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Water Quality of Nullah Aik on Various Locations of Districts Sialkot and Gujranwala, Pakistan

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ABSTRACT

The present study focused on water quality assessment of Nullah Aik on various locations of districts Sialkot and Gujranwala, Pakistan. Samples of water from various locations of Nullah were collected in June (Pre-Monsoon) and September (post-Monsoon) in 2020. These samples were taken to the laboratory for assessment of various chemical parameters. Calcium found to be highly significant ($p< 0.001$), total hardness, chemical oxygen demand (COD) and biological oxygen demand (BOD) identified as significant ($p< 0.05$) while other parameters i.e., total dissolved solids (TDS), electrical conductivity (EC), pH, turbidity, Chlorine (Cl), nitrate ($NO3$), salinity, magnesium (Mg), iron (Fe), lead (Pb) and cadmium (Cd) revealed no significant ($p<0.05$) co-relation. The results indicated that all the parameters had significant spatio-temporal variations during June due to low rain falls which as result higher contaminant concentrations. Whereas during September there were higher flooding due to monsoon rains, consequently the contaminants were found in diluted concentrations. It is concluded that natural as well as anthropogenic factors are responsible for surface water contamination.

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INTRODUCTION

Water is mandatory for all life processes. It has both quantitative and qualitative limitations. Contamination in water results in health associated dangers by drinking polluted water. Freshwater assets and inhabitant's masses are unequally dispersed, this must set excessive stress on the obtain ability of harmful water to lots of the individuals all over the world (Shahid *et al.*, 2019). Pollution is the beginning of infectivity into the environment (Webster.com, 2010). Pollution can also be well-defined as the introduction into the environment of a substance which have harmful effects. A contamination is addition of a substance (synthetic or compound) that is harmful for humans, plants, and other creatures (Nesaratnam, 2014). Diffuse contamination, otherwise called non-point source contamination, there is no unmistakable or certain purpose of release and contamination arrives the earth byan enormous number of ways. Water pollution is the pollution of aquatic sources. There are three main sources of water pollution named as natural sources, domestic sources, and industrial sources. Naturalsources contain warm air and acid wastes from volcanic zones and are not usual in the world. Local sources, the most part sewage and clothing squanders, and created in houses, lofts, and different residences. In urban zones, residential squanders are assembled in manure pipes and transferred to oversee area additionally into a conduit without action. Industrial sources reflected as the real possible wellspring of water contamination. Municipal manure as by perceived management organizations; it is more often that could not be efficiently measured (Boyd and Tucker, 2014).

Causes of water contamination has an influence on outlook towards the control on water assets. Moreover, situational causes such as the obtain ability of wastes, effect actions in response to water contamination. These results recommend the necessity to excavate consciousness on water contamination and to reflect situational causes in programme project and carrying out (Okumah *et al*., 2020).

Nullah Aik is currently under cruel biological repulsive conditions because of human actions. Environmental reliability of tributary is in receipt of crude metropolitan unwanted water. Manufacturing wastes and horticultural overflow (Abbas *et al*., 2004). No investigation has watched the spatial and transient changes and acknowledgment of wellsprings of contaminants. Additionally, no struggle has been ready to judge and check its surface water esteem. First and main objective of study was to measure the spatial and temporal variations of wastes and spatial and transient varieties in water nature of Nullah Aik. Second aim was to classify the imaginable causes of contaminants in Nullah Aik. Third aim was to study the spatio-temporal differences in surface water quality and recognition of water value factors.

MATERIAL AND METHODS

Study area

Current study focused on Nullah Aik (32°63′N-74°99′E and 32°45′N-74°69′E) which was carried out on District Sialkot and Gujranwala, Pakistan (Figure-1). This is the tributary of the river Chenab that begin from Himalayas in Kashmir, at a height 530 and 290 m. This tributary depletes around 1,875 km2 catchments zone and travel an aggregate separation of around 131.6 km and 98 km individually with a normal yearly release of 315 and 288 Cs for each second. Sialkot is the fundamental city alongside a few towns, for example, Ugoki, Bhopalwala, Bhegowala, Sohdhra, Jathekay, and Wazirabad and situated in the premises of this Nullah. Nullah joins in Wazirabad before passing through Sialkot and are then emptied into river Chenab.

The chosen area of streams has 4 isolate seasons viz., summer (pre-rainstorm; April to mid-June), blustery season (storm; mid-June to mid-September), harvest time (post rainstorm; mid-September to November), winter (December to February) and a short spring (March). June is the most blazing month of the year where maximum temperature reaches up to 40o C. Temperature in winter may drop to 4o C. The mean yearly precipitation in the catchment is around 950 mm of which most extreme precipitation (~80 %) happens amid the storm season. In storm season, rainwater streams through surface, overflow and cause flooding which affects products and human settlements.

Nullah Aik gathers water from east of Jammu Kashmir and from substantial rains in its upper catchment territory. Its most extreme release level is roughly 35,000 Cs for every second which progressively lessens as the Nullah advances towards downstream (Qadir et al., 2008). The discharge of Nullah increases as they navigate from upstream to downstream. In pre-summer season, water inside the stream can be viewed as secluded discard. Various other tributaries (Roras, Jourian, Tannai wah and Neil wah) also discharge into Nullah at downstream locations. Then Nullah joins and empties into river Chenab.

Global positioning system (GPS) locations of different sites of Nullah Aik

The testing was initiating from 7:00 AM to 3:00 PM. Three sub-tests were gathered from every site. Water tests were gathered on regular premise from June to September 2017. Water testing was done from pre-storm (June) and post rainstorm (September). Portrayal of each site is given underneath.

Water Sampling and laboratory analysis

Water samples were taken in disinfected glass water sampling bottles and were tightly sealed. Water samples were taken 20 cm beneath the water surface and were taken within 100 m of examining site. Inspecting compartment was depleted into examining contains to the mouth without catching any air pocket. From each site, three sub-tests of stream water were gathered, which were joined to get composite examples amid examination. The water samples were kept in plastic containers and were firmly fixed to maintain a strategic distance from spillage amid transportation. All water tests were protected in fridges and transported to research centre as indicated by endorsed standard strategy (APHA, 1998). All examples were transported to the lab of Pakistan Council of Research in Water Resources (PCRWR), Lahore. These examples were put away in cooler to stop any plausible physio-substance changes. All examinations on water were performed in PCRWR research facility. Water tests were isolated out for the broken-down metal substance and particulate issue. The water tests for broke down metals were fermented with few drops of HNO3 to influence it to stay accessible in disintegrated shape amid capacity. TDS, EC, DO and salinity were examined on site. Whereas Hardness, turbidity, COD, NO3, Ca, Mg, Fe, Pb were examined in lab. The BOD and COD were calculated by standard procedures as depicted by Boyles (1997).

Statistical analysis

Mean, median and standard deviation and standard error were measured and for graphical representation of water quality information by using Microsoft Excel 2010 (Microsoft Corporation, 1985). One-Way ANOVA was determined by IBM-SPSS version 20 statistics.

