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Determination of Physicochemical and Heavy Metals Concentration in Khanpur Dam Reservoir Khyber Pakhtunkhwa, Pakistan

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***Abstract*:** *The present study was conducted to examine the water quality characteristics of Khanpur Dam Reservoir, Khyber Pakhtunkhwa, Pakistan, water samples were collected from agriculture, runoff, society and mid of the Dam during pre and post monsoon. Physicochemical parameters were determined by using standard methods. The results of pre and post monsoon were obtained in the following order. pH ranged 6.1 to 7 and 6.4 to 7.2, conductivity 363 to 505 µS/cm and 448 to 507 µS/cm, TDS 240 to 262 and 240 to 270 mg/L, Chloride17.725 to 53.175 mg/L and 10.635 to 26.5875 mg/L, Fluoride zero to 3.5 mg/L and zero to 2.4 mg/L , respectively. Heavy metals were also assessed in the samples by using Atomic absorption spectrophotometer and standard method. The concentration of heavy metals in pre and post monsoon was found in the following order. Cadmium 0.08 to 0.44 mg/L and 0.2 to 0.9 mg/L, Iron 0.09 to 1.6 mg/L and 0.29 to 1.28 mg/L, Manganese 0.29 to 0.52 mg/L and 0.37 to 0.5 mg/L, Lead 0.03 to 0.21 mg/L and 0.1 to 0.79 mg/L, Chromium 0.12 to 1.2 mg/L and 0.1 to 0.28 mg/L, Nickel 0.21 to 1.5 mg/L and 0.1 to 0.6 mg/l, respectively. The results obtained were compared with Pak-EPA standard limit. It was found that the concentration of Fluoride and heavy metals like Nickel, Lead, chromium and Cadmium were above the permissible limit in mostly Post monsoon samples. Regulatory authorities and concerned departments should monitor the water quality before its supply to the community.*

Keywords: *Water, Physicochemical, heavy metals, Dam, Pak-EPA.*

1. Introduction

Surface and ground water resources are mostly affected causing diseases, aquatic ecosystem disturbances, crop failure and loss of aesthetics etc. (Khan, 2017). Water pollution is one of the major threats to public health in Pakistan. Drinking water quality is poorly managed and monitored. Pakistan ranks at number 80 among 122 nations regarding drinking water quality. Drinking water sources, both surface, and groundwater are contaminated with coliforms, toxic metals, and pesticides throughout the country. Various drinking water quality parameters set by WHO are frequently violated. Human activities like improper disposal of municipal and industrial effluents and indiscriminate applications of agrochemicals in agriculture are the main factors contributing to the deterioration of water quality. Microbial and chemical pollutants are the main factors responsible exclusively or in combination with various public health problems (Azizullah., et al.,2011).

Ground water recharging is dependent upon rainfall and storage in the reservoir/dam. Higher rainfall contributes efficient recharging of groundwater, while dam has positive impact on groundwater recharging. In areas surrounding the dam site, water table is about 75 ft deep but it falls to as much as 150 ft deep as we move away from the dam site. Khanpur Dam is playing an important role to sustain the groundwater aquifer in study area. This reservoir is maintaining efficient recharging for last forty years. Many positive environmental aspects are associated with the construction of the dam. A remarkable development in agriculture has been observed in the study area after the construction of dam. Inflow and outflow pattern at dam-site are indicating that proper water management is required to further enhance the agricultural activities. When the water containing heavy metals leaches down to the ground water, it will contaminate the water which is normally used for washing and drinking purpose. The results show that waste water containing heavy metals, is the evidence that industrial water getting mixed with domestic waste water can cause serious risk to environment. Heavy metals such as lead, chromium etc lead to diseases like cancer when they get mixed with drinking water (Khan, 2017).

