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Investigation of Water Pollution in the Baghlan River Caused by Dust and Wastewater from the Ghori Cement Factory: A Case Study

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ABSTRACT

Rivers are one of the most crucial fluid ecosystems, primarily due to their freshwater content. Understanding the trends in water quality changes in seas enables the anticipation of future challenges and the implementation of plans to address them. Water quality management necessitates the collection and analysis of a vast amount of data and water quality parameters. To facilitate this, various tools have been developed for simpler assessment of data and water quality, among which water quality indices are highly utilized. The objective of this study is to assess the water quality of the Balkh Sea using the (IRWQISC) and (IRWQIST) indices, alongside examining the levels of heavy metals, cations, anions, and its physical characteristics. Sampling was conducted at two time points: initially in October 2022, with heavy metal analysis performed using Flame Atomic Absorption Spectroscopy (FAAS), and subsequently in April 2023, where samples were collected from various points, and the concentrations of cations, anions, pH, and electrical conductivity (EC) were measured. Data analysis was carried out using SPSS version 26, and ArcGIS 10.4.1 was employed for map production. The research findings indicate a trend of heavy metal changes as follows: Al>As>Pb>Cd>(Cr=Co=Ni)>Hg. Based on the calculation of the toxicity index (IRWQIST), the studied water falls into the poor category. Consequently, sea water, due to the presence of heavy metals such as lead, cadmium, arsenic, and mercury, is relatively to very toxic and unsuitable for drinking. Additionally, it may cause detrimental effects for other uses such as agriculture and livestock farming.

Keywords: Cements factory, Environmental pollution, surface water, Pollutants, Parameters and water quality.

I. INTRODUCTION

Water is vital for human life, well-being, food security, and socio-economic development. In many developing countries, access to water has become a critical and urgent issue, causing concern for families and communities reliant on water supply systems [9]. On the other hand, seas are among the most important sources of freshwater for use in agriculture, drinking, and industry. Today, given the impact of human activities on the quality and quantity of the environment and the issues related to water pollution that have arisen, attention to the quality of water resources has become increasingly important [7]. Access to surface and groundwater sources and their quality is decreasing due to important factors such as population growth, agricultural development, industrialization, and urbanization worldwide [12].

Among all water resources, surface waters are highly vulnerable to pollution due to the growth and development of contaminant sources [5]. The increasing population of living organisms also puts significant pressure on providing safe drinking water, especially in developing countries [13]. Physical and chemical parameters in drinking water are of utmost importance, as their low or high concentrations can directly or indirectly affect human health [10]. Additionally, cement dust is dispersed widely through rain and wind over large areas, accumulating on plants and soil, which can have adverse effects on plant growth, human health, and animals [1].

Generally, major causes of water pollution include wastewater discharge, industrial and agricultural wastes, both organic and inorganic, mining, cement production, garbage, fertilizers, and pesticides washed from the land by rain, oil spills, radioactive elements, atmospheric dust, acid rains, and irrigation [6]. The dispersion of dust from cement factories has not only impacted the environment but also open well water is clearly suffering from surface pollution resulting from the settling of cement dust. This is concerning as the water quality may experience undesirable changes due to the infiltration of cement dust. Water quality significantly affects the health status of any population; therefore, the analysis of water in terms of physical, biological, and chemical properties, including the concentration of heavy elements, is crucial for public health studies [3].

Results from the study of the microbial and chemical quality of the Dan Jie Sea in Hong Kong have shown that during the dry season, there was an increase in pollutants. The reason cited for this increase was the use of chemical fertilizers in agriculture and the discharge of urban sewage into the sea. The qualitative results of the water showed a decrease in dissolved oxygen and an increase in dissolved solids. In the study area, total nitrogen and total phosphorus concentrations were not indicated, but phosphates and heavy metals including cadmium, copper, and zinc were found to be higher in the dry season compared to the wet season [2].

