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Background Radiation Detection and Measurement by Using A GM Counter At Kolar And Chikkaballapur Districts

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ABSTRACT
A Portable GM Counter was used to quantify the total Radiation level at different places of Kolar and Chikkaballapur districts. For all sample locations, there are no abnormal radiation counts, so there is generally less significant risk of public exposure to the background radiation for sample places. The purpose of this study is to monitor the amount of Background radiation at urban and rural areas of Kolar and Chikkaballapur Districts, Karnataka.

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I. INTRODUCTION

1.1 Radiation

Energy that is moving, in the form of waves or particles, is referred to as radiation. There are many different types of radiation all around us. Radioactivity is the spontaneous release of energy from a certain element's atomic nucleus as particles, waves, or both (electromagnetic radiation).Henri Becquerel, a French physicist, made the discovery in 1896 after noticing that uranium consistently and without prompting released penetrating rays.

Figure 1: Radiation

Pierre and Marie Curie demonstrated that uranium's radioactivity is an atomic characteristic rather than a chemical one. In order to comprehend what happens when radioactive atoms emit radiation, it is crucial to understand how the atom is constructed. Each atom, as Rutherford initially described in 1911, is composed of a small, massive nucleus that is encircled by a rotating cloud of light electrons. The radioactivity, including the alpha, beta, and gamma rays, emanates from the nucleus. The positively charged protons and the electrically neutral neutrons, which are the smaller particles that make up the nucleus, were discovered in 1932 by Rutherford's colleagues. The mass of a proton or neutron is about equal to that of a hydrogen atom. The atomic number, or the quantity of protons in each atom's nucleus, is the same for all atoms of a certain element. They have an equivalent number of electrons rotating around the nucleus to counteract this charge. These electron shells are what give the atom its chemical characteristics.

Various atomic masses can result from various neutron counts in an element's atoms. The isotopes of an element are the varieties of that element that have various atomic masses, according to Soddy. For instance, hydrogen, the lightest element, has an atomic number of 1. Since it typically has a single proton in its nucleus and no neutrons, its atomic mass is also 1. On the other hand, there are isotopes of hydrogen with various atomic masses. Deuterium, also known as "heavy" hydrogen, has an atomic mass of 2 and consists of one proton and one neutron in its nucleus. Tritium is a radioactive isotope of hydrogen. Tritium has an atomic mass of three because it has one proton and two neutrons. Each of the three types of hydrogen has one electron, making its chemical characteristics the same.

1.2 Types and Sources of Radiation

Energy in the form of particle waves is known as radiation. Ionizing radiation and non-ionizing radiation are the two types of radiation.

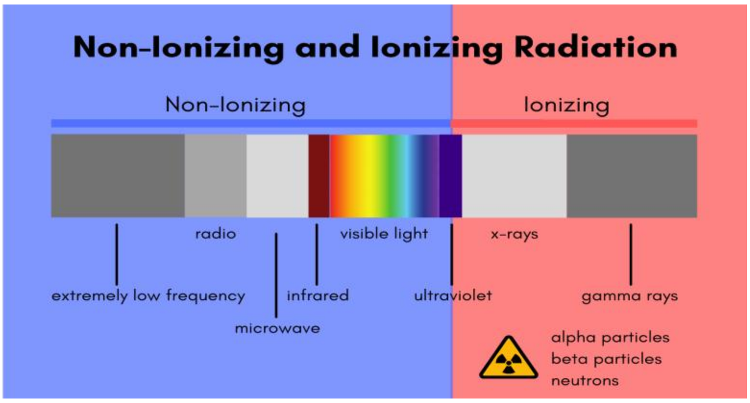

Figure 1: Electromagnetic spectrum

1.3 Background Radiation

The overall radiation (ionizing radiation) from various sources on a specific location on earth's surface refers to the background radiation level of that zone. Exposure to background radiation is an inescapable feature of the environment. Background radiations are received from natural and man-made source.

