ± 5.6	1.3 ± 0.1	0.5 ± 0.0	0.005 ± 0.0005	0.32 ± 0.07
2	Peeparwaha	(0-15) cm	150.9 ± 51.5	1.4 ± 0.1	0.8 ± 0.0	0.012 ± 0.002	0.31 ± 0.1
		(15-30) cm	135.0 ± 12.7	1.3 ± 0.1	0.5 ± 0.1	0.005 ± 0.0004	0.28 ± 0.08
3	Bahadurpur	(0-15) cm	72.1 ± 4.3	1.3 ± 0.1	1.0 ± 0.0	0.005 ± 0.0007	0.29 ± 0.07
		(15-30) cm	85.6 ± 10.3	1.1 ± 0.1	0.6 ± 0.1	0.007 ± 0.0005	0.34 ± 0.1
4	Achanakpur	(0-15) cm	55.3 ± 2.8	1.4 ± 0.1	0.8 ± 0.2	0.007 ± 0.0009	0.28 ± 0.09
		(15-30) cm	78.0 ± 3.6	1.3 ± 0.1	0.6 ± 0.1	0.010 ± 0.007	0.30 ± 0.08
5	Kachhpura	(0-15) cm	105.2 ± 0.6	1.3 ± 0.2	0.5 ± 0.2	0.004 ± 0.0008	0.29 ± 0.09
		(15-30) cm	108.8 ± 4.2	1.2 ± 0.1	0.6 ± 0.1	0.004 ± 0.0007	0.29 ± 0.07

3.2. Seasonal Variation of Soil Quality Parameters

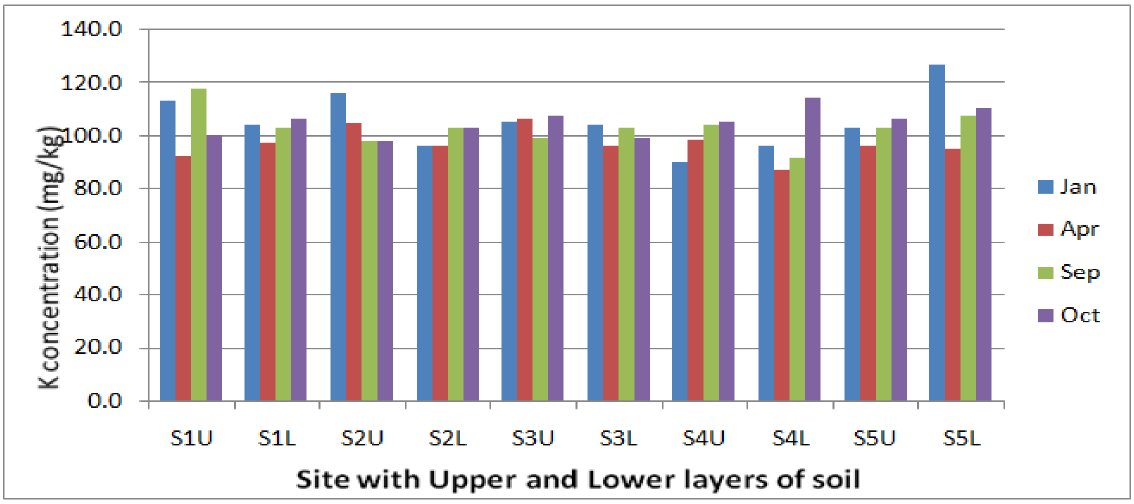
The studied soil quality parameters were also studied seasonally. The samples were collected during the representative month for seasons which were chosen viz., January (Winter), April (Summer), September (Monsoon) and October (Autumn). The seasonal variations of the studied soil parameters are presented in the below Figure 2, Figure 3, Figure 4 in the form of bar diagram. In the Figure 2, Figure 3 and Figure 4, the abbreviations S1, S2, S3, S4 and S5 are the sites and U and L represents the upper and lower layers of the soil.