Having information about the quality status of surface waters enables us to utilize them in various ways while adopting methods to minimize damage to these resources. Various techniques for assessing water quality have been proposed worldwide, among which water quality indices are one of the most commonly used and straightforward methods. Considering that Iran is classified as a dry country, the development of usable water resources, as well as the preservation and improvement of their quality, are vital. Therefore, by providing an accurate picture of the quality status of surface waters, besides increasing public participation in preserving the health and quality of surface waters, a useful tool has been provided to make informed management decisions and determine the necessity of implementing water resource management methods at each specific point [11].

This study aimed to investigate and measure water pollutants in the Baghlan River resulting from the activities of the Ghori cement factory and other upstream uses. Considering the importance of surface freshwater and in order to control water quality and preserve humans' health and normal life, conducting this research seems essential.

II. METHODOLOGY

2.1- The study area

The Baghlan Sea, originating from the Hindu Kush Mountains, eventually merges with the Amu River after irrigating agricultural lands in Baghlan and Kunduz provinces. The water from this sea is extensively used for various purposes such as drinking, industrial activities, aquaculture, and especially agriculture, over a very large area, which has considerable impacts on the national economy. Adjacent to this sea, the Ghori cement factory is located north of the city of Pol-e-Khumri, with an elevation of 634 meters above sea level and geographical coordinates ranging from 68°40'41.04" to 68°41'38.05" east longitude and 35°57'33.08" to 35°58'31.44" north latitude. To the south of this factory lies the limestone mountain, the raw material for cement production, while residential areas, orchards, and agricultural lands are situated in the other three directions [14]. This factory is situated alongside the city of Pol-e Khumri, where the majority of the city's population resides within a radius of one to four kilometers. Since 1964, the Ghori cement factories have been producing black cement under the 400 marks, with a current production capacity of 500 tons per day. In this factory, 8121 persons work in production, technical, extraction, service, security, and agricultural departments [8].

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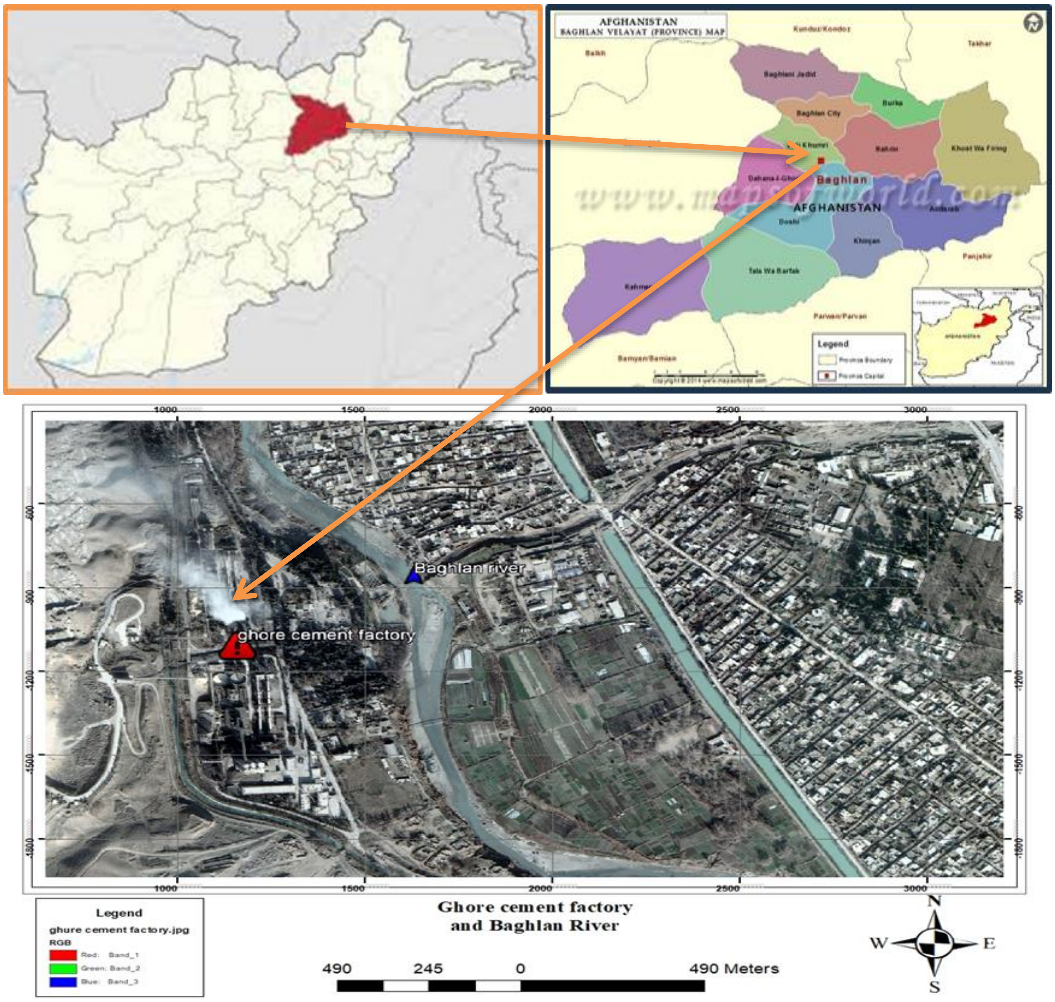