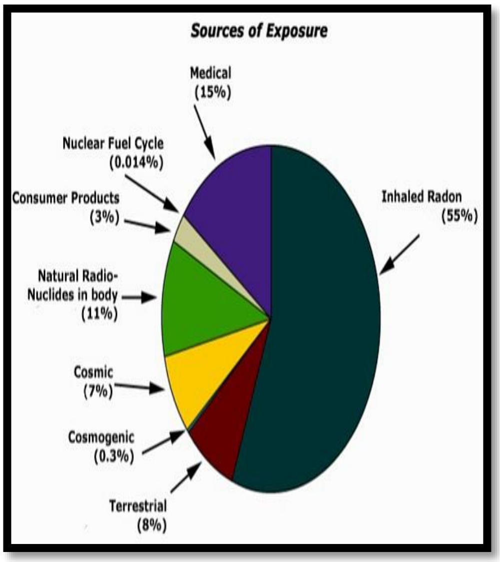

Figure 2 : Types of ionizing radiations

II. LITERATURE SURVEY

In this chapter we discussed the some detailed survey about Radiation detection and measurements in different places by using Geiger Muller (GM) Counter.

G.B. Dhami et al [9] have done detailed investigated on Comparison of the Background Radiation Level within Kanchanpur District, Nepal. This study reported on the prevalence of background radiation in Kanchanpur district, Nepal, including both urban and rural areas. Six bazars and forty-one rural communities in the Kanchanpur district have had their background radiation levels measured. Using this information, researchers found that background radiation levels in urban and rural areas were nearly identical: in urban areas, the average was 25.661.80 CPM while in rural areas, it was 26.113.18 CPM. Some rural areas, however, have been linked to slightly higher radiation levels than bazaar areas and other rural areas as a whole. This is because of natural occurrences (such as land sliding and river depositing).Background radiation counts are available for rural regions because of the widespread use of phosphate-containing chemical fertiliser on farmland. After analysing all of the available data, scientists have concluded that the radiation level in the Kanchanpur district is safe (defined as 100 CPM or below).

M.J. Hossen et al [1] by using a Geiger-muller counter, they collected data on background radiation levels at many locations inside the university region and its surroundings for their research report. The values of external hazard dose rate at the HSTU campus area were compared to worldwide average values. They discovered that radiations in that area below 1mSv/yr are not detrimental to human health for the people who live there.The maximum value of 35.333 CPM was discovered at the coordinates 25°41'49.7"N, 88°39'19.2"E.The minimal figure was 28 CPM, which was discovered in three distinct locations on campus. The inquiry offered scientific data on local natural radiation levels that medical experts could use to verify and make decisions about potential radiation issues.

The information for this study came from a variety of sources, including Syangja Hospital, Radio Chowk, Mahendra Chowk, Gurung Dada, Aandhikhola Bnak, the NTC office, Sanyas Aashram, Pokhari Dada, and District Hospital. Different values of mean cpm have been recorded across these several locations. There is also variance in the peak value and the standard deviation of count/sec. When used in this context, the phrase "peak value of count/sec." refers to the highest possible value of count/sec. The overarching purpose of the study was to determine the average background radiation count per minute at a few different locations in the Syangja District.At the edge of the Aadhikhola River, the lowest measured level of radiation, which was 21.63 cpm, was recorded. In contrast, the value of background radiation measured at the Shri Champagiri Sanyas Aashram was found to be 49.98 cpm. This number is slightly higher than average.After that, the highest values were found in two locations that are quite close to one another: Gurung dada and Pokhari dada (with respective values of 70.23 and 64.77 cpm). This could be because of the high altitude, which puts people at greater risk of being exposed to cosmic rays. Therefore, it is clear that there is no major radiation threat due to background radiation is noticed in the people who live in locations with high cpm and low cpm. This can be deduced from the information presented above. By Rajan Paudel Chhetri [3]

K Umesh Reddy et al [16] have explored the level of natural radioactivity in soils, which has a big impact on health, has been researched in this research report. In this investigation, gamma ray spectrometry was used to estimate the activity concentration of radionuclides in soil samples that were collected from 30 locations around the Kolar Gold Fields. According to the study, soil samples taken from the area near and around the Koolar Gold Fields show that thorium activity is higher than radium activity. It states that soil derived from gneiss, metabasalt, metagabbro, and amphibolites has lower radioactive activity than soil derived from granitic regions. The study area's activity concentration levels are greater than the average values for India and the world. The calculated values of the hazard indices were less than unity because the absorbed dose rate was found to be higher than the global average value based on radionuclide activity.

III. MATERIALS AND METHODS

3.1 Geographical Location of the Study Area:

KOLAR AND CHIKKABALLAPUR DISTRICT is located at KARNATAKA, INDIA.

