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Background radiation detection and measurement by using a GM counter at northwestern mining area of Bangladesh

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Abstract:
The background radiation level of a zone refers to the total radiation from multiple sources at a certain location on the earth's surface. The energy that moves in the form of electromagnetic waves or particles is referred to as radiation. Among the several radiations: Humans are exposed to ionizing radiation, which can be harmful to their health. We were interested in high-energy radiations that could ionize matter in this work. Overexposure to ionizing radiations can cause a variety of malignancies. Radiation can come from a variety of sources, including cosmic rays (radiation from space), radiation from radioactive atoms on the earth's surface, radiation from our own bodies, and so on. 40K, 226Ra, 238U, and 232Th are the most common radionuclides. Humans are largely exposed to inescapable ionizing radiation that is emitted by naturally occurring radioactive minerals in the earth's crust as well as man-made sources. A GM counter was employed in our research to estimate the overall radiation level at several locations in the granite and coal mining areas, as well as their surroundings. For all sample locations, there are no abnormal radiation counts. As a result, there is little chance of acute health effects on workers and the general public as a result of background radiation in the research area.

Keywords:_Background Radiation, GM counter, Longitude, Latitude etc._

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I. INTRODUCTION

Radiation is the most common form of energy emitted by radioactive substances. Radiation exists in various structures around us. The radiation can be supplied non-end ionizing radiation depending on the energy or ionizing energy [1]. Non-ionizing radiation is considered non-destructive in light of the fact that the amount of damage caused by this radiation is much less than that of ionizing radiation. This study manages ionizing radiation. Along these lines, radiation is referred to here as ionizing radiation [2]. The effects of ionizing radiation affect individuals as well as animals. Unreasonable exposure to alpha particles, beta particles, gamma rays, X-beams, etc. can induce a variety of malignant growths. Different forms of radiation springs exist, including infinite beam radiation from space. Radiation from our own bodies, radioactive chemicals in the earth's outer layer, etc.

Radio waves, microwaves, infrared, visible light, brilliant beams, X-beams, and atomic particles are all examples of radiation. We're talking about high-energy radiation that can ionize stuff. Radiation can be used for valuation purposes such as clinical imaging, radiation treatment, farming, more developing industry quality, and disease cell therapy. Indicates omnipresent radiation from many sources in a certain location on the earth's outer layer. The base of that zone is the radiation level. Exposure to foundation radiation is an indispensable element of climate. A compact GM counter was used to measure absolute radiation levels in different areas. Its discovery shows variations in radiation levels [3]. Radiation can be similarly assigned to normal and counterfeit radiation. Regular radiation from the sun, massive stars, or radioactive material on the earth's outer surface is distinguished as normal radiation by radiation from artificial sources used for various purposes, sometimes known as fake or man-made radiation. There is a wide range of human exercise opportunities for clinical purposes such as X-beam, radiotherapy, etc., and Non-nuclear initiatives typically increase the concentration of a fraction of the radioactive material found in the Earth's crust, which has an impact on people and the environment [4]. Ionizing radiation from the Earth's crust, as well as radioactive substances from man-made sources, are the main sources of exposure for humans. [5].

The human body is presented at about 82% radiation dose, which is insane; they start from the foundation radiation source. The presence of certain quarries and springs in certain areas called undisputed level foundation radiation zones expands the level of foundation radiation. Sorting the building material used at home can affect the speed of the foundation radiation part. The investigation of radioactivity in the climate is important for monitoring the level of radioactivity that occurs in humans through direct or circular communication [2].Mineral Resources Geographically, most of Bangladesh has a place with the Bengal Basin. Notable mineral resources of Bangladesh are gaseous petrol, coal, limestone, hard rock, rock, stone, glass sand, development sand, porcelain, block earth, peat, and coastal sand-weighted minerals.