Figure 1: Location of Baghlan River and Ghori Cement Factory

2.2- Sampling and laboratory analysis

Sampling was conducted from the target water at two time points. Initially, in the April 2022, six samples were collected according to sampling regulations from the entrance point of the factory sewage. As depicted in Figure 2 and Table 1, two samples were taken from the bottom part of the sewage entry point, two from the upper part of the sewage entry, 200 meters apart, one sample from the sewage entry, and one sample as a control sample taken 13 kilometers south of the factory. Sampling was performed using 200-milliliter plastic bottles and simultaneously coded. Later, two drops of concentrated nitric acid were added to each sample for preservation. The collected samples were transferred to the laboratory and stored at 4 degrees Celsius. As observed in Table 1, two bottom samples and two top samples were composited together due to the cost of sample analysis. Then, 50 milliliters of each composite sample were poured into sterile plastic bottles using a filter. Finally, for heavy metal concentration determination, the samples were transferred to the laboratory and analyzed using Flame Atomic Absorption Spectroscopy (FAAS).

Table 1: Specifications of sampling points in the first stage

no	sample-type	samples	station-location	distance from the sewage inlet point in meters	geographical range of samples	
					x	y
1	composite	1	downstream of the sewage inlet	400	355817.23	684110.42
		2	downstream of the sewage inlet	200	355813.60	684112.72
2	normal	3	Inlet sewage	0	355810.75	684117.72
3	composite	4	upstream of the sewage inlet point	200	35588.45	684120.27

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		5	upstream of the sewage inlet point	400	35585.60	684121.18
4*	normal	6*	control sample	13000	355229.16	684524.23

In the next stage, in February 2023, using the same method as the first stage, a total of six samples were taken from various points. These included two samples from the lower part of the wastewater inlet, two samples from the upper part at a distance of 200 meters, one sample from the wastewater inlet, and one sample as a control from a point 13 kilometers south of the factory. Samples were collected using 300 ml plastic bottles, coded, and then two drops of concentrated nitric acid were added to each for stabilization. Subsequently, the concentrations of ions and cations, as well as the physical properties of the water samples, were determined in the laboratory using various devices and titration procedures. As depicted in Figure 2, all samples were analyzed normally.