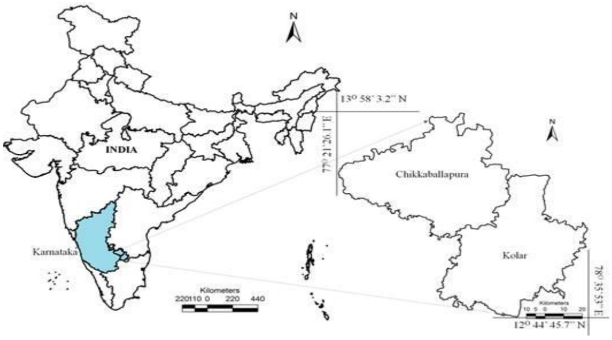

Figure 4: Geographical Location of the Study Area

The above figure shows the geological map of Kolar and Chikkaballapur district with different study locations.

Kolar and Chikkaballapur districts are southern part of KARNATAKA. Kolar is well known for gold mining and also known as milk and silk city, whereas Chikkaballapura is called as Panchagiri (As it is surrounded by 5 hills). The Kolar and Chikkaballapura districts are located between 12^0 44' to $13^0$58' North latitudes and $77^0$21' to $78^0$35' East longitudes. The sample readings were taken randomly inside different places.

3.2 Measurement set-up: GM COUNTER

Various tools can be used to find ionizing background radiation. Using GM counter equipment, radiation from several areas of KOLAR AND CHIKKABALLAPUR Districts were precisely studied.

A Geiger counter consists of a Geiger-Muller tube, a radiation-sensing substance, and processing circuits that show the data. It was given that name in honor of Hans Geiger, who developed the notion behind it in 1908, and Walter Muller, who investigates with Geiger in 1928 to improve the method for creating a real tube that, could detect various types of radiation. The Geiger Muller tube is a portable radiation measuring and detection device used to find radiation in the area. Alpha particles, gamma rays, beta particles, or X-rays can all be the source of this radiation. Additionally it is perhaps one of the world's best known of radiation detection instruments in wide and prominent use as a hand held radiation survey instrument.

Figure 5: GM counter

3.2.1 Definitions:

Mean: Mean is the average value of a set of (n) measurements in an experiment.
Mathematically it is defined as

$$\overline{N} = \frac{N_1+N_2+N_3+N_4........+N_n}{n}$$

$$= \frac{1}{n}\sum_{i=1}^{n} N_i$$

Mean is also called as average value.

Deviation: Deviation is the difference between the actual measured values and the average value. Deviation from the mean, d_i is simply the difference between any data point N_i, and the mean. We define this by

$$d_i = N_i - \overline{N}$$

When we try to look at the error or average deviation, the value probably will become zero. Because, we may have both positive and negative values which get cancelled. Yet an average value of the error will be desirable, since it tells us how good the data is in a quantitative way. Therefore we need a different way to obtain the measure of the scatter of the data.

Variance and standard deviation:

One way is to obtain standard deviation which is defined as

$$\sigma^2 = \frac{d_1{}^2+d_2{}^2+d_3{}^2+\cdots+d_n{}^2}{(n-1)}$$

$$= \frac{1}{(n-1)}\sum_{i=1}^{n} d_i{}^2$$

From this $\sigma = (\sigma^2)^{\frac{1}{2}}$ we see no negative sign and indicates average error contribution.
We find that all the deviations make a contribution. we call the term σ^2 as variance.

Standard deviation is a square root of the variance, which is widely used to indicate about the spread of our data.

$$\sigma^2 = \frac{1}{n}\sum_{i=1}^{n} d_i{}^2 \quad \text{(for large samples)}$$

The definition of the standard deviation differs slightly for small samples. It is defined as follows:

$$\sigma^2 = \frac{1}{(n-1)}\sum_{i=1}^{n} d_i{}^2 \quad \text{(for small samples)}$$

3.3 Methodology

Background radiations were measured at different places of KOLAR AND CHIKKABALLAPURA district involving hospital areas, signal areas, religious places and high residential areas. Measurements were performed during daytime between 9 AM to 5 PM in the month July 2023. The unit of measurement is count per 3000 seconds and converted into count per minute (CPM).