Here, coal was first discovered in 1959 in the invasive abundance of the earth's surface, five coal fields were found. Non-nuclear initiatives typically increase the concentration of a fraction of the radioactive material found in the Earth's crust, which has an impact on people and the environment. Progress of Barapukuria coal mining, one of the five found coal mines, started in 1997. The Barapukuria coal mine has a focus on extracting 74 million tons of extraction and generating 1 million tons annually. There are plans to build a 300 MW power plant utilizing coal from the mine that has been isolated. The Barapukuria Underground Coal Mine is one of Bangladesh's first and most promising coal mines, with efficient extraction and extraction of coal from this mine serving as the backbone of mining operations in various coalfields in the future, and thus this excellent coal has been created in the country using energy. At a basic level, both underground and open mining activities are profoundly subtle and adversely affect the general climate now and then. Due to the Barapukuria coal mining, huge mining effects have been observed in the area around erosion, geography, hydrology, etc. [6]. The evaluation focused on the Barapukuria coal mine project in northwestern Bangladesh, with the goal of determining the impact of coal mining on the environment in general. Although coal mining adds to a country's economic progress, it pollutes the air, water, and land, as well as the environment. It greatly affects the well-being of the human body for those who are exposed to inevitable regular or base radiation. What's more, it affects the surrounding farmland, limiting crop yields [7].

Similarly, it is a matter of pride for Bangladesh that it is the main rock mine of the planet. At the same time, it is the main underground quarry in Bangladesh. Rock is a great solid stone used in home development. It is also used in making marble stones. Madhyapara Hard Rock Mine in ParbatipurUpazila of Dinajpur is a truly important resource of Bangladesh that can bring constructive results to the country. 4,000 tons of stone per day is being distributed in three rice fields, which will later increase to 20,000 tons per day. Rooppur Nuclear Power Plant, one of the largest megaprojects in the country, is now being supplied with stones due to its quality. Hard rock probes over the entire range of MGM may have real environmental impacts, for the most part, due to submergence in the mining area, groundwater pollution, noise pollution as well as annoying and reduced air pollution and groundwater levels during impact. Irrational siphoning of sub-surface water.So, experts are dealing with treatments like skin diseases, eye diseases, ear complications, and many more without joking. The explosion of Ammonium Nitrate Fuel Oil (ANFO) in MGM produces CO2, NO2, and CO toxic fumes resulting in suffocation, toxicity, and dizziness among the workers [8].

The chemical composition of water affects both its quality and its applicability for home, industrial, and irrigated purposes. The study of wastewater pollution in Bangladesh is still in its infancy, and there is very little published on the subject. A channel of the Ganges River once passed through the Dhaleshwaririver on its way to the Bay of Bengal. This stream subsequently changed, eventually lost contact with the Ganges' principal channel, and was given the new name Buriganga [9].

The differential migration of transportable proportions of NORMs to the environment can alter the location, scope, and severity of gamma radiation exposure. The main place where NORMs gather in the terrestrial environment is in the soil. Moreover, because it supplies water and nutrients for plant growth, soil is one of the most significant environmental backgrounds. In order to determine potential changes in environmental radioactivity as a result of such activities, it is crucial to identify, quantify, and characterize the activity level, effective dose consequences, negative effects, potential radiological risk and distribution, accumulation, migration, and source of NORMs in soils [10].

II. EXPERIMENTAL METHODS

Geographical location of the study area:

Barapukuria Coal Mine (BCM) is located at Parbatipur, Dinajpur in the northern corner of Bangladesh. It is 123 feet (37.50 m) above sea level. Madhyapara Granite Mine (MGM) Petrobangla and the first and only underground hard rock mine in Bangladesh under the Ministry of Power, Energy, and Mineral Resources of Bangladesh. MGM is located in Madhyapara, Dinajpur District, North-West Bangladesh, with an area of about 1.44 km², between latitude 25º23´22´´ N and 25º34´43´´ N and longitude 89º03´34´´ E and 89º05´04´´ E. [8] In the Madhyapara area, basement rock is encountered at a depth of 130 m [11]. Solid rock mining at MGM helps to meet the needs of our country and save a lot of unfamiliar trade by advancing the economy of the common people of Bangladesh.

