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Monitoring of Radioactive Background in Qlyasan Stream, Tanjero River and Derbendikhan Lake in Sulaimani Governorate/Kurdistan Region-Iraq.

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Abstract

The study aimed to assess the background radiation and to calculate the annual effective dose of Qlyasan stream, Tanjero River and Derbendikhan Lake in Sulaimani Governorate. Although Qlyasan stream and Tanjero River were used intensively for irrigation purposes, they also used as sink for receiving a large volume of domestic and industrial wastewater without any treatment. Consequently, this may be led to different types of contamination such as radiation. Therefore the background radiation was measured at nine sites along Qlyasan stream, Tanjero River and after the confluence Point of Tanjero River by Derbendikhan Lake. The measurements were carried out in two periods, namely May and June 2015, by using a PRM-9000 Mazur nuclear radiation monitor instrument. The average background radiation of effective dose at destination sites was ranged from 0.07 to 0.08 $\mu Svhr^{-1}$ in May, but in June, ranged from 0.06 to 0.10 $\mu Sv\ hr^{-1}$. The calculated average of the annual accumulated effective dose was varied between 0.105-0.175 $mSv\ y^{-1}$, this finding was within the recommended permissible limit by the International Commission on Radiological Protection (ICRP) and (UNSCEAR). The highest average of annual accumulated effective dose was 0.175 $mSv\ y^{-1}$ and measured at site S3of Qlyasan stream.

Introduction

In recent years, the quality of freshwater in Iraqi Kurdistan Region (IKR) became a critical issue. Therefore the quality of surface water resources should be monitoring [1] and [2]. Qlyasan Stream, Tanjero River and Derbendikhan Lake in Sulaimani Governorate are used intensively for irrigation, and also used as an end point of urban wastewater. The *pollution caused by* the *discharge* of domestic, agricultural, and industrial *effluents* into the mention water body sources caused degradation of water quality year after year. Generally, most rivers pass through cities in the developing countries use as a sink and end point of effluents discharged from the urban areas [3]. Many studies, for example like [4] and [5] indicated that Qlyasan stream and Tanjero River were contaminated with wastewater. Radionuclide pollutants may be released to the environment from industrial activities and in contrast with non-degraded organic materials, therefore accumulate in water stream [6]. Particulate matter present in water may hold and adsorb the low solubility radionuclides that exist in the water [7]. Inorganic fertilizer that used intensively to improve crop yield may be possible sources of radionuclides that released to water sources and the continuous used of fertilize enhance the radioactivity level in water sources [8] and [9]. Natural radioactive present in water, soil, air come from the terrestrial radiation, therefore natural radioactivity in water depends on geological and geographical nature of the water's origin [10] and [11].

According to [12], radioactive contamination is radioactive substances which deposition and presence on surfaces or within solids, liquids or gasses, where their presence is undesirable. Radioactivity exists in the environment as a natural phenomenon, radiation and radioactive material that used in many beneficial applications such as; industry, medicine, agriculture, and research also use worldwide in nuclear power generation. Therefore radiation and radioactive material may arise risks to human and environment, the safety standard must be used to control [13]. Radiation exposed to human may be natural or artificial origin, 79% of the radiation exposed to peoples is from natural sources, while 19% from the application in medical and resting 2% from the fallout of the nuclear power generation [14]. Inhalation of aerosols contaminated with radionuclides and ingestion water and food contaminate with radionuclides and irradiation my pose a threat to the public [15] and [16]. Aquatic environment contaminate by radioactive may result in ingestion doses by three pathways: surface and ground water sources use as freshwater for drinking, consumption fish and another aquatic biota, and consumption of terrestrial biota irrigated by contaminated water [17].

For assessment the radiation exposure to the human, the pollution levels of radiation in the environment must be studied carefully, many countries studied and measured the hazardous level of radiation and radionuclides in the water. World Health Organization recommended a permissible level of radionuclides in freshwater and irrigation [18]. The annual effective dose has been recommended by the International Commission on Radiological Protection (ICRP) is one mSv y^{-1} for the individual members of the general public for prolonged exposure [19], and according to [17] estimated the natural radioactivity that exposed to the public by the effective average annual dose equivalent to 2.4 mSv y^{-1} (cosmic ray 0.4, terrestrial gamma ray 0.5, radon 1.2, and food and drinking water 0.3), the mean value of outdoor annual effective dose for area with the normal background radiation 0.48 mSv y^{-1}.

This study aimed to measure the levels of background radiation of effective dose in surface water of Qlyasan stream, Tanjero River and Derbendikhan Lake. Furthermore the study aimed to calculate the annual effective dose and to generate a radiometric data that might be useful for future radiation evaluation studies in the study area.