3.3.1 Measuring Of Background Radiation

The region of Tamaka is located at Kolar district, and It is near to Kolar city.
On 20-07-23, In Tamaka of latitude 13.135341^0 longitude 78.168612^0 location, around 2 PM We have been recorded background radiation counts by using GM counter as shown in the Table: 1

Figure 06: Background Radiation counting at Tamaka

Sl.No	Background counts(N_i)	Average value($\bar{N}$)	$N_i - \bar{N}$	$(N_i - \bar{N})^2$
1	89		-10.44	108.99
2	81		-18.44	340.03
3	99		-0.44	0.19
4	98		-1.44	2.07
5	97		-2.44	5.95
6	93		-6.44	41.47
7	106		6.56	43.03
8	95		-4.44	19.71
9	89		-10.44	108.99
10	91		-8.44	71.23
11	91		-8.44	71.23
12	111		11.56	133.63
13	101		1.56	2.43
14	119		19.56	382.59
15	92		-7.44	55.35
16	77		-22.44	503.55
17	92		-7.44	55.35
18	110	99.44	10.56	111.51
19	119		19.56	382.59
20	121		21.56	464.83
21	92		-7.44	55.35
22	95		-4.44	19.71
23	84		-15.44	238.39
24	111		11.56	133.63
25	86		-13.44	180.63
26	108		8.56	73.27
27	107		7.56	57.15
28	99		-0.44	0.19
29	104		4.56	20.79
30	113		13.56	183.87
31	109		9.56	91.39
32	97		-2.44	5.95
33	123		23.56	555.07
34	93		-6.44	41.47
35	110		10.56	111.51
36	102		2.56	6.55

37	103		3.56	12.67
38	86		-13.44	180.63
39	86		-13.44	180.63
40	94		-5.44	29.59
41	109		9.56	91.39
42	76		-23.44	549.43
43	83		-16.44	270.27
44	116		16.56	274.23
45	101		1.56	2.43
46	108		8.56	73.27
47	98		-1.44	2.07
48	118		18.56	344.47
49	93		-6.44	41.47
50	97		-2.44	5.95
Sum	**4972**			**6738.32**

Table 1: Background radiation counts In the Region of Tamaka

The following parameters for the set of tabulated background readings of Table : 1 can be calculated as :

Mean value = $\overline{N} = \frac{4972}{50}$ = 99.44

Variance = $\boldsymbol{\sigma}^2 = \frac{1}{n}\sum_{i=1}^{n}(\boldsymbol{Ni}-\overline{\boldsymbol{N}})^2 = \frac{5767.38}{50}$ = 134.765

Standard Deviation = σ = $\sqrt{134.765}$= 11.6088

The region of PG Centre Mangasandra is located at Kolar district .On 21-07-23, In PG Centre Mangasandra of latitude 13.098453^0 longitude 78.081863^0 location, around 12 PM We have been recorded background radiation counts by using GM counter .

Mean value = $\overline{N} = \frac{4640}{50}$ = 92.8

Variance = $\boldsymbol{\sigma}^2 = \frac{1}{n}\sum_{i=1}^{n}(\boldsymbol{Ni}-\overline{\boldsymbol{N}})^2= \frac{4660}{50}$= 93.28

Standard Deviation = σ = $\sqrt{93.28}$ = 9.6581

The region of Vemagal is located at kolar district .On 21-07-23, In Vemaga of latitude 13.189782^0 longitude 78.018213^0 location, around 4 PM We have been recorded background radiation counts by using GM counter .

Mean value = $\overline{N} = \frac{3214}{50}$ = 64.28

Variance = $\boldsymbol{\sigma}^2 = \frac{1}{n}\sum_{i=1}^{n}(\boldsymbol{Ni}-\overline{\boldsymbol{N}})^2= \frac{3266.08}{50}$ = 65.3216

Standard Deviation = σ = $\sqrt{65.3216}$= 8.0821

The region of Chinthamani is located at Chikkaballapura district. It is urban area.

On 22-07-23, In Chinthamani of latitude 13.400424^{0}loangitude 78.061053^0 location, around 10 AM, We have been recorded background radiation counts by using GM counter.

Mean value=$\overline{N} = \frac{4794}{50}$ = 95.88

Variance = $\boldsymbol{\sigma}^2 = \frac{1}{n}\sum_{i=1}^{n}(\boldsymbol{Ni}-\overline{\boldsymbol{N}})^2= \frac{5321.28}{50}$ = 106.4255

Standard Deviation = σ = $\sqrt{106.4255}$= 10.3162

The region of Kaiwara is located at chikkaballapura district .On 22-07-23, In Kaiwara of latitude 13.336513^0 longitude 77.946644^0 location, around 01 PM, We have been recorded background radiation counts by using GM counter .

