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ASSESSMENT OF SURFACE WATER QUALITY OF RIVER KORANG

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Water quality of fresh water basins in Pakistan is being degraded because of human actions. Surface water quality at Angoori road, Phulgaran, Baheria golf city which are the main tributaries of river Korang, Rawal Lake and WASA filtration plant were investigated during June and April. Physico-chemical parameters including heavy metal detection of the water samples and possible sources of contamination were analyzed. The study showed that the pollution level in all the sampling sites is rising because of discharge of domestic wastes, poultry waste, agricultural activities and solid waste dumping directly into the sites. Parameters like COD, DO, TA and TSS and metals like lead and cadmium exceeded the permissible limits as compared with USEPA, PakEPA and WHO standards. The contamination level is higher in June as compared to April. The two station Angoori road and Rawal Lake are more contaminated as compared to other sites. Moreover WASA filtration plant is working efficiently it decreases the amount of contaminants coming from all sites and the water quality is fit for drinking.
Key words: river Korang, surface water quality, physico-chemical parameters, heavy metal.

Procjena kakvoće površinskih voda rijeke Korang i njenih pritoka. Kvaliteta vode slatkovodnih vodonosnika u Pakistanu je degradirana zbog ljudskog djelovanja. U ovom radu je ispitivana kvaliteta površinskih voda uz Angoori cestu, Phulgaran, Baheria grad golfa, koje su ujedno i glavni pritoci rijeke Korang, Rawal jezero i WASA sustav za pročišćavanje su ispitivani tijekom lipnja i travnja. Analizirani su fizikalno-kemijski pokazatelji, uključujući određivanje teških metala u uzorcima vode kao i mogući izvori onečišćenja. Studija je pokazala da je razina onečišćenja na svim mjestima uzorkovanja u porastu zbog onečišćenih ispusta iz domaćinstava, stočnog otpada, poljoprivrednih aktivnosti i izravnog odlaganja krutog otpada u mjeatima. Parametri poput KPK, otopljenog kisika, alkalitet, ukupne suspendirane tvari i metali poput olova i kadmija prelaze dozvoljenu vrijednost u usporedbi s USEPA, PakEPA i WHO standardima. Stupanj onečišćenja je viši u lipnju u odnosu na travanj. Dvije lokacije, Angoori cesta i Rawal jezero, su onečišćene više u odnosu na druge lokacije. Nadalje WASA sustav za pročišćavanje radi učinkovito smanjuje količinu onečistila sa svih strana a kvaliteta vode je pogodna za piće.
Ključne riječi: rijeka Korang, kakvoća površinskih voda, fizikalno-kemijski pokazatelji, teški metali.

INTRODUCTION

Water is very important to health, well being, food, safety measures and socio-economic well being of mankind. Therefore the presence of contaminants in natural fresh water continues to be one of the most important environmental issues in many areas of the world, particularly in developing countries where several population are far away from portable water supply [1].

Most important wealth of a country is its natural resources. Water is a blessing of life, *"No life without water''* is a common saying depending upon the fact that water is the one of the logically occurring vital necessity of life supporting all activities [2].

Fresh water resources are among the most valuable assets of any human civilization. They play a basic role in overall economy of a country due to certain demand of water in all sectors of life. Rivers are significant component of natural environment having many values such as economic,

aesthetic, ecological, water for consumption, and conveying wastewater discharges. However declining water quality of these ecological systems has threatened their sustainability [3].

Surface water is a vibrant system containing living as well as non living, organic, inorganic, soluble insoluble substances so its quality is likely to change day by day. Any change in quality will change the natural equilibrium and would become unfit for designated sources [4]. Aquatic resources have the ability to dilute and by the activity of detoxifying agent's they are being used as dumping sites for sewage industrial and domestic waste [5]. Water quality of natural rivers and streams are becoming stumpy due to mixing of large quantity of untreated wastewater. It is obligatory to investigate and originate such policy for water quality management which would maintain acceptable water quality standards for irrigation and community usage [6].

Serious environmental concerns the most crucial of which is associated with sewage disposal and low water quality has created demographic explosion in developing countries.

Pollution of river first influences its physicochemical distinctiveness, then affects the community, and accordingly disturbs the food web and is harmful for human health. Due to increase pollution various uses of rivers are becoming less. Therefore it is important to evaluate the water quality of rivers and to calculate the future changes in water quality resulting from different human activities [7].

Natural processes and anthropogenic activities influence surface water quality. In many developing countries, natural water bodies due to their capacity to absorb and dilute the harmful constituents of the effluents are used to dispose waste water. Effluents of low quality are dumped unchecked into the natural water bodies resulting in further deprivation of their water quality. As a result, human health and crop yields are being affected or threatened in many cases [8].

Human consume water, discard it, poison it and change the water cycle uncaring to the cost: too many people, too little water, water in the wrong places and in the wrong amount. The human population is growing but water demand is increasing twice as fast Farm chemicals, heavy metals affect the water and the quality of water is also deteriorated due to unscientific waste disposal and improper waste management [9].

The major concern of surface water contamination is due to toxic chemicals, elevated nutrients due to geogenic processes such as atmospheric deposition, rock weathering and erosion as well as anthropogenic inputs such as urban waste industrial effluents and agricultural activities [10].

Heavy metals are getting importance among the inorganic contaminants because of their non degradable nature and often accumulate through tropic level causing a lethal biological effects the use of heave metals containing fertilizers and pesticides in agriculture resulted in deterioration of water quality interpreting serious environmental problems posturing threat on human being and sustaining aquatic biodiversity. Therefore examining these metals is important for safety assessment of environment and human health in particular.

Due to accumulation of the trace elements in the aquatic ecosystem adverse health effects are created on organic subdivisions, therefore, researchers have been focusing on calculating the toxic trace elements and apportioning their sources in the aquatic ecosystem [11].

The current population of Pakistan is about 161 million and expected to increase up to 208 million in 2025 with about 50 percent of this population living in urban

centers. Urbanization is taking place in the country at the rate of 32.5 percent [12].

The industrial waste and domestic sewage is discarded through surface ditches into water bodies of the country. A wastewater assessment showed that total waste water supply in Pakistan is 4.6x106m3/day, and of total 7.85 million m3/day of wastewater (30 percent of the total) is used for irrigating an area of 32500 hectares. It has also been projected that 64 percent of the total wastewater is disposed off either into rivers. Similarly, 400,000 m^3/day wastewater is additionally added to canals. These practices alerted both human health and the environment at downstream and more importantly reduce the effective availability of Pakistan's already short water supplies [13].