(a) Concentration of Nitrogen in soil in four seasons

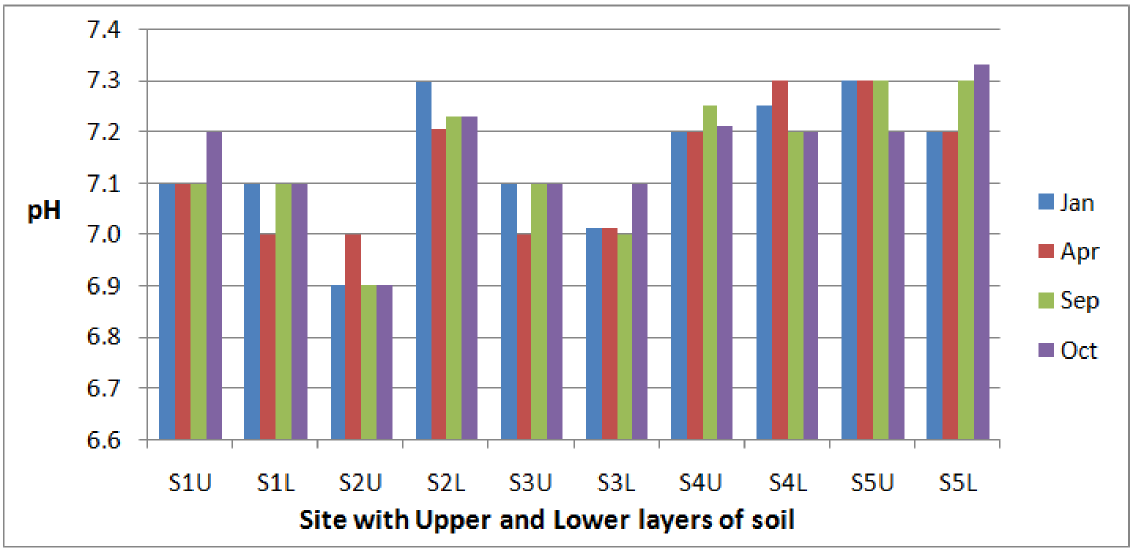


(b) Concentration of Phosphorus in soil in four seasons

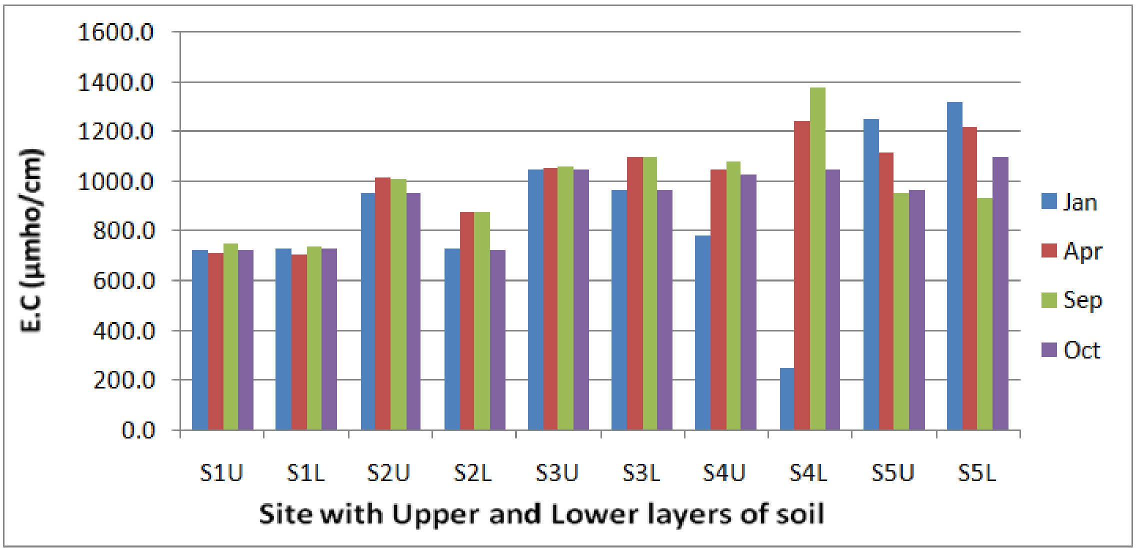


(c) Concentration of Potassium in soil in four seasons