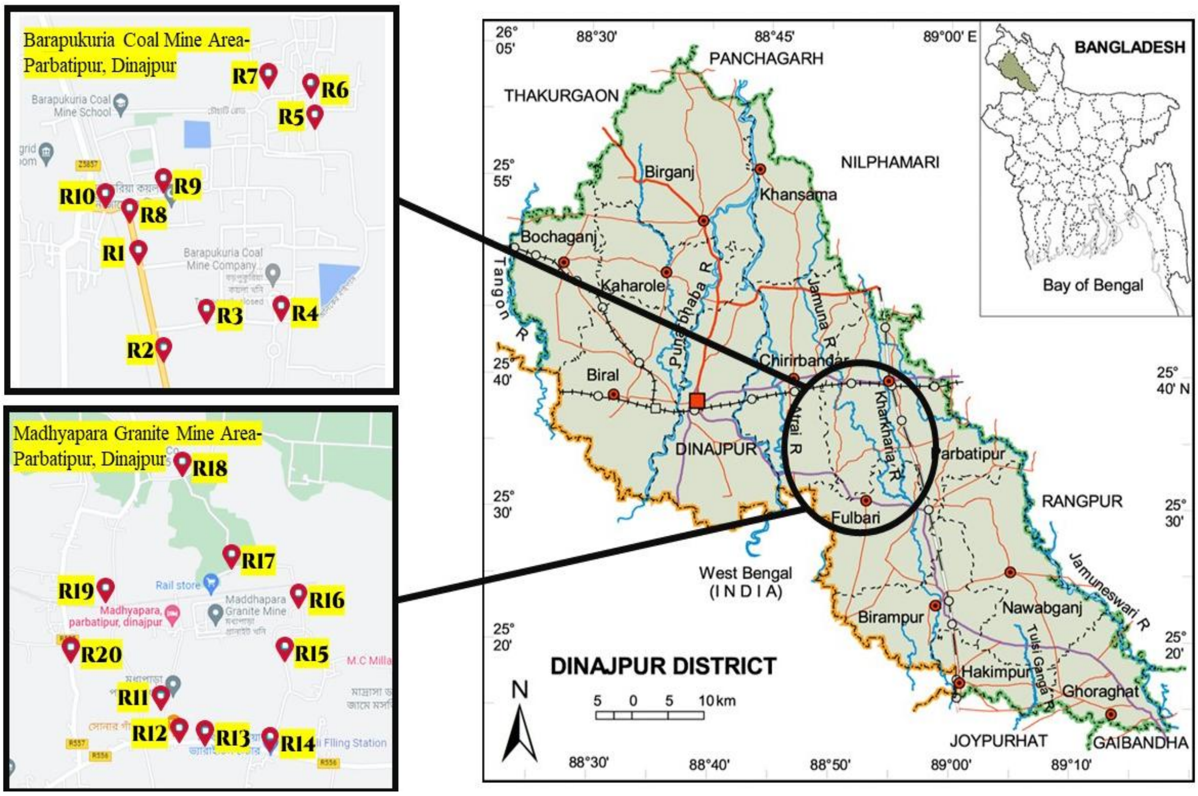

Fig. 1: Reading Map of TheBarapukuria Coal Mine Area &Madhyapara Granite Mine Area Atnorthern of Bangladesh [12].

The ST160 nuclear lab station is an independent unit equipped with a flexible clock/counter, GM tube, test stand, and an 11-piece pool set. The unit comes in total with a serial point interaction with Macintosh or IBM-Vibible PC and Universal Serial Bus (USB) interface [13].Physically limited by the high voltage console or front board pushbutton and completely factor in the range of 0 and +800 volts. Improved accuracy in the presentation of the PC screen and the stock of readout is completely limited by the processor. Extra-large, 1 "LEDs are used for advanced shovels on the front board, inducing clarity with zero privacy, for clear visual readouts over a wide range of lighting conditions.

Study Hall exhibits and nuclear tests can now be run directly from a Windows PC using the built-in USB or sequential RS-232 connection point and STX copy programming. Computing power can be started from ST160 or a PC. The given product gives a PC screen showcase; everything is equal, including a simple and advanced copy of the rate meter. Running data is normally transferred to the PC and kept on a functional record in the calculation sheet. Data Analysis and Graphical Presentation It is now possible to develop new techniques in nuclear science training using many common bookkeeping sheet programs [13].

An AC to DC line converter is provided for continuous benchtop operation.

Fig. 2:A conventional GM counter of ST160.

Measurement Set-Up:

Radiation was precisely isolated from various areas near the Barapukuria coal mine and the Madhyapara granite mine area using a versatile GM counter gadget.