In this scenario, the water quality issue in Pakistan has not yet got its due significance. A wide-ranging water quality monitoring program is critical to assess the water quality status of the national rivers. The objectives of the study are to assess of water quality of Phulgaran, Bahria golf city, Angoori road, Rawal lake and WASA filtration plant under the higher concentration of untreated municipal, sewage and poultry effluents and to determine the physicochemical properties and heavy metals of effluents and finally to propose effective water quality management strategies. The present study facilitates the determination of possible sources of contamination. The three sampling sites are major tributaries of Korang stream which has been set to form Rawal lake which is one of the major source of drinking water for the residents of Islamabad and Rawalpindi, Pakistan. It is therefore, necessary to examine the water quality of major tributaries, Rawal lake and efficiency of WASA filtration plant to analyze the level of contamination. This study facilitates to evaluate the toxicity effects of contaminated water from all sampling sites and monitored the efficiency of filtration plant which is the main source of drinking water.

Figure 1. Map of the study area with major tributaries
Slika 1. Karta istraživanog područja s glavnim pritocima

MATERIALS AND METHODS

Water samples were collected in April and June from the allocated sampling sites three in a week. Ten Grab samples (1500 ml) were collected at a distance of 10 meters from one point to another using acid washed (10% HCL) high density polyethylene bottles to avoid any contamination from metal and non-metal ions. The physico-chemical parameters (pH, tempera-ture DO and EC) were measured in the field /on site: pH was measured using a digital pH meter (Model: Martini 180); DO was estimated by utilizing a digital DO meter (Model: Martini Mi 190); EC was measured by a digital conductivity meter (Model: Jenway 470).Water samples were stored in a cooler box and transported to the laboratory and analyzed within 24 hours.COD, TA, Chloride and Sulphate content were analyzed using standard titrimetric methods (APHA-AWWA-WEF, 2005). TSS and TDS were analyzed using standards methods (APHA-AWWA-WEF, 2005). The quantification of trace metals (Cd, Cu, Pb, Zn and Ni) in the water samples was performed using atomic absorption spectrophotometer. (Spectroamon – 2000)

RESULTS AND DISCUSSION

The present study was carried out to measure the physicochemical characteristics and to investigate the presence of heavy metals (Cd, Ni, Cu, Pb and Zn) in the water samples of Angoori Road, Rawal Lake, Phulgaran, Bahria Golf city and Wasa Filtration Plant.

Table 1. Physicochemical parameters of water samples
Tablica 1. Fizikalno kemijski parametri uzoraka vode

Parameters	Technique	April	June	Pak EPA	US EPA	WHO
pH	pH meter	6.20-8.26	6.55–8.29	6.5-8.5	6.5-8.5	7
Temperature	Thermometer	26.3-29.9	32.2-36.5	-	-	
EC (µs)	Digital conductivity meter	258-367	264–513	200-600	200-600	200-600
TDS(mg/L)	Standard gravimetric methods	200-500	450–800	1000	500	1000
TSS (mg/L)	Standard gravimetric methods	800-1050	900-1450	1000	500	1000
TA(mg/L)	Standard titrimetric methods	195–232	280-450	200	200	200
Chloride (mg/L)	Standard titrimetric methods	14.7-22	15.4–30	250	250	250
Sulphate (mg/L)	Standard titrimetric methods	15-50	18-70	250	250	250
DO (mg/L)	Digital DO meter	3.00-6.09	3.38–4.70	6	4-6	6
COD (mg/L)	Standard titrimetric method	8-31	15-38	150	150	150

Table 2. Heavy Metals concentration in water samples
Tablica 2. Koncentracija teških metala u uzorcima vode

Metals	April	June	Pak EPA	US EPA	WHO
Cadmium	0.001–0.468	0.020–0.568	0.001	0.5	0.003
Nickel	0.001-0.338	0.003-0.031	1	2	2
Lead	0.001–0.568	0.001–0.663	0.05	0.015	0.01
Zinc	0.001–0.066	0.001–0.059	5.0	5.0	3.0
Copper	0.001–0.048	0.001–0.051	1.0	1.0	2.0

VARIATION IN Ph

pH is the indicator of alkaline and acidic condition of water status. In the present study, pH of the water samples during June ranged from 6.55 to 8.29 while during April it varied from 6.55 to 8.26. These pH values were within the permissible limits for drinking water as per WHO, USEPA and Pak EPA guidelines [14-15].

There is slight increase in the values of pH in the month of June because in summer water temperatures are high which exaggerate the problem and increases the rate of natural oxygen loss from the water. Thus encourages the growth of algae, which in turn enhance the amount of carbon dioxide consumed and raises the pH level. All of this occurs within natural tolerances if left on its own [16].

Most ecosystems are set up to sustain a certain pH level naturally, so slight natural variations can be tolerated. In summer there is more sunlight, which enhances the photosynthetic activity of microorganisms, algae, and plants in the water, causing them to use up the dissolved carbon dioxide (CO_2) in the water. Since the carbon dioxide in water (H_2O) has already mixed with the atoms in water to form natural carbonic acid (H_2CO_3), the acids in the water are reduced. This reduction of acid raises the water's pH [17].

Humans increase this pH swing even more with the introduction of chemical pollution like fertilizers, which are used most frequently during summer months and are present in storm water runoff in higher concentrations during that time. The phosphates and nitrogen in these fertilizers create disproportionate algae growth, raising the water pH [18].

Analysis showed that pH from 6.20-8.26 in April and 6.55–8.29 in June, the greater values found in water samples Angoori road and Rawal Lake (Figure 2) which slightly exceeded permissible limit 6.5-8.5 [14]. However the pH values are high in month of June as compared to April.

VARIATION IN TEMPERATURE

Water temperature is playing an important role in aquatic ecosystem as a critical factor. It affects biological reactions, population fluctuations in water body as well as physical and chemical characteristics of water. It is essential to revise temperature variations in water body, in animals ecophysiological and toxicological characteristic because, water density and oxygen content are temperature related and hence temperature indirectly affects osmoregula-

tion, respiration, behavior and metabolism of organism [19].

