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Investigation of Water Quality of River Poonch for Drinking and Irrigation Purposes

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Abstract
In the present work, we reported fifteen water samples that were collected from selected locations in the study area of Poonch River. All water samples were collected and labelled in polythene bottles at the sites where water depth was 1 meter. The river Poonch flows through Indian occupied Kashmir and Jammu and Kashmir in Pakistan. The collected samples were tested for major physical and chemical water suitability parameters such as pH, electrical conductivity total dissolved solids, total alkalinity total hardness chlorides, major metals and heavy metals standard. The aforementioned analysis of samples was reported by methods such as conductometery, potentiometery and atomic absorption spectrometry.

Keywords: River Poonch, Water Sample, Total Dissolved Solids, Nitrates, pH, Total Hardness, Alkalinity, Major Metals, Heavy Metals

1. Introduction
Kashmir is a region of Indian subcontinent and it is the largest one in India [1]. It is situated between Pakistan, China and Russia [2]. It is a land source of many rivers. The state of Azad Jammu and Kashmir is a semi-independent part of Kashmir Valley which is administered by Pakistan having longitude between 73-75 and latitude between 33-36 [3]. Its total area is 13293 square km. Its administrative divisions are three namely Muzaffarabad, Mirpur and Poonch [4]. It has 10 districts, that are consisted of Muzaffarabad, Neelum, Bagh, Haveli, Poonch, Sudhnoti, Kotli, Mirpur and Bhimber. Each district has 2 or more subdivisions [5].

The Poonch District is one of the districts of The State of Azad Jammu and Kashmir. Fig 1 shows view of River Poonch [6]. Different areas of District Poonch have different range of height from the sea level which might fall between approximately 1560 m [7]. The climate of district Poonch is very temperate but it also shows extreme temperature in winter season. The annual precipitation range lies between 1130 to 1155 mm [8].

Water is present on earth in different forms such as glaciers, underground water, vapors and many other water bodies [9]. The intermolecular forces are responsible for many of the novel characteristics in water molecules like floating of ice on the surface of liquid water which saves the internal aquatic life during extreme weather conditions [10]. Shainberg and Oster (1985) presented that the pH of irrigating water is not a valid criterion for water quality owing to the fact that it is tilting to be buffered by the soil and most crops can withstand a long range of pH [9]. Water, ice and snow are also pivotal to many sports and other types of entertaining activities, like to swim, to boat, boat racing, surfing, sport fishing, diving, ice skating etc [11].

Fig 1: View of River Poonch [6]

Fish growth activities and other varieties in water, activities regarding conserving species, recreational activities like to swim and to boat, industry linked / city water channels, agricultural application like channels for supplying water to lands and livestock watering activities [12], filth eradication and similar water usage are polluted by the man-made activities like throwing garbage in water bodies, chemical species, germ related and poorly meant conditions that are found in the water channels as well as in earth crust aquifer [11, 13].

This is very important to reach at a point that the kind of model study which may be suited to the recent situation of river pollution. Singkran *et al*. (2010) employed dissolved oxygen (DO) and Biochemical oxygen demand (BOD), NO3- nitrogen, P, fecal coliform bacteria and suspended solid material to examine quality of water in the 5 north-eastern rivers of Thailand as., L. Chi, Lam Pao, Lam Seaw, Loei, and Namoon [14]. The observed mean output of water quality factors are six in number in every river for 5-year period (2003-2007) that employed to calculate quality of water quality index ($WQI_{present}$) of every water body that is in river form within dry seasons as well as wet sessions [15]. The natural event as alterations in earth abrasion, acid precipitation, rocks wearing of material in crustal form as well as human activities like city, industry linked and agricultural based processes, accelerates rate of depletion of water bodies, lowering the standard and amount of the exterior water bodies which are inappropriate for household usage [16]. Mathematical examination could be divided in five discontinuous paths; like (a) Presentation activities and data elaboration of examined data (b) Link that describe the comparison of data between fundamental group and individuals (c) Carving the template to sum up comprehending the links of the data with one another, (d) Proving or disproving the authenticity of the respected structure, (e) Employs an obvious examination for the upcoming demands [17, 18].