Mean value = $\overline{N} = \frac{3509}{50}$ = 70.18

Variance = $\boldsymbol{\sigma}^2 = \frac{1}{n}\sum_{i=1}^{n}(\boldsymbol{Ni}-\overline{\boldsymbol{N}})^2= \frac{4357.38}{50}$ = 87.1476

Standard Deviation = σ = $\sqrt{87.1476}$ = 9.335

The region of Chikkaballapura is located at Chikkaballapura district .On 23-07-23, In Kaiwara of latitude 13.436694^0 , longitude 77.735077^0 location, around 10AM We have been recorded background radiation counts by using GM counter.

Mean value =$\overline{N} = \frac{3791}{50}$ = 75.82

Variance = $\boldsymbol{\sigma}^2 = \frac{1}{n}\sum_{i=1}^{n}(\boldsymbol{Ni}-\overline{\boldsymbol{N}})^2= \frac{5767.38}{50}$ = 115.3476

Standard Deviation = σ = $\sqrt{115.3476}$ = 10.74

IV. RESULT AND DISCUSSION

Using simple GM counter, the level of background radiation of different sample places of Kolar and Chikkaballapur district were recorded in CPM (counts per minute) successfully. The background radiation counts recorded along six different places have been averaged. The average values with standard deviation of the radiation counts of the corresponding places were calculated using Ms Excel Tabulated as below.

S.N	Name of the place	Mean Count Per minute	Standard Deviation (S.D)	Mean ± S.D
1	Tamaka	99.44	11.60	99.44 ±11.60 i.e.(87.84,111.04)
2	P.G Centre	92.8	9.65	92.8 ±9.65 i.e.(83.15,102.45)
3	Vemagal	64.28	8.08	64.28 ±8.08 i.e.(56.2,72.36)
4	Chinthamani	95.88	10.31	95.88 ±10.31 i.e.(85.57,106.19)
5	Kaiwara	70.18	9.33	70.18 ±9.33 i.e.(60.85,79.51)
6	Chikkaballapur	74.92	10.77	74.92 ±10.77 i.e.(64.15,85.69)

Table 2: background Radiation count of various places with standard deviation

There are no significantly large fluctuations in the arrival of radioactive particles inside GM tube for six places while moving it at variety of regions of the someplace. So counts are placed in some category. But for three places there are significant fluctuations in the count rates while moving the device at several places. So the data are further categorized into two or three parts and average values and standard deviations of separate parts have also been calculated as tabulated above.

From this table it is clear that different places have different value of mean CPM. There is also variation in the standard deviation.

The average values of background radiation counts for various places are plotted in a bar diagram taking name of places along x-axis and count/minute along Y-axis as shown below :