The temperature variations of various site are observed in water samples .The temperature of water samples during June ranged from 32.2-36.5ºC while during April it varied from 26.3-29.9ºC.

The water temperature during winter was low because of land breeze and precipitation and the recorded high summer value could be attributed to high solar radiations [20].

Surface water temperature is inclined by the intensity of solar radiation, evaporation, fresh water influx and cooling and mixing with outgoing tide and flow from adjacent water [21].

Analysis showed that temperature values are high at Angoori road and Rawal Lake (Figure 3) in month of June as compared to April.

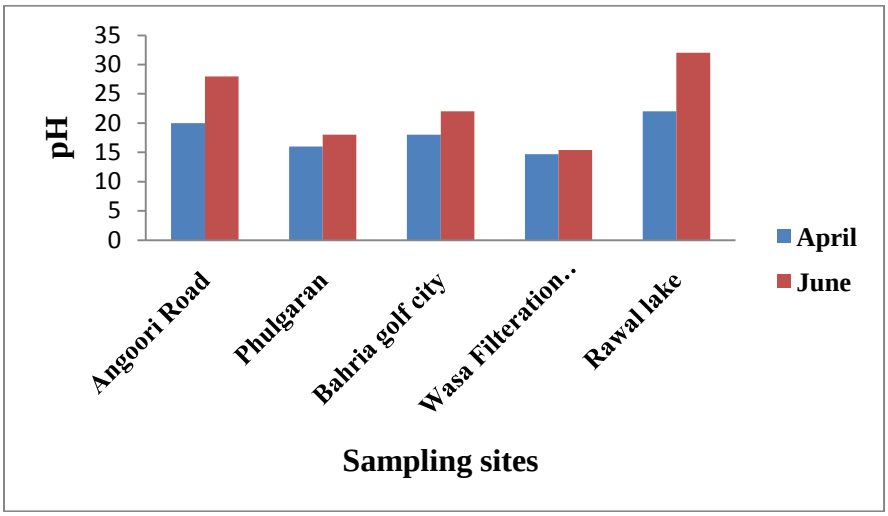

Figure 2. pH variation of water samples of sampling sites
Slika 2. Promjena pH u uzorcima vode sa mjesta uzorkovanja

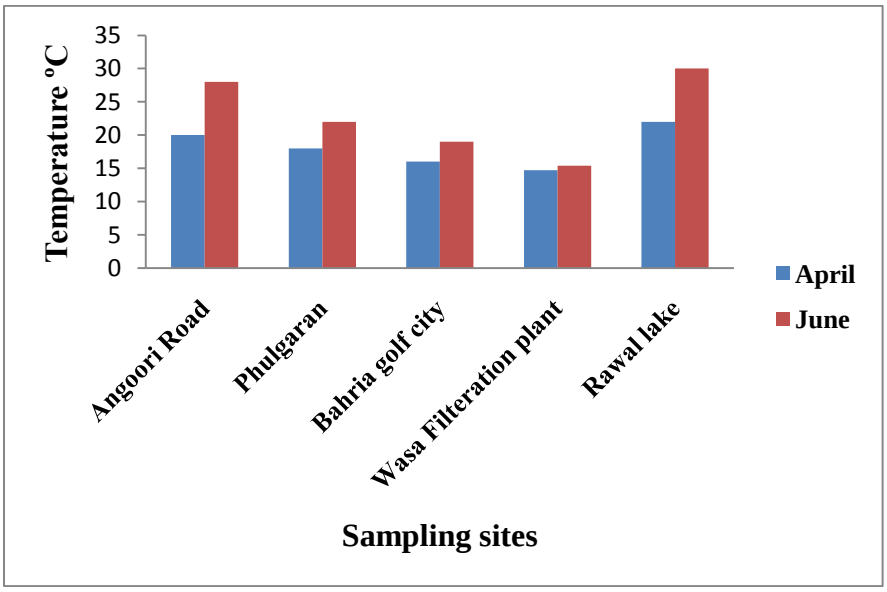

Figure 3. Temperature variation of water samples of sampling sites
Slika 3. Promjena temperature u uzorcima vode sa mjesta uzorkovanja

VARIATION IN DO

Salinity affects dissolution of oxygen in rivers. In the current study investigation showed the higher values of dissolved oxygen during April which might be due to the cumulative effect of rainfall and the resultant fresh water mixing. The high concentration of dissolved oxygen in the reservoir could be attributed to low organic enrichment [22].

The dissolved oxygen levels was lowest recorded minimum at all sampling sites during June which may be due to over loading concentrations of organic and industrial wastes. The fluctuation indicated an contrary link between temperature and dissolved oxygen. In June when temperature was high, the water was unable to bind with oxygen which therefore released. The free oxygen gets used up in the oxidation of organic matter, which consumes a part of oxygen and thus decreasing its concentration in water. The low dissolved oxygen values at all sites in June indicated the high levels of pollution at these points [23].

Analysis showed that DO content varied from 3.38 to 4.70 mg/L and 3.00 to 6.09 mg/L during June and April, respectively. On the average basis DO contents were slightly higher in April than June (Figure 4), which is certified to the temperature variations as well as increased human activities around the sampling sites.

VARIATION IN COD

Chemical oxygen demand verify the oxygen required for chemical oxidation of organic matter.COD values transmit the amount of suspended oxidizable organic matter including the non-biodegradable matters existing in it [24].

Increased level of COD observed in June may be due to high temperature and raised evaporation of water, consumption of oxygen for degradation of organic matter and load of fertilizers and chemical waste discharged in to the river system. High COD value indicate the presence of chemically oxidizable carbonaceous matter as well as inorganic matter such as sulphides, nitrates and reduced metal ions [25].

Analysis showed that COD values ranges from 8-31 mg/L in April and 15-38 mg/L which is within permissible limit 150mg/L. However COD values are higher in June as compare to April (Figure 5) and these values are higher at Rawal Lake and Angoori Road.

