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Determination of heavy metals levels in water of River Jhelum in the State of Azad Jammu and Kashmir, Pakistan

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Abstract

Rivers are dynamic fresh water systems that are essential for the extension of life. The goal of present research was to analyze spatial distribution of some selected heavy metals in water of River Jhelum flowing through Azad Jammu and Kashmir (AJ&K). Overall eleven water samples were collected during month of June 2014 and were examined for heavy metals lead, arsenic, chromium, cadmium, mercury, nickel, copper and zinc. The obtained results were matched with the guiding principle laid by World Health Organization (WHO) for river water. The concentration of metals namely lead, arsenic, chromium, cadmium, mercury and nickel were found beyond the permissible limits suggested by WHO. Only copper and zinc were recorded within the range.

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Introduction

On our planet Earth water is the most valued resource (Katachalam *et al.*, 2010). Naturally water has two forms, groundwater and surface water (Ramkumar *et al.*, 2009). The change in quality of water either ground or surface water is due to natural effects and anthropogenic activities (Kolawole *et al.*, 2008). Rivers are the most important freshwater ecosystems that are vital for the maintenance of life. It is a serious issue that the water qualities of these freshwater ecosystems are declining day by day. Rivers provide water for agricultural, domestic and industrial purposes (Jain, 2009). The major source of water supply is riverine system, in different countries of the world (Sadia *et al.*, 2013). Worldwide recent environmental issue in research is quality of water that is determined by many natural inspirations and human actions (Shrestha and Kazama, 2007).

Currently it is accepted that aquatic surroundings are not only the holding tanks which provide water for use of human. While such environments need careful use to ensure their upcoming sustainability (United Nations Environment Programme Global Environment Monitoring System/Water Programme. Water Quality for Ecosystem and Human Health. National Water Research Institute; Burlington, ON, Canada: 2000). Discharge of raw pollutants from different sources like industrial wastewaters, domestic sewers, agricultural runoff and different sources all may affect river water quality (Singh, 2007). Surface and groundwater pollution are the chief producers of health difficulties (Jurate and Sillanpaa, 2006).

In India Rivers, watercourses and lakes get polluted because of industrial effluents and domestic sewage thrown unswervingly into water (Sangu and Sharma, 1987). Today the most challenging problem in Nigeria is lack of sufficient water for irrigation, domestic and other purposes. For health and any sustainable growth good water quality is essential (Maitera *et al.*, 2010). Khangembam and Gupta (2008) considered Nambul River of Manipur as one of the greatest polluted rivers that gets majority of contaminants from agricultural, domestic and sewage.

According to the World Commission on Water for the 21st Century, more than half of the world´s major rivers are so deficient polluted which poison adjacent environment and impend human health (IPS, 1999). Present study was planned to examine some selected heavy metals in the water of River Jhelum in the area of Azad Jammu and Kashmir. This study will give information related to spatial scattering of heavy metals that distress the purity of water of the River Jhelum.

Materials and methods

Study Area

Azad Jammu and Kashmir (AJ&K) is located in the North Eastern part of Pakistan, between 33^{o} and 36^{o} latitude. It includes an area of 13,297km^2 (Akhtar, 1991). In North, the State is restrained by Gilgit-Baltistan, in the East, by the Indian occupied State of Jammu and Kashmir, in the West, by Khyber Pukhtoonkhwa (KPK) and in the Southwest Punjab. AJ&K is mostly hilly trail, with elevations range from 360m in the South to 6,325m in the North. River Jhelum is the leading river curving in the State of AJK. It arises from the spring of "Chashma Varinag", on the Northwest side of Per Panjal and flows in a direction analogous to the Indus at an average elevation of 5,500 feet (1677m). River Jhelum is joined by many streams flowing in a North-west direction, before reaching the Wular Lake. The river runoff rises below the Wular Lake, and flows in a southeast direction. At downstream of Baramola the river valley starts contracting. At Chakothi, it enters in AJ&K area and flows in a slim valley taking a bend in north-west direction. At steep flow, the river takes a sharp turn at Domail to flow in southward direction with its tributaries namely Neelum (Kishan Ganga) and River Kunhar. River Poonch enters in Mangla Lake at Palak Mirpur AJK.

Sampling

A total of 11 samples of water were taken from selective locations of River Jhelum, Neelum, Kunhar and Poonch namely: Kel (KEL), Sharda (SHA), Athmuqam (ATH), Chakothi (CHA), Hattian Bala (HAT), Sundh Garan (SUN), Domeshi (DAM), Kohala (KOH), Dahan Gali (DAN), Raj Dhani (RAJ) and Mangla (MNG) during the month of June, 2014.

