REVIEW OF RESEARCH
ISSN: 2249-894X
IMPACT FACTOR : 5.7631(UIF)
VOLUME - 12 | ISSUE - 8 | MAY - 2023

EVALUATION OF RADIATION HAZARDS AND NATURAL RADIOACTIVITY INDICES IN SAVADATTI AND BELAWADI TALUKAS, DISTRICT: BELGAUM STATE: KARNATAKA, INDIA.

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ABSTRACT:
To find out how the radioactive elements ^{40}K, ^{232}Th, and ^{238}U were active in the soil, the study used a 4" × 4" NaI (Tl) scintillating monitor that utilized a gamma-ray spectrometer. The information was used to calculate the absorbed dose rate, average effective dose equalent and radium equivalents activities (Ra_{eq}), external hazard index. Soil samples were provided by the districts of Belawadi, Belgaum, and Savadatti. The average concentrations activity of ^{232}Th, ^{40}K, and ^{238}U are 26.84±0.16 $Bqkg^{-1}$ in Savadatti, 48.33±0.09 $Bqkg^{-1}$ in ^{232}Th, and 150.71 ± 1.61 $Bqkg^{-1}$ in ^{40}K. For future reference, the data supplied the area's baseline radiation readings.

KEYWORDS: *Activity concentration, absorbed dose, gamma-ray spectrometry, surface soil, hazards indices.*

INTRODUCTION

The soil is the main place where people are exposed to ambient radiation and radionuclides ^{40}K, ^{232}Th, and ^{238}U. Because radionuclides discovered in soil are passed to biological systems and the food chain, soil is an important indicator of radioactive contamination. The maximum radiation concentration found in soil can be utilized as a prediction when human activity causes a negative shift in radionuclide activity in the surroundings [1]. One significant source of the cumulative dose of radiation to the human population is extraterrestrial bodies. The total activity is somewhat impacted by other nuclides [2]. Given that radionuclides were a component of the fertilizer that was previously applied and that natural radioactivity is the radioactivity study of fertilizer, we want to evaluate the radionuclide activity in the soils of Savadatti, Belawadi district, and Belgaum Farmers have access to a large variety of fertilizers that are appropriate for different crops and soil types thanks to the agricultural supply chain [3]. Fertilizer dealers sell a range of fertilizers, including types based on potassium, phosphorus, and nitrogen, as well as blended formulas to address specific nutritional needs. They also often give farmers advice and information to help them make rational decisions about the type and quantity of fertilizers required for the best crop yield [4]. Savadatti Taluk, which uses these agricultural chemicals and soil supplements, is located in the northern section of the Belgaum district, between 15045′59.9364′N latitude and 7506′55.8036′ E longitudinal. The Belgaum is mostly covered with Black and Red soil. The principal crops farmed in this division are pearl millet, chilly, groundnuts, cotton, maize, wheat, and paddy [5]. It is a manmade reservoir on the Malaprabha River. Many tourists travel to Savadatti, a popular tourist site, to see the town's medieval fort and its historic temples, including the Yallammagudda and Kadasiddeshwarw temples, as well as to observe or learn more about the intriguing local way of life and culture. By measuring the rate of external gamma radiation, the current work safeguards the public.

MATERIAL AND METHODS:

Sample Collection and Preparing:

The sample sites are chosen based on the first evaluation of the ambient gamma radiation. Twenty soil samples were collected in the Belgaum district from the Savadatti and Belawadi localities. Samples of dirt weighing two kilos were taken from each location, measuring between one and ten meters in diameter. The samples were first dehydrated to remove any last traces of moisture [9]. After that, each sample was powdered and put through a 200 mesh sieve to get rid of any soil particles that had been processed unevenly. Subsequently, each sieved sample was put in a plastic container for additional processing after the sample had been modified to fit the blank plastic container. An electronic balance was utilized to ascertain its net weight [10]. The date of soil sample preparation, together with the coded sample ID, was noted on plastic containers and entered into the register. This process was carried out once again for every sample from every district and taluk. Before being exposed to gamma spectrometric examination, the soil was placed into the plastic containers, sealed with an adhesive solution, and allowed to reach equilibrium among radon (^{222}Rn) and their daughter product for 4-5 weeks.