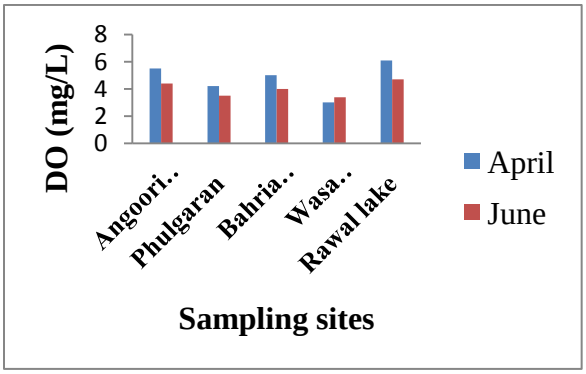

Figure 4. DO variation of water samples at sampling sites
Slika 4. Promjena otopljenog kisika u uzorcima vode sa mjesta uzorkovanja

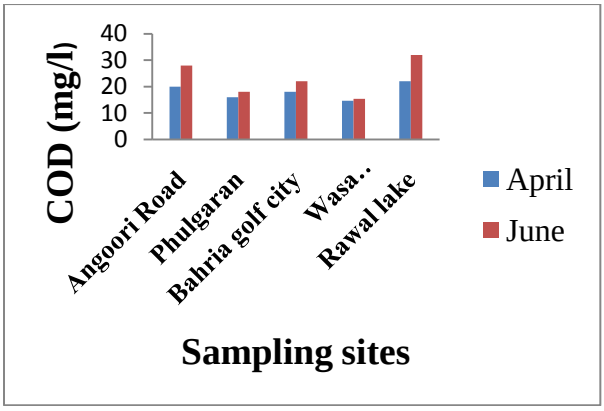

Figure 5. COD variation of water samples at sampling sites
Slika 5. Promjena KPK u uzorcima vode sa mjesta uzorkovanja

VARIATION IN ELECTRICAL CONDUCTIVITY

Electrical conductivity is a essential key to select the suitability of water for agricultural use. Conductivity for a given water body, is related to the concentrations of dissolved solids and major ions. Thus it is sensitive to difference in dissolved solids and major ions and indicator of the mineral content of water body and can be used as an indirect measurement of dissolved solids in water.

Analysis showed that values of electrical conductivity (Figure 6) during June and April of water samples are in satisfactory limits set by worldwide and national authorities [14-15], signifying the appropriateness of water samples for the drinking and irrigation purpose. However EC values are less in April due to precipitation but in June values are comparatively higher due to mineralization of organic water.

VARIATION IN TDS

Analysis showed value of TDS value ranges from 200-500 mg/L in April and 450–800 mg/L which is within permissible limits (Figure 7)

The EPA resultant system advice a utmost contamination level of 500 mg/l for total dissolved solids. Above 1000mg/l it is generally unhealthy for human utilization [14].

Total dissolved solids indicate the amount of inorganic chemicals in water. The presence of K, Cl, Na, Cd, Pb and nitrates caused increase in TDS. High level may produce undesirable tastes. The levels of TDS raised in water body due to silt, leaves, industrial waste, sewage, pesticides etc.

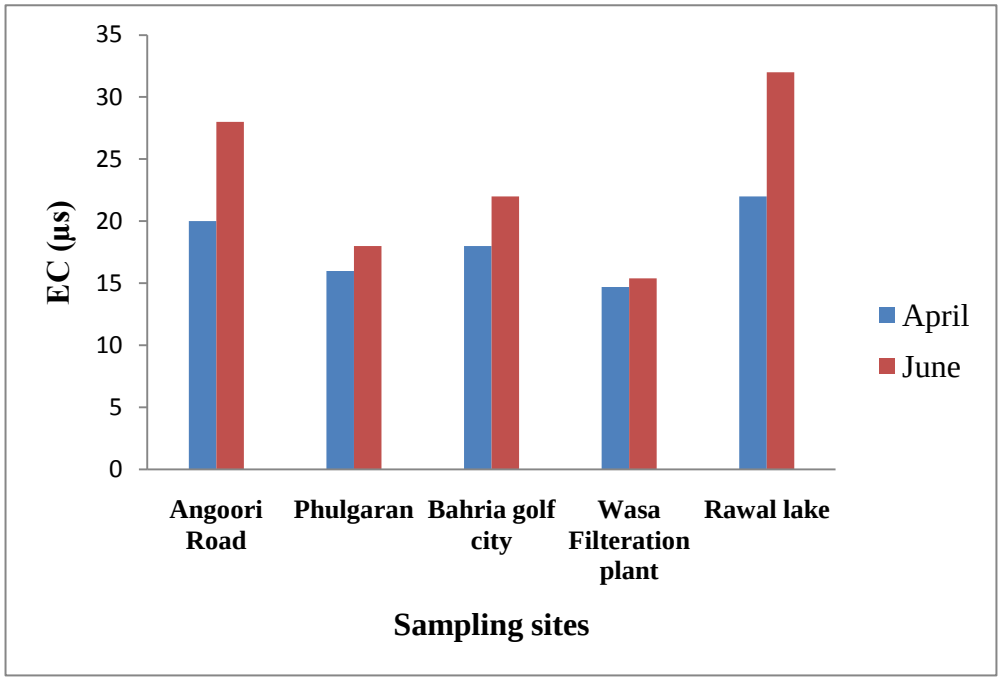

Figure 6. EC variation of water samples at sampling sites
Slika 6. Promjena električne vodljivosti u uzorcima vode sa mjesta uzorkovanja