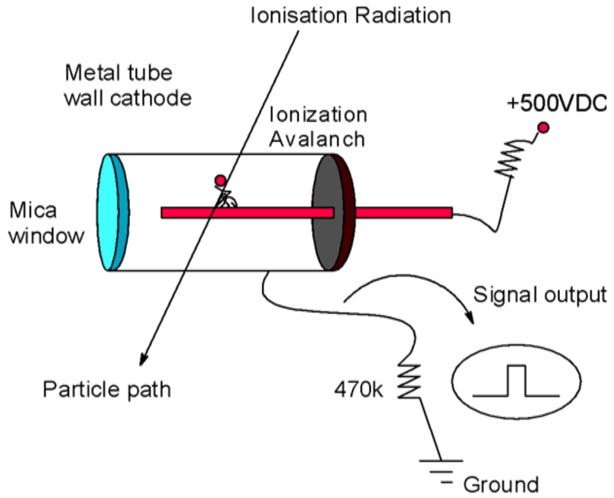

Fig. 3:A thin end window tube and a high voltage source applied through a resistor are used in a traditional Geiger Muller counter. [14].

At a Geiger counter, a Geiger-Müller tube (detecting material that separates radiation) and handling hardware, show the results. The Geiger counter model is recognized by the ST-160 nuclear lab station S / N-248. This gadget has the ability to calculate high-energy β-particles, γ-particles, and X-beams entering the cylinder. It shows the endless count rate on the showcase screen. This counter has a clock and an independent unit. Along these lines, we can place a point in time for 60 seconds. When each radiation is recognized it utters a less clear sound and gives a higher perceptible sound after the time set is over. The unit ends with a sequential connection point on a Macintosh or IBM-like PC or a USB interface.

Working of Gm Tube:

Geiger-Müller tubes are loaded with latent gases such as helium, neon, or argon, where a high voltage is applied. The cylinder conducts an electric charge from time to time while the episode conducts gas through the ionization of a molecule or radiation photon. At the GM counter, the ionizing particles passing through the gas tube ionize the gas and electrons and move to the anode along these supplied lines. The speed is extremely high and they produce helpful electrons after rehashed effects with gas particles. The ionization in the cylinder is intensified by the Townsend release effect to provide a simple guess-finding beat, which is taken care of in handling and showing gadgets. This huge vibration of the cylinder makes the gigabyte counter generally moderate to work, as subsequent gadgets are remarkably accessible [15]. Electronics similarly produce high voltages, regular 0 to +800 volts, which should be applied to Giger-Muller cylinders to strengthen their activity. A limited amount of halogen gas or alcohol is added to the gas mixture to stop the discharge in the Geiger-Müller tube.

Detector Circuit:

The locator circuit includes a radiation indicator (GM tube), a lift converter (to supply the expected voltage to the GM tube), and a heartbeat counting circuit (to count and communicate the beats produced by the GM tube) [16].

Giger-Muller tubes generate electrical vibrations at their sensitive volumes when ionizing radiation occurs. For legitimate activity, these identifiers must be operated or temporarily available at a predetermined working voltage set by the manufacturer. In order to work on the antidote to alpha and beta molecular radiation, numerous GM tubes have very few entry windows that require significant consideration when caring for them. Example Do not allow any item to interact with the GM tube placed on top of the compartment.

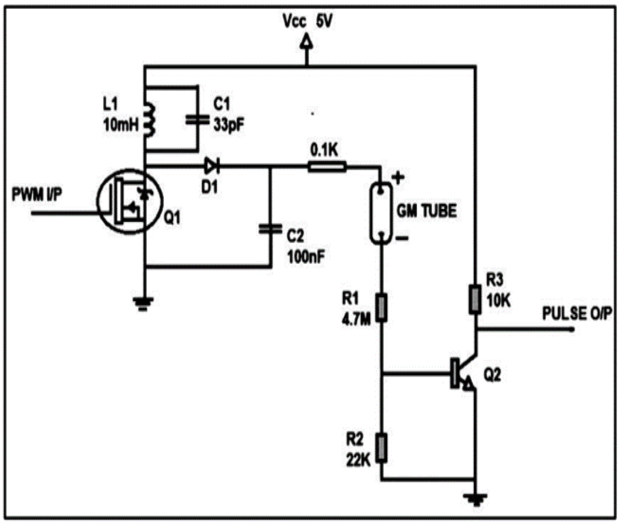

Fig. 4: Detector circuit diagram [14].

The ST160 has a fully functional high voltage power supply that can cover a wide range of uses. High voltage levels can be shown in a computerized readout by pressing H.V. Button once. The high voltage can then be switched using the UP / DOWN button to extend the 20-volt. Press H.V to return to PC show mode. Let's tie once more [13].