Chakrabarty and Sarma (2011) examined portable and drinking water quality by using factors such as Electrical conducting method, by using pH, dissolved Total Solids, Total material that is Suspended Solids (TSS) along with Turbidity, DO, Total Hardness, Ca available Hardness in water (CH), DA gave a reducing pattern in dimensionality of variety of data-set and figured that a fewer important factors that were meant for many of the changes in quality of water [18].

Ouyang *et al*. (2006) proposed the variations in the water quality of surface water in a spatial as well as temporal manner and also suggested that how the quality of water can be affected by the human and other natural changes in the environment [19].

Principal component assessment tool was used to elaborate the seasonal relationships of water quality factors, where examining technique was employed to attain the factors that were almost necessary in determining the seasonal changes of quality of river water [20].

Zhou *et al*. (2006) employed examining system called as cluster analysis system (CA) and (DA) tool to find temporal or spatial changes in water quality in water-courses in North western New Territories in Hong Kong, during time period of 5-years (2000–2004) employing 22 parameter at 22 locations (31,740 times) [21].

2. Experimental

2.1 Sampling

A physical survey was conducted to select the sample sites and the major part of total water was collected for study purpose from River Poonch that is used for drinking and irrigation purposes.

2.2 Methodology

Field method was used for the detection of color of the samples. In this method comparator tubes containing sample water were compared with distilled water. For the measurement of temperature, ordinary thermometer was used by inserting directly into the sample water. At the same time, temperature of the atmosphere was measured at 1 m height from water surface and it was made sure that no direct solar radiations hit the thermometer. pH was measured by using lab pH meter by directly inserting the meter into the sample water. pH meter was standardized in a solution having a pH of 7. To determine electrical conductance, the device was standardized with that of [KCl (0.01M) showed EC OF 1372 µS/cm at 25 ^{0}C] by dipping pre-washed electrode and then dipping into water sample EC was measured. Through changing the mode of conductivity meter salinity was measured.

Glass fiber filter was used in order to measure the total dissolved solids. Measured water sample was filtered through these filters then the filtrate was collected and then placed in an oven at 104 ^{0}C in a pre-weighed glass plate. After that, filtrate was completely evaporated, glass plate was weighed again. The difference in previous and new weight determined the total dissolved solids in water sample.

2.3 Laboratory methods (Chemical Parameters)

2.3.1 Alkalinity

This parameter was estimated by titrating the water sample with standard HCl solution using indicator named methyl orange.

2.3.1.1 Reagents

Hydrochloric acid (HCl) solution (0.01N in 1000 mL), standard sodium carbonate (Na_2CO_3) solution (0.01N in 100 mL) and methyl orange were used.

2.3.1.2 Procedure

10.5 mL of sample in titration flask was taken, 3-4 drops of indicator methyl orange were added and then titrated against standard HCl solution.

2.3.1.3 Calculation

Alkalinity in mg/L=A×N×50000/Ml of sample (S)

Where
A=Volume of titrant
N=Normality of HCl
S=Volme of sample taken in mL
50000=constant used.

2.3.2 Hardness

Hardness was measured by preparing standard EDTA solution and an indicator along with a buffer.

Complexometric titration using buffer (NH_4Cl-NH_4OH) Solution having pH 10 was carried out with standard solution of disodium salt (Na_2EDTA) using Erichrome black-T as indicator. End point was noted when colour changed from wine red to blue.

2.3.2.1 Reagents

Na_2EDTA solution (0.01M in 500 mL), buffer solution of pH 10, Erichrome black-T(EBT) indicator and standard calcium carbonate Solution (0.01M in 100 mL) were used. Solution was made in 100 mL distilled water.

2.3.2.2 Procedure

10 mL of water sample, 1-1.5 mL of $CaCO_3$ buffer having pH 10 along with 5mg of EBT and then titrated with standard EDTA solution comparing with blank using distilled water instead of sample water.

2.3.2.3 Calculation

Hardness of water in mg/L as $CaCO_3$ = **(**A - B**)**M (50000) **/** ml of sample (S)

2.3.3 Chloride (Cl^{-1}) Determination

Amount of chloride that was determined in water by standardizing with $AgNO_3$ having pH ranging from 7-10 chrome was used as indicator.

2.3.3.1 Reagents

Silver nitrate ($AgNO_3$) solution (0.01 N in 500 mL), potassium chromate solution, phenolphthalein, standard sodium chloride solution (0.01 N in 25 mL) and standardization of $AgNO_3$ (0.01N) solution were used.