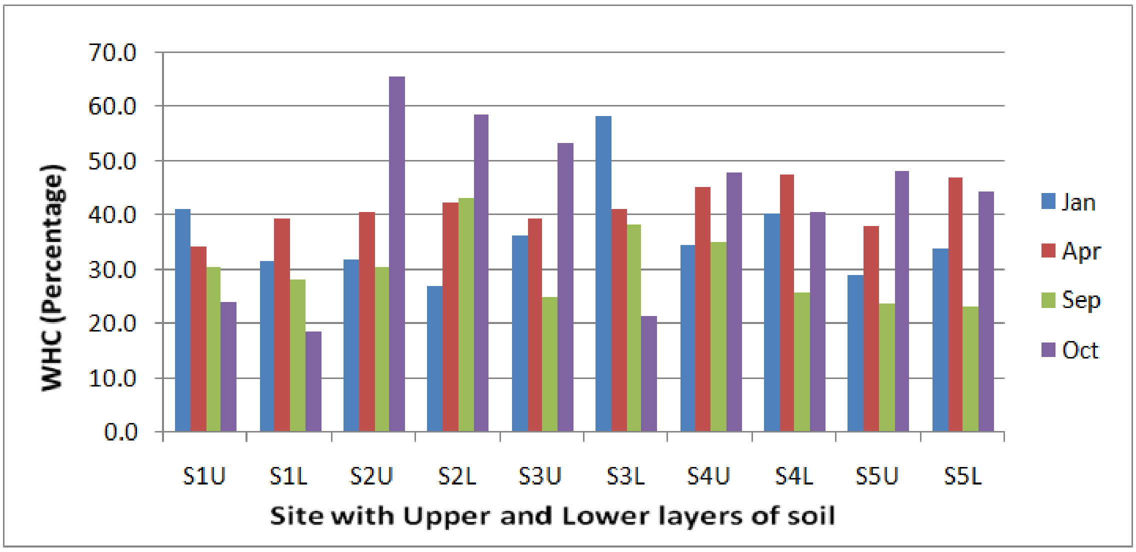
Figure 2. The Bar diagram shows the seasonal variation of the concentration of N, P and K in the upper and lower layers of soils. (S1U, represents upper layer of soil at site 1 and S1L represents lower layer of soil at site 1)