GM Plateau:

The specific working voltage of a Geiger-Mueller cylinder can be temporarily resolved using a slightly radioactive source, for example, 1 micro currency Cs-137 or Co-60. A properly operated cylinder will show a "level" effect, where the set rate is virtually constant at the applied voltage. Place the radioactive source near the GM test window and increase the high voltage step by step until the radiation event is recognized. Increase the voltage to the current 20-volt step; record the starting rate at each connection. This rate should be truly stable at different voltages and then, the higher the voltage, the faster it will increase with the further increase, indicating that the cylinder is entering the break zone. Try not to continue the cylinder in this breakdown state but lower the highvoltage and create a plot at a fixed rate as opposed to the applied voltage. The proposed working voltage level cannot be set in stone as a district loop. Note in the model below that the level has risen from about 350V to 600V. For this situation, a sensitive working voltage would be 500V.

III. RESULTS AND DISCUSSIONS

The coordinates (longitude and latitude) of the locations where radiation measurements were taken in the field were discovered by using a Global Positioning System (Plate XXXI).The following table shows the data for naturally occurring background radiation by using a GM counter [13].

Table no 1: Background radiation data at Barapukuria Coal Mine Area-Parbatipur, Dinajpur.

NO.	Location		Reading (Counts per min.)			
	Longitude (N)	**Latitude (E)**	**Reading-1**	**Reading-2**	**Reading-3**	**Average1**
R-1	25°32’48.0”	88°57’21.9”	28	23	26	25.67
R-2	25°32’39.3”	88°57’24.9”	31	25	28	28
R-3	25°32’43.2”	88°57’30.3”	26	30	34	30
R-4	25°32’43.4”	88°57’39.4”	24	28	32	28
R-5	25°33’02.2”	88°57’43.6”	41	32	28	33.67
R-6	25°33’05.3”	88°57’43.0”	23	28	26	25.67
R-7	25°33’06.2”	88°57’37.8”	26	21	29	25.33
R-8	25°32’53.1”	88°57’20.8”	28	25	29	27.33
R-9	25°32’56.0”	88°57’24.9”	24	28	27	26.33
R-10	25°32’54.5”	88°57’17.8”	30	32	31	31

*Observation time: 1 Min (60 Sec.), Operating Voltage: 600V

Table no2: Background radiation data at Madhyapara Granite Mine Area-Parbatipur, Dinajpur.

NO.	Location		Reading (Counts per min.)			
	Longitude (N)	**Latitude (E)**	**Reading-1**	**Reading-2**	**Reading-3**	**Average 2**
R-11	25°33’44.6”	89°03’41.9”	28	38	30	32
R-12	25°33’38.9”	89°03’45.6”	26	35	31	30.666
R-13	25°33’38.4”	89°03’50.9”	29	31	36	32
R-14	25°33’37.5”	89°04’03.7”	20	21	27	22.666
R-15	25°33’53.6”	89°04’06.7”	36	30	24	30
R-16	25°34’02.9”	89°04’09.4”	32	35	31	32.666
R-17	25°34’09.9”	89°03’56.1”	33	30	29	30.666
R-18	25°34’26.3”	89°03’46.2”	30	25	28	27.666
R-19	25°34’03.9”	89°03’30.9”	28	36	32	32
R-20	25°33’53.3”	89°03’23.9”	24	23	25	24

*Observation time: 1 Min (60 Sec.), Operating Voltage: 600V

In order to protect people from ionizing radiation, it is vital to know the standard information about natural radiation and radioactivity. In this way, continuous ecology monitoring projects are expected to decide on any progress in the mining area because of the regular rock radiation from exposed mining rocks, coal, and water.

In the case of MGM mining area, the lowest value 24 cpm was found at the location 25°33’53.3” N, 89°03’23.9” E. On the other hand, the highest value 32.67 cpm was found at the location 25°34’02.9” N, 25°34’02.9” E.Naturally-occurring background radiation is the main source of exposure for most people. Levels typically range from about 1.5 mSv/yr. to 3.5 mSv/yr. (0.171 µSv/h to 0.399 µSv/h) but can be more than 50 mSv/yr. To prepare maps of the distribution of radiation dose rates, data of field gamma radiation measurements were first converted to various dose units such as dose equivalents (mSv/yr) as follows:

Gross Gamma Radiation Measurement:

The data for gross gamma counts that were collected in counts per minute were translated to exposure in roentgen/hour. 2000c/s is equivalent to 0.85 milli Roentgen/hour (mR/h) with this apparatus. The results show the exposure rates, or level of ionization, at a specific location in the roentgen unit (R). Using the relationship between absorbed dose rate (Da) and exposure (E) as provided by Grasty et al., the exposure rates were once more converted to absorbed dose rate in rad/hour (1984)i.e.