Water samples were taken in plastic polyethylene bottles rinsed with Nitric acid (diluted) its pH was kept at 2, transported to the lab and preserved at 4ºC temperature by following (APHA, 1998).

Analysis of Heavy Metals

In river water samples heavy metals (Pb, Cu, Ni, Cd, As, Zn, Cr, Hg) concentration were checked by Atomic Absorption Spectrometer (AAS) Analyst 800 (Perkin Elemer Serial No. 801550705010).

Pre-concentration of the Samples

Water sample (350 ml) was taken in a beaker and few drops of concentrated HNO_3 was added to maintain the pH less than 2 and then condensed on the hot plate to about 15-20 ml and then filtered. The final volume was made up to 25 ml with 0.1 N HNO_3. In the pre concentrated water samples by using atomic Absorption spectrometer heavy metal contents were checked. Five standard solutions with concentrations 2, 4, 6, 8 and 10 ppm of the respective metals were run to calibrate the instrument. To check the accuracy of instrument the standard solution of 4 or 6 ppm was run after five samples. If the relative standard deviation (%RSD) was noted above 5% the instrument was adjusting by running standards.

Results and discussion

Heavy metals have been used as an indicator of contamination due to their poisonousness to humans and aquatic organisms (Omoigberale and Ogbeibu, 2005). The human activities are linked with civic and industrial effluents, water runoff, urban storm, coal and ore mining, inputs rural areas and atmospheric origin (Zarazua *et al.*, 2006). Extraordinary ingestion of these heavy metals Hg, Cd, Cr, Pb, Ni, Zn and Co cause carcinogenic effects on human health, these heavy metals have an obvious effect on aquatic vegetation and animals (Muhammad *et al.*, 2011).

Lead

In the current study concentration of lead at KEL was calculated as 0.92±0.06mg/L, at SHA 1.42±0.08mg/L, at ATH 0.09±0.02mg/L, at CHA 0.69±0.1mg/L, at HAT 1.21±0.1mg/L, at SUN 0.98±0.12mg/L, at DAM 0.92±0.15mg/L, at KOH 0.28±0.05mg/L, at DAN 0.104±0.1mg/L, at RAJ 0.94±1.07mg/L and at MNG its value was 0.76±0.1mg/L. The highest lead concentration was calculated at SHA (1.42±0.08mg/L) and minimum at the ATH (0.09±0.02mg/L). At all sites lead concentration was higher when compared with standard value of 0.01mg/L suggested by WHO. The most ancient metals known to man is lead & is released on surface water by pipes, building material, gasoline and paints etc. It is familiar poisonous metal (Ayele *et al.*, 1993). It affects human health like kidney damage, digestive disturbance, brain and nerve damage, blood disorders and hypertension (SDWF, 2003). Farooq *et al.* (2012) described high level of lead (Pb) mainly assigned to human activities. Surface water quality is main issue particularly in regions where it is used for drinking purposes. Many workers studied it (Varol and Sen, 2009; Ammar and Rahmane, 2010).

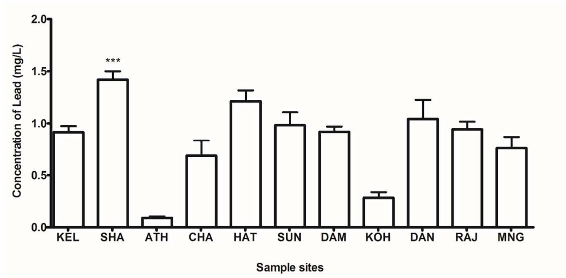

Fig. 1. Level of Lead from water samples at various sampling sites.

Chromium

In the current study the concentration of chromium at KEL was calculated 1.06±0.08mg/L, at SHA 1.13±0.1mg/L, at ATH 1.27±0.1mg/L, at CHA 0.85±0.09mg/L, at HAT 1.11±0.1mg/L, at SUN 0.85±0.07mg/L, at DAM 0.99±0.1mg/L, at KOH 1.20±0.08mg/L, DAN 1.11±0.07mg/L, at RAJ 1.25±0.1mg/L and at MNG concentration of chromium was calculated 1.00±0.2mg/L. The highest chromium concentration was recorded at three sites, ATH , KOH and RAJ (1.27±0.1mg/L) and the lowest at two sites CHA and MNG (0.85±0.0mg/L) having mean value of 0.954m/L. At all sites of the study area the concentration of Cr was observed higher, when compared with standard guideline value 0.05mg/L of (WHO). Higher concentration of chromium cause air passage and lungs problems (Tariq *et al.*, 2008; Nickson *et al.*, 2005).