Description of the study area:

The study area of Qlyasan Stream, Tanjero River and Derbendikhan Lake are geographically lies between latitude 35°34'58"- 35°13'07" N and Longitude 45°22'41" - 45°51'47" E and elevated 467 -752 m above sea level in Sulaimani Governorate (*Figure 1*). Qlyasan stream that used as end point for untreated wastewater of Sulaimani Governorate located between 35°35′02″- 35°28′44″ N and 45°21' 39″- 45°26′16″ E. Tanjero River is located between 35°28′44″- 35°19′04″ N and 45°26' 16″- 45°50′27″ E in Sulaimani Governorate, Qlyasan and Kani ban streams linked to the Tanjero River, as well as many outlet discharge of sewage effluent from industrial area in this River [4]. Therefore Tanjero River flows into Derbendikhan Lake which is one of the great tributaries of Tigris River.

Methodology:

To estimate the Background radiation of Qlyasan Stream, Tanjero River and Derbendikhan Lake, four sites S1, S2, S3 and S4 were chosen along the stretch of the Qlyasan Stream to measured radiation and four sites S5, S6, S7 and S8 were chosen to measure radiation along Tanjero River, which polluted with wastewater without any treatment [4] and [5]. Also, site S9 was selected after about 9 km of the confluence Point of polluted Tanjero River by Derbendikhan Lake, to assess radiation level in this part of Derbendikhan Lake (*Figure 1*).

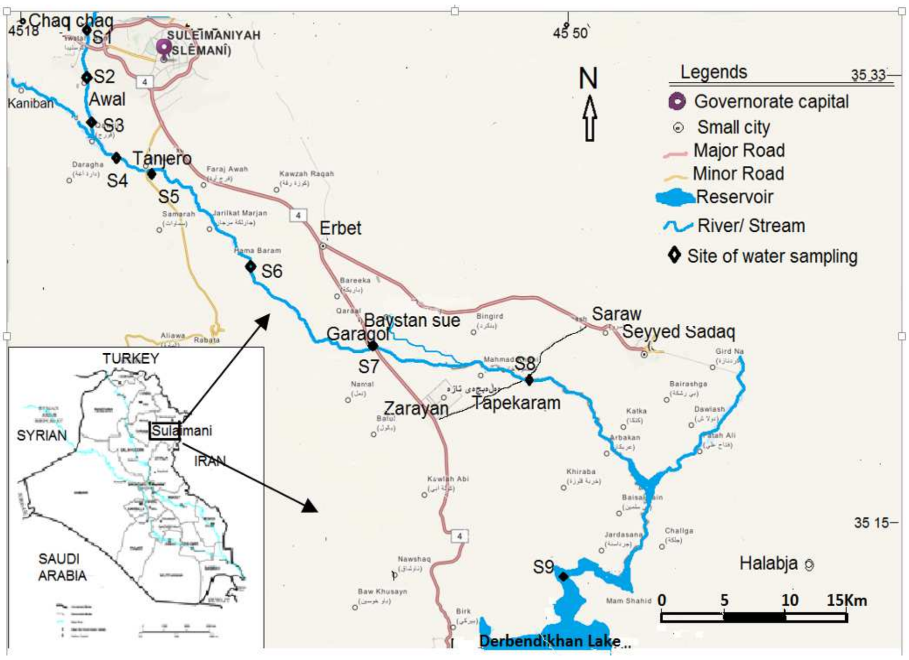

Figure 1: Location map showing the measuring sites at the study area (Source: Google maps)

To measure the background radiation levels in water along Qlyasan Stream, Tanjero River and Derbendikhan Lake. A portable MAZUR PRM 9000 instrument for monitoring nuclear radiation was used. This model measures the ionizing particles and radiation levels of alpha, beta, gamma and x-ray, since the model is equipped with Geiger-Muller Pancake Tube Window. Measurements were recorded twice in May and June 2015 on a 30-minute timed measurement basis at each site of study. The instrument placed a way from any items that could be radioactive, such as metals, pottery, granite counter tops, etc. The reading of effective dose radiations emission was measured by micro Sieverts per hour ($\mu Svhr^{-1}$), and the values of minimum, maximum, and average were obtained from the display of the instrument (IR).

Additionally, the total counts of the beeps (pulses) which indicate the released nuclear particles from the decay of atomic nuclei were measured in Counts per Minute (CPM). Also, the annual effective dose (AED) in ($mSv\ y^{-1}$) was calculated from the measured values of the annual effective doses as in equation (1), to assess the contribution of radiation to public exposure.