Table 2: Specifications of sampling points in the second stage

no	sample-type	sample	station-location	distance from the sewage inlet point in meters	geographical range of samples	
					x	y
1	normal	1	downstream of the sewage inlet	400 m	355817.23	684110.42
	normal	2	downstream of the sewage inlet	200 m	355813.60	684112.72
2	normal	3	Inlet sewage	0	355810.75	684117.72
3	normal	4	upstream of the sewage inlet point	200 m	35588.45	684120.27
	normal	5	upstream of the sewage inlet point	400 m	35585.60	684121.18
4*	normal	6*	Control sample	13000 m	355229.16	684524.23

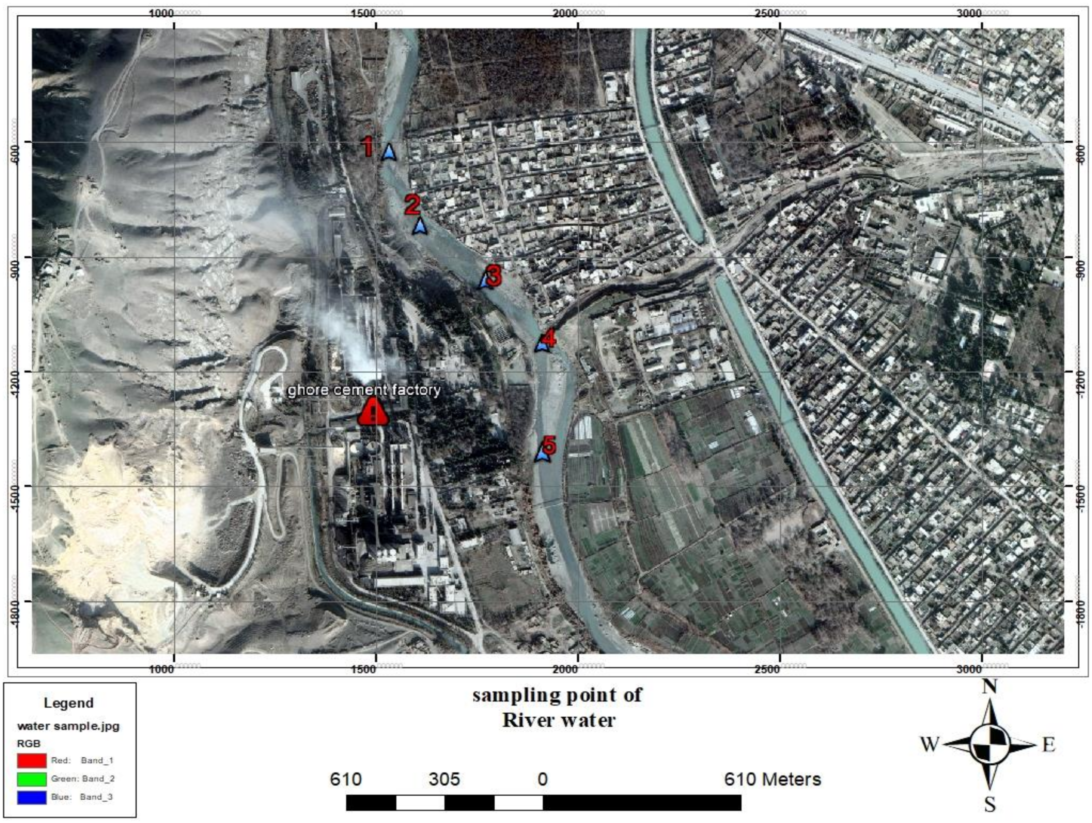

Figure 2: Sampling points of river water

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2.3- Determination of water quality

Sea water quality was measured using the quality control index (IRWQISC) and toxicity index (IRWQIST) of Iranian surface water resources. These indices are calculated by the same relationship, only the calculation parameters are different in each of the indices. To determine the water quality, the index of common parameters of the quality of surface water resources of Iran (IRWQISC) was used. This index is calculated by equation 1, 2 [4].

$$IRWQI_{SC}=\left[\prod_{i=1}^{n} I_i^{w_i}\right]^{\frac{1}{r}} \ldots\ldots\ldots\ldots 1$$

In the above relationship, the price r is obtained from the following (2) relationship:

$$r = \sum_{i=1}^{n} w_i \ldots\ldots\ldots 2$$

Where wi = the weight of parameter i, n = the number of parameters, Ii = the value of the index for parameter i from the ranking curve (Hashemi et al., 2011). The classification of water quality is done based on the index values calculated compared to Table 2.