Da (rad/h) = a (rad/R). E(R/h) ……………...…… (1)

Where, a has the value of 0.869 rad/R.

The effects of radiation in biological tissues differ with types of radiation [17]. For this reason, therefore, in comparing the effects of radiation on living systems, a unit known as roentgen equivalent man (rem) [18]. Therefore,

D.E. (rems) = RBE × rads

[RBE = Relative Biological Effectiveness].

For gamma rays, RBE = 1

Values obtained in rad were therefore converted to their rems equivalent, as well as the Sievert (Sv) unit which is the SI (System International) unit used in radiation protection.

1Gy = 100rad = 1J/kg, and 1Sv = 100rems.

Since 2000 c/s correspond to 0.85 milliroentgen/hr (mR/h),

1c/s = 4.25×10^{-4}mR/h ………………………... (2)

For low energy photons, the instrumental multiplication factor (K) is 0.2. Therefore,

1c/s = 4.25×10^{-4} x 0.2 (mR/h) ……………... (3)

= 8.5×10^{-5}mR/h or 8.5×10^{-8} R/h

Using the relation Da (rad/h) = a(rad/R). E(R/h),

1c/s = 8.5×10^{-8} R/h × 0.869 rad/R ………… (4)

= 7.39×10^{-8} rad /h or 1.24×10^{-5} rad/week

The values obtained in rad were multiplied by the gamma radiation's Relative Biological Effectiveness (REB) value to convert to rem units.

Dose equivalent in rem = Relative biological effectiveness × rad.

1 c/s = 1.24×10^{-5}rem/week.

= 6.45×10^{-4} rem/yr

$= 6.45 \times 10^{-6}$Sv/yr…………………… (5)

Therefore, 1c/s of gamma radiation measured corresponds to 6.45 × 10-3 mSv/yr. The dose equivalent was found below one (01) mSv/yr(≤ 1mSv/yr). These values are not actually health hazardous for the dwellers of that area.

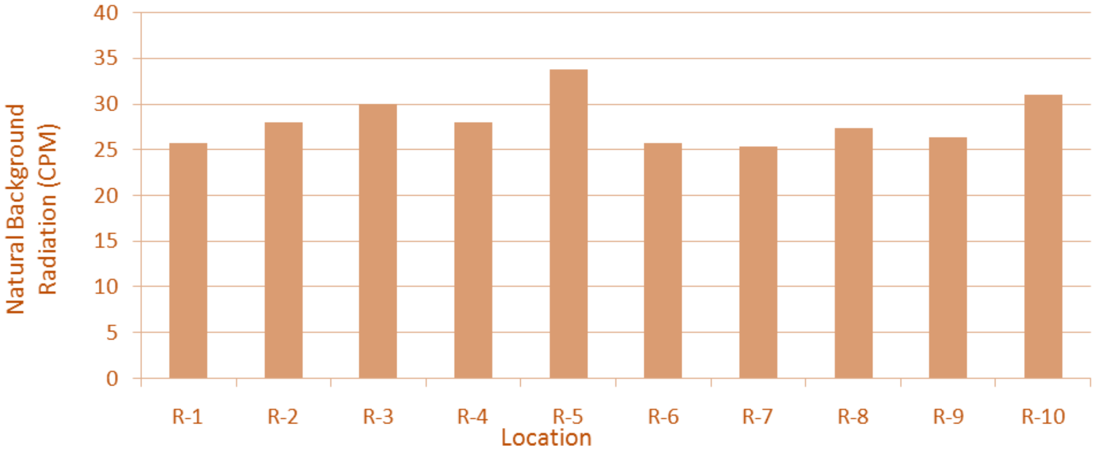

Fig. 5: Location Vs Natural Background Radiation (CPM) graph for BCM – Parbatipur, Dinajpur.