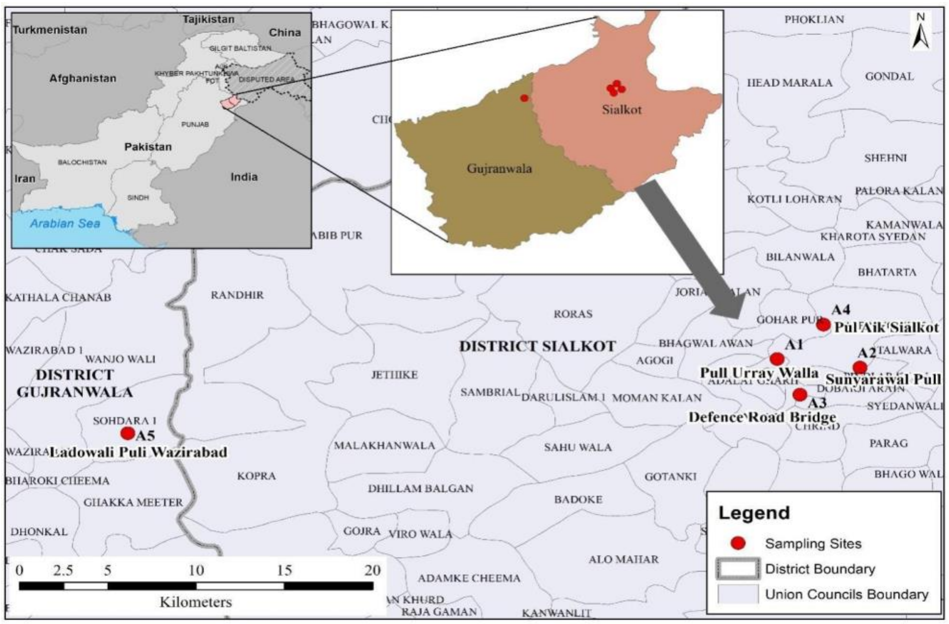

Figure 1. Location Map of the Study Area.

Table 1. GPS locations of different sites of Nullah Aik.

Sr. No.	Sampling Sites	GPS Locations
1.	A1. Nullah Aik Initial site near Pull Urray Walla	32° 29′ 30″ N 74° 30′ 25″ E
2.	A2. Sunyarawal Pull Sialkot	32° 29′ 13″ N 74° 32′ 57″ E
3.	A3. Defence Road Bridge	32° 28′ 19″ N 74° 31′ 07″ E
4.	A4. Pul Aik Sialkot	74° 31′ 50″ E 32° 30′ 39″ W
5.	A5. Ladowali Puli Wazirabad	74° 09′ 95″ E 32° 27′ 02″ W

RESULTS

The results indicated that the mean values of TDS, EC, pH, turbidity, Cl, total hardness, nitrate, salinity, Calcium, Magnesium, BOD, COD, DO, Fe, Pb and Cd had highermean values in R1 samples, collected during the month ofJune (pre-monsoon), as compared to R2 samples which were collected during the month of September (post-monsoon). This is because during the month of June, there was less rain thereby the contaminants had higher concentrations. During the month of September therewas higher flooding of Nullah due to monsoon rains. The contaminants were therefore found in relatively diluted form. This indicated significant temporal variations of contaminants in Nullah Aik. Moreover, all these results indicate that the samples collected from upstream i.e., A1 had lesser concentrationof contaminants as compared to those samples collected from downstream locations i.e., A5. This trend indicates that Nullah collected these contaminants from anthropogenic activities of inhabitants of Sialkot. These anthropogenic activities added contaminants into Nullah's stream thereby leading towards significantspatial variations of contaminants.

Laboratory assessment

Pre-monsoon samples were designated as R1 whereas post-monsoon samples were labelled as R2. This trend indicates that almost all samples had lesser values at upstream locations (Figure 2).

Total dissolved solids

Total Dissolved Solids illustrated different variations. From R1, Maximum value of 358 mg/L was recorded from A5 and minimum value was recorded 320 mg/L from A1 located at downstream of Nullah Aik. From R2, Maximum value of 340 mg/L was recorded from A4 and minimum value was recorded 302 mg/L from A1 located at downstream of Nullah Aik (Figure 2).

Electrical conductivity

The maximum value of electrical conductivity 711µS/cm for R1 was recorded from A5 and minimum value was recorded 525µS/cm from A1. From R2, Maximum value of 646 µS/cm was recorded from A5 and minimum value was recorded 480µS/cm from A1 located at downstream of Nullah Aik (Figure 3).

pH

The majority of the stream water samples illustrate pH varied between 7 and 8. A comparison of pH is shown in figure 4.3. A5 show higher pH from R1 (Figure 4).

Turbidity

From R1, maximum estimation of 75 NTU was recorded from A5 and least esteem was recorded 31NTU from A1. From R2, Maximum turbidity was estimated to be 60NTU from A5 and least value was recorded as 21NTU from A1 situated (Figure 5).

Chloride

The value of chloride also indicated variations. From pre-monsoon reading, maximum value of 120mg/L was recorded from A5 and minimum value was recorded 23mg/L from A1. Similar results for chloride were also estimated from R2 (Figure 6).

Total hardness

The maximum value of 232 mg/L for total hardness was recorded from A5 and lowest value was recorded 186 mg/L from A1 of R1. From R2, Maximum estimation of 121 mg/L was recorded from A5 and least reading was recorded 54 mg/L from A1 situated at downstream of Nullah Aik (Figure 7).

Nitrates

Maximum nitrate from R1 was estimation to be 1.7 mg/L from A5 and least value was recorded 1.01 mg/L from A4. From R2, Maximum estimation of 1.29 mg/L was recorded from A5 and least esteem was recorded 1.00 mg/L from A4 (Figure 8).

Calcium

The results of calcium from pre-monsoon showed a maximum value of 60.5 mg/L from A5 and minimum value was recorded 57.6 mg/L from A4. From post- monsoon, Maximum value of 56.6 mg/L was recorded from A5 and minimum value 50 mg/L was recorded from A4 (Figure 9).

Magnesium

The results of magnesium indicate that a maximum value of 18 mg/L was recorded from A5 whereas the lowest value of 11 mg/L was recorded from A4. Maximum estimation of 15 mg/L was recorded from A4 and least value was recorded 10 mg/L from A1 for post-monsoon reading (Figure 10).

Salinity

Salinity also showed similar variations as have already been discussed for other parameters. From R1, Maximum estimation of 0.9 mg/L was recorded from A5 and least esteem was recorded 0.05 mg/L from A1. From R2, Maximum value of 0.25 mg/L was recorded from A5 and least value was estimated (0.02 mg/L) from A1 (Figure 11).

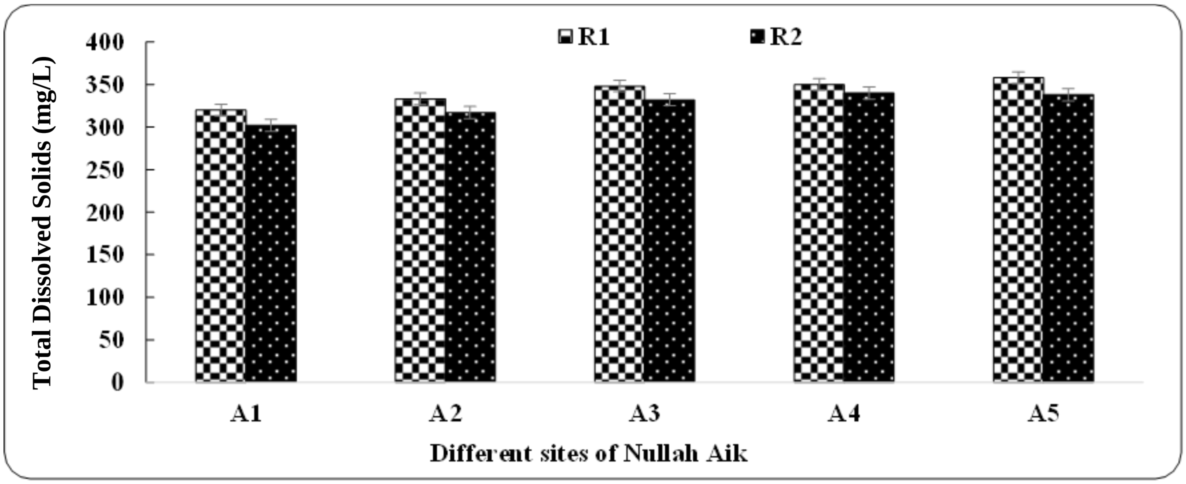

Figure 2. Spatio-temporal variations of Total Dissolved Solids in the water quality of Nullah Aik (R1: First reading, R2: Second reading, A1: First site of Nullah Aik, A2: Second site, A3: Third site, A4: Forth site, A5: Fifth site).