Table 3: Water quality classification based on common quality indicators of surface water resources in Iran [4].

Index value	descriptive equivalent
15>	very bad
15-29.9	Bad
30-44.9	relatively bad
45-55	Medium
55.1-70	Fair
70.1-85	Good
85<	very well

III. RESULT

The concentration of heavy metals (Al, Pb, As, Ni, Cd, Co, Cr & Hg) was measured by flame atomic absorption device. As the concentration of all heavy metals is shown in Table 4 in terms of (mg/kg), aluminum has the highest concentration and mercury has the lowest concentration. According to Table 4, on the average, the trend of changes of heavy metals in water samples is Al>As>Pb>Cd>(Cr=Co=Ni)>Hg.

Table 4: Concentration of heavy metals in water samples

Characteristics of samples		Concentration heavy meatals in mg/kg							
No	Analysis code	Pb	Cd	Al	Ni	Co	Cr	As	Hg
1	F/111	0.06	0.002	0.12	0.01<	0.01<	0.01<	0.087	0.0087
2	F/113	0.08	0.001	1.2	0.01<	0.01<	0.01<	0.095	0.0092
3	F/113	0.03	0.001	0.1	0.01<	0.01<	0.01<	0.072	0.0075
4	F/114	0.02	0.001	0.3	0.01<	0.01<	0.01<	0.083	0.007
Mean		0.048	0.002	0.43	0.01<	0.01<	0.01<	0.085	0.0081

pH is a term used universally to indicate the acidity or alkalinity of a solution. Natural waters typically have a pH within the range of 6-8. At room temperature, a pH less than 7 indicates acidity, while a pH greater than 7 indicates alkalinity. The pH of water samples was measured using a pH meter device. Electrical conductivity (EC) of water is considered an important indicator of surface water quality. This parameter has a direct relationship with the total dissolved solids in water, increasing as the amount of dissolved substances in the solution increases. In this study, the electrical conductivity of water samples was measured using an EC meter device. In Table 5, based on the observed pH values, it is evident that industrial wastewater does not significantly affect acidity or alkalinity. Similarly, considering the characteristics of electrical conductivity (EC) of water, it is observed that industrial wastewater has no significant effect on the trend of changes in EC values compared to the control samples, as the values of this parameter in the wastewater input are lower than in other samples. However, it can be speculated that the existing variations are due to wastewaters from agricultural, residential, and urban uses being discharged into the river. The values of water physical parameters as shown in table 5.

Table 5: Values of water physical parameters

No	sample-type	Samples	station-location	distance from the sewage inlet point in meters	physical parameters	
					pH	EC
1	Normal	1	downstream of the sewage inlet	400 m	6.3	353

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	Normal	2	downstream of the sewage inlet	200 m	6.36	352
2	Normal	3	Inlet sewage	0	6.53	338
3	Normal	4	upstream of the sewage inlet point	200 m	6.54	338
	Normal	5	upstream of the sewage inlet point	400 m	6.63	339
4*	normal	6*	Control sample	13000 m	6.9	131

The concentrations of cations (Ca^{2+}, Mg^{2+}) and cations (Na^{+}, K^{+}) were measured using a Flame Photometer device, while the concentrations of anions (Cl^{-}, CO_3, HCO_3) were determined through titration. Additionally, the concentration of the SO^{-4} ion present in the water was measured using a Spectrophotocromometer device. As observed in Figure 3 and Table 6, the concentrations of chloride and carbonate ions in all samples were found to be equal to zero. Based on the averages, calcium ion had the highest concentration while potassium ion had the lowest concentration.