Laws play a major role to protect natural resources from damage and first legislation in Pakistan regarding protection of the environment and natural resources were Environmental Protection Ordinance 1983. This ordinance is the foundation of Pakistan Environmental Protection Agency (Pak-EPA) and Pakistan Environmental Protection Council (PEPC). The implementation of Environmental protection Ordinance 1983 further involves Environmental Assessment to analyze the available resources. Require demand for these resources which further provide a useful conclusion about the scarcity of natural resources in Pakistan. Furthermore, National Environmental Quality Standards (NEQ'S) and Pollutant Emission limits were established in 1993 in a meeting organized by Pakistan Environmental Protection Council (PEPC) after the creation Pakistan Environmental Protection Agency (Pak-EPA) and Pakistan Environmental Protection Council (PEPC) in 1983. Latter on Pakistan Environmental Protection Act 1997 was implemented to regulate critical issues associated with environmental protection (GOP, 1997).

After 1997 environmental protection regulatory framework Government also focuses on to design new policies, for example, National Environmental Policy 2005, National Drinking Water Policy 2009, National Sanitation Policy 2006 (MOE-PAK, 2005, 2006, 2009). These policies focus on the availability of safe drinking water for all peoples of the country, provide water supply at minimum cost and control over water pollution to secure the fresh water resources of Pakistan from a future perspective. Monitoring and evaluation of environmental policies, the outcome of the policy and public health targets shows that implementation of environmental protection policies is not effective. Data about industrial pollution in Pakistan shows that most of the industries cross the maximum limit for emission which is the major cause of pollution and damages to natural resources especially fresh water quality. Government introduces environmental programs, for example, cleaner production in common effluent treatment plants and in industries, pollution charge systems, self monitoring, and reporting. Results of these programs are not according to aim and objectives of these programs due to drawbacks in the implementation of the law in Pakistan. Analysis of public sector involvement indicates less focus on impact assessment of projects due to which future strategies will be failed to achieve the required objectives of environmental protection programs. Provincial laboratories for quality assessment of water resources face a lack of financial resources. Communication system between concerned authorities and local peoples is also weak which creates abarrierto the implementation of programs associated with PESTEL (Political, Economic, Social, Technological, Environmental and Legal) analysis of Pakistan (WWF, 2007). So The present study was to determine the Physiochemical and heavy metals concentrations in Khanpur Dam Reservoir, Khyber Pakhtunkhwa, Pakistan and generate the base line data of the study area.

2. Methodology

Research samples were collected from various location points pre and post monsoon, All the water samples were tested for physical and chemical as well as for heavy metals by using standards methods employed by WHO and ASTM. All the samples were taken in Pre and Post monsoon at sampling sites. Samples were randomly collected from Khanpur Dam before and after rain from different locations of the study area. Samples were composed of four different types of water. It includes society water, runoff water, agriculture water, and dam water from the center of the Dam. Total 40 samples were collected from different locations in the season of Pre-monsoon 20 samples and post monsoon 20 samples.

3. Results and Discussion

Physicochemical parameters of the Khanpur Dam water samples at various location points of pre and post monsoon were checked and they were found: pH 6.1 to 7 and 6.4 to 7.2, conductivity 365 to 505 µS/cm and 448 to 507 µS/cm, TDS 240 to 262 and 240 to 270 mg/l, Cl 17 to 53 mg/L and 9 to 27 mg/l, F 0.2 to 3.5 mg/L and 0.3 to 2.4 mg/l, respectively. These values were compared with Pak-EPA, pH, conductivity, TDS and Cl were found with in permissible limits while in most of the samples F values were found above the permissible limit as shown in table1.