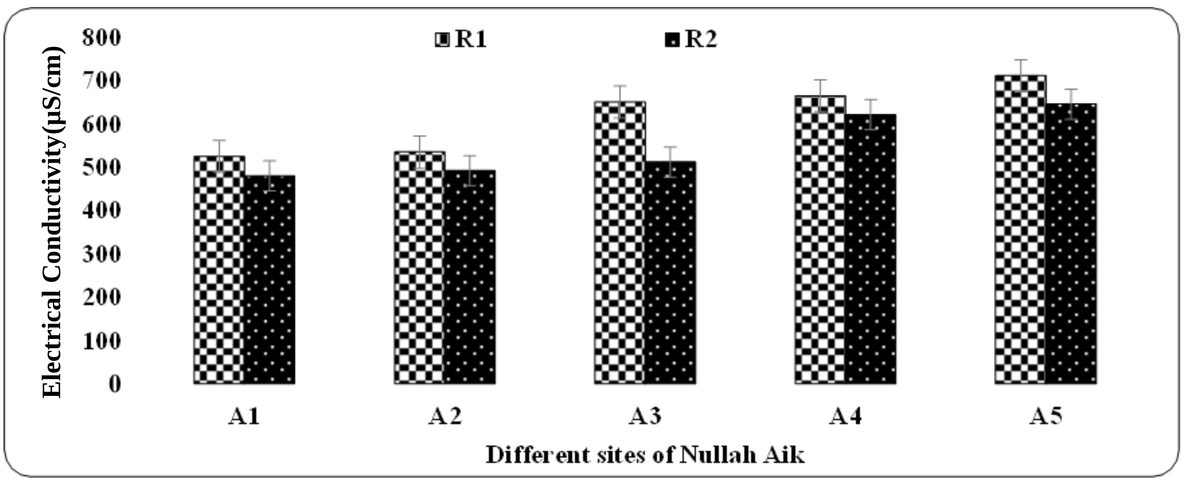

Figure 3. Spatio-temporal variations of Electrical conductivity in the water quality of Nullah Aik (R1: First reading, R2: Second reading, A1: First site of Nullah Aik, A2: Second site, A3: Third site, A4: Forth site, AP5: Fifth site).

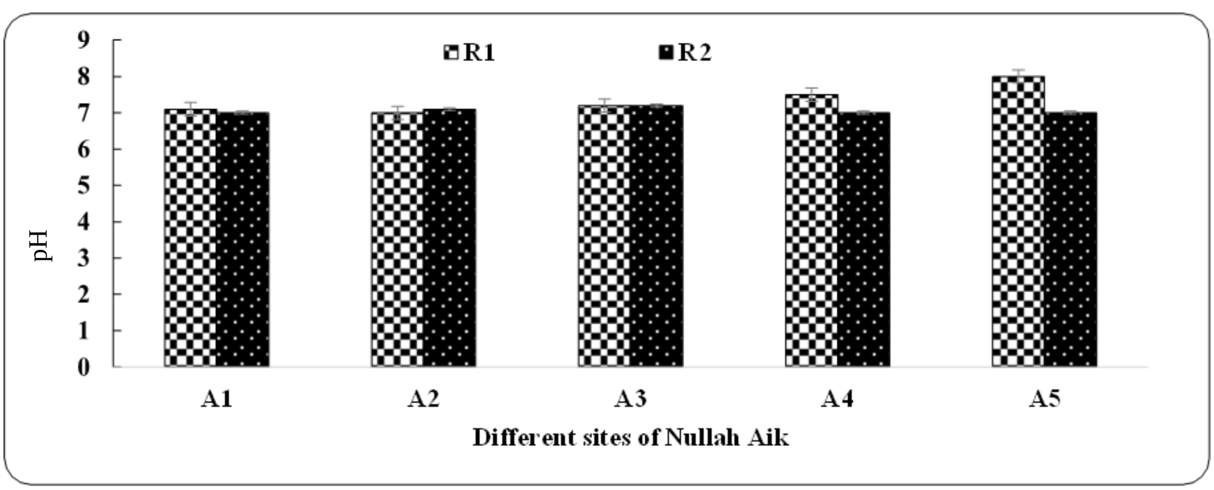

Figure 4. Spatio-temporal variations of pH in the water quality of Nullah Aik (R1: First reading, R2: Second reading, A1: First site of Nullah Aik, A2: Second site, A3: Third site, A4: Forth site, A5: Fifth site).

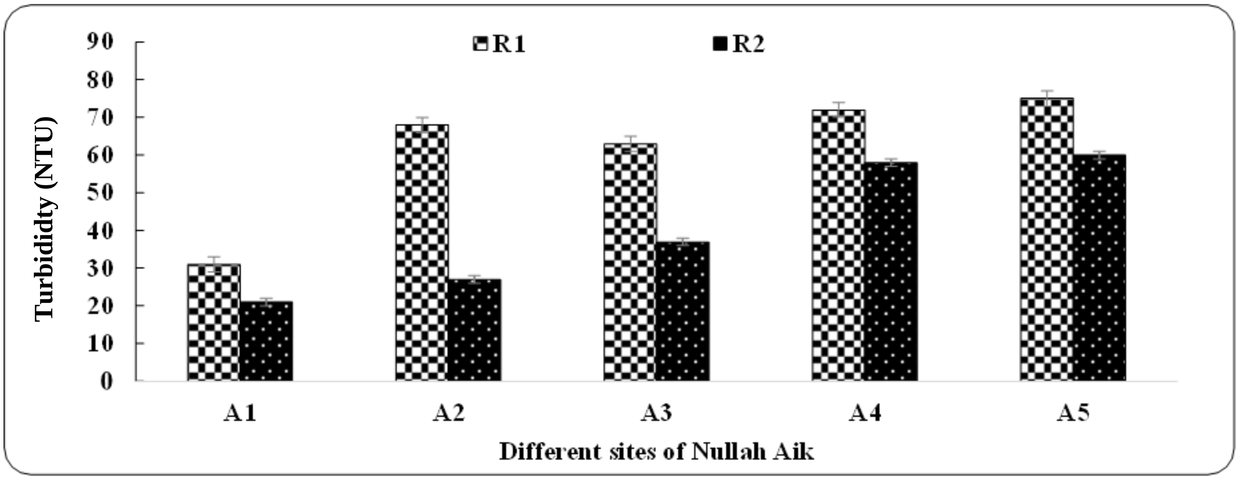

Figure 5. Spatio-temporal variations of turbidity in the water quality of Nullah Aik (R1: First reading, R2: Second reading, A1: First site of Nullah Aik, A2: Second site, A3: Third site, A4: Forth site, A5: Fifth site).