2.3.3.2 Procedure

1ml of chrome indicator was added in 10 ml of water sample and titrated with $AgNO_3$ Solution until solution turned brick red and showed end point. Blank titration was also carried.

2.3.3.3 Calculation

Cl^{-1}mg/L =(A-B) N (35450)/ml of the sample(s)

A=Volume of $AgNO_3$ used against sample
B=Volume of $AgNO_3$ used against blank
N=Normality of $AgNO_3$ solution

2.4 Instrumental Measurement

2.4.1 Sulfate

Construction of sulphate ions in water sample was measured by using turbidimetric method. Limit of method is 1-41mg/L sulphate ions at 420 nm. The amount of sulphate was measured through calibration curve.

2.4.1.1 Reagents

Barium chloride crystals ($BaCl_2$), Conditioning Reagent and Stock Sulphate Solution were prepared.

Barium chloride (0.05g) was added in water sample each. For a conditioning reagent, 60ml of distilled water was being added by 15 g NaCl which is further dissolved in 6ml of HCl, 10 mL glycerol and 20 mL of 95% ethyl alcohol. By dissolving 0.148 g of sodium sulphate in 100 mL of distilled water, stock solution of sulphate was prepared.

2.4.1.2 Procedure

In Erlenmeyer flask, conditioning reagents containing water sample were mixed under constant stirring. The absorbance was recorded on spectrophotometer after 30 sec each up to 4 minutes at 420 nm wavelength. Eight readings gave max absorbance. A blank was also performed with 25 mL of distilled water.

2.5 Major Metals (Na, K, Ca, Mg)

Sherwood flame photometer 410 was utilized to determine the amount of Na, K, Ca in water samples where Mg was measured by atomic absorption spectrometer analyst 800.

2.5.1 Stock Solutions

Stock solutions of sodium chloride (NaCl) 1000 ppm Na solution, potassium chloride(KCl)1000 ppm solution and calcium chloride($CaCl_2$)1000 ppm Ca solution were prepared.

At 40 ºC dried sodium chloride 0.6355 g was dissolved in distilled water, few drops of HCl were used to acidify and 250 mL volume was made. At 110 ºC dried potassium chloride was dissolved in distilled water and few drops of HCl then diluted upto 250 mL. 0.2775 g dried calcium chloride was dissolved in distilled water and diluted to 250ml

2.5.2 Procedure

Determination of concentration of Na, K, and Ca in water sample flame photometer was used. Standard solutions of each metal having concentration 10, 20, 30, 40 and 50 ppm were prepared to check instrument. To check the instrument the standard solution of 10, 20 ppm was used. Water samples were analyzed for essential metals (Na, K, and Ca) after proper dilution. Calibration curve was used to measure each metal concentration.

2.6 Heavy Metals (Fe, Co, Cu, Ni, Cd, Mn, Cr and Mg)

Atomic absorption spectrometer analyst 800 used to determine the concentration of heavy metals and Mg.

2.6.1 Pre-concentration of the Samples

Concentrated HNO_3 was added to 350 mL water sample. At pH less than 2 samples (15-20 ml) was digested on hot plate and filtered. Final volume was made up to 25 mL using distilled water.

2.6.2 Procedure

(ABS) was used to check the heavy metal contents pre-concentrated samples.

Concentration of 2, 4, 6, 8 and 10 ppm five standard solutions of respective metal were run for checking of instrument accuracy. If it is above 5% then it is recalibrated by running standards.

3. Results and Discussion

The selected area is from District Kotli and displayed in the map. The location and numerical data of physico-chemical properties of River Poonch is reviewed in (Table 1). The change in quality of river water is because of soil composition, changes in environment and zones affected by human activities. Fig 2 depicts the map of the study area along with sites.