(a) Values of pH values during four seasons

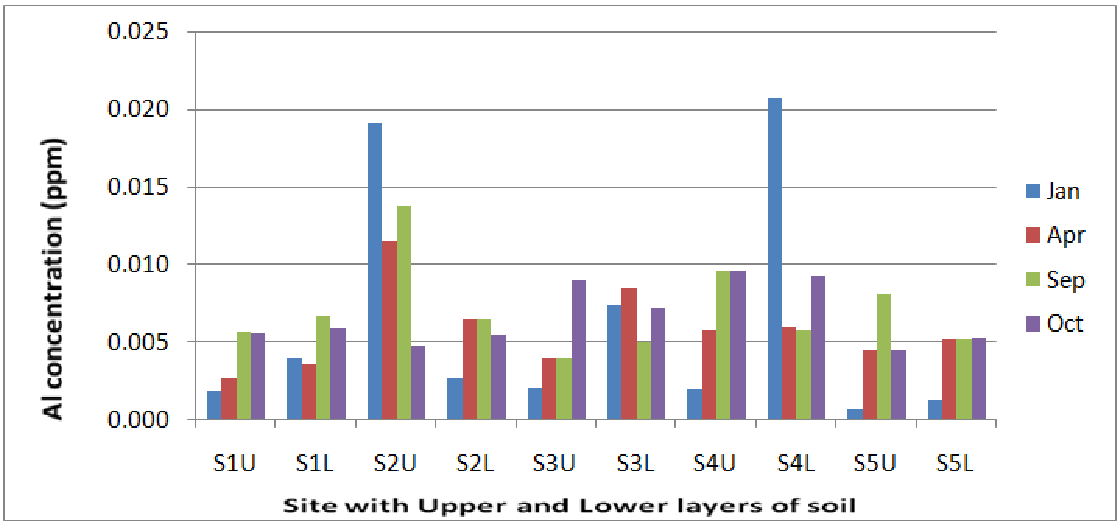


(b) Values of Electrical Conductivity (EC) during four seasons

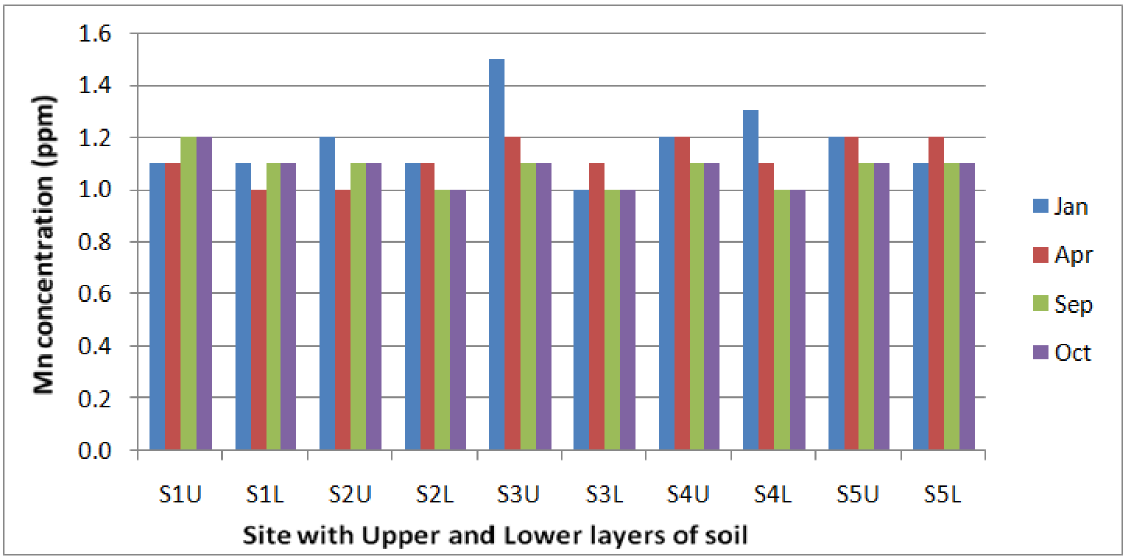


(c) Values of Water Holding Capacity (WHC) during four seasons

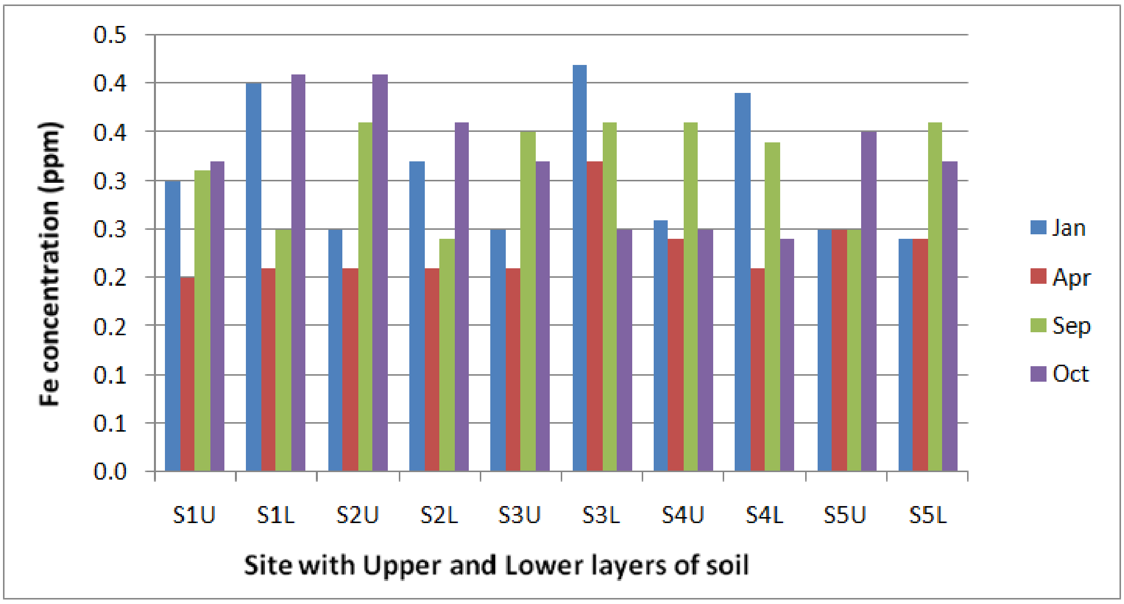
Figure 3. The bar diagram showing the (a) pH values, (b) Electrical conductivity and (c) Water Holding Capacity of soil