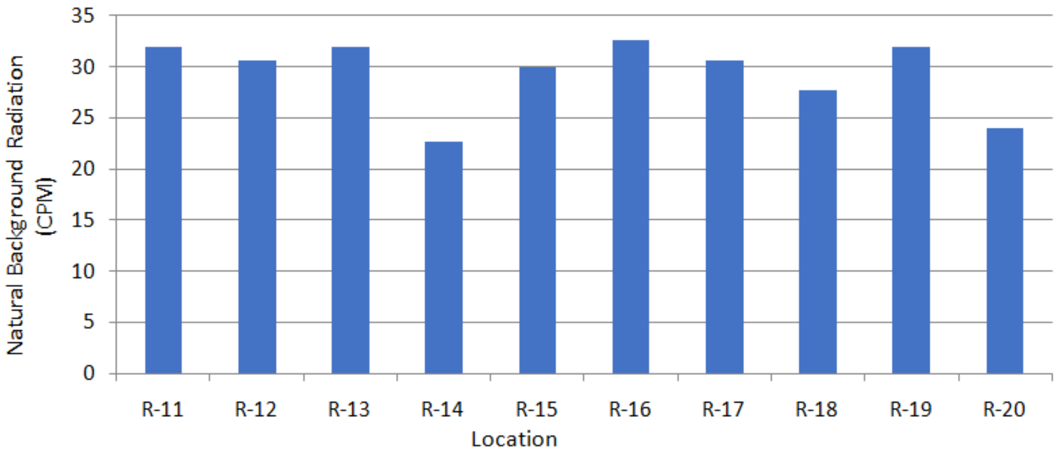

Fig. 6: Location Vs Natural Background Radiation (CPM) graph for MGM area – Parbatipur, Dinajpur.

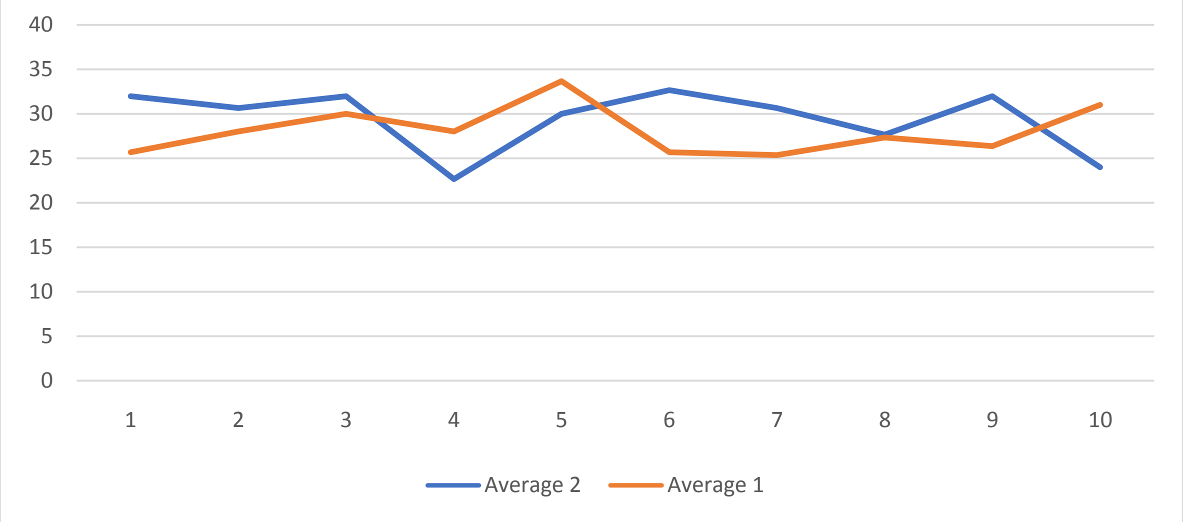

Fig. 7: Comparison between background radiations (CPM) of BCM Vs MGM.

IV. CONCLUSION AND FUTURE PERSPECTIVE

A study of natural radiation levels and dose rate distribution in parts of the BCM and MGM areas of Parbatipur, Dinajpur, has just been completed, with the following significant findings:

i). The highest value 32.67 counts per minute (cpm) was found at the location 25°34'02.9"N, 25°34'02.9"E in MGM. In BCM the average value of radiation found from the range 25.67 to 33.67 cpm which is minimum and maximum value respectively. The highest value 33.67 cpm was found near the pile of coal which was stored up for sale and for producing electricity.

ii).By the comparison between absorbed dose rate compared with the global average values, we found that the radiations in this area are not hazardous for human health for the people living here.

iii). Geologically, basaltic regions are the safest for ionizing radiation exposure from natural terrestrial sources since dose rates there are typically around 50% less than the maximum allowable dose limit. As a result, it may be argued that using rocks in structures is radiologically safe.

iv). For the protection of the population from ionizing radiation, it is essential to know the baseline data of environmental radiation and radioactivity. So, there is a need for continuous environmental monitoring programs in order to determine any change due to natural radioactivity released from the material used in the buildings.

v). Since radioactive elements are taken into the body through food and drinking water, it is important to routinely check for radiation levels in these substances.

vi). The work has produced scientific data on natural radiation levels in the area, which health officials can use to validate and plan judgments about potential radiation concerns in the area. Finally, this research is critical for maintaining a sanitary environment for humans.

