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RESEARCH ARTICLE

Presense of Radio Nuclides and Asessment of Excess Life Time Cancer Risk (ELCR) in North Malabar Coasts of Kerala, India

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Abstract

Radioactivity is an essential part of earth and it influences the environment. There are different geographical processes are included the concentration and distribution of natural radionuclides such as weathering, erosion, deposition, leaching, volcanism, mass wasting, weathering of rocks and soils. High background radiation is cause for the long lifetime risk such as the cancer, cardiovascular disease etc. Monitoring of radioactive elements is the uttermost importance for the humankind and environmental protection. Similarly it also provides helpful information to evaluate the dose to the humankind to identify the health risk and to have baseline data for future changes. And it give the radiological parameters such as the absorbed dose rate, indoor annual effective dose rate, outdoor annual effective dose rate, excess lifetime cancer risk for analyses the lifetime risk in that region. This study is to assess the cancer health risk of Chootad beach and Ettikulam beach in Kannur district of Kerala, India. The radiological parameters are estimated using Micro – R survey meter (Scintillometer) and the mean values of excess lifetime cancer risk are compared with the world and national average.

Keywords: Radioactivity; Regional Geomorphology; Excess Life Time Cancer Risk (ELCR); Radiological Parameters

1 Introduction

Radioactivity is an essential part of earth and it influences the environment. The natural radiation are come from the terrestrial sources and the distribution, amount, concentration of natural radiation is based on geographical and geological structure, geographical processes, geographical formations, physical and chemical properties of soil and other characteristics of that region, these are also the behind reason of amount, distribution, concentration of radionuclides for its variation from one place to another place. Rocks, soil, sand and other materials from the earth's crust are the major contributors of deposition of heavy minerals and the natural radioactivity. The natural radionuclides are plays a vital role in the environment, and these are the major source of natural radioactivity. Monitoring of radioactive elements is uttermost importance for the humankind and environmental protection. Similarly it also provides helpful information to evaluate the dose to the humankind to identify the health risk and to have baseline data for future changes.

The radionuclides are the part of rocks, water, soil etc. and these are the basic reasons for variation in the radionuclides. Radionuclides have the important role in monazites, because monazites are clearly seen in the monazite bearing sands. Monazites are commonly origin from the parent rock and seen in the metamorphic rocks. The radionuclides, such as monazite, thorium etc. are origin from the igneous and metamorphic rocks. These are happened due to the some geochemical processes like Weathering. There are different geographical processes are included the concentration and distribution of natural radionuclides such as weathering, erosion, deposition, leaching, volcanism, mass wasting, weathering of rocks and soils. There are many studies find the deposition of heavy minerals in the beach sands like monazite, thorium, radium etc. are due to the tidal action and waves from the sea. And also other geomorphological processes, that are happened in that region.

This study is to assess the cancer health risk of Chootad beach and Ettikulam beach in Kannur district of Kerala. The radiological parameters are estimated using Scintillometer. And the mean value of excess lifetime cancer risk is lesser than the world average value of 0.29×10^{-3}, so the coastal regions of Chootad beach are not significant in the cancer causing effects. The mean values of excess life time cancer risk are compared with the world and national average.

2 Materials and Methods

Micro – R survey meter, (Scintillometer) is used for calculating the low level gamma radiation dose rate and also it is preferable for monitoring of environmental and radiometric parameters. GPS is used for to locate with exact coordinates of the region, it give exact latitudinal and longitudinal points of a site. Arc GIS 10. 4 software is used for the mapping. There are different radiological parameters are used in this study such as Absorbed Dose Rate, Annual Effective Dose rate indoor and outdoor also excess lifetime cancer risk for this analysis.

2.1 Absorbed dose rate (D)

Absorbed dose rate due to the external gamma radiation from the air at ground level of 1m for the consistent distribution of naturally occurring radionuclide were calculated using the conversion factor given below. The exposure rate estimated in μRh^{-1} was converted into absorbed dosage rate $nGyh^{-1}$ using the transformation factor.