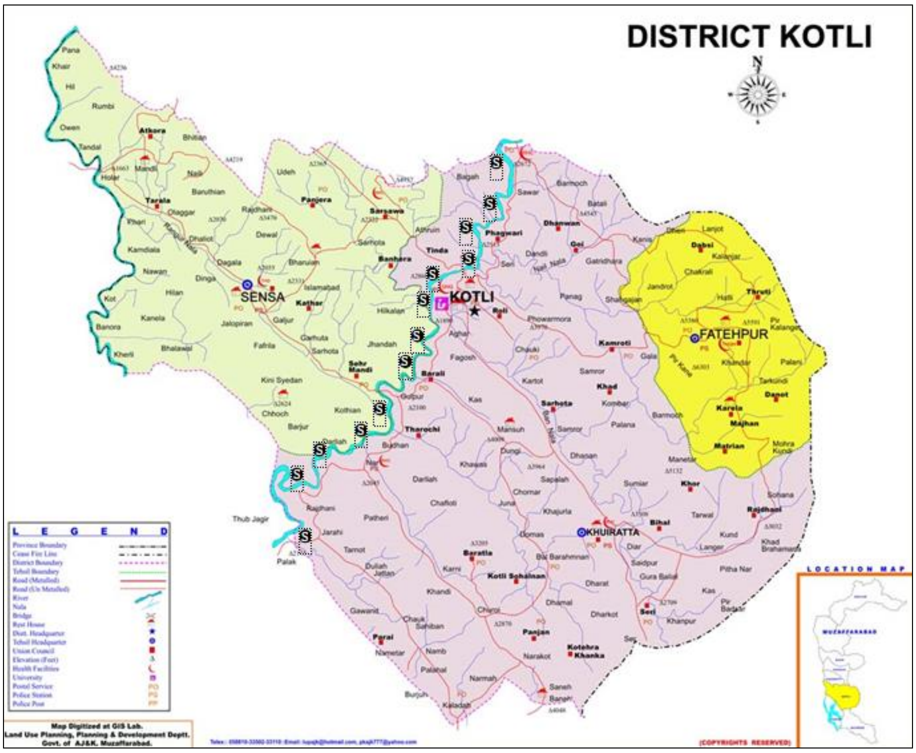


Fig 2: Map of the Study Area along with Sites

Table 1: Sampling Sites of Study Area

S. No	Location of River
S-1	Titri Not
S-2	Hajeera
S-3	Tatta Pani
S-4	Sawarr
S-5	Phagwari
S-6	Thalair Pul
S-7	Kotli City
S-8	Thala Lat
S-9	Baan
S-10	Barali
S-11	Gulpur
S-12	Mohli
S-13	Nar
S-14	Rajdhani
S-15	Dadyal

S = Sample

Table 2

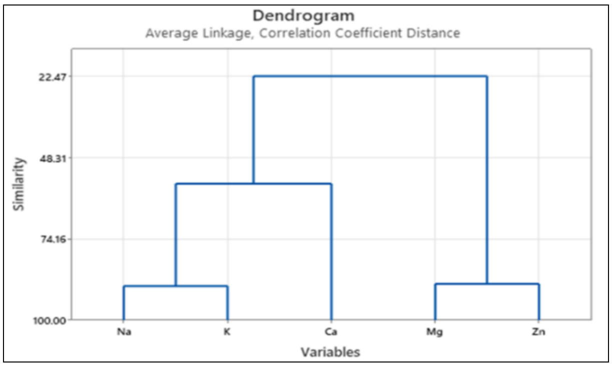
Parameters	S-1	S-2	S-3	S-4	S-5	S-6	S-7	S-8	S-9	S-10	S-11	S-12	S-13	S-14	S-15
Temperature ^{0}C	31.6	15	14	31.9	32.2	32	31.6	15.6	32.1	32	31.9	19	31.2	31.9	32
pH (25^{0}C)	7.8	7.7	7.6	7.9	7.8	7.8	8.1	8.3	8.1	8.1	8.1	8.2	8.1	8.2	8.2
TDS ppm	152	163	158	174	156	156	156	180	209	160	158	160	161	157	158
Turbidity ntu	13.8	8.1	9.3	7.4	14.4	13.4	13.7	18.3	26.8	44	41	44	52.1	49.3	72.1
Ec S/m	0.287	0.287	0.902	0.522	0.657	0.033	0.737	0.253	0.362	0.258	0.591	0.441	0.376	0.401	0.503
Hardness mg/L															
Na mg/L	27.6	35.3	66.4	28.4	24.3	22.5	23.7	34.2	39.0	26.8	28.6	27.3	28.8	21.7	20.3
K mg/L	28.10	31.2	47.67	24.5	11.19	9.10	9.212	13.2	15.21	14.7	9.998	8.3	9.499	7.7	5.336
Ca mg/L	54.87	56.4	59.32	54.30	58.61	57.29	58.93	57.34	58.43	62.92	64.72	60.91	58.96	59.30	59.93
Mg mg/L	19.82	18.34	15.29	16.06	17.09	17.64	18.36	16.92	16.72	15.55	14.18	16.12	17.50	15.97	13.22
Cr mg/L	0.092	0.183	0.162	0.170	0.177	0.173	0.170	0.198	0.224	0.221	0.241	0.213	0.177	0.199	0.215
Pb mg/L	1.66	1.47	1.30	1.61	1.91	1.77	1.29	1.87	2.19	2.10	1.93	2.21	2.32	1.89	1.01
Cd mg/L	0.045	0.043	0.041	0.037	0.034	0.036	0.038	0.046	0.050	0.041	0.039	0.038	0.040	0.041	0.040