Annual Effective Dose (AED) $mSv\ y^{-1} = \mu Sv\ hr^{-1} \times 24\ hr\ d^{-1} \times 365\ d\ y^{-1} \times 10^{-3} \times 0.2$………(1).

For outdoor exposure occupancy factor is taken as 0.2 [17].

Results and Discussion

The background radiation of effective dose quantity in surface water along Qlyasan Stream, Tanjero River and Derbendikhan Lake for the months May and June 2015 were measured and the values of minimum, maximum and average of background radiation at nine sites presented in Table (1 and 2) respectively. Regarding the minimum and maximum measured for background radiation of effective dose in May 2015 were revealed that values were 0.05 and 0.07 $\mu Sv\ hr^{-1}$ and 0.08 and 0.12 $\mu Sv\ hr^{-1}$as minimum and maximum ranges respectively, and the average background radiation was ranged from 0.07 to 0.08 $\mu Sv\ hr^{-1}$ (Table 1). *The relative variation in* background radiation of these water sources is attributed to release of radiation from different radiating sources of both anthropogenic activity and natural terrestrial radiation. Also the researchers [10] and [11] pointed out that the background radiation in water depends on geological and geographical nature of the water's origin.

Table 1: Background radiation values measured for all sites in May 2015.

Sites	*Elapse time (minutes)*	*Beeps per minutes*	*Radiation in microSievert/ hour (µSvhr^{-1})*		
			Minimum	*Maximum*	*Average*IR*
S1	*30*	*37*	*0.06*	*0.12*	*0.08*
S2	*30*	*29*	*0.05*	*0.09*	*0.07*
S3	*30*	*34*	*0.07*	*0.10*	*0.08*
S4	*30*	*31*	*0.06*	*0.10*	*0.07*
S5	*30*	*33*	*0.06*	*0.10*	*0.08*
S6	*30*	*32*	*0.06*	*0.10*	*0.08*
S7	*30*	*30*	*0.05*	*0.09*	*0.07*
S8	*30*	*32*	*0.06*	*0.09*	*0.08*
S9	*30*	*28*	*0.06*	*0.08*	*0.07*

**IR stands for instrument reading and not represents the calculated average.*

Results in June 2015 (Table 2) showed that the minimum, maximum, and average background radiation were ranged from 0.03 to 0.09 *µSv hr^{-1}*, 0.08 to 0.014 *µSv hr^{-1}* and 0.06 to 0.10 *µSv hr^{-1} respectively, the high value recorded at site S3* might be due to discharging of wastewater from outlet of different sources such as; domestic activities and hazardous waste of industrial activities into Qlyasan stream, as well as the measuring site of S3 was close to the outlet of the wastewater as confirmed previously by [4] and [5].

Table 2: Background radiation values measured for all sites in June 2015.

Sites	*Elapse time (minutes)*	*Beeps per minutes*	*Radiation in microSievert/ hour (µSvhr^{-1})*		
			Minimum	*Maximum*	*Average*IR*
S1	*30*	*29*	*0.06*	*0.08*	*0.07*
S2	*30*	*29*	*0.04*	*0.09*	*0.07*
S3	*30*	*42*	*0.09*	*0.14*	*0.10*
S4	*30*	*29*	*0.06*	*0.08*	*0.07*
S5	*30*	*28*	*0.04*	*0.11*	*0.07*
S6	*30*	*30*	*0.04*	*0.10*	*0.07*
S7	*30*	*29*	*0.05*	*0.10*	*0.07*
S8	*30*	*30*	*0.05*	*0.08*	*0.06*
S9	*30*	*29*	*0.03*	*0.11*	*0.07*