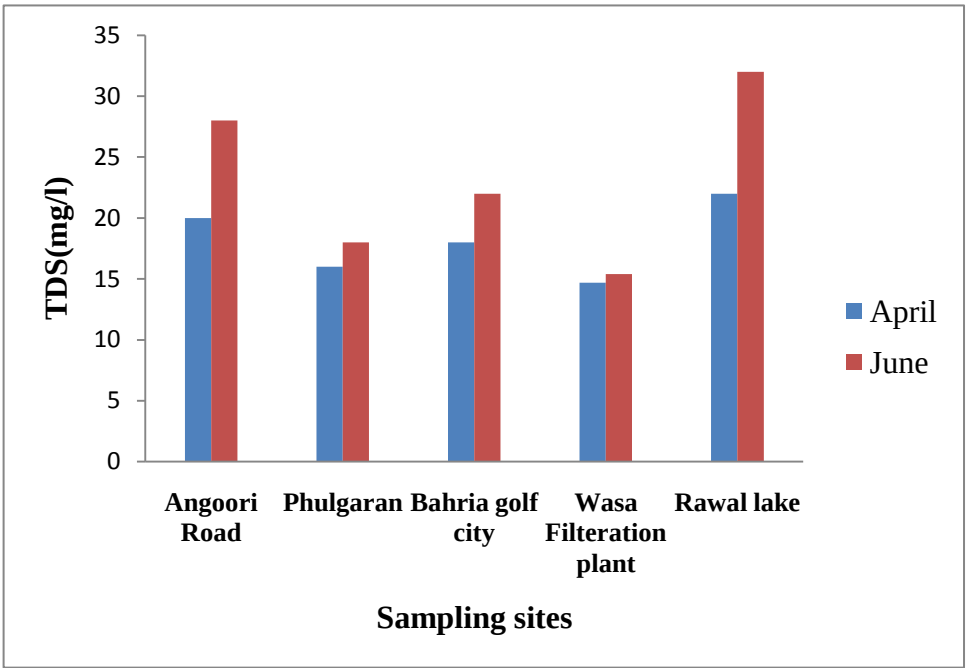

Figure 7. TDS variation of water samples at sampling sites
Slika 7. Promjena ukupno otopljenih krutih tvari u uzorcima vode sa mjesta uzorkovanja

VARIATION IN TSS

The suspended solid examination is particularly functional in analysis of sewage and other waste waters and is important. It is used to assess the potency of domestic waste waters and effectiveness of treatment plants. Suspended solids are obnoxious in aquatic systems for many reasons such as if including much organic matter it can cause rotting and therefore the stream may be devoid of dissolved oxygen [26].

Analysis showed that TSS value ranges from 800-1050 in April while in June these value increased ranging from 900-1450 and these values are higher at two sites Angoori Road and Rawal Lake (Figure 8) which exceeds the permissible limit set up national and international authorities [14].

Suspended particulate matter consists of material initiating from the surface of the catchment area, craggy from banks and their source can be attributed to runoff from mine, fertilizers and pesticides used in farms, industrial wastes and algae growth [27].

TSS varies seasonally according to natural processes in the water and surface surplus carrying soil particles.TSS provides a means of transport of toxic heavy metals and long term impacts of TSS include alteration of in-stream dynamics and receiving bodies, potential flooding problems and loss of aquatic flora and fauna habitat [28].

VARIATION IN TA

The capability of water to neutralize a strong acid is known as alkalinity; most of the alkalinity of water is due to dissolution of carbonate [19].

Total alkalinity (TA) contributes to the stability of water and controls its assertiveness to pipes and machines [15].

Analysis showed that average levels of TA in the sampling sites were drastically higher in June 280-450 compared with the April 195–232 (Figure 9), greater values are observed at Angoori road and Rawal Lake and exceeds the permissible limit in June 200mg/L [14]. High concentration of total alkalinity in the sampling sites could be higher due to high carbon dioxide concentration and discharge of bicarbonates ions by sediments. The mean array of total alkalinity compared with the range given by USEPA, [29] reveal that water quality is unfavorable and is indication of bad quality of the water.

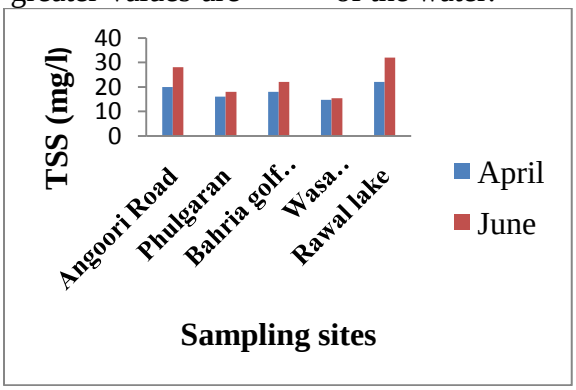

Figure 8. TSS variations of water samples at sampling sites
Slika 8. Promjena ukupno suspendiranih krutih tvari u uzorcima vode sa mjesta uzorkovanja

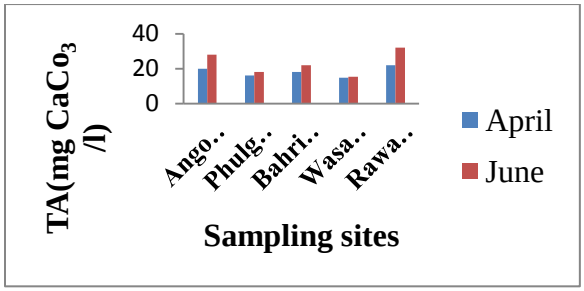

Figure 9. TA variations of water samples at sampling sites
Slika 9. Promjena alkaliteta u uzorcima vode sa mjesta uzorkovanja

VARIATION IN SULPHATE (SO_4^{2-})

Sulphate is present in fertilizers they contribute to water pollution and increase sulphate concentration in water body. They can come from runoff water, which contain relatively large quantities of organic and mineral sulphur compounds. Sulphate ions can be supplied to surface water by the reaction of water with sulphate containing rock and with the biochemical and partly chemical oxidation of sulphides and other compounds of sulphur [19].

Analysis showed that values of Sulphate in April and June are within permissible limits set up national and international authorities and values are higher at Angoori road and Rawal Lake (Figure 10) [14-15].

VARIATION IN CHLORIDE

Chloride is generally present in natural water and is major in waste water. The ecological significance of chloride lies in its potential to regulate salinity of water and exert consequent osmotic stress on biotic communities [19].

Chloride concentration in water indicates presence of organic waste particularly of animal origin and chloride concentration can be increased due to discharge of municipal and industrial waste [30].

Analysis showed the maximum value was recorded in June and minimum was recorded during April on the average basis the values of chloride were higher in June 15.4–30 as compared to April 14.7-22 (Figure 11). All values are within the guideline values [14].

Surplus chloride in water is usually taken as the key of pollution .The sewage water and industrial effluents and hence the discharge of these wastes result in high chloride levels in fresh water [31].