Table 6: concentration of anions and cations in water

sample	Cations				Anions				unit
	Na^{+}	K^{+}	Ca^{+2}	Mg^{+2}	Cl^{-}	SO_4^{-2}	CO_3^{-2}	HCO_3^{-}	
1	0.722	0.162	13.6	Mg^{+2}	0	Mg^{+2}	0	8	mg/Lit
2	0.671	0.162	13.2	10	0	10	0	6	mg/Lit
3	0.588	0.162	12.8	8.8	0	8.8	0	6	mg/Lit
4	0.629	0.162	13.6	10.4	0	10.4	0	6	mg/Lit
5	0.649	0.139	12.4	12.4	0	12.4	0	4.8	mg/Lit
6*	0.052	0.023	8	14.12	0	14.12	0	4	mg/Lit
mean	0.552	0.135	12.267	3.6	0	3.6	0	5.8	mg/Lit

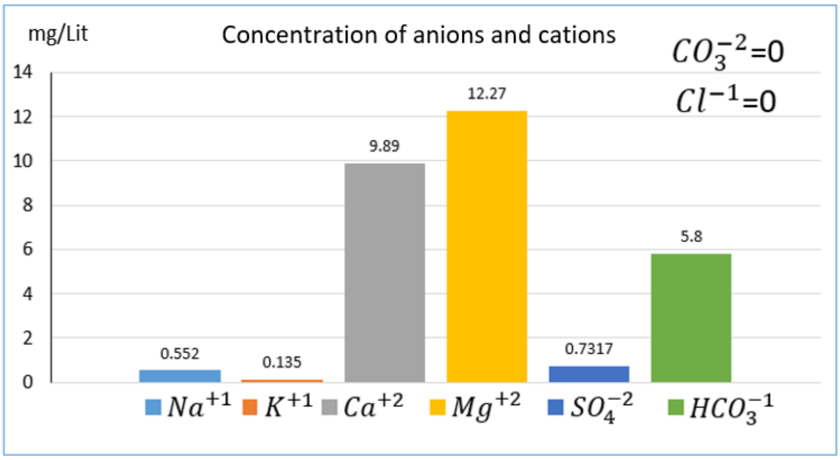

Figure 3: concentration of water anions and cations

Baghlan sea water quality was calculated according to the index (IRWQISC) based on pH and electrical conductivity (EC) parameters. The result shows that the water quality is relatively good compared to Table 3 (water quality classification) and is shown in green.

69.375	Relatively good

The reason for the water quality classification of the sea in this category is the relatively high levels of nutrients and fecal coliforms, which can originate from residential, recreational, and urban activities upstream of the sampling station. Additionally, its relatively acidic properties lead to the dissolution of mineral salts.

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Also calculated to determine the water quality using the toxicity index (IRWQIST) shown in Table 7.

Table 7: Toxicity index parameters (IRWQIST)

Parameters	Weight	Parameter index value
As	0.128	7
Hg	0.117	40
Pb	0.092	14
Cd	0.092	98
Cr	0.084	90
Mg	0.056	1

The obtained result indicates that the water quality, compared to the classification provided in Table 3 (Water Quality Classification), falls into the bad category, as depicted by the dark red color.

27.664	Bad

The reason for Baghlan sea water being in the bad category is the presence of heavy elements such as magnesium, arsenic, lead and mercury, whose indicator values are in the relatively bad and very bad category. Then, according to the toxicity index, it is concluded that the water of this sea is not suitable for drinking.