As shown in table 3 and figure 2, the annual effective dose (AED) ranged from 0.088 mSv y^{-1} to 0.123 mSvy^{-1} for the minimum values at the sites (S2 and S7) and site S3 respectively, while the annual effective dose for maximum values ranged from 0.140 mSv y^{-1} at site S9 to 0.210 mSv y^{-1}at site S1 in May 2015. Results also revealed that the average *of the annual* accumulated effective dose were ranged between 0.123 *mSv y^{-1}* in the sites S2, S4, S7 and S9 to 0.140 *mSv y^{-1}* in the sites S1, S3, S5, S6 and S8*, the mean value of annual effective dose were (0.103, 0.169 and 0.132 mSv y^{-1}) calculated from minimum, maximum, and average values respectively. The annual effective dose for June 2015 (Table 3 and figure 2) ranged from 0.053 mSv y^{-1} to 0.158 mSv y^{-1} as a minimum values, while the annual effective dose ranged from 0.140 mSvy^{-1} to 0.245 mSv y^{-1} for the maximum values, also the* maximum value of average *annual* effective dose was calculated in site S3 (0.175 *mSv y^{-1}*) , the mean value of average *annual* accumulated effective dose in May 2015 was 0.132 *mSv y^{-1}, while in June was 0.127 mSv y^{-1}. Therefore the calculated mean values of* average *annual* accumulated effective dose *in May and June was lower than recommended standard value, that corresponding world value of annual effective dose is 1* mSvy^{-1} for the individual members of the public [19] and average of annual effective dose is 2.4 *mSv y^{-1}*, Also lower than *world average value 0.48 mSv y^{-1} for outdoor of* annual effective dose come from gamma radiation which recommended by [17]. Results agreement with [20], which found the total radiation dose rate inside Sulaimani city was within the recommended permissible limit. High level of radiation at site S3 is attributed to the discharge of wastewater from domestic activities into Qlyasan stream. Hazardous waste may contain release radionuclides pollutants from the present industrial activity into Qlyasan stream [6]. Additionally, inorganic fertilizer that used by farmers in the study area may be released into the stream and enhance the radioactivity level in water stream [8] and [9]. *The researchers [21] have studied the annual effective dose to an individual consumer due to the intake of radon from drinking water in the province of Babylon, Iraq, they found the annual effective dose was ranged from 0.087 to 0.0019 mSv y^{-1}which lower than 1mSvy^{-1} that recommended by UNSCEAR.*

Table 3: The Annual Effective Dose (AED) calculated for all sites.

Sites	***AED (mSv.y^{-1})***					
	May 2015			***June 2015***		
	Minimum	***Maximum***	***Average***	***Minimum***	***Maximum***	***Average***
S1	*0.105*	*0.210*	*0.140*	*0.105*	*0.140*	*0.123*
S2	*0.088*	*0.158*	*0.123*	*0.070*	*0.158*	*0.123*
S3	*0.123*	*0.175*	*0.140*	*0.158*	*0.245*	*0.175*
S4	*0.105*	*0.175*	*0.123*	*0.105*	*0.140*	*0.123*
S5	*0.105*	*0.175*	*0.140*	*0.070*	*0.193*	*0.123*
S6	*0.105*	*0.175*	*0.140*	*0.070*	*0.175*	*0.123*
S7	*0.088*	*0.158*	*0.123*	*0.088*	*0.175*	*0.123*
S8	*0.105*	*0.158*	*0.140*	*0.088*	*0.140*	*0.105*
S9	*0.105*	*0.140*	*0.123*	*0.053*	*0.193*	*0.123*
Mean	*0.103*	*0.169*	*0.132*	*0.090*	*0.173*	*0.127*

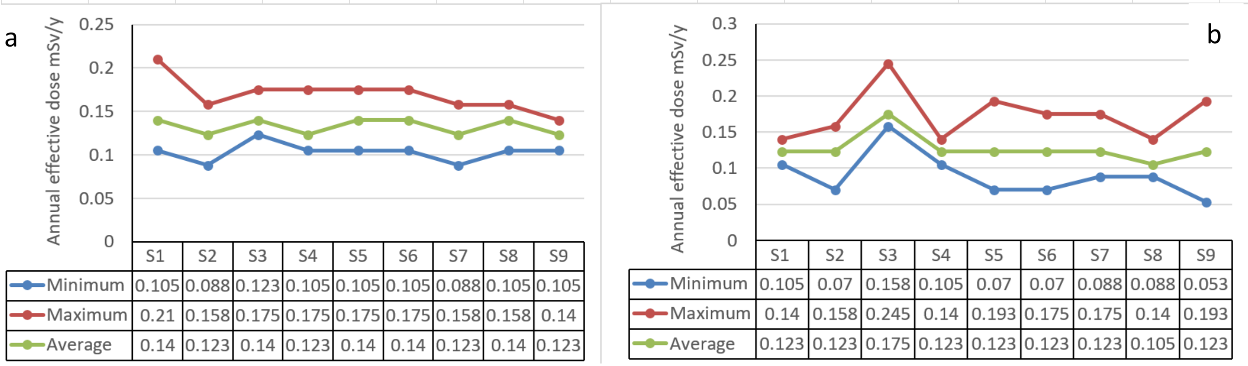

Figure 2: Annual Effective Dose for all sites a) May 2015 and b) June 2015

CONCLUSIONAND RECOMMENDATION

1-The background radiation clearly showed that the status of radiation was normal during the period of study.

2-Value of annual effective dose for all sites was normal and within the level of standard.

3-This study revealed that site S3 located in Qlyasan stream had been higher values than other sites.

To establish a perfect data set on radiation background for the urban areas and natural location in Sulaimani Governorate, the current study recommends for a more further detailed future research studies.

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