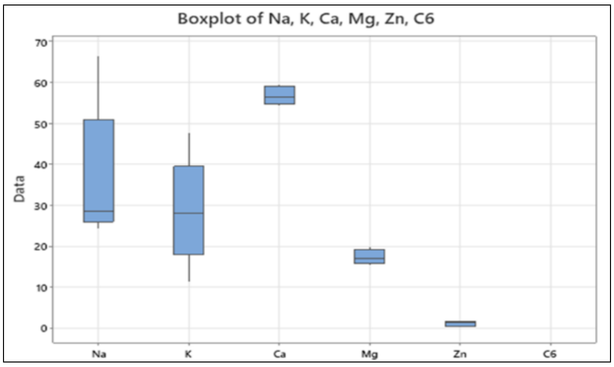
Zn mg/L	1.433	1.479	1.592	0.481	0.414	2.78	11.52	1.093	0.080	1.032	1.582	1.382	0.064	0.066	0.067
Cl^-	9	8	9	10	12	11	12	10	9	11	9	10	9	11	12
F^-	0.20	0.21	0.22	0.22	0.20	0.23	0.20	0.21	0.30	0.27	0.20	0.16	0.10	0.09	0.10
NO_3^{-1} mg/L	1.00	1.00	2.00	1.00	3.00	2.00	3.00	1.00	3.00	2.00	1.00	2.00	1.00	3.00	2.00
Microbe	+Ve	+Ve	+Ve	+Ve	+Ve	+Ve	+Ve	+Ve	+Ve	+Ve	+Ve	+Ve	+Ve	+Ve	+Ve

Major Metals
Sample 1-5

Statistics

Variable	Mean	SE Mean	StDev	Minimum	Median	Maximum	Skewness
Na	36.40	7.71	17.24	24.30	28.40	66.40	1.95
K	28.53	5.88	13.14	11.19	28.10	47.67	0.32
Ca	56.700	0.993	2.220	54.300	56.400	59.320	0.19
Mg	17.320	0.808	1.806	15.290	17.090	19.820	0.45
Zn	1.080	0.260	0.581	0.414	1.433	1.592	-0.57





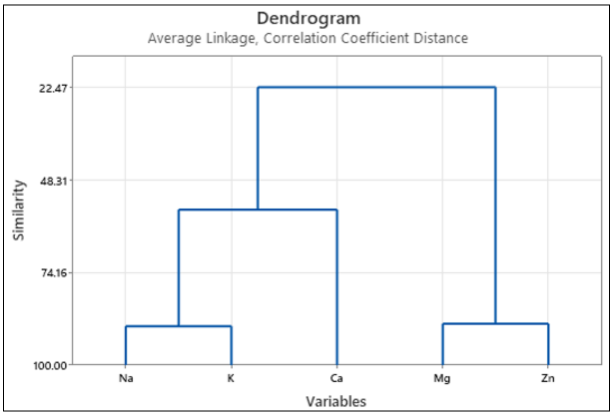
Correlations

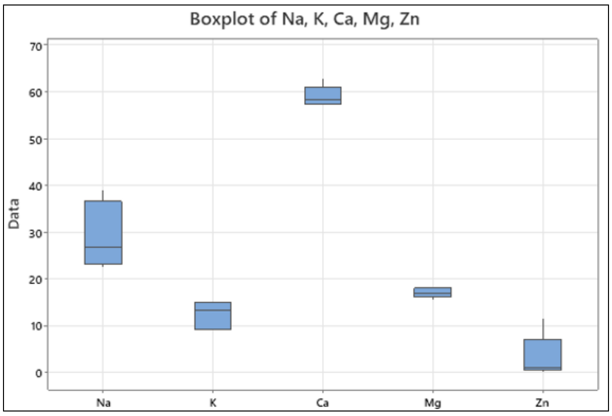
	Na	K	Ca	Mg
K	0.902			
Ca	0.595	0.229		
Mg	-0.571	-0.296	-0.475	
Zn	0.616	0.809	0.144	0.276