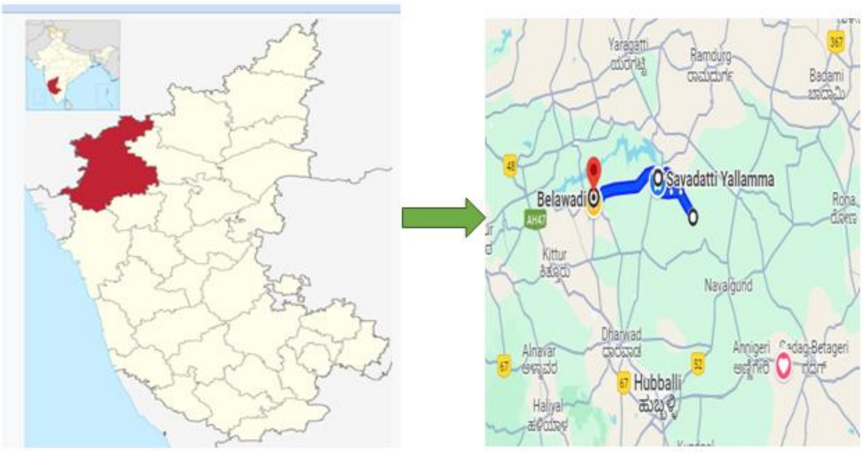


Figure.1 Sample collected area map

Figure.2 collection and preparation of Soil Samples

Estimation of Natural radioactivity:

A gamma-ray spectrometer built around NaI(Tl) detector. The detector is protected from extraneous influences and cosmic radiation by a three-inch-thick lead barrier. A 1kPC-based multi-channel analyzer (win TMCA32) with an integrated spectroscopic amplifier computer records data. Totaling the data and using the enriched uranium, thorium, and potassium norms set for 60,000 seconds to measure the system's efficiency resulted in high-quality statistical gamma spectra. For every measurement, the net count rate was calculated by taking a record of the surrounding gamma radiation spectrum and subtracting it [11]. The highest maximum intensity (cps) connected to each gamma line and the correlation efficiency was used to determine the specimen's activity concentrations. The least squares approach was used to examine the complicated gamma spectra of samples that were going through the detector because of ^{232}Th ^{238}U, and 40K [12].

$$\boldsymbol{Activity}(Bq) = \frac{Net\ Area\ under\ the\ photopeak\ (cps)}{Efficiency}$$

Assessment of radiological hazard indices:

These techniques can be used to determine natural radionuclides: absorbed gamma dose (D), radium equivalents activities (Ra_{eq}), gamma activity indices (I_γ), internal as well as external hazard parameters (Hin and Hex), average effects doses equivalent (AED), and radium. The activity concentration in Bqkg^{-1} for each computation is ^{238}U, ^{232}Th, and ^{40}K, corresponding to that order. Table - 2 displays the formulas that were used to determine the various radiation hazards.

RESULTS:

The results for the concentrations of natural radionuclide activity were displayed in Table 1 following the estimated activity concentration of ^{238}U, ^{232}Th, and ^{40}K along with the mean concentrations in soil samples. The population at risk for radiation sickness was assessed using one of the following radioactive hazard factors.

Gamma absorbed dose rates (D):

The absorption of gamma dose rates by domestic gamma rays above one kilometer above the earth's surface is computed using the corresponding concentrations of ^{40}K, ^{232}Th, and ^{238}U

$$D = \left(0.604\, C_{Th} + 0.462\, C_U + 0.0417\ C_K\right) nGy\, h^{-1}$$

Where C_K, C_{Th}, and C_U, are the average activity concentrations of ^{40}K, ^{232}Th, and ^{238}U, respectively.