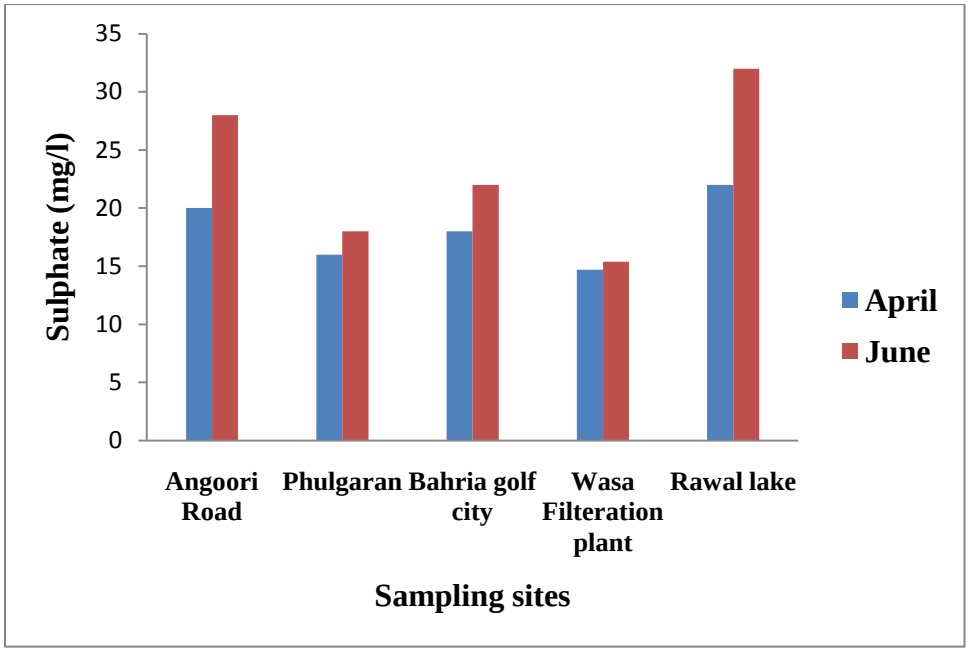

Figure 10. Sulphate variation of water samples at sampling sites
Slika 10. Promjena sulfata u uzorcima vode sa mjesta uzorkovanja

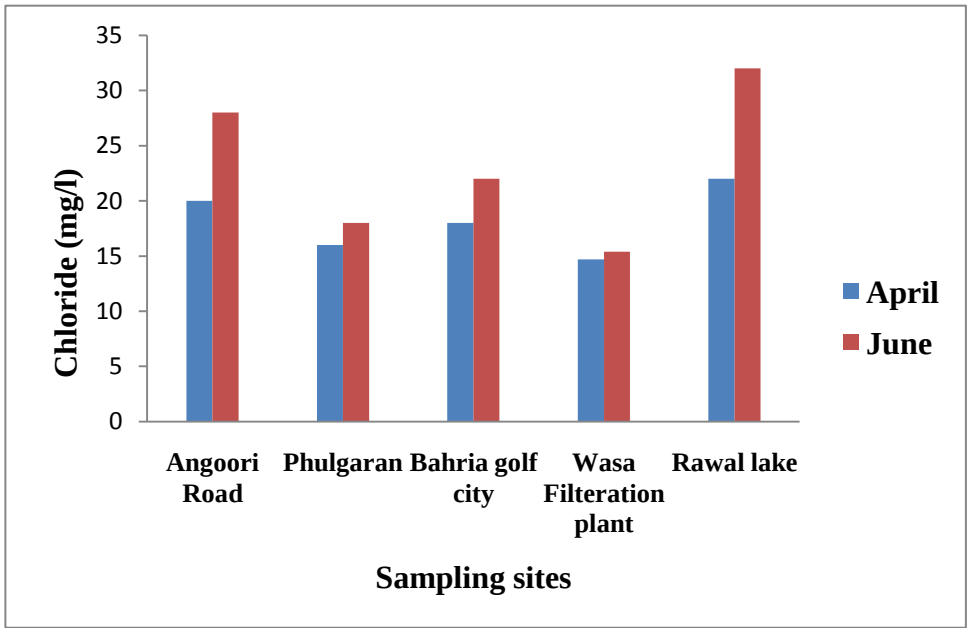

Figure 11. Chloride variation of water samples at sampling sites
Slika 11. Promjena klorida u uzorcima vode sa mjesta uzorkovanja

HEAVY METALS

Heavy metal analysis was done by using Atomic Absorption Spectroscopy. cadmium, lead nickel, copper and zinc were observed to be present in all water samples.

Sources of these metals may be attributed to the nature of the catchment area, industrial waste discharges, poultry wastewater runoffs, agricultural wastes (fertilizers, pesticides and herbicides), geological weathering of parent rocks and atmospheric sources [15].

LEAD (Pb) IN WATER SAMPLES

The results of Pb concentration in water samples of sampling sites are illustrated in Table 1. The concentration of lead (Pb) in water samples was exceeded from permissible limit (0.5 mg/L) which is 0.001–0.568 mg/L in April and 0.001–0.663 mg/L in June in water samples of Rawal lake, Angoori road and Phulgaran (Figures 12, 13, 15)

Emissions of the Pb to the atmosphere from burning of fossil fuels is more than 6,000 tones [32].

Pb is potentially health dangerous and poisonous to most forms of life. Large concentrations lead to respiratory disorders and other never-ending neurological disorders in fetuses and children.

CADMIUM (Cd) IN WATER SAMPLES

Cd is reported to be a component of pesticide and fertilizer [32]. Volatilization of Cd from fertilized agricultural lands introduces significant amounts of Cd to the atmosphere which through runoff gets into the aquatic ecosystem [32].

The result of cadmium concentrations in water samples of sampling site is illustrated in Table 1. The concentration of Cd in water samples are 0.001–0.468 in April and 0.020–0.568 in June which is exceeding the permissible limit of 0.1 mg/l [14]. The higher concentration was found in Rawal Lake and Angoori road (Figures 12, 13).

Cd is reported to cause neurotoxin, hypertension, carcinogenic, teratogenic, and mutagenic and kidney dysfunction. The impacts to marine life may range from their instant kills to impacts disturbing growth, activities or capability to replicate.

Cd and Pb concentration are higher at all sites as compared to standards especially at Angoori road and Rawal Lake due to increase population, burning of wood for fuels, use of fertilizers in agricultural fields and huge discharge of contaminants in these two sites. The concentrations of metals are high in June as compared to April because during summer many tourists visit Murree Hills which is the catchment area of all the sampling sites.

Recreational activities along the surrounding areas of sampling sites cause high contamination of the surface water resources.