Ismail *et al.* (2006) evaluated concentration of Cr in water of Indus delta and described 0.291 ppb of Cr and it was due to human activities. For growth chromium is necessary element (Saif *et al.*, 2005). To invertebrates acute toxicity of Cr is highly variable, depends upon species (Moore and Ramamoorthy, 1984).

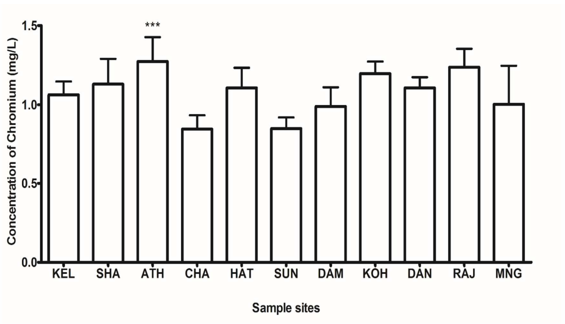

Fig. 2. Level of Chromium from water samples at various sampling sites.

Arsenic

In the current study arsenic concentration at KEL was calculated 0.90±0.04mg/L, at *SHA* 0.16±0.04mg/L, at ATH 1.06±0.08mg/L, at CHA 0.72±0.07mg/L, at HAT 0.81±0.05mg/L, at SUN it was 0.27±0.04mg/L, at DAM 0.74±0.07mg/L, at KOH 0.71±0.01mg/L, at DAN 0.61±0.1mg/L, at RAJ 1.19±0.7mg/L and at MNG concentration of arsenic was measured 0.98±0.1mg/L. The extreme concentration of arsenic was measured at RAJ (0.19±0.7mg/L) and minimum at SHA (0.12mg 0.16±0.04/L). At all sites concentration of arsenic observed higher when compared with standard guidelines value 0.05mg/L of (WHO). Naturally arsenic is present in metalloid form. Arsenic accumulation leads to discoloration of the skin and cause cancer (Ashraf *et al.*, 1991; He *et al.*, 1994).

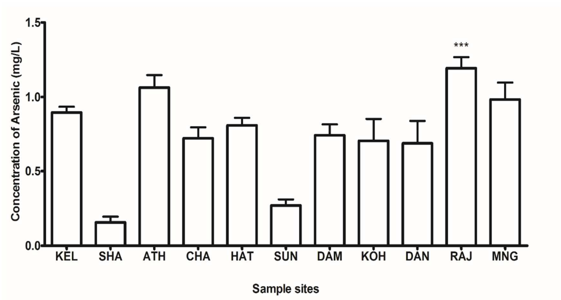

Fig. 3. Level of Arsenic from water samples at various sampling sites.

Cadmium

In this study concentration of cadmium at *KEL* measured 1.06±0.09mg/L, at *SHA* 1.15±0.04mg/L, at ATH 0.06±0.02mg/L, at site *CHA* 0.78±0.1mg/L, at HAT 1.16±0.1mg/L, at SUN 1.06±0.09mg/L, at DAM 2.06±0.08mg/L, at KOH 0.76±0.1mg/L, at DAN 0.56±0.1mg/L, at RAJ 0.76±0.1mg/L and at MNG concentration of Cd was calculated 0.73±0.06mg/L. The highest concentration of cadmium was calculated at DAM (2.06±0.08mg/L) and minimum at ATH (0.06±0.02mg/L) having mean value of 0.835mg/L. The Cd concentration at all sites was observed higher when compared with WHO guidelines (0.003mg/L). Through paints, glass enamel, pigments and deterioration of the galvanized pipes, cadmium is added to the surface waters (Sindhu, 2002). Few cases of Cd poisoning are reported in humans by ingestion of contaminated fishes. Its toxicity is low in case of plants than Cu. Cd is toxic to invertebrates and fishes (Moore and Ramamoorthy, 1984). Cd effect human health by kidney and liver damage, renal malfunction and gastrointestinal damage (Bagchi*et al.*, 2002).