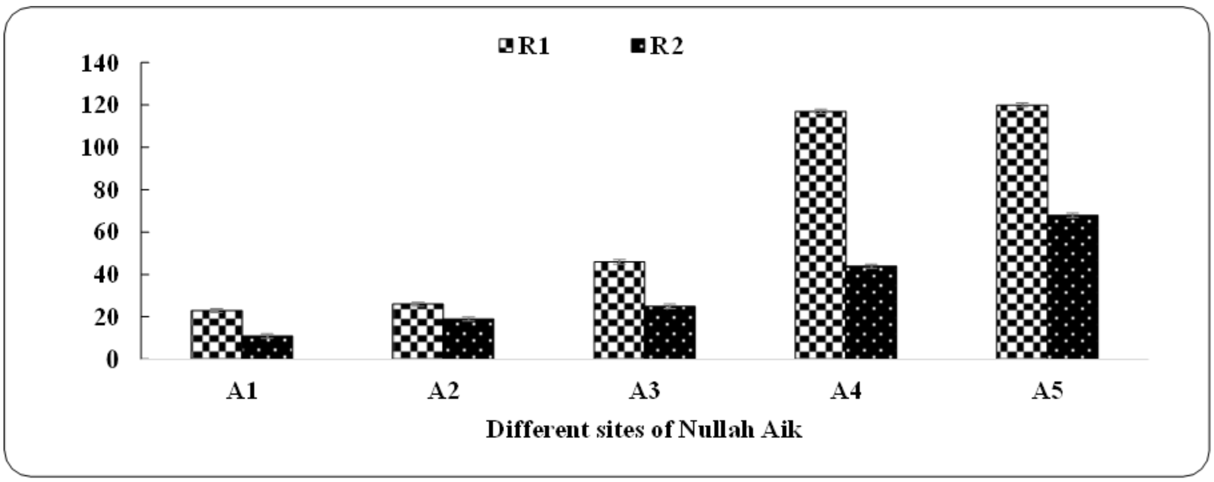

Figure 6. Spatio-temporal variations of chloride in the water quality of Nullah Aik (R1: First reading, R2: Second reading, A1: First site of Nullah Aik, A2: Second site, A3: Third site, A4: Forth site, A5: Fifth site).

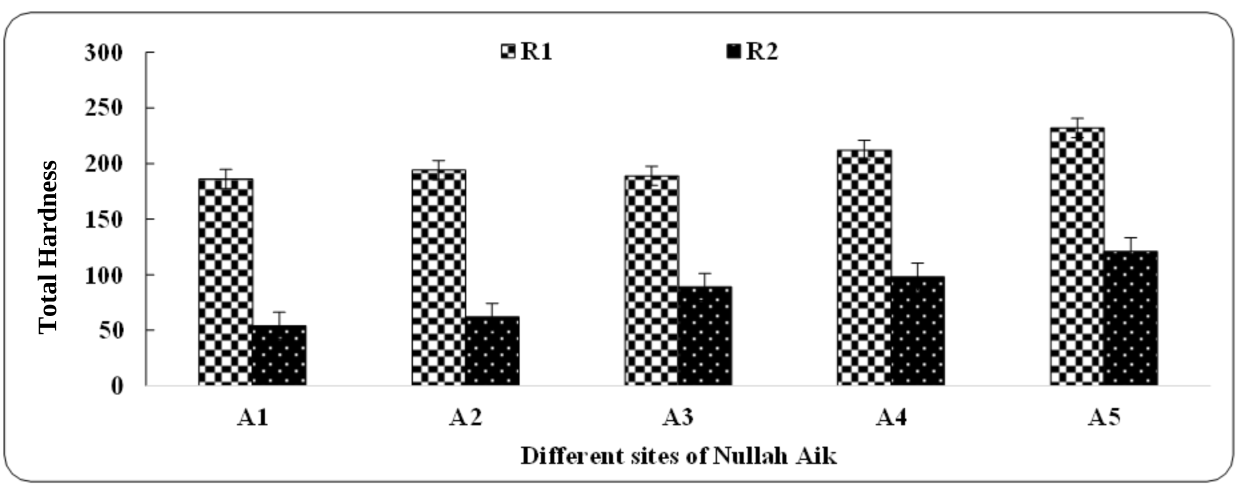

Figure 7. Spatio-temporal variations of total hardness in the water quality of Nullah Aik (R1: First reading, R2: Second reading, A1: First site of Nullah Aik, A2: Second site, A3: Third site, A4: Forth site, A5: Fifth site).

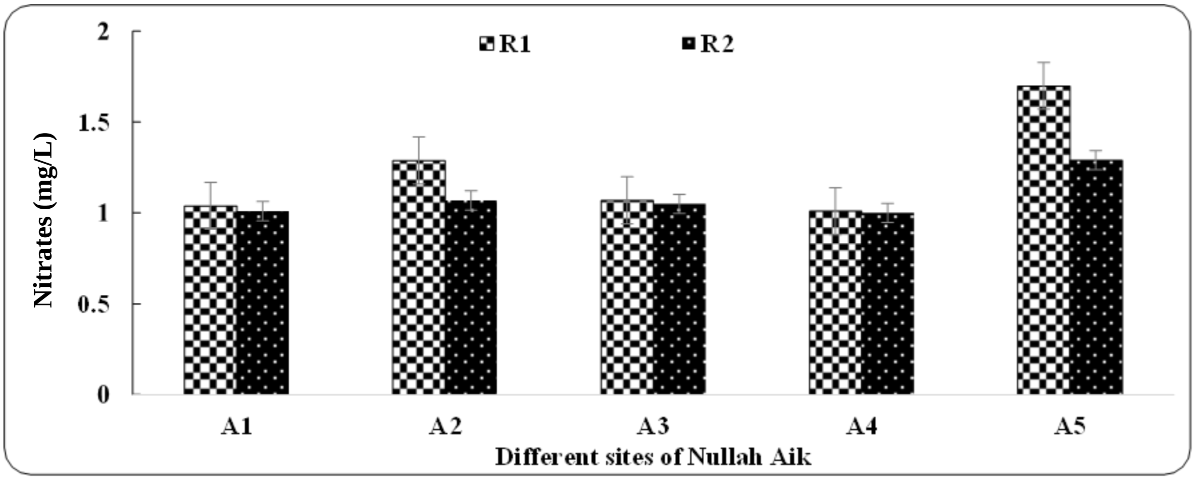

Figure 8. Spatio-temporal variations of Nitrates in the water quality of Nullah Aik (R1: First reading, R2: Second reading, A1: First site of Nullah Aik, A2: Second site, A3: Third site, A4: Forth site, A5: Fifth site).

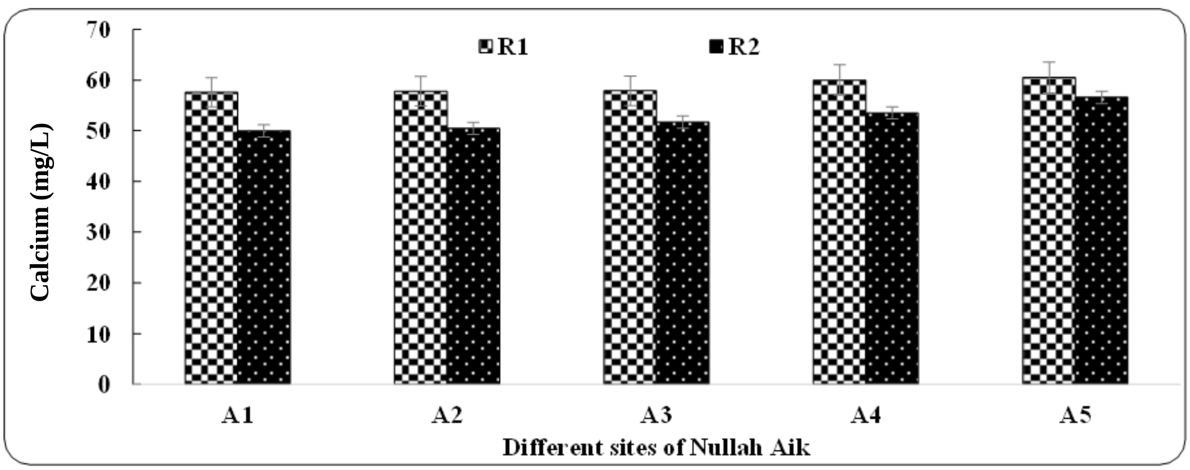

Figure 9. Spatio-temporal variations of Calcium in the water quality of Nullah Aik (R1: First reading, R2: Second reading, A1: First site of Nullah Aik, A2: Second site, A3: Third site, A4: Forth site, A5: Fifth site).