Higher the value of dissolved solids, greater the amount of ions in water (Bhatt et al., 1999). Increasing levels of conductivity and cations are the products of decomposition and mineralization of organic materials (Abida, 2008). Chlorides can contaminate fresh water streams and lakes. Fish and aquatic communities cannot survive in high level of chlorides. Therefore, water that is used in industry or proceeds for any use has a recommended maximum chloride level (Kumar and Puri, 2012). Fluoride may be an essential element for animals and humans. For humans, however, the essentiality has not been demonstrated unequivocally, and no data indicating the minimum nutritional requirement are available. To produce signs of acute fluoride intoxication, minimum oral doses of at least 1 mg of fluoride per kg of body weight were required (Janssen et al., 1988). Heavy metals concentrations were also assessed during pre and post monsoon water samples their results were ranged Cd 0.08 to 0.44 mg/L and 0.2 to 0.9 mg/L, Fe 0.09 to 1.6 mg/L and 0.29 to 1.28 mg/L, Mn 0.29 to 0.52 mg/L and 0.37 to 0.5 mg/L, Pb 0.03 to 0.21 mg/L and 0.1 to 0.79 mg/L, Cr 0.12 to 1.2 mg/L and 0.1 to 0.28 mg/L, Ni ranged 0.21 to 1.5 mg/L and 0.1 to 0.6, respectively. These values were compared with Pak-EPA. Results values of the Fe and Mn were found with in permissible while Ni, Pb, Cr and Cd were found higher then permissible both pre and post monsoon as shown in table 2.

TABLE I: 1hysicochemical concentration of pre monsoon water quality of the study area

S.No	**pH**	**Conductivity (µS/cm)**	**Concentration (mg/l)**								
			TDS	**F**	**Cl**	**Fe**	**Mn**	**Ni**	**Pb**	**Cr**	**Cd**
1	7	385	240	0.9	21	0.5	0.42	0.92	0.1	0.19	0.3
2	6.8	423	250	0.7	32	0.5	0.35	0.21	0.06	0.14	0.3
3	6.5	481	250	0.6	41	0.5	0.45	0.62	0.09	0.19	0.2
4	6.7	387	260	0.1	27	0.6	0.41	1.5	0.12	0.24	0.1
5	6.8	396	260	0.8	28	0.4	0.38	1.2	0.09	0.12	0.3
6	7	423	260	0.8	18	0.5	0.42	0.67	0.19	0.22	0.1
7	6.9	365	250	1.2	17	0.7	0.42	0.55	0.09	0.26	0.2
8	7	456	260	1.1	23	0.4	0.41	0.76	0.21	0.22	0.4
9	6.6	475	262	3.5	24	0.7	0.37	0.52	0.18	0.2	0.2
10	6.9	421	250	0.9	27	0.1	0.39	0.45	0.08	0.28	0.2
11	6.9	469	250	0.9	26	0.6	0.37	1.2	0.06	0.21	0.1
12	6.5	498	250	3.2	27	0.2	0.39	1.5	0.1	0.24	0.1
13	6.8	503	250	2.6	27	1	0.48	1.25	0.11	0.22	0.3
14	6.7	488	250	1.4	28	1.6	0.52	1.21	0.03	0.17	0.1
15	6.9	505	240	2.2	21	1.5	0.51	0.9	0.06	0.21	0.3
16	6.6	461	250	0	25	1.1	0.48	1.5	0.05	0.5	0.3
17	6.1	492	260	7.7	53	0.7	0.29	1.2	0.12	0.35	0.4
18	6.7	412	250	0.2	28	0.9	0.31	0.9	0.11	0.43	0.3
19	6.9	432	260	1.5	23	1.4	0.38	0.87	0.14	0.42	0.4
20	7	466	250	1.4	32	0.2	0.46	1.4	0.12	1.2	0.3
Pak-EPA	6.5-8.5	400	1000	1.5	250	2	0.5	0.02	0.05	0.05	0.01

Dam samples collected from a point near society and runoff indicated maximum cadmium level of 0.42 mg/L whereas samples collected from agriculture and within the dam showed cadmium level above permissible limits. Cadmium level is also very significant for laboratory test due to its direct relationship with human health which causes failure of some human organs for example Kidneys (Buchet et al., 1990). Cadmium is toxic metal which is originated naturally in the environment. Anthropogenic sources including agriculture and industries also produce cadmium. For a non-smoker, food is the only source of cadmium dosage. It is also known as aneurotoxin which further fails the renal system of human body. Clinical studies about kidneys laboratory reports explain that kidneys store cadmium for 10-30 years period. Clinical studies also report that diabetes-induced effects on kidneys are caused by cadmium (Chen et al., 2006)