Radium equivalent activity (Ra_{eq}): Using this relation:

$$\mathbf{Ra_{eq} = A_{Ra} + 1.43A_{Th} + 0.077A_K \quad (1)}$$

Where ^{226}Ra, ^{232}Th, and ^{40}K in Bqkg^{-1} are the activity concentrations represented by the letters A_{Ra}, A_{Th}, and A_K, respectively. Radium equivalent activity was recently developed as a standard radiological indication.

$$Ra_{eq} = C_U + AC_{Th} + BC_K$$

Where A and B are constants 1.43 and 0.077, respectively.

External hazard indexes:

An external electromagnetic field is something that individuals are exposed to when naturally existing radioactive materials decay. The exterior hazard index shows the danger that the earth's samples under research have due to external radiation exposure from ^{232}Th, ^{238}U, and ^{40}K. The following formula is used to generate it from a comparable Raeq expression assuming that Raeq's upper bound is proportionate to its largest value.

$$H_{ex} = \frac{C_U}{370} + \frac{C_{Th}}{259} + \frac{C_K}{4810}$$

Internal hazard indexes:

Apart from the external danger, the respiratory system is also at risk due to radon and its short-lived metabolites. A risk internal index (Hin), provided by the equation, measures the internal degree of exposure to radon and its byproducts. (Beretka and Mathew, 1985)

$$H_{in} = \frac{C_U}{185} + \frac{C_{Th}}{259} + \frac{C_K}{4810}$$

The specific activity over ^{232}Th, ^{238}U, and ^{40}K respectively, in Bq.kg^{-1}. For an element to be utilized properly in house construction must be less than unity (Iqbal et al. 2000).

Annual effective dose:

The UNSCEAR-provided factor of conversion 0.7SvGy^{-1} to the absorption dose rate can be used to get the yearly effective dosage. Assuming that eighty percent of the period is spent indoors and the other two-thirds are spent outside.

$$Annual\ effective\ dose\ rate\left(mSvy^{-1}\right) = D\left(nGyh^{-1}\right) \times 8760\left(hy^{-1}\right) \times 0.7 \times 0.8$$

The average rate of absorbed gamma radiation was found to be 18 to 230 nGy h^{-1}. The annual effective dosages for each sample were computed. The acceptable dosage equivalent limit of 1 mSvy^{-1} is not exceeded by these readings.

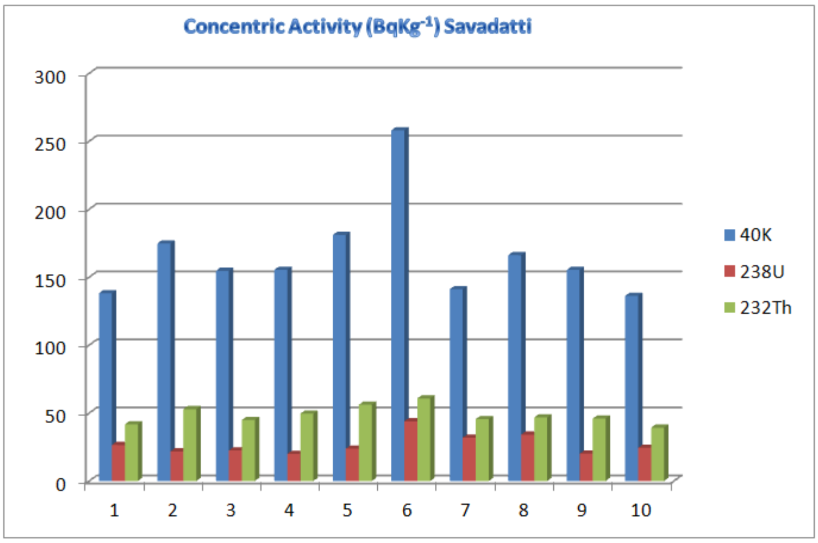
Gamma activity index:

The yearly efficiency radiation danger related to the naturally produced radionuclide in the tested samples is ascertained using average gamma indices (I_γ). To verify the compliance of environmental samples, it also serves as a screening index. The European Commission (EC) states that the gamma activities concentrations index (I_γ), which assists in determining whether a dose standard should be followed by calculated using the following formula.

$$I_\gamma = \frac{C_U}{300} + \frac{C_{Th}}{200} + \frac{C_K}{3000}$$

Table 1: Average of Activity concentration (Bqkg^{-1}) of ^{238}U, ^{232}Th and ^{40}K surface soil samples in Savadatti, Belawadi district: Belagavi.

Sl.no	Place	Sample Code	Concentric Activity (BqKg^{-1})		
			^{40}K	^{238}U	^{232}Th
1	Savadatti	SL060101	138.19±1.51	26.49±0.15	41.71±0.09
2		SL060102	174.80±1.68	21.77±0.17	52.88 ±0.10
3		SL060103	154.67±1.61	22.46±0.16	44.93±0.92
4		SL060104	155.38±1.57	19.95±0.16	49.51±0.09
5		SL060105	181.08±1.77	23.84±0.18	56.15±0.11
6		SL060106	258.01±1.92	43.91±0.16	60.77±0.13
7		SL060107	141.12±1.65	31.88±0.17	45.54±0.11
8		SL060108	166.18±1.72	34.14±0.17	46.77±0.10
9		SL060109	155.34±1.52	20.11±0.16	45.90±0.11
10		SL060110	136.24±1.53	24.39±0.14	39.23±0.09
		Min	**136.24±1.53**	**19.95±0.16**	**39.23±0.09**
		Max	**258.01±1.92**	**43.91±0.16**	**60.77±0.13**
		Average	**150.71±1.61**	**26.84±0.16**	**48.33±0.09**
		Range	**136-258**	**19-43**	**39-60**
Sl.no	**Place**	**Sample code**	**^{40}K**	**^{238}U**	**^{232}Th**
1	Belawadi	SL060201	230.00±1.70	20.00±0.20	50.00±0.10
2		SL060202	210.00±1.60	20.00±0.20	50.00±0.10
3		SL060203	180.00±1.70	20.00±0.20	50.00±0.10
4		SL060204	203.90±2.10	21.34±0.19	62.82±0.11
5		SL060205	194.93±1.98	18.14±0.17	60.00±0.11
6		SL060206	210.62±1.7	27.52±0.24	50.59±0.11
7		SL060207	252.44±1.7	31.25±0.19	54.74±0.12
8		SL060208	232.49±1.7	21.05±0.18	55.49±0.11
9		SL060209	249.97±1.83	26.64±0.19	56.04±0.12
10		SL060210	236.49±1.80	22.80±0.18	54.46±0.12
		Min	**180.00±1.70**	**18.14±0.17**	**50.00±0.10**
		Max	**252.44±1.7**	**31.25±0.19**	**62.82±0.11**
		Average	**219.99 ± 1.77**	**22.87 ±0.19**	**54.43±0.11**
		Range	**180-252**	**18 - 31**	**50-62**