(a) Levels of Aluminium (Al) in the soil during four seasons

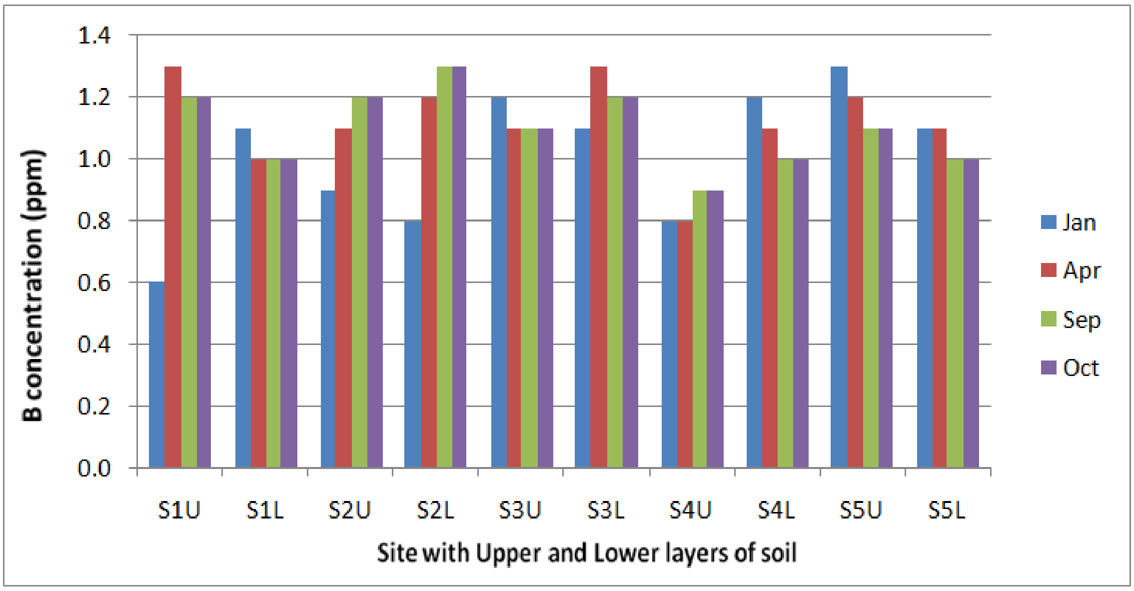


(b) Levels of Manganese (Mn) in the soil during four seasons



(c) Levels of Iron (Fe) in the soil during four seasons

Figure 4. a-c



(d) Levels of Boron (B) in the soil during four seasons

Figure 4. Showing the different metals (Al, Mn, Fe and Boron) present in the upper and lower layers of soil

3.3. *E coli* Content in Soil at Different Sampling Locations

To know the biological content of the soil only *E.coli* content was measured. For the measurement of the *E.coli* the standard method was named by M-endo. This method determines the total coliforms and *E.coli* present in the soil. The Table 6 shows the *E.coli* content at five studied sites during the four representative months of four seasons.

Table 6. Shows the *E.coli* bacteria count during four sampling seasons.

S.No.	Village/Site	January	April	September	October
		cfu/100ml	cfu/100ml	cfu/100ml	cfu/100ml
1.	Ranipur	6	0	0	0
2.	Peeparwaha	0	1	0	0
3.	Bahadurpur	0	0	1	0
4.	Achanakpur	0	2	0	0
5.	Kachhpura	2	0	0	1

From the Table 6, it can be interpreted that the range of *E.coli* content varied from range 0 to 6 cfu/100ml. At the Ranipur, the count of *E.coli* during the month January was highest while it was zero value during the other months. At Peeparwaha, the April has the 1 value while it is zero in other months. In case of Bahadurpur, the month of July have the value of one. At Kachhpura, the cfu of *E.coli* was highest in the month of January and lowest in October while it is absent or not detectable in other sampled months. Among all the sites, the cfu values of *E.coli* were highest at Ranipur while it was lowest at other sites in different months.

3.4. Relationship between the Land Use and Land Cover Change Impact on Soil Quality Parameters

Different kinds of human activities may lead to increase or decrease in the different types of pollutants in the lithosphere, atmosphere and hydrosphere. These pollutants may affect positively or negatively on the productivity of the ecosystem [47,48,49]. To serve the needs of the people, there has been lot of activities related to land use and land cover, the quality of the soil and water resources of the area undergoes changes which may lead to changes in the physical, chemical and biological characteristics of natural resources. The release of different types of air and water pollutants and solid waste from the industrial, commercial and residential area leads to the positive or negative effects on the water bodies and soil in the region [48,50,51]. The plants need different types of micro and macronutrients for their growth and development. These pollutants may interfere with these nutrients content in the soil and water bodies. The area is mainly under the agriculture use where the different types of crops are grown. The industrial areas are far away from the studied site, but the surface water (canals, lakes and rivers) which is used by the farmers has industrial units nearby these water resources. These industrial units, commercial places and municipality bodies releases different types of chemicals, oil, greases, pollutants, solid waste etc., into these surface water bodies which leads to the degradation of water quality and when this water is used for irrigation purposes by the farmers then the contaminants present in the water mixes with the soil. The mixing of contaminated water with soil may lead to change in physical, chemical and biological properties soil and water which may lead to the increase or decrease in the plant nutrients present in the soil which ultimately affects the productivity of crops grown in these areas [52,53,54]. The more study in this regard is needed to reach the concrete conclusions.