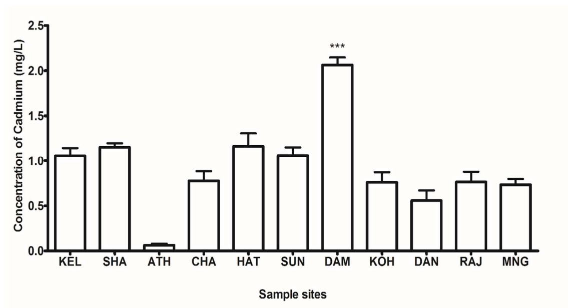

Fig. 4. Level of Cadmium from water samples at various sampling sites.

Copper

In the present study copper concentration at KEL was measured 0.84±0.07mg/L, at *SHA* 1.33±0.1mg/L, at ATH 0.65±0.1mg/L, at CHA 0.77±0.1 mg/L, at HAT 1.18± 0.06 mg/L, at SUN 1.07±0.09mg/L, at DAM 1.01±01mg/L, at KOH 0.76±0.1mg/L, at DAN 0.72±0.08mg/L, at RAJ 0.77±0.1mg/L and at MNG the concentration of copper was calculated 0.78±0.1mg/L. The concentration of copper recorded was highest at two sites SHA and HAT (1.33±0.1mg/L) and minimum at ATH (0.65±0.1mg/L). The concentrations of copper at all sites were below the standard limit of 2.0mg/L suggested by WHO.

Copper (Cu) is poisonous to living organisms when rate of excretion is lower than the rate of absorption, while Cu is stored in animals and plants, therefore it's necessary to lower Cu conc. in the water way (Moore and Ramamoorthy, 1984).

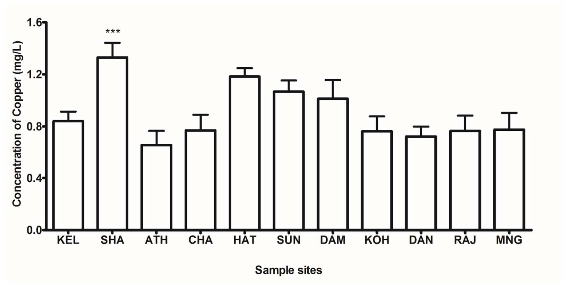

Fig. 5. Level of Copper from water samples at various sampling sites.

Zinc

In this study zinc concentration at KEL was calculated 0.75±0.08mg/L, at SHA 0.940.65±0.10.08mg/L, at ATH 0.770.65±0.3mg/L, at CHA 1.25±0.04mg/L, at HAT 0.99±0.1mg/L, at SUN 0.48±0.05mg/L, at DAM 1.09±0.1mg/L, at KOH 0.76±0.1mg/L, at DAN 0.84±0.08mg/L, at RAJ 0.75±0.1mg/L and at MNG its concentration was calculated 1.30±0.07mg/L. The highest concentration of zinc was measured at two sites CHA MNG (1.25±0.04mg/L) while the lowest at site SUN (48±0.05mg/L). The Zn concentration at all sampling sites of the study area detected below when compared with the standard limit suggested by WHO (3.0mg/L). Its exceeding limits can cause serious damage to living organisms, but fortunately the results of this study are in safe limit). Zinc (Zn) is an important element for metabolic and physiological actions of many organisms (Pillai, 1983).

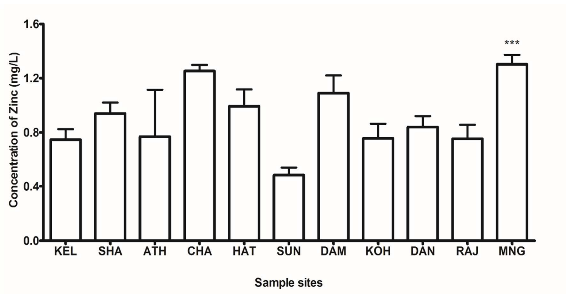

Fig. 6. Level of Zinc from water samples at various sampling sites.