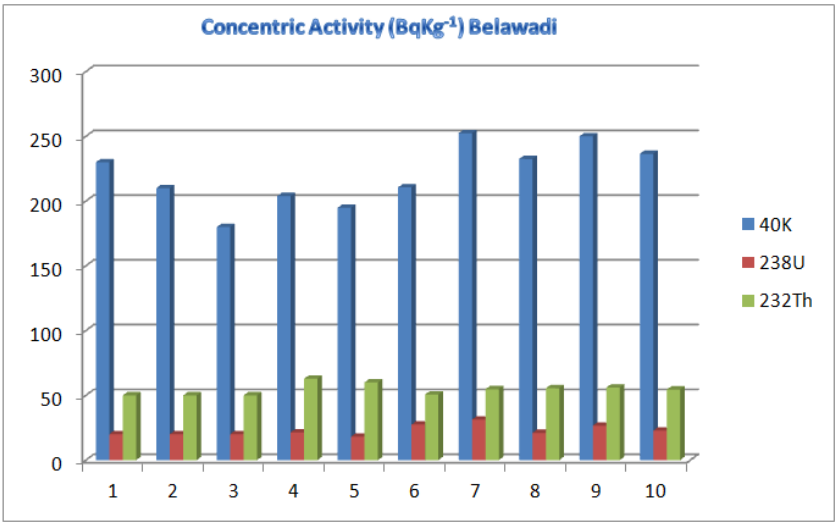


Table 2: The Gamma absorb dose rate , Radium equivalent, , hazard index, annual effective dose rate for soil samples.

Sample No.	D $nGyh^{-1}$	Ra_{eq} $Bqkg^{-1}$	Hex $nGyh^{-1}$	Hin $nGyh^{-1}$	Iyr	Annual Effect of dose μSvy^{-1}
1	43.19	96.77	0.26	0.33	0.34	211882.67
2	49.28	110.77	0.29	0.35	0.34	241772.49
3	43.96	105.15	0.26	0.32	0.39	215664.89
4	45.59	102.70	0.27	0.33	0.39	223646.30
5	52.47	118.08	0.31	0.38	0.36	257440.98
6	67.73	150.67	0.40	0.51	0.53	332256.28
7	48.11	107.86	0.29	0.37	0.38	236008.41
8	50.95	113.81	0.30	0.39	0.40	249940.32
9	39.29	97.70	0.26	0.31	0.34	192741.02
10	36.96	90.97	0.24	0.31	0.32	181340.40
11	49.03	109.21	0.17	0.34	0.39	240526.47

12	48.19	107.67	0.17	0.34	0.38	236435.20
13	46.94	105.36	0.16	0.33	0.37	230298.29
14	56.26	126.87	0.34	0.40	0.45	276023.39
15	27.46	119.23	0.32	0.37	0.42	13472.39
16	51.95	116.07	0.31	0.38	0.41	254890.07
17	58.01	128.95	0.34	0.43	0.42	284608.19
18	52.93	118.30	0.31	0.37	0.45	259673.03
19	56.57	130.30	0.34	0.41	0.46	277549.03
20	53.28	118.87	0.32	0.38	0.42	261404.70

Table 3. The mean activity concentrations (BqKg^{-1}) of ^{238}U, ^{232}Th, and ^{40}K for different countries in the world.

Location (Soil samples)	**Activity (Bq/kg)**		
	238U	**232Th**	**40K**
Present Study (Savadatti)	**19-43**	**39-60**	**136-258**
Present Study (Belawadi)	**18-31**	**50-62**	**180-252**
Gudalore, Tamilnadu (10)	17-62	19-272	78-596
China	62	90	524
France	37	38	599
Bangladesh	38	66	272
Taiwan	18	28	479
Egypt	17	18	316
USA	34	36	472
All India (6)	31	63	394
World Average (3)	35	45	420

CONCLUSIONS:

Based on what has been found throughout this examination, the expected radiological parameters were generated by radionuclide's that are naturally occurring and satisfied global and national standards. The results of the concentric activity levels of ^{232}Th, ^{238}U, and ^{40}K showed that Savadatti ^{40}K had higher activities (258.01±1.92 Bqkg^{-1}) than the concentration of activity of ^{232}Th, which was 60.77±0.13 Bqkg^{-1}.The average ^{238}U value was 26.84±0.16 Bqkg^{-1}.Belawadi ^{40}K had a low activity concentration (62.82±0.11 Bq kg^{-1}) and the average ^{238}U has a value (22.87±0.19 Bqkg^{-1}) of the other two talukas.

Conflict of Interest: The author claims to have no competing interests.

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