MR/h = 8 7 nGyh-1

2.2 Annual effective dose (AED)

The annual effective dose rate is determined by considering the conversion coefficient from absorbed dose in the air to effective dose and the indoor occupancy factor. The estimated average effective dose received by a member is calculated using the conversion factor as 0.7 Sv Gy^{-1} with indoor and outdoor occupancy of 80% and 20% respectively (UNSCEAR, 2000). The annual effective dose rate (indoor and outdoor) is calculated using the following formula (UNSCEAR, 2000)

AED = D x 8760h x 0.8 x 0.7 Sv Gy^{-1} x 10^{-6} (indoors)

AED = D x 8760h x 0.2 x 0.7 Sv Gy-1 x 10^{-6} (outdoors)

Where, AED is the annual effective dose rate in $mSvy^{-1}$ and D is absorbed dose rate in $nGyh^{-1}$.

2.3 Excess lifetime cancer risk (ELCR)

Excess lifetime cancer risk is the potential carcinogenic effects that are being estimated from the probability of cancer occurrence in a population of individuals for a specific lifetime from projected intakes (Ramaswamy et al.). It is an additional risk of rising cancer due to the exposure to radionuclides incurred over the lifetime of a person. ELCR is calculated following the equation (UNSCEAR, 2000).

ELCR = AED x DL x RF

Where, AED is the annual effective dose equivalent or whole body dose (μSvY^{-1}), DL is the duration of life (70 years) and RF is the risk factor (0.05 Sv^{-1}) (Mountford & Temperton, 1992).

3 Result and Discussion

This study is focused on the excess lifetime cancer risk from the coastal areas of Chootad in Madayi grama panchayath and Ettikulam in Ramanthali grama panchayath, north of Kannur District in Kerala. In this study radiological parameters of two selected sample sites were calculated from the Scintillometer readings. The reported values of radiological parameters are compared with the values from the other environs of the world. The deduction are drawn from the systematic analysis of the results and the literature values.

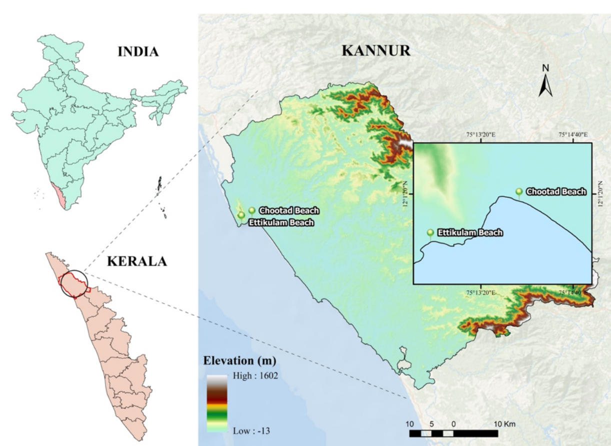

Fig. 1. Study area: Location

3.1 Study area 1 – Chootad beach

Chootad beach which is located in Madayi grama panchayath in Kannur district of Kerala. It is located at 11º58′0″North latitude and 75°18′0″East longitude.. It is one of the most charming beach facing the Ezhimala. It is located few kilometers from the pazhayangadi town. District tourism department provided the parks and other facilities near this beach. Speed boats and pedal boats are provided here part of the entertainment purpose. Caesarians trees are another major attraction of this beach for to sit, relax with experiencing the soothing breeze. Ramapuram River also drains through this region. Physiographically region is low lying land, so the soils are very deep moderately well drained alluvial soils. And the coastal soils are sand to loamy sand in texture. are clayey, mixed, ustic Haplohumults fine – loamy, mixed, Oxic Humitropepts. These soils are very deep and well drained.