IV. CONCLUSION AND DISCUSSION

According to the research findings, it is concluded that the studied water is relatively acidic in terms of pH and sweet in terms of electrical conductivity (EC). Also, according to the quality indicators (IRWQISC), the studied water is in the relatively good class and in terms of the toxic indicators (IRWQIST) in the bad class, which is based on the study of Ahmad Noha Ger (2013) as an investigation of the physical and chemical quality of water. level is considered. Minab River: With the entry of pollutants from different sources, the quality status of this river is in the unfavorable category, which is consistent with the results of this research in terms of toxicity index. However, in this research, the shortcomings of the small number of samples and all physical and chemical compounds and heavy elements have not been analyzed due to the many problems to calculate the performance of the indicators.
On the other hand, the elements that have the ecological risk factor and the highest toxicity, such as cadmium, arsenic, lead and mercury, are in the relatively bad and completely bad category in aquatic environments. On the other hand, the sampling of water resources has been instantaneous and the difference between the measurements, especially in mercury, arsenic and cadmium in water environments, is considered as explanatory or exploratory studies. This is due to the lack of access to environmental resources and insufficient funding to analyze the number of samples and reduce the error of random samples, it is suggested that the present study be studied as a justification study in the composition of environmental components. which can be achieved in the future with more samples from the water environment with specific and more reliable results.

REFERENCES

[1] Ayvas Z. (1992) “Cevre kililiġive kontrolii. E. Ŭ. I. Uluslar arasi Crevre koruma sempozyumu Bilgiri kitabỹ 22, p 303-305.
[2] Chow, Y. L. & Yau J. T. S. (2003). Chemical and microbiological qualities of Hong Kong River (Dongjiang) Wate, university of Hong Kong, Chemosphere, v.52, p.1441– 1450.
[3] Chinedu S. N. Nwinyi O. C. Oluwadamisi, A. Y. & Eze V. N. (2013). Assessment of water quality in Canaanland, Ota, southwest Nigeria. Agriculture and Biology Journal of North America, 2(4), 577-583.
[4] Hashemi, S. H., Farzampour, T., Ramezani, T., & Khoshroo, Gh. (2011). Guide to calculate Iran Surface Water Resources Quality Index (IRWQISC). Department of Environment, Islamic Republic of Iran. (In Persian).
[5] Jonnalagadda S, Mhere G. (2001). Water quality of the Odzi River in the eastern highlands of Zimbabwe. Water Research;35(10):2371-76.
[6] Nwajei, G. E., Obi-Iyeke, G. E., & Okwagi, P. (2012). “Distribution of selected trace metals in fish parts from the River Nigeria”. Res. J. Rec. Sci., 1(1): 81-84.
[7] Nouhegar, Ahmad. (2012). Investigation of the Physical and Chemical Quality of Surface Waters in Minab River. Earth Sciences Research: 2(7), 1-16.
[8] Noorani, J. (2015). Plunderers of Hope: The Political Economy of Five Afghan Mines. Afghanistan Transparency Watch, pp. 11-20.
[9] Okonko, I. O., Adejoye, O. D., Ogunnusi, T. A., Fajobi, E. A., & Shittu, O. B. (2008). “Microbiological and physicochemical analysis of different water samples used for domestic purposes in Abeokuta and Ojota, Lagos Nigeria”. African journal of Biotechnology. Vol 7(5), 617-621.
[10] Snapshot. P. A. (2016). of the world’s water quality: towards a global assessment. Nairobi, Kenya: United Nations Environment Program me.
[11] Sheikh Sistani, N. (2001). Explanation of Surface Water Quality Indices and Their Application in Assessing the Quality Vulnerability and Zoning of Rivers. Master's

ISSN: 2583-4053

Volume-3 Issue-2 || April 2024 || PP. 212-219

https://doi.org/10.55544/jrasb.3.2.38

Thesis, Iran University of Science and Technology.

[12] Tyagi PK, Shruti SV, Ahuja A. (2012). Synthesis. of metal nanoparticals: A biological prospective for analysis. International Journal of Pharmaceutical Innovations; 4:48-60.

[13] Umeh, C. N., Okorie, O. I., & Emesiani, G. A. (2005). "Towards the provision of safe drinking water: The bacteriological quality and safety of sachet water in Awka, Anambra State". In: the Book of Abstract of the 29th Annual Conference & General Meeting on Microbes as Agents of Sustainable Development, organized by Nigerian Society for Microbiology (NSM), University of Agriculture, Abeokuta, pp. 22.

[14] Google Earth 2023.