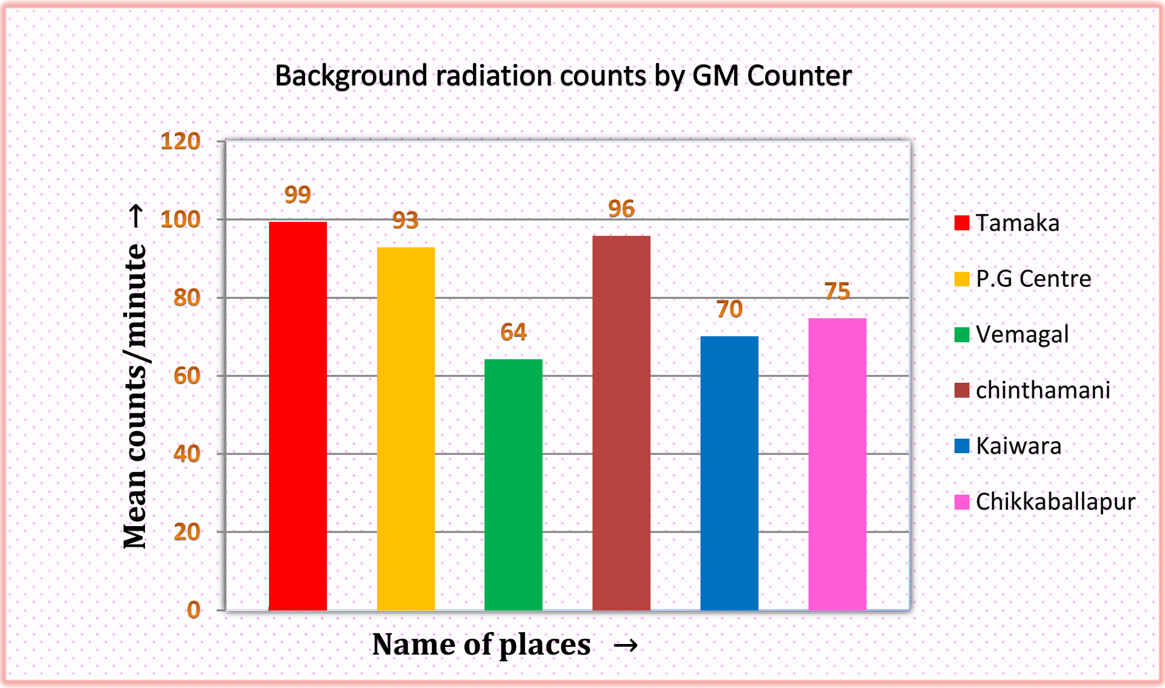

Figure 7: Graphical representation of Background counts

❖ Among these places, the Maximum background counts (99 CPM) was found at Tamaka near Kolar. Mainly it indicates that there is a presence of high amount of radiating substances at region of Tamaka.

➢ In Tamaka maximum background counts may due to the radio nuclides present in medical waste and X-ray exposure from the nearest Hospital. But the background counts were significantly similar at all the morning, day and evening time.

➢ Also the maximum value of background count at Tamaka it is may due to radioactive (Gamma and beta) sources in practical lab.

❖ The Chinthamani town exhibits High Background counts 96CPM; it may be due to significant building with granite usage as construction materials and, which can elevated background counts ,granite and construction materials commonly contains trace amount of naturally occurring radioactive isotopes such as uranium , thorium and their decay product and also Radon gas is a radioactive gas that form as a result of decay of uranium and thorium present in soil, rock and building materials. While we recording the counts there is a process of extraction of ground water (Bore well). May be this leads to exposing of Radon gas. Because of these reason we observed maximum background counts.

❖ Background count at PG CENTRE is found to be 93CPM. This background counts shows that there is the presence of high radiating substances in the soil and nearest hills and it may due to the excess use of chemical fertilizer in agricultural land. In total, the average of mean background count of all the CPM while that of the rural areas CPM is no any significant difference between the average background counts of the urban and rural areas. However, comparing individually, some of the rural areas shows high background counts due to the presence of radioactive isotopes of natural resource.

❖ In Vemagal region the background counts observed that 64CPM. Background radiation varies from place to place over time depending on amount of naturally occurring radioactive elements in soil, water, air, weather conditions also effect radiation levels as snow and clouds cover may shield these elements, and radioactive particulates can washout of the air during rain storms.

➢ The type of the soil and rock in an area can influence background radiation levels. Background radiation counts decreases with distance from source of naturally occurring event like Rocks and Hills radioactivity. In Vemagal there is no Hills near to the village and there are less building compare to urban areas. It may be show less radioactive isotopes of natural resource. Due to this reason we may observe less radiation counts in Vemagal compare to other regions.

❖ Kaiwara is a rural and less significant building construction area. Here background radiation counts are found to be 70 CPM; it may be due to natural radioactive sources like soil, rocks, and Nearest Hills. Also cosmic radiation from the atmosphere.

❖ Chikkaballapur is the Urban and high significant building construction area. Here background radiation counts 75 CPM; it may be due to the maximum number of buildings and also radio nuclides present in medical waste and X-ray exposure from the nearest Hospital of the Chikkaballapur.

❖ The normal background radiation count is typically in the range 25 to 75 CPM and the alert level is 100 CPM. So, it can be recommended that both the rural and urban areas of Kolar and Chikkaballapur district having almost similar level of background radiation below risk level are not hazardous for lives. A small difference of CPM among different rural areas may be due to the vegetation and radioactive resources. However, comparing individually, some of the rural areas shows high background counts due to the presence of radioactive isotopes of natural resource.

V. CONCLUSION

From this study the background count per minute in the selected areas of **Kolar and Chikkaballapur** district following conclusions are drawn:

- The minimum value of background radiation was observed at the region of **Vemagal, Kolar district**.(i.e.. 64.28CPM).
- A little high value of background radiation has been observed at the region of Kaiwara (i.e..70.18CPM) and **Chikkaballapur**.(i.e.. 74.92CPM).
- The maximum values of CPM are obtained at the regions of **Tamaka** (i.e.. 99.44 CPM),**Chinthamani** (i.e.. 95.88CPM) and **PG centre Mangasandra**.(i.e.. 92.8CPM).
- No significant radiation hazard due to background radiation is observed in the people at places with high CPM and low CPM.
- It is clearly verified from this study that Radioactivity is not a continuous phenomenon because radiations are observed in the form of discrete counts and Count number is not same in a fixed time while several observations are taken.

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