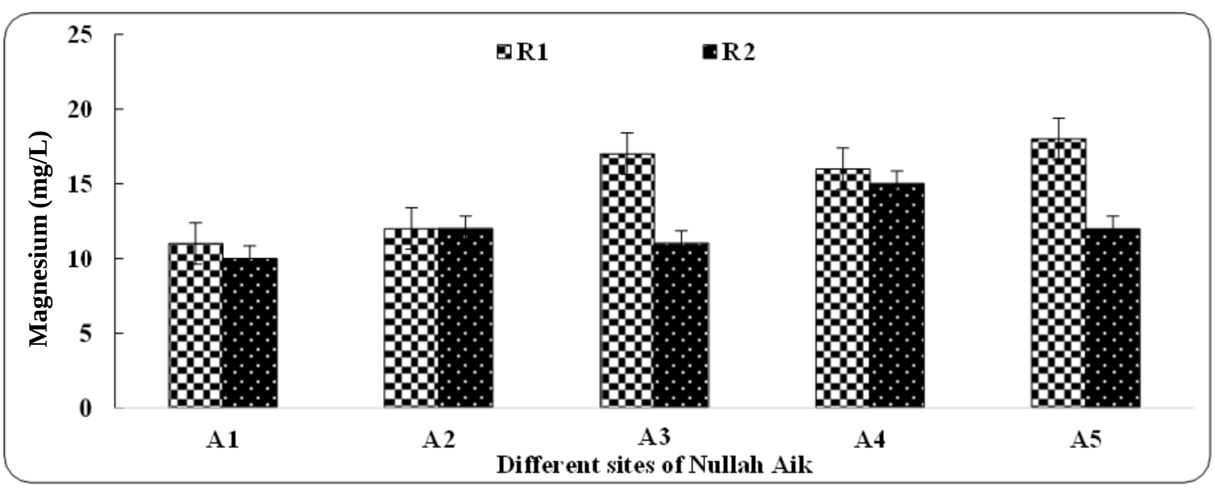

Figure 10. Spatio-temporal variations of Magnesium in the water quality of Nullah Aik (R1: First reading, R2: Second reading, A1: First site of Nullah Aik, A2: Second site, A3: Third site, A4: Forth site, A5: Fifth site).

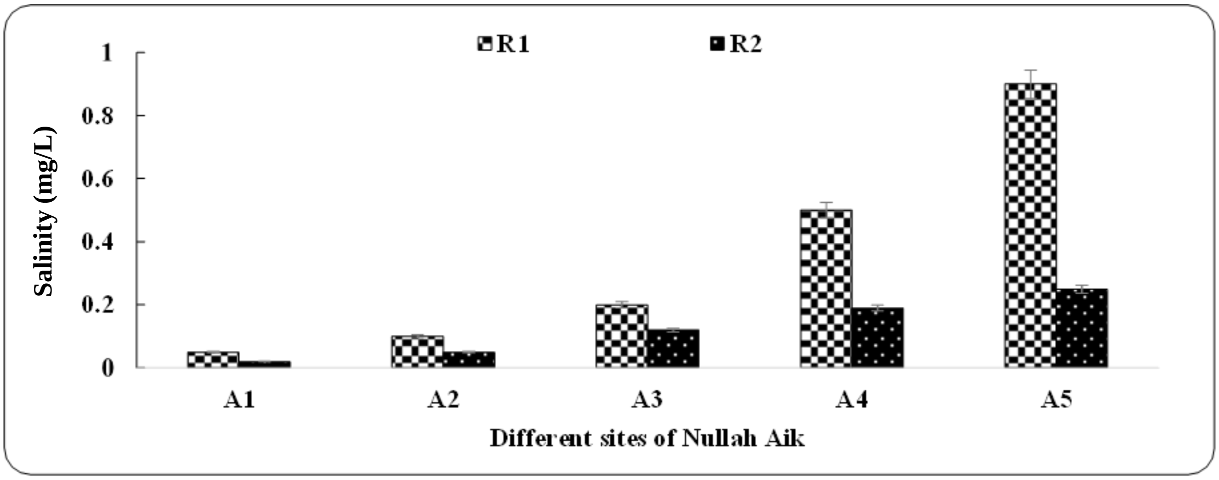

Figure 11. Spatio-temporal variations of Salinity in the water quality of Nullah Aik (R1: First reading, R2: Second reading, A1: First site of Nullah Aik, A2: Second site, A3: Third site, A4: Forth site, A5: Fifth site).

Biological oxygen demand

Biological oxygen demand, chemical oxygen demand and dissolved oxygen indicated different variations. From pre-monsoon results R1, Maximum value of BOD is 199 mg/L was recorded from A5 and minimum value was recorded 27 mg/L from A1. Similar results were found for R2 (Figure 12).

Chemical oxygen demand

From A1, maximum value of COD (52 mg/L) was recorded from A5 and minimum value (3 mg/L) was recorded from A1. Same results were recorded for COD as 46 mg/L was recorded from A5 and minimum value was recorded 2 mg/L from A1 (Figure 13).

Lead

Maximum value (0.71 mg/L) of lead from R1 was recorded from A4 and minimum value was recorded 0.11 mg/L from A1. From R2, Maximum value of 0.6 mg/L was recorded from A5 and minimum value was recorded 0.1 mg/L from A1 (Figure 14).

Cadmium

The results of Cadmium illustrated that from R1, maximum value of 0.06 mg/L was recorded from A4 and minimum value was recorded 0.02 mg/L from A1 located at downstream of Nullah Aik. Similar trend was observed from samples collected in post-monsoon season (Figure 15).

Dissolved Oxygen

Maximum value of DO, from R1, was calculated to be 7.9 mg/L. This was recorded from A5 and minimum value was recorded 2 mg/L from A1. Similar results were found from R2 in which maximum value (4.7 mg/L) recorded from A5 and minimum value (1.5 mg/L) was recorded from A1 (Figure 16).

Iron

Similarly, the estimation of Iron was also performed. From R1, Maximum value of 0.6 mg/L was recorded from A1 and minimum value was recorded 0.15 mg/L from A5. From R2, Maximum value of 0.6 mg/L was recorded from A5 and minimum value was recorded 0.12 mg/L from A2 located at downstream of Nullah Aik. These results are different as compared already discussed results of other parameters. In rest of the parameter, it has been seen that the values increase in samples collected from downstream (Figure 17). The comparative results of all the parameters indicated that R1 had higher mean as compared to R2. This isbecause during the month of June, in which R1 samples were collected, there was less rain thereby the contaminants had higher concentrations. During the month of September there was higher flooding of Nullah Palkhu due to monsoon rains. The contaminants were therefore found in relatively diluted form. This indicatedsignificant temporal variations of contaminants in Nullah Palkhu (Figure 18). One-way ANOVA indicates the significant co-relation between different values ($p<0.001$). In current study, results indicate that Electrical Conductivity, Chloride and Total Hardness are highly significant which are less than 0.05 whereas other parameters as Total Dissolved Solids, pH, Turbidity, Nitrates, Calcium, Magnesium, Salinity, Biological Oxygen Demand, Chemical Oxygen Demand, Dissolved Oxygen, Iron, Lead and Cadmium indicates there is no significant ($p<0.05$) co-relation (Table 2).