From this study, the obtained absorbed dose rate varies from 8.7 to 104.4 $nGyh^{-1}$ with a mean value of 55.628 $nGyh^{-1}$. The obtained value is within the Indian average value of 56 $nGyh^{-1}$ and world average value of 57 $nGyh^{-1}$ (UNSCEAR, 2000). The indoor annual effective dose ranges from 0.042 to 0.512 mSv with a mean value of 0.272, and the outdoor annual effective dose ranges from 0.10 to 0.12 with a mean value of 0.067 mSv. When considering the mean value of annual effective dose rate, the indoor annual effective dose rate is greater and outdoor annual effective dose rate and outdoor annual effective dose is lower than the world average value of 0.48 mSv (UNSCEAR, 2000). The excess lifetime cancer risk ranges from $0.037 * 10^{-3}$ to $0.448 * 10^{-3}$ with a mean value of $0.238 * 10^{-3}$. The mean value of excess lifetime cancer risk is within the world average value of $0.29 * 10^{-3}$. This study finds the cancer causing effects are not significant in this coastal regions of Chootad in Madayi grama panchayath.

3.2 Study area 2 - Ettikulam beach

Ettikulam beach which is located in Ramanthali grama panchayath in Kannur district of Kerala. It is located at 12°3′0″north and 75°11′0″east. It is situated near Ezhimala Naval Academy. Ezhimala hill, a height of 286m, and it is the isolated cluster of hills. Ezhimala which is famous for the medical herbs and mythological significance. The soil is fine, kaolintic Oxic Humitropepts and are characterized by deep, well drained. It is associated with the rock outcrop.

From this study, the obtained absorbed dose rate varies from 8.7 to 34.8 $nGyh^{-1}$ with a mean value of 27.84 $nGyh^{-1}$. The obtained value is low when compared with the Indian average value of 56 $nGyh^{-1}$ and world average value of 57 $nGyh^{-1}$ (UNSCEAR, 2000). The indoor annual effective dose ranges from 0.042 to 0.170 mSv with a mean value of 0.135 and the outdoor annual effective dose ranges from 0.010 to 0.042 with a mean value of 0.033 mSv. When considering the mean value of annual effective dose rate, the indoor annual effective dose is greater and outdoor annual effective dose is lower than the world average value of 0.48 mSv (UNSCEAR, 2000). The excess lifetime cancer risk ranges from $0.037 * 10^{-3}$ to $0.149 * 10^{-3}$ with a mean value of $0.119 * 10^{-3}$. The mean value of excess lifetime cancer risk, is lower than the world average value of $0.29 * 10^{-3}$. This study finds the cancer causing effects are not significant in this coastal regions of Ettikulam beach in Ramanthali grama panchayath.

3.3 Findings

The study is mainly concentrated on the assessment of excess lifetime risk in North Kannur, and the samples are collected from the coastal areas of Chootad and Ettikulam. And the samples were collected from the Ettikulam beach in Ramanthali grama panchayath and Chootad in Madayi grama panchayath. When compare the radiological parameters of these areas, these two areas were not significant cancer causing effects. And also the obtained absorbed dose rate, annual effective dose rate (indoor), annual effective dose rate (outdoor), excess life time cancer risk are within the Indian average value as well as the World average value.

- According the radiological parameters of the values of Chootad beach is greater than the radiological parameters values of Ettikulam beach, but these are not significant in the cancer causing effects. These areas are also having the presence of radionuclides such as the thorium, potassium, radium.
- Study areas are influenced by the geomorphological and geological features of that region significantly Ezhimala. Ezhimala is the cluster of hills between the Chootad and Ettikulam beach.
- The spatial distribution of radioactivity is based on the lithological and geological characteristics. Physico chemical properties of the landscape and climate characteristics influence the deposition of heavy minerals in that region.

4 Conclusion

We get doses of radiation from our natural environment in each day in the way low doses of radiation or high doses of radiation. Low doses of radiation are we get every day in our surroundings, and they did not make the health issues. But the high doses of radiation which makes long time health risk for body like skin issues, cancer, could harm fetuses, and sometimes it leads to death. High background radiation is cause for the long lifetime risk such as the cancer, cardiovascular disease etc. The radiation is more effected for the children and young adults, because it is more sensitive to the effects of radiation. Radiation can destroy the DNA and the genetic materials in our body. High radiation can lead to