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Author Contribution

The main author of this study is Md. JakirHossen. He created the computation files, composed the manuscript, and created the input files. The remaining writers gathered the data, read, and approved the paper's final draft.

REFERENCES

[1]. R.P.Chhetri, "Background Radiation: Detection, Measurement and Hazards," Himalayan Physics, 2017.

[2]. A. R. K. J. M. P. Abdu Hamoud Al-Khawlany, "Review on studies in natural background radiation,"Radiation Protection and Environment, p. 215, 2018.

[3]. Amazon, "Product Information 6011," Amazon.com, 2019.

[4]. A. O. M. AyorindeOgunremi, "Natural Radionuclide Concentrations and Associated Doses Around Three Dumpsites in Lagos, Nigeria," 2021.

[5]. K. F. a. M. R. E. Litvak, "Health and Safety Implications of Exposure to Electromagnetic Fields in the Frequency Range 300 Hz to 10 MHz," E. Litvak, K.R. Foster, and M.H. Repachol, vol. 23, pp. 68-82, 2002.

[6]. H. M. R.-A.-I. T. R. M. B. B. S. M. Md. NahidNowsher, "Environmental Impact Assessment of Madhyapara Granite Mine," International Conference on Mechanical, Industrial and Materials Engineering, p. 827, 2013.

[7]. M. S. H. Z. U. a. M. S. I. Harun-Or-Rashid, "Environmental Impact of Coal Mining: A Case Study on the Barapukuria," Middle-East Journal of Scientific Research, p. 21, 2014.

[8]. H. M. R.-A.-I. T. R. M. B. B. Md. NahidNowsher, "Environmental Impact Assessment of Madhyapara Granite Mine," International Conference on Mechanical, Industrial and Materials Engineering, 2013.

[9]. Mohiuddin, K.M. &Alam, M & Ahmed, Istiaq&Zakir, H. &Chowdhury, A., "Physicochemical Properties and Metallic Constituent Load in the Water Samples of the Buriganga of Bangladesh. J. Environ. Sci. & Natural Resources", 8. 130-135, 2015.

[10]. Habib, Md& Khan, Rahat&Phoungthong, Khamphe., "Evaluation of environmental radioactivity in soils around a coal burning power plant and a coal mining area in Barapukuria, Bangladesh: Radiological risks assessment." 'Chemical Geology. 600. 120865, 2022.

[11]. M.A. Akbar, "An Assessment of the geothermal potential of Bangladesh," United Nations University –Geothermal, vol. 5, pp. 1-33, 2011.

[12]. Fahmida, Maisha&Rahman, Mohammad &Rity, Milufarzana&Sen, Rintu., "Determination of Evapotranspiration and Supplemental Irrigation for Aman Rice Cultivation in Dinajpur." 10.5923, 2017.

[13]. "ST160 Nuclear Lab Station," in Operating and Service Manual, 2009.

[14]. N.N. Ghuge, SapnaJasrotia ,Anamika, Chilsea Sadhu, "GEIGER MULLER: A THIN END WINDOW TUBE RADIATION DETECTOR", International Journal of Research in Engineering and Technology ,Volume: 04 Issue:05, Page 190-195 , 2015.

[15]. G. E. Knoll, Radiation Detection and Measurement, New York: John Wiley and Sons, 2000.

[16]. N. Ghuge, "GEIGER MULLER: A THIN END WINDOW TUBE RADIATION DETECTOR," IJRET, vol. 4, no. 5, pp. 190-196, 2015.

[17]. G. Q. M. Marilyn E. Noz, Radiation Protection in the Radiologic and Health Sciences, 1979.

[18]. A. A. A. A. O. H. M. A. E. Mohamed A. El-Sadek, "Environmental and lithological indices of atmospheric geophysical radiological spectral units Characteristics Egypt., "2010.