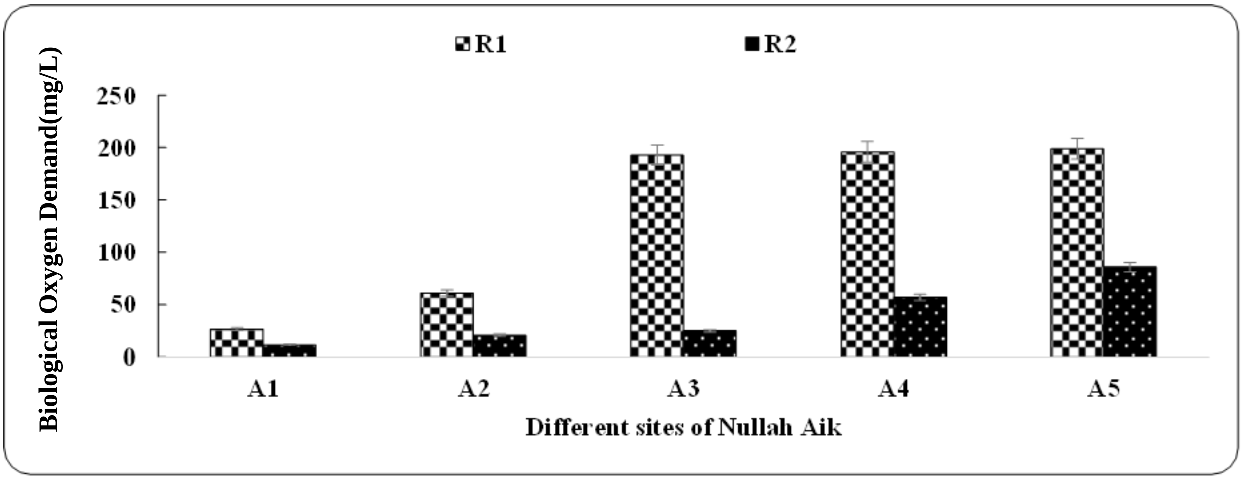

Figure 12. Spatio-temporal variations of biological oxygen demand in the water quality of Nullah Aik (R1: First reading, R2: Second reading, A1: First site of Nullah Aik, A2: Second site, A3: Third site, A4: Forth site, A5: Fifth site).

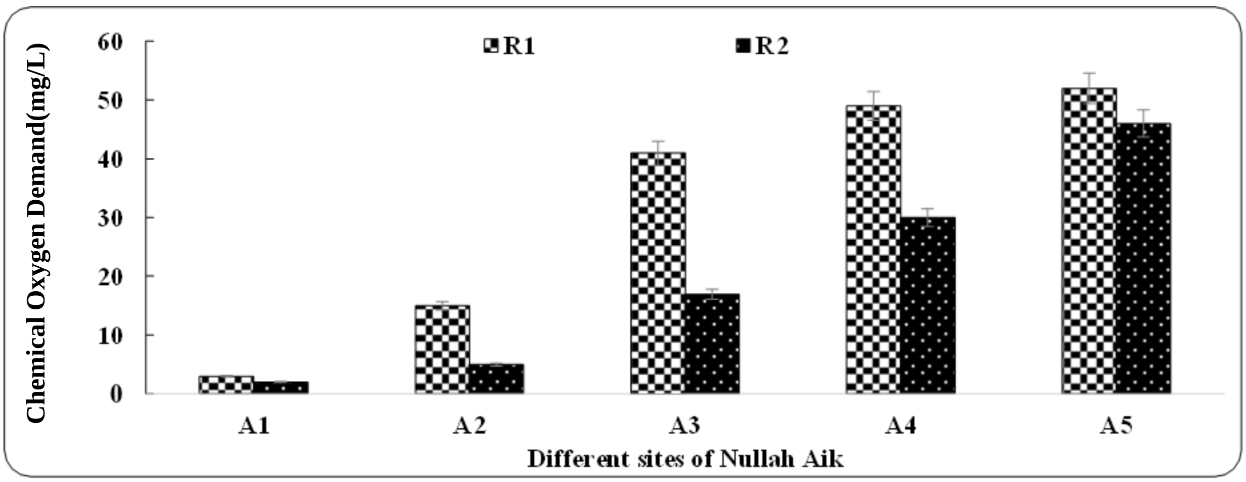

Figure 13. Spatio-temporal variations of chemical oxygen demand in the water quality of Nullah Aik (R1: First reading, R2: Second reading, A1: First site of Nullah Aik, A2: Second site, A3: Third site, A4: Forth site, A5: Fifth site).

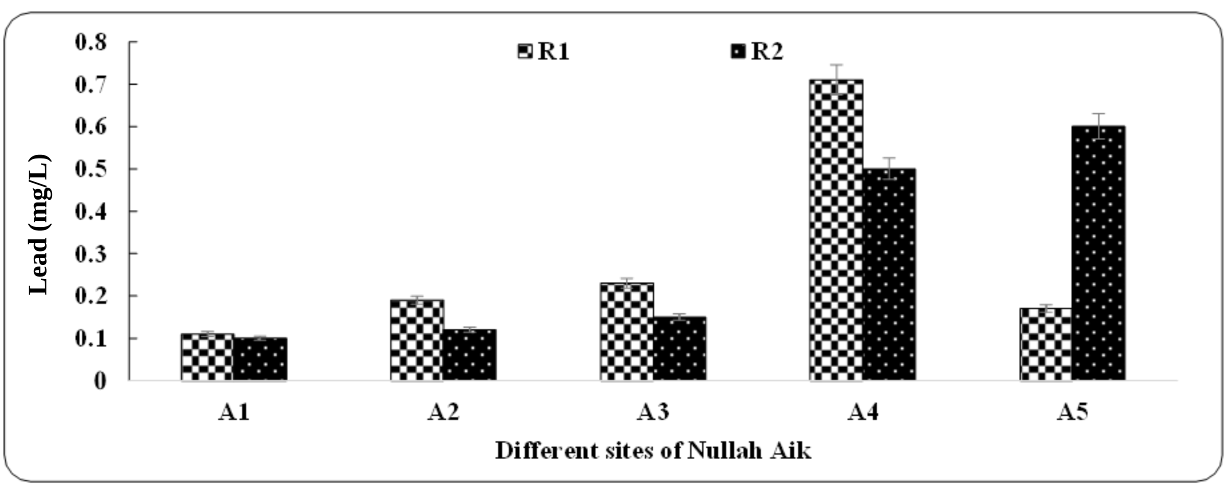

Figure 14. Spatio-temporal variations of Lead in the water quality of Nullah Aik (R1: First reading, R2: Second reading, A1: First site, A2: Second site, A3: Third site, A4: Forth site, A5: Fifth site).