ZINC (Zn) IN WATER SAMPLES

The results of Zn concentration in water samples of allocated sites is illustrated in Table 1.the concentration of Zn in water samples range from 0.001–0.066 mg/L in April and 0.001–0.059 mg/L, greater concentration found in Angoori road (Figure 12) which is within permissible limit 5mg/L [14].

COPPER (Cu) IN WATER SAMPLES

Copper concentration in water often increases during distribution, particularly in the systems where an acidic pH exists or in the existence of high-carbonate waters with an alkaline pH. The course of action are derived on the base to be defensive against the gastrointestinal effects of copper [33].

The results of copper concentration in water samples is illustrated in Table 1.Copper in water samples range from 0.001–0.048 mg/l in April and 0.001–0.051mg/L in June ,greater concentration found in Rawal lake (see figure-13) and which is in safe limits from the permissible limit which is 1.0 mg/l [14].

NICKEL (Ni) IN WATER SAMPLES

The results of Nickel concentration in water samples of sampling sites is illustrated in Table 1.

The concentration of Nickel (Ni) range from 0.001-0.338 mg/L in April and 0.003-0.031 mg/L in June, greater concentration found in Angoori road (Figure 12) which is within permissible limits 1mg/L [14].

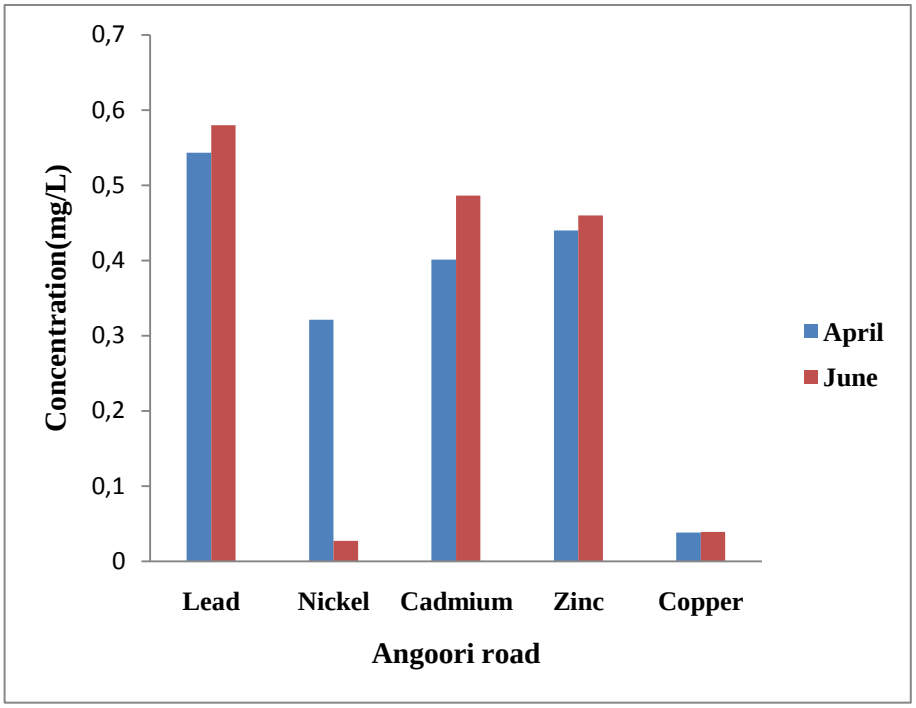

Figure 12. Concentration of heavy metals in water samples of Angoori road
Slika 12. Koncentracija teških metala u uzorcima vode Angori ulice

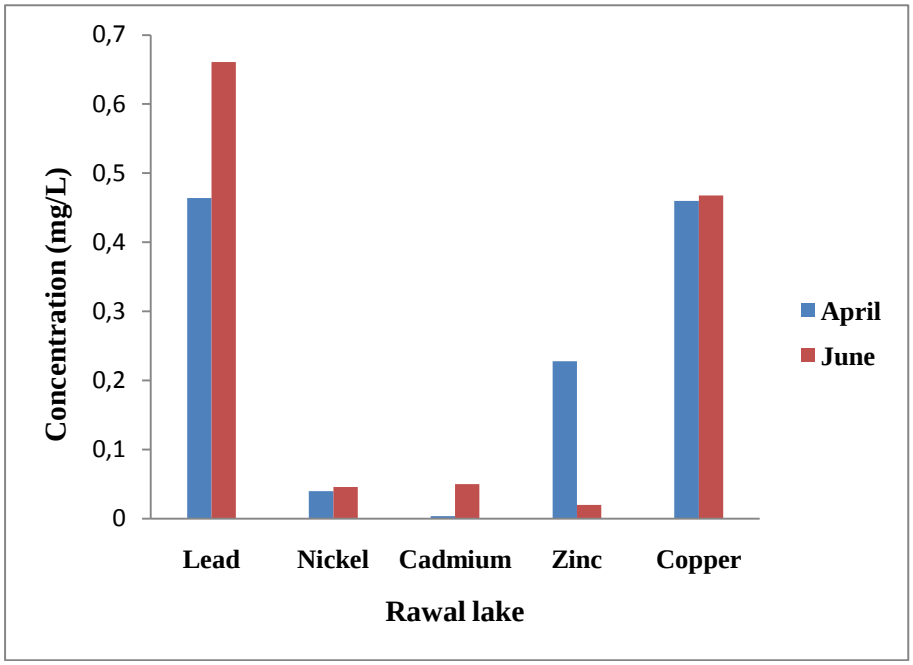

Figure 13. Concentration of heavy metals in water samples of Rawal lake
Slika 13. Koncentracija teških metala u uzorcima vode iz Rawal jezera