Mercury

In this study the concentration of mercury at KEL was calculated 0.76±0.1mg/L, at SHA 0.56± 0.1mg/L, at ATH 0.48±0.04mg/L, at CHA 0.91±0.05mg/L, at HAT 1.39±0.07mg/L, at SUN 0.52±0.09mg/L, at DAM 1.01±0.1mg/L, at KOH 0.91±0.04mg/L, at DAN 0.94±0.08mg/L, at RAJ 0.66±0.1mg/L and at MNG the concentration of mercury measured 0.84±0.08 mg/L. The highest concentration of mercury was calculated at site HAT (1.39±0.07mg/L) and the lowest at SUN (0.48±0.04mg/L). The concentration of mercury at all sampling sites was higher than the standard value of WHO (0.001mg/L). The exceeding value from WHO guidelines of mercury in study are may due to combustion facilities, including open hospital incineration, municipal solid waste incineration and coal-fired are the chief sources of mercury in urban areas. This toxic metal interferes with human central nervous system (Ferguson, 1991). Harmful waste and sewage sludge are other origins of mercury contamination in urban areas. In sediments of Poznan, mercury concentrations are low and ranging from 29-283ng/g (Boszke and Walski, 2006). In surface water of Changchun, China higher mercury concentrations were measured ranging from 56.7 to 192.6ng/L (Fan *et al.*, 2004). In the Danube River at Budapest, mean values for mercury concentrations were recorded 1.0-1.2µg/L with maxima of 4.7-18.1µg/L and at the Iron Gate reservoir 0.2-0.4 µg/L, with maxima of 3.5µg/L (Marjanovic *et al.*, 1995).

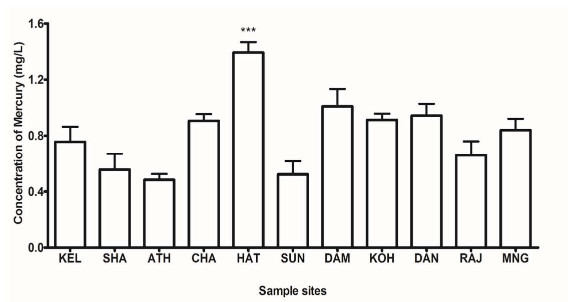

Fig. 7. Level of Mercury from water samples at various sampling sites.

Nickel

In current study nickel concentration at KEL was measured 1.32±0.1mg/L, at SHA 0.56±0.01mg/L, at site ATH 0.76±0.01 g/L, at CHA 0.34±0.01 g/L, at

HAT 0.56±0.01 g/L, at SUN 1.32±0.01 g/L, at DAM 0.67±0.01 g/L, at KOH 0.89±0.01 g/L, at DAN 0.76±0.01 g/L, at RAJ 0.89±0.01 g/L and at MNG nickel concentration was recorded 0.34±0.02 g/L. The highest concentration of Nickel was recorded at two sites KEL and SUN (1.32±0.01 g/L) while the lowest also at two sites CHA and MNG (0.34±0.02 g/L). The concentration of Ni at all sampling sites observed higher, when compared with standard value set by WHO (0.1mg/L). Ni is released from both human actions and natural causes. In air, water, soil and biological substantial it is contemporary (Clayton and Clayton, 1994; Grandjean, 1984; Clarkson, 1988). For animal species, plants and micro-organisms nickel (Ni) is vital trace metal and consequently toxicity and insufficiency symptoms occur when Ni is taken up too much or too low. Ni go in in body as pollutant in food and water (Haber *et al.*, 2000; Diagomanolin *et al.*, 2004; Young, 1995; Clayton and Clayton, 1994). Ni is released into the river in connotation with organic matter and as a precipitated coating on particles. In River Karoon in Iran, Ni concentrations reached from 69.3 to 110.7µg/l in winter and from 41.0 to 60.7µg/l in spring.

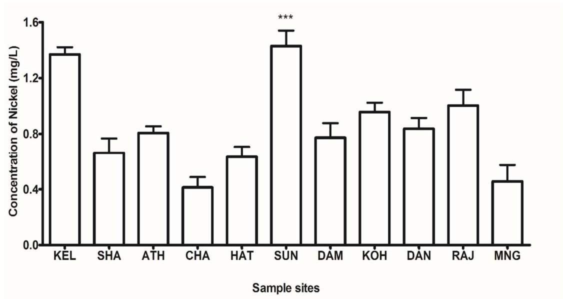

Fig. 8. Level of Nickel from water samples at various sampling sites.

Conclusion

This recent study summarizes the spatial distribution of heavy metal pollution in the river Jhelum and its major tributaries flowing through AJ&K. Results of this study of heavy metal pollution show that the levels of various heavy metals in the river Jhelum water are far above the acceptable concentrations suggested by WHO. The water of the river Jhelum is receiving metal contamination due to several factors; most noteworthy is the anthropogenic activities like agriculture, industry, road developments, domestic use of water and discharge into the river without any pre-treatment. The hazard of bioaccumulation and biomagnification of the heavy metals through river water can make a big risk to human health and aquatic life. Hence, it is necessary that various sources of heavy metals in the water of the river Jhelum should be closely monitored; improvement of industrial effluent and domestic sewage discharge should be reduced or treated before introducing in to it.

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