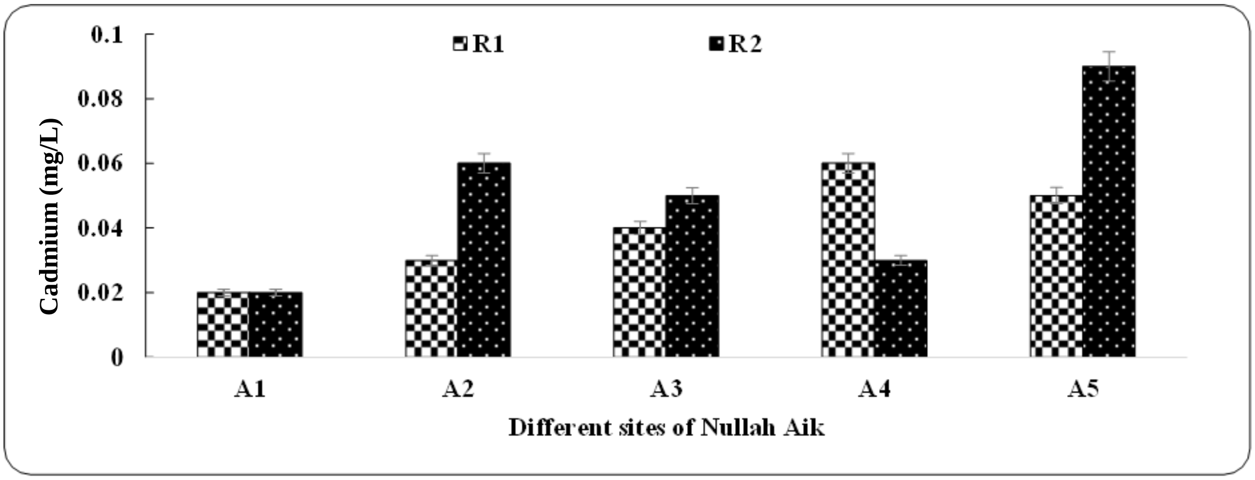

Figure 15. Spatio-temporal variations of cadmium in the water quality of Nullah Aik (R1: First reading, R2: Second reading, A1: First site of Nullah Aik, A2: Second site, A3: Third site, A4: Forth site, A5: Fifth site).

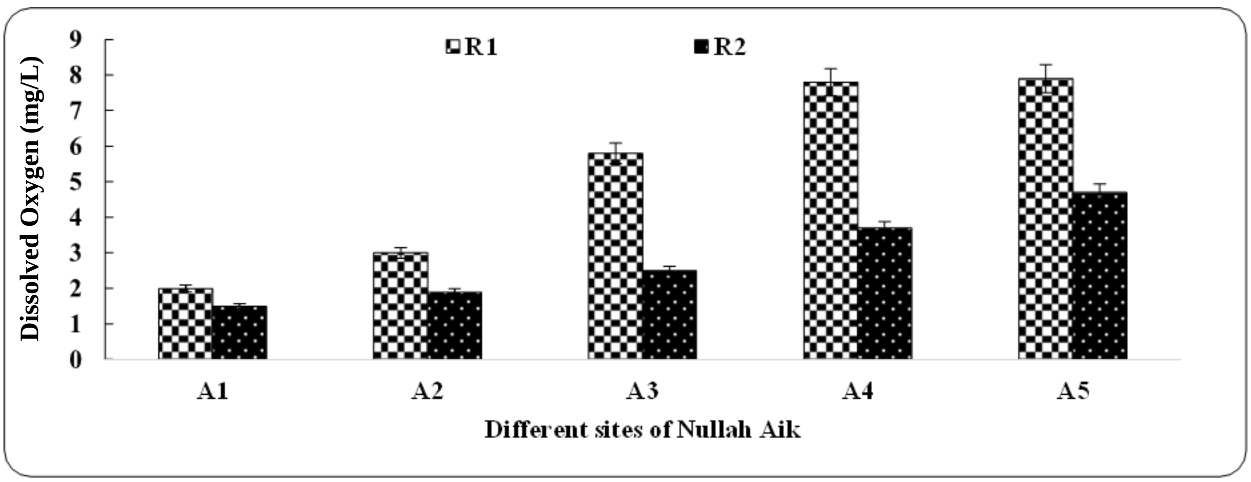

Figure 16. Spatio-temporal variations of dissolved oxygen in the water quality of Nullah Aik (R1: First reading, R2: Second reading, A1: First site of Nullah Aik, A2: Second site, A3: Third site, A4: Forth site, A5: Fifth site).

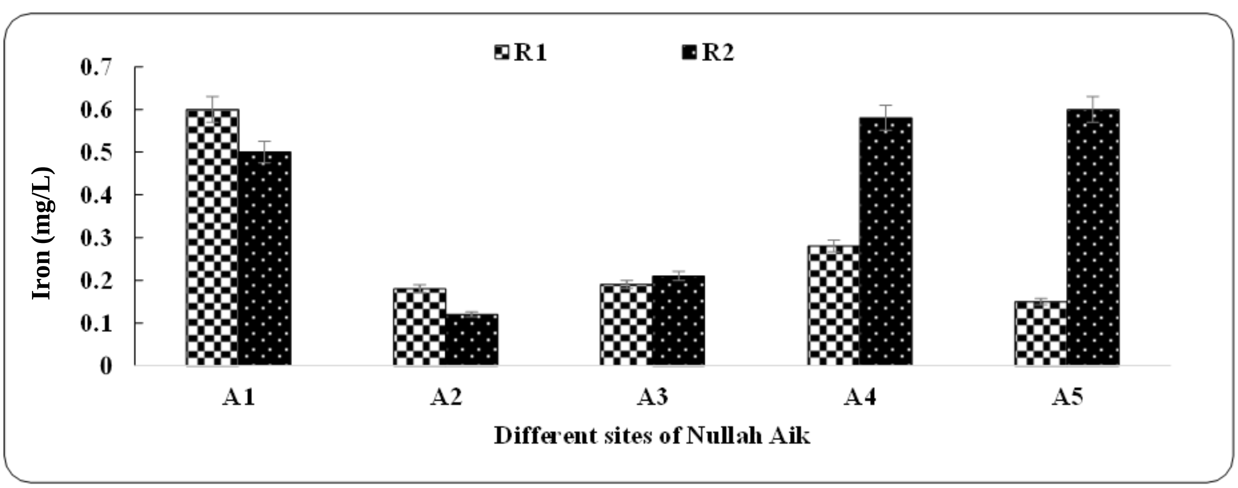

Figure 17. Spatio-temporal variations of Iron in the water quality of Nullah Aik (R1: First reading, R2: Second reading, A1: First site of Nullah Aik, A2: Second site, A3: Third site, A4: Forth site, A5: Fifth site).

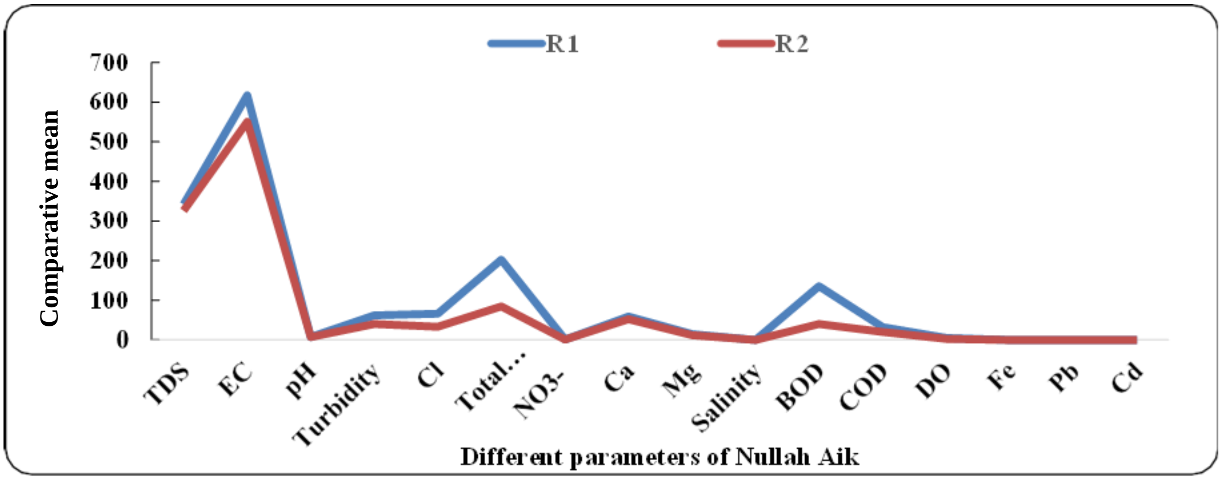

Figure 18. Comparative mean of various parameters for spatio-temporal variations in the water quality of Nullah Aik (R1: First reading, R2: Second reading).