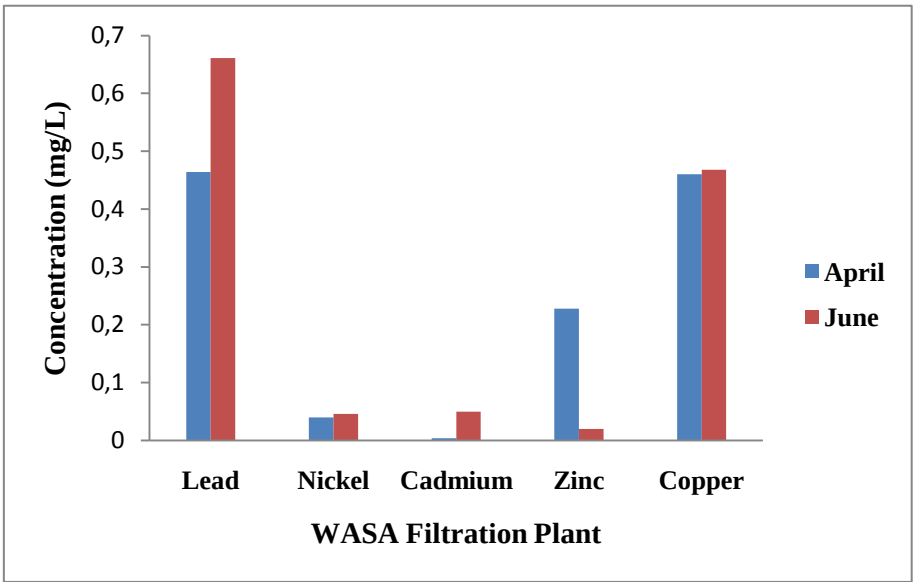

Figure 14. Concentration of heavy metals in water samples of WASA filtration plant
Slika 14. Koncentracija teških metala u uzorcima vode WASA sustava za pročišćavanje

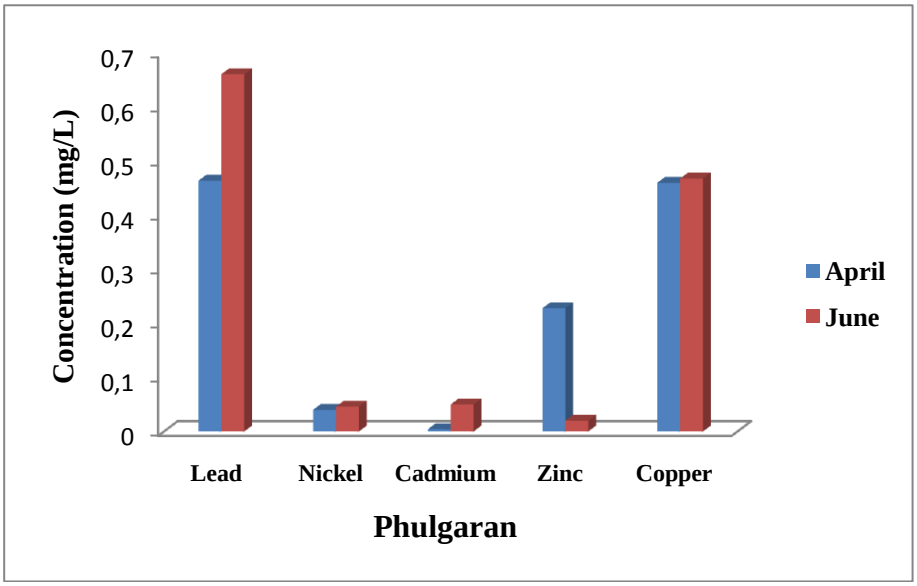

Figure 15. Concentration of heavy metals in water samples of Phulgaran
Slika 15. Koncentracija teških metala u uzorcima vode iz Phulgarana

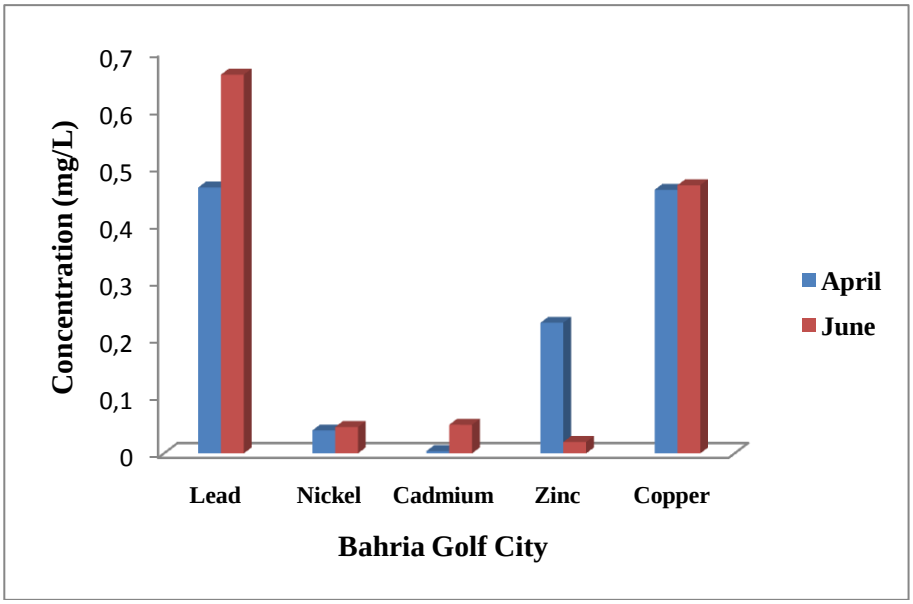

Figure 16. Concentration of heavy metals in Bahria golf city
Slika 16. Koncentracija teških metala u uzorcima vode iz Baheria grada golfa

CONCLUSION

The water quality of all the analyzed sites is deteriorating due to several factors; most noteworthy is the anthropogenic activities like agriculture, deforestation, soil erosion, poultry waste, solid waste dumping and domestic use of water and discharge into the sites without any pretreatment. The sampling sites near populated areas like Angoori road and Rawal Lake were to derive to be more contaminated; and this load is major in June as compared to April. Pollution load in June is due to increase

anthropogenic activities, summer heat and many tourists visit Murree Hills which is the catchment area of all the sampling sites. Recreational activities along the surrounding areas of sampling sites cause high contamination of the surface water resources. Most of the parameters are in acceptable range except COD, DO, TA and TSS and metals like lead and cadmium as compared with USEPA, PakEPA and WHO standards at all sites except WASA filtration plant, and hence cannot be used for drinking purpose; though other water activities can be carry out effortlessly.

Moreover WASA filtration plant is working efficiently it decreases the amount of contaminants coming from all sites and the water quality is fit for drinking. The water samples have high contamination of lead and cadmium so irrigation in agricultural fields should be strongly prohibited and the use of agro chemicals trictly controlled .Safety of water resources should be the primary line of defense. National environmental quality standards or the release of municipal and industrial effluents should be enforce .A program of standard examining of water-quality should be formulated and put into practice. All critical parameters should be constantly monitored.

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