4. Conclusions

The study shows that the land use of a region is an important factor which affects the different type of natural resources including the soil and water. The present study tries to find out the biogeochemical parameters of the region. The different parameters studied in the present study are important from the point of view to know the level of degradation of the soil and the water resources of the region. The degradation of the land and water resources directly affects the plants growth, development and in turns affects the agricultural productivity of the region. The planned and unplanned economic development in the region of Auraiya district degrades the quality of water bodies (rivers, lakes, underground water etc) by releasing different types of waste like of sewage water, industrial solid waste and water, excessive pumping of the underground water which is used by the farmers for the agricultural purposes. This use of this degraded water by farmers for agricultural purposes leads to the degradation of the quality of soil and water present in the soil which in turn leads to the lower agricultural productivity. So there is need for the proper and comprehensive planning which takes care of economic development without affecting the water bodies and soils of the region so that the sustainability in the region is achieved.

Conflict of Interest Statement

All authors hereby declare that there is no conflict of interest.

References

[1] Sposito, G., 2013. Green water and global food security. *Vadose Zone J*. 12.

[2] Verheye, W., Brinkman, R., Sims, D., 1997. Elements of a Different Approach to Land Development Issues. *The Land*, 1(2), 143-152.

[3] Matson, P., Parton, W., Power, A., 1997. Agricultural intensification and ecosystem properties. Science, 277, 504-509.

[4] Malo, D.D., Schumacher, T.E., Doolittle J.J., 2005. Long-term cultivation impacts on selected soil properties in the northern Great Plains. *Soil and Tillage Research*, 81, 277-291.

[5] Schulp, C., Veldkamp, A., 2008. Long-term landscape-land use interactions as explaining factor for soil organic matter variability in Dutch agricultural landscapes. *Geoderma*, 146, 3-4.

[6] Zajícová, K., Chuman, T., 2018. Effect of land use on soil chemical properties after 190 years of forest to agricultural land conversion, *Soil and water research*, 1, 1-11.

[7] Biro, K., Pradhan, B., Buchroithner, M., and Makeschin, F., 2011. Land use / land cover change analysis and its impact on soil properties in the northern part of Gadarif region, Sudan. *Land Degradation and Development*, 24 (1). Jan/Feb, 90-102.

[8] Braimoh, A.K., Vlek, P.L.G., 2004. The impact of land cover change on soil properties in northern Ghana. *Land Degradation and Development*, 15, 65-74.

[9] Jiang, Y., Zhang, Y.G., Zhou, D. Qin, Y., Liang W.J., 2009. Profile distribution of micronutrients in an aquic brown soil as affected by land use. *Plant Soil Environ*. 55(11), 468-476.

[10] Navarro, F.B., Ripoll, M.A., Jiménez, M.N., De Simón, E., Valle, F., 2006. Vegetation response to conditions caused by different soil-preparation techniques applied to afforestation in semiarid abandoned farmland. *Land Degradation and Development*, 17, 73-87.

[11] Khresat, S., Al-Bakri, J, Al-Tahhan, R., 2008. Impacts of land use/cover change on soil properties in the Mediterranean Region of North-western Jordan. *Land Degradation and Development*, 19, 397- 407.

[12] Emadodin, I, Reiss, S, Mitusov, A.V., Bork, H.R., 2009. Interdisciplinary and multidisciplinary approaches to the study of long-term soil degradation: A case study from Schleswig-Holstein, Germany. *Land Degradation and Development* 20, 551-561.

[13] Göl, C., 2009. The effects of land use change on soil properties and organic carbon at Dagdami river catchment in Turkey. *Journal of Environmental Biology*, 30, 825-830.

[14] Korkanc, S.Y., Ozyuvaci, N., Hizal, A., 2008. Impacts of land use conversion on soil properties and soil erodibility. *Journal of Environmental Biology*, 29, 363-370.