Table 2. One-way ANOVA indicates the significant co-relation between different values.

Parameters	Sum of Squares	Degree of Freedom (df.)	Mean Square	F-Value	P-Value
TDS	640.000	1	640.000	2.621	.144 ns
	1953.600	8	244.200	-	-
	2593.600	9	-	-	-
EC	11289.600	1	11289.600	1.755	.222 ns
	51448.000	8	6431.000	-	-
	62737.600	9	-	-	-
pH	.225	1	.225	2.632	.143 ns
	.684	8	.085	-	-
	.909	9	-	-	-
Turbidity	1123.600	1	1123.600	3.556	.096 ns
	2528.000	8	316.000	-	-
	3651.600	9	-	-	-
Cl	2722.500	1	2722.500	1.901	.205 ns
	11454.400	8	1431.800	-	-
	14176.900	9	-	-	-
Total Hardness	34692.100	1	34692.100	62.256	.000***
	4458.000	8	557.250	-	-
	39150.100	9	-	-	-
NO_3	.048	1	.048	.975	.352 ns
	.391	8	.049	-	-
	.438	9	-	-	-
Ca	99.225	1	99.225	21.889	.002**
	36.264	8	4.533	-	-
	135.489	9	-	-	-
Mg	19.600	1	19.600	2.970	.123 ns
	52.800	8	6.600	-	-
	72.400	9	-	-	-
Salinity	.125	1	.125	1.870	.209 ns
	.537	8	.067	-	-

DISCUSSION

Studies showed that spatial and transient varieties in stream are profoundly impacted by natural and human actions as studied by Sullivan and Drever (2001; De Carlo *et al*., (2005) while working on trace elements of Peru streams and Oahu, Hawai. Particular regular contrasts in grouping of contaminants might be because of variance in the stream release level and windstorms. The measure of waste issues stayed same during the time in the catchment zone and contaminants fixation is normally greater, near to the ground stream as studied by Tsai *et al*. (2003). Most extreme release was seen in rainstorm period and least release level was seen amid winter and pre-storm periods, for example, Khan *et al*., (2003); PCRWR (2004); Singh *et al*., (2005) and Qadir *et al*., (2008).

The results showed that values of TDS, EC and Cl is relating to the value recorded by Qadir *et al*., (2008). Salinity, turbidity and hardness influence the accessibility of metals to creature. At abnormal state of saltiness follow metals introduce in broke down shape respond with partially dissolved particulate issue and wind up unsolvable and settle down in residue. In normal tributary, occurrence of dissolved salts shows that salts begin from close relative shake substance (Crosa *et al*., 2006). The outcomes demonstrated that estimations of saltiness and hardness is identify with the esteem recorded by (Qadir *et al*., 2008). Tributary release level diminishes the saltiness in tributary water. Therefore, the worldly varieties in saltiness can be related with high amount of dissolvable salts utilized. Mg and Ca are main deciding elements for add up to hardness in freshwater, be that as it may, different factors additionally donate an expansion in absolute rigidity.

In unadulterated water, convergence of Ca ran 0.06-210 mg/L. (Nanda, 2005). PCRWR (2004) detailed mean convergence of Ca (30mg/L) in water tests assembled. The estimation of calcium as evaluated by the present investigation is essentially higher as contrast with the mean calcium estimation of PCRWR (2004). Value of pH differed somewhere in the range of 7 and 8 and most abnormal amount of Mg was recorded amid winter while least fixation was recorded amid rainstorm seasons. The convergence of Mg was recorded in introduce consider was generally equivalent to River Chenab 12.0 mg/L (PCRWR 2004). Greatest centralization of disintegrated Fe was recorded amid storm period and greater than the allowable incentive for crisp water. Taboada-Castro *et al*., (2002) additionally revealed greatest broke up Fe content while tributary was most extreme. This likewise hold inflow of Fe in broke down shape can be because of its remobilization from earth covering in streams. Fe focus computed in ebb and flow think about was greater to those detailed in River Indus and lower to those of Ravi and Gomti streams as similar situations also reported by Singh *et al*. (2004) during study of spatial and temporal variations in water quality of Gomti River (India).

Abnormal state of BOD and COD might be because of the arrival of high volume of crude mechanical and city squander matters into tributaries. The level of TDS was great when contrasted with the grouping of TDS make a note be that as it may, underneath TDS esteems make a note by Khan *et al*., (2003), PCRWR (2004) and Singh *et al*., (2005). Great estimations of TDS because of waste issue comprising greater centralization of solvent salts connected with regular and human action causes.

Pb fixation is increments from upper tributary towards down tributary destinations. Air confirms in city zones and superficial overflow can be primary wellsprings of Pb in tributary water. Amid substantial precipitation, Pb on soil surface winds up broke down, which advances into the stream (Sutherland *et al*., 2003). Assembling procedures, paints and colors, burning of city strong squanders and risky squanders are alternate wellsprings of Pb. Pb originates from car fumes and kept on soil frame condition fundamentally close primary parkways (Tomazelli *et al*., 2003). In current investigation, high grouping of Pb was contrasted with the investigations of Khan *et al*., (2003) and Singh *et al*., (2004) and its focuses were inferior to those revealed by Khan *et al*., (2003).

The appropriation of Mg in adjusted particulate is issue speak to an expanding propensity from upper to down tributary level. The reason for Mg is anthropogenic exercises. Similarly, high centralizations of Mg in sensibly hindered locales may mean the impact of human actions. Tzankov *et al*., (2007) revealed that advanced centralization of Mg in tributary water is capably affected by enduring of resources.

Mean convergence of Cd was low at a large portion of the areas yet most extreme focus was recorded in rainstorm. The plausible wellsprings of Cd are climatic affidavit, surface spillover, electroplating businesses, strong waste evacuation and the employments of manures (Jonsson *et al*., 2002). Most noteworthy mean convergence of Cd was note down in rainstorm time, which was over the normal for intake water as clarified by USEPA, (1993), CEC,

(1978) and WHO, (1993). Likewise, Cd focus was likewise over the passable side by side of freshwater and for water life as depicted by Wright & Welbourn, (2002). More elevated amount of broke down Fe, Pb and Cd in storm when water discharge level turns out to be high. Presently expanded grouping of colloidal iron and lead masses amid high stream, likely coming about because of again suspension of iron colloids built up onto bed residue.

CONCLUSION

Current study offers important information about spatial and temporal differences in water quality of Nullah Aik, Northeast of Pakistan which are significant tributaries of River Chenab. The results highlight that this increased concentration of pollutants in the nullah is a result of human interventions. The sample collected revealed that Calcium found to be highly significant ($p < 0.001$), total hardness, chemical oxygen demand (COD) and biological oxygen demand (BOD) identified as significant ($p < 0.05$) while other parameters *i.e., total dissolved solids (*TDS), electrical conductivity (EC), pH, turbidity, Chlorine (Cl), nitrate (NO_3), salinity, magnesium (Mg), iron (Fe), lead (Pb) and cadmium (Cd) revealed no significant ($p<0.05$) co-relation. The investigation recognized particular spatial and transitory variation in water quality estimations and furthermore included that spatial heterogeneity as far as surface water contamination identified with anthropogenic components.

CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

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