Sample 6-10

Statistics

Variable	Mean	SE Mean	StDev	Minimum	Median	Maximum	Skewness
Na	29.24	3.18	7.11	22.50	26.80	39.00	0.65
K	12.28	1.32	2.95	9.10	13.20	15.21	-0.35
Ca	58.98	1.03	2.31	57.29	58.43	62.92	1.74
Mg	17.038	0.471	1.053	15.550	16.920	18.360	-0.29
Zn	3.30	2.10	4.70	0.08	1.09	11.52	2.01





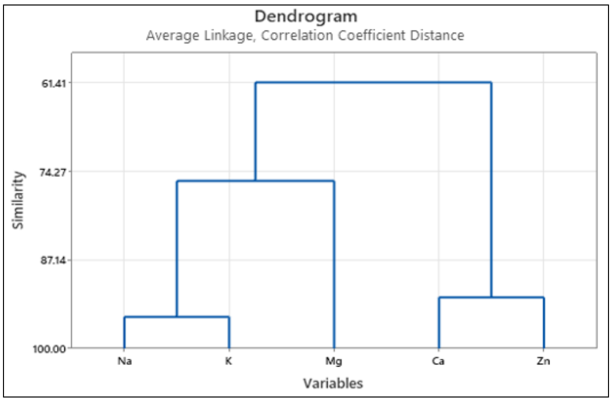
Correlations

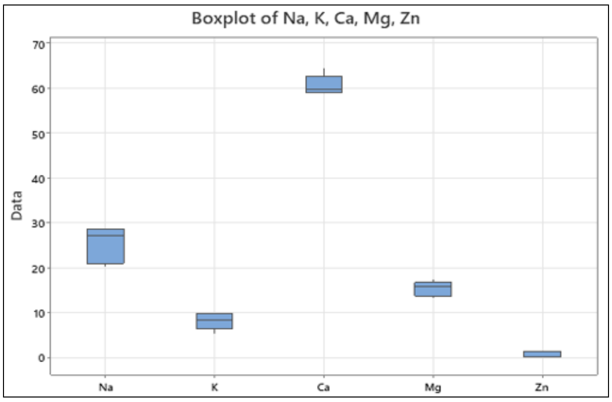
	Na	K	Ca	Mg
K	0.783			
Ca	-0.174	0.438		
Mg	-0.382	-0.854	-0.675	
Zn	-0.591	-0.731	-0.071	0.769

Sample 11-15

Statistics

Variable	Mean	SE Mean	StDev	Minimum	Median	Maximum	Skewness
Na	25.34	1.80	4.03	20.30	27.30	28.80	-0.59
K	8.167	0.818	1.829	5.336	8.300	9.998	-0.97
Ca	60.76	1.04	2.33	58.96	59.93	64.72	1.72
Mg	15.398	0.758	1.695	13.220	15.970	17.500	-0.20
Zn	0.632	0.348	0.779	0.064	0.067	1.582	0.65