[15] Li, X.Y., Ma, Y.J., Xu, H.Y., Wang, J.H., Zhang, D.S., 2009. Impact of land use and land cover change on environmental degradation in Lake Qinghai watershed, northeast Qinghai-Tibet Plateau. *Land Degradation and Development*, 20, 69-83.

[16] Zeng, D.H., Hu, Y.L., Chang, S.X., Fan, Z.P., 2009. Land cover change effects on soil chemical and biological properties after planting Mongolian pine (*Pinus sylvestris var. mongolica*) in sandy lands in Keerqin, north-eastern China. *Plant and Soil*, 317, 121-133.

[17] Yao, M.K., Angui P.K.T., Konaté, S., Tondoh, J.E., Tano, Y., Abbadie, L., Benest, D., 2010. Effects of land use types on soil organic carbon and nitrogen dynamics in mid-west Côte d'Ivoire. *European Journal of Scientific Research*, 40, 211-222.

[18] ES, 2016, Economic Survey, 2016, Ministry of Finance, Govt. of India.

[19] KVK 2015, Krishi Vigyan Kendra, Auraiya (http://auraiya.kvk4.in/district-profile.html).

[20] DIC, 2016, District Industrial Centre, Auraiya, Ministry of MSME, GOI, 2016. (http://auraiya.nic.in/geography.html).

[21] *COI, 2011, Census of India, 2011,* Registrar General and Census Commissioner, India, Series 10,Part XII-A, UTTAR PRADESH District Census Handbook Auraiya. Village and Town Directory Directorate of Census, Operations, Uttar Pradesh, Lucknow *(*www.censusindia.gov.in*)*.

[22] Krishikoshegranth, 2014, (www.Krishikosh.egranth.ac.in).

[23] Subbaiah, B.V., Asija, G.L.A., 1956. Rapid procedure for the estimation of available nitrogen in soil. *Current Science*, 25, 259.

[24] Olsen, S.R., Cole, C.V., Watanabe, F.S., Dean, L.A., 1954. Estimation of Available Phosphorus in Soils by Extraction with Sodium Bicarbonate. U. S. Department of Agriculture Circular No. 939.

[25] Watanabe, F.S., Olsen, S.R., 1965. Test of an Ascorbic Acid Method for Determining Phosphorus in Water and NaHCO3 Extracts from the Soil. *Soil Science Society of America Journal*. 29, 677-678.

[26] Hanway, J.J., Heidal, H., 1952. Soil analysis methods as used in Iowa State College Soil Testing Laboratory. Iowa State College of Agriculture Bulletin, 57, 1-31.

[27] Wolf, B., 1974. Improvements in the azomethine-H method for determination of boron. Communications in Soil. *Soil Science and Plant Analysis*, 5, 39-44.

[28] Lindsay, W.L., Norvell, W.A., 1978. Development of DTPA soil test for zinc, iron, manganese and copper. *Soil Science Society of America Journal*, 42, 421-428.

[29] Deb, P., Debnath, P., Pattanaaik, S.K., 2014. Physico-chemical properties and water holding capacity of cultivated soils along altitudinal gradient in south Sikkim, India, *Indian J. Agricultural Research*, (2), 120-126.

[30] Schilling, K.E., Palmer, J.A., Arthur Bettis III,E., Jacobson, P., Schultz, R.C. and Isenhart, T.M., 2009. Vertical distribution of total carbon, nitrogen and phosphorus in riparian soils of Walnut Creek, southern Iowa. *Catena*. 77, 266, 273.

[31] Wei, X.R., Shao, M.G., Fu, X.L., Horton, R., Li, Y., Zhang, X.C., 2009. Distribution of soil C, N and P in three adjacent land use patterns in the northern Loess Plateau, China. *Biogeochemistry*, 96, 149-162.

[32] Khokhar, Y., Singh, H., Rattanpal., Dhillon, W.S., Singh, G., Gill P.S., 2012. Soil fertility and nutritional status of Kinnow orchards grown in aridisol of Punjab, India. *African J. Agricultural Research*, 2012, 7(33), 4692-4697.

[33] Patil, R.B., Saler, R.S., Gaikwad, V.B., 2015. Nutritional survey of different vineyards in Nashik district. Mahar. *J. Basic Science*, 1, 6-12.

[34] Yadav, R.L., Meena, M.C., 2009. Available micronutrients status and their relationship with soil properties of Degana soil series of Rajasthan. *J. Indian Soc. Soil Science*. 57(1): 90-92.