TABLE II: physicochemical concentration of post monsoon water quality of the study area

S.No	**pH**	**Conductivity (μS/cm)**	**Concentration (mg/l)**								
			TDS	**F**	**Cl**	**Fe**	**Mn**	**Ni**	**Pb**	**Cr**	**Cd**
1	7	497	250	0.9	11	0.48	0.41	0.1	0.33	0.22	0.3
2	7	476	260	1.1	23	0.87	0.39	0.4	0.38	0.14	0.4
3	6.4	448	260	0.9	17	0.51	0.39	0.5	0.22	0.19	0.4
4	7	483	250	0.8	18	0.67	0.42	0.4	0.21	0.21	0.3
5	7	455	250	1.1	16	0.65	0.4	0.6	0.3	0.26	0.4
6	7.2	473	270	2.4	15	0.3	0.38	0.2	0.21	0.17	0.2
7	6.9	476	260	0.9	27	0.79	0.41	0.6	0.22	0.11	0.2
8	6.8	481	270	0.9	15	0.4	0.38	0.3	0.29	0.14	0.3
9	7.2	483	270	0.6	16	0.29	0.42	0.2	0.28	0.11	0.35
10	7	473	260	2	20	0.71	0.38	0.1	0.35	0.1	0.9
11	6.9	473	240	0.4	12	0.5	0.41	0.5	0.4	0.21	0.3
12	7	460	250	0.3	18	0.71	0.38	0.3	0.41	0.22	0.35
13	6.9	469	245	0.8	14	0.55	0.37	0.34	0.39	0.24	0.41
14	7.1	462	240	0	25	1.28	0.37	0.5	0.79	0.28	0.38
15	7.1	472	240	0.6	19	1.1	0.39	0.4	0.42	0.12	0.42
16	7.2	483	260	0.5	14	0.09	0.41	0.34	0.1	0.16	0.7
17	7	467	270	0.4	27	0.61	0.39	0.32	0.38	0.12	0.6
18	7.1	473	260	1.8	21	0.7	0.5	0.21	0.32	0.14	0.6
19	6.7	507	250	0.8	12	0.66	0.42	0.2	0.41	0.22	0.5
20	6.8	479	240	0.3	9	0.66	0.38	0.4	0.11	0.1	0.6
Pak-EPA	6.5-8.5	400	1000	1.5	250	2	0.5	0.02	0.05	0.05	0.01

Iron levels were recorded with in the permissible limit. Whereas the analysis of society, Dam, Runoff and Agriculture showed above than the permissible limit.

Samples collected from Society indicated a bit high level of lead concentration, the Maximum lead concentration was observed nearly in only society samples. The result showed that highest level of lead was traced in society samples. For drinking water, Lead is categorized in most toxic heavy metal which shows its significant relationship with human health. A common intake of inorganic form of lead is digested through food, water, and inhalation. What begins as a sub lethal effect of a metal may end up as a lethal effect. As is the case with other metals, chromium toxicity to aquatic organisms increases as water temperature increases and as pH and salinity decreases. Clinical studies about nickel toxicity find its relationship with embryo toxic, nephrotoxic effects, contact dermatitis and allergic reactions (EPA, 2002). Medical case studies also diagnosis that nickel is also major cause conjunctivitis, pneumonitis and asthma.

4. Conclusion

The present study is concluded that pH, TDS and Cl were found with in permissible limits while in most of the samples F values were found above the permissible limit. Heavy metals concentrations were also assessed during pre and post monsoon water samples. Results values of the Fe and Mn were found with in permissible while Ni, Pb, Cr and Cd were found higher then permissible both pre and post monsoon. Environmental protection agency and other concern department should inspect all the parameters of water before supplying to the public and ensure the health of aquatic organism by monitoring the effluents

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