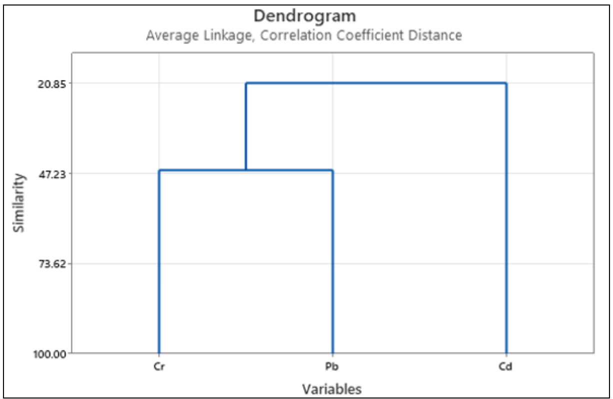
Correlations

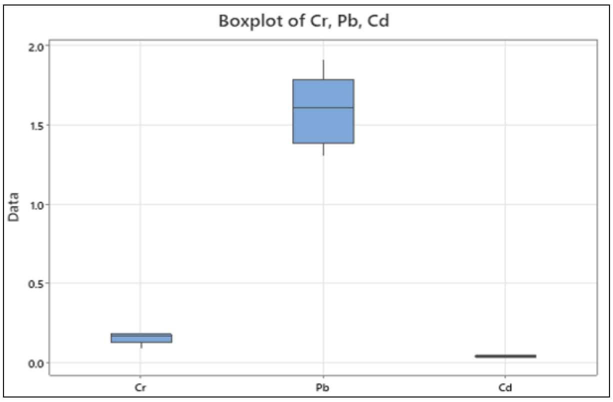
	Na	K	Ca	Mg
K	0.908			
Ca	0.438	0.463		
Mg	0.498	0.529	-0.476	
Zn	0.597	0.517	0.852	-0.171

Heavy Metals
Sample 1-5

Statistics

Variable	Mean	SE Mean	StDev	Minimum	Median	Maximum	Skewness
Cr	0.1568	0.0166	0.0371	0.0920	0.1700	0.1830	-1.99
Pb	1.590	0.102	0.227	1.300	1.610	1.910	0.25
Cd	0.04000	0.00200	0.00447	0.03400	0.04100	0.04500	-0.42





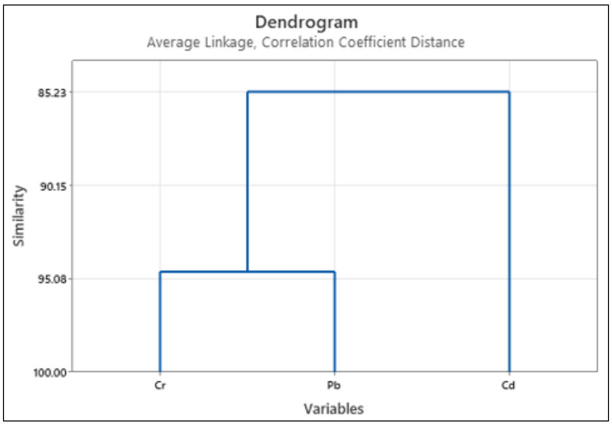
Correlations

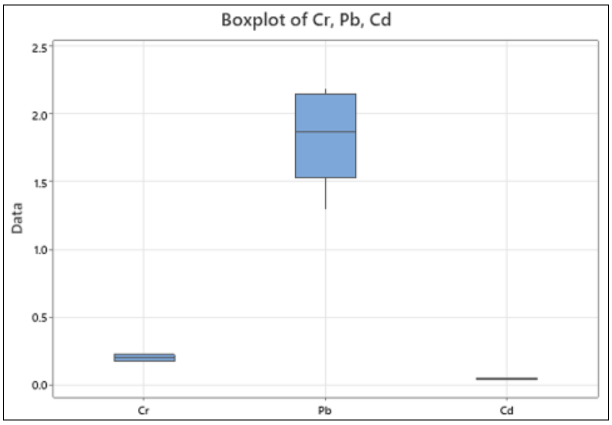
	Cr	Pb
Pb	-0.073	
Cd	-0.605	-0.561

Sample 6-10

Statistics

Variable	Mean	SE Mean	StDev	Minimum	Median	Maximum	Skewness
Cr	0.1972	0.0114	0.0255	0.1700	0.1980	0.2240	-0.04
Pb	1.844	0.158	0.353	1.290	1.870	2.190	-1.06
Cd	0.04220	0.00258	0.00576	0.03600	0.04100	0.05000	0.47