[35] Ashok., S, Aggarwal, G.R., Kumar, S.P., 2006. NPK status of wheat growing soils in Auraiya district of Uttar Pradesh. *International J. Agricultural Science*, 2(1), 286-287.

[36] Rammoorthy, B., Bajaj, J.C., 1969. Available Nitrogen, phosphorous and Potassium status of Indian soil. *Fertilizer News*. 14(4), 1-12.

[37] Bhat, Z.A., Padder, S.A., Ganaie, A.Q., Dar, N.A, Rehman, H.U., Wani, M.Y., 2017. Correlation of available nutrients with physico-chemical properties and nutrient content of grape orchards of Kashmir. *J. of Pharmacognosy and Phytochemistry*; 6(2), 181-185.

[38] Waghmare, M.S., Bavalgare, V.G., Deshmukh, V.A., Takankhar, V.G., 2009. Status of available N, P and K in some soil of Ausa tahsil of Latur district. *International J. Tropical Agriculture,* 27(1-2), 327-331.

[39] Aduayi, E.A., 1978. Role of boron on growth components and elemental composition of Ife plum tomato. *Commun. Soil Sci. Plant Anal.*, 9, 1-11.

[40] Alvarez-Tinaut, M.C., Leal, A., Recalde-Martinez, L., 1980. Iron-Manganese interaction and its relation to boron levels in tomato plants. *Plant Soil*, 55, 377-388.

[41] Agbenin, J.O., G. Lombin, J.J. Owonubi., 1991. Direct and interactive effect of boron and nitrogen on selected agronomic parameters and nutrient uptake by cowpea (*Vigna unguiculata* L. Walp) under glass house conditions. *Trop. Agric*., 68, 356-362.

[42] Singh, K.P., H. Sinha., 1976. Effect of boron application on K, Ca and Mg concentrations and their ratios with boron in plants. *J. Inst. Chem*., 43, 189-191.

[43] Yamauchi, T., Hara, T., Sonoda., 1986. Effects of boron deficiency and calcium supply on the calcium metabolism in tomato plant. *Plant Soil*, 93, 223-230.

[44] Brown, J.C., 1979. Effects of boron stress on copper enzyme activity in tomato. J. Plant Nutrition, 1, 39-53.

[45] Bonilla, I., Cadahia, O., Carpena, O., and Hernando, V., 1980. Effects of boron on nitrogen metabolism and sugar levels of sugar beet. *Plant Soil*, 57, 3-9.

[46] CGWB, 2013, Ministry of Water Resources, Govt. of India. (www.cgwb.gov.in)

[47] May, R. M. (1973) *Stability and Complexity in Model Ecosystems* (Princeton Univ. Press, Princeton). World Bank, (2001), “Environmental Assessment Source Book”, Washington D.C. World Bank Technical Paper, P. 139.

[48] Niu, X.Y., Wang, Y.H., Yang, H., Zheng, J.W., Zou, J., Xu, M.N., Wu, S.S. Xie, B. 2015. Effect of land use on soil erosion and nutrients in Dianchi Lake watershed, China. *Pedosphere*, 25(1), 103-111.

[49] Barbosa, F.T., Bertol, I., Luciano, R.V., Gonzalez, A.P., 2009. Phosphorus losses in water and sediments in runoff the water erosion in oat and vetch crops seed in contour and downhill. *Soil Till. Res.* 106, 22-28.

[50] DeGryze, S., Six, J., Paustian, K., Morris, S.J., Paul, E.A. Merckx, R., 2004. Soil organic carbon pool changes following land-use conversions. *Glob. Change Biol.* 10, 1120-1132.

[51] Fu, X.L., Shao, M.G., Wei, X.R., Horton, R., 2010. Soil organic carbon and total nitrogen as affected by vegetation types in Northern Loess Plateau of China. *Geoderma*, 155, 31-35.

[52] Warton, D., 1998. *Community and Sustainable Development* (Earthscan, London).

[53] Hontoria, C., Rodriguez-Murillo, J.C., Saa, A., 1999. Relationships between soil organic carbon and site characteristics in Peninsular Spain. *Soil Sci. Soc. Am. J.* 63, 614-621.

[54] Navas, A., Gaspar, L., Quijano, L., Lopez-Vicente, M. and Ma-chIn, J. 2012. Patterns of soil organic carbon and nitrogen in relation to soil movement under different land uses in mountain fields (South Central Pyrenees). *Catena.* 94: 43, 52.