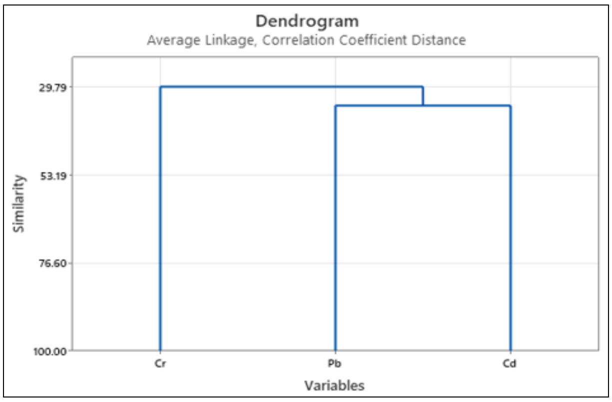
Correlations

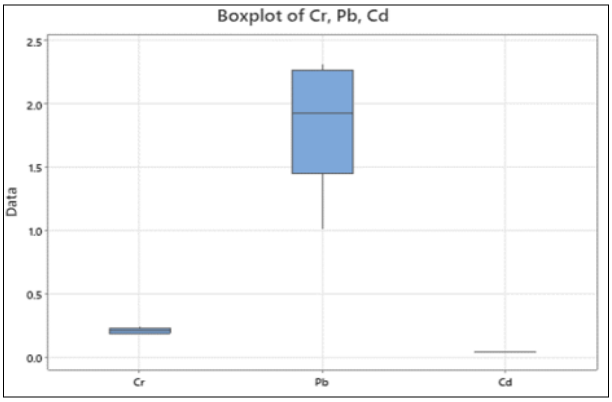
	Cr	Pb
Pb	0.894	
Cd	0.760	0.649

Sample 11-15

Statistics

Variable	Mean	SE Mean	StDev	Minimum	Median	Maximum	Skewness
Cr	0.2090	0.0105	0.0235	0.1770	0.2130	0.2410	-0.02
Pb	1.872	0.230	0.515	1.010	1.930	2.320	-1.56
Cd	0.039600	0.000510	0.001140	0.038000	0.040000	0.041000	-0.40





Correlations

	Cr	Pb
Pb	-0.341	
Cd	-0.467	-0.305

3.1 pH
The pH of the samples ranges from 7.8 to 8.2. This data indicates higher alkalinity, different chemicals and pollutants that are responsible for the elevated range of pH. This higher value has also changed the taste and smell of the river water. Increasing value of pH shows increase in concentration of calcium metals as the result of soil decadence.

3.2 Total Dissolved Solids (TDS)
Total dissolved solids altered within the range of 152 – 209. A huge difference was noted in TDS. TDS value enhanced in populated areas.

3.3 Nitrates
All the collected samples showed the concentration of nitrates between the range of 1.0 to 3.20 mg/L. All these values lie in the permission limit of WHO. Safe nitrate limit in water according to WHO (10 mg/L). Nitrogen fixation from bacteria and soil is converted into another form called ammonia and by bacteria finally changed into nitrate. Higher nitrogen value is harmful and can be responsible for blue-baby diseases.

3.4 Total Chlorides
Within 15 samples of collected water chlorides varied within a range of 9 mg/L to 12 mg/L. The top level chloride value within samples 5,7 and 15 manifest the effect of human involvement in terms of sewage and domestic refuse.

3.5 The Cations Chemistry
Concentration of sodium, potassium, calcium and magnesium (major metals) changes with sodium as more concentration compared to other major metals which are in the order Na > Ca > K > Mg with the ranges Na 20.3 – 66.4 mg/L, Ca 11.08 – 64.72 mg/L, K 5.336 – 47.62 mg/L, Mg 13.22 – 19.82 mg/L. The contents of heavy metals were observed in the limit Cr 0.092 – 0.224, Pb 1.30 – 2.32, Cd 0.034 – 1.01 mg/L and Zn 0.064 – 11.52 mg/L. As the water sample contains heavy metals.

4. Conclusions
In conclusion, the present work focused on the analysis of fifteen water samples collected from selected locations in the study area of Poonch River. The samples were collected and labelled in polythene bottles at sites where the water depth was 1 meter. The collected water samples underwent testing for various physical and chemical parameters to assess their suitability for different purposes. Parameters such as pH, electrical conductivity, total dissolved solids, total alkalinity, total hardness, chlorides, major metals, and heavy metals were analyzed using methods like conductometry, potentiometry, and atomic absorption spectrometry. The results of the analysis provide valuable insights into the quality of water in the Poonch River. This study contributes to our understanding of the water quality in the Poonch River and highlights any potential concerns regarding contamination or pollution. The findings can be used by policymakers, environmental agencies, and local communities to make informed decisions regarding water resource management and conservation efforts. Overall, this research provides a comprehensive assessment of the physical and chemical characteristics of water samples from the Poonch River, shedding light on its current state and potential implications for human and environmental health.

5. References

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