Table 1. Sampling location of dose rate

Sampling Location								
Dose values								
Sl.no	**Radiation points**	**Reading 1**	**Reading 2**	**Reading 3**	**Reading 4**	**Reading 5**	**Latitude**	**Longitude**
1	R1	1μR/h	2μR/h	1μR/h	2μR/h	1μR/h	12.02297	75.22856
2	R2	11μR/h	12μR/h	11μR/h	10μR/h	12μR/h	12.02295	75.22793
3	R3	7μR/h	8μR/h	9μR/h	7μR/h	7μR/h	12.02295	75.22737
4	R4	7μR/h	8μR/h	6μR/h	7μR/h	6μR/h	12.02293	75.22636
5	R5	2μR/h	2μR/h	2μR/h	2μR/h	2μR/h	12.02273	75.23205
6	R6	3μR/h	2μR/h	3μR/h	3μR/h	4μR/h	12.0227	75.23202

Table 2. Radiological parameters at sampling point 1 (S1)

Sl.no	**Absorbed dose rate ($nGyh^{-3}$)**	**Annual effective dose rate (mSv)**		**ELCR x 10^3**
		Indoor	**Outdoor**	
1	8.7	0.04267872	0.01066968	0.03734388
2	17.4	0.08535744	0.02133936	0.07468776
3	8.7	0.04267872	0.01066968	0.03734388
4	17.4	0.08535744	0.02133936	0.07468776
5	8.7	0.04267872	0.01066968	0.03734388
Mean	**12.18**	**0.059750208**	**0.014937552**	**0.052281432**

Table 3. Radiological parameters at sampling point 2 (S2)

Sl.no	**Absorbed dose rate ($nGyh^{-3}$)**	**Annual effective dose rate (mSv)**		**ELCR x 10^3**
		Indoor	**Outdoor**	
1	95.7	0.46946592	0.11736648	0.41078268
2	104.4	0.51214464	0.12803616	0.44812656
3	95.7	0.46946592	0.11736648	0.41078268
4	87	0.4267872	0.1066968	0.3734388
5	104.4	0.51214464	0.12803616	0.44812656
Mean	**97.44**	**0.478001664**	**0.119500416**	**0.418251456**

Table 4. Radiological parameters at sampling point 3 (S3)

Sl.no	**Absorbed dose rate ($nGyh^{-3}$)**	**Annual effective dose rate (mSv)**		**ELCR x 10^3**
		Indoor	**Outdoor**	
1	60.9	0.29875104	0.07468776	0.26140716
2	69.6	0.34142976	0.08535744	0.29875104
3	78.3	0.38410848	0.09602712	0.33609492
4	60.9	0.29875104	0.07468776	0.26140716
5	60.9	0.29875104	0.07468776	0.26140716
Mean	**66.12**	**0.324358272**	**0.081089568**	**0.283813488**

Table 5. Radiological parameters at sampling point 4 (S4)

Sl.no	**Absorbed dose rate($nGyh^{-3}$)**	**Annual effective dose rate (mSv)**		**ELCR x 10^3**
		Indoor	**Outdoor**	
1	60.9	0.29875104	0.07468776	0.26140716
2	69.6	0.34142976	0.08535744	0.29875104
3	52.2	0.25607232	0.06401808	0.22406328
4	60.9	0.29875104	0.07468776	0.26140716
5	52.2	0.25607232	0.06401808	0.22406328
Mean	**59.16**	**0.290215296**	**0.072553824**	**0.253938384**

Table 6. Radiological parameters at sampling point 5 (S5)

Sl.no	Absorbed dose rate(nGyh^{-3})	Annual effective dose rate (mSv)		ELCR x 10^{3}
		Indoor	Outdoor	
1	17.4	0.08535744	0.02133936	0.07468776
2	17.4	0.08535744	0.02133936	0.07468776
3	17.4	0.08535744	0.02133936	0.07468776
4	17.4	0.08535744	0.02133936	0.07468776
5	17.4	0.08535744	0.02133936	0.07468776
Mean	**17.4**	**0.08535744**	**0.02133936**	**0.07468776**

Table 7. Radiological parameters at sampling point 6 (S6)

Sl.no	Absorbed dose rate(nGyh^{-3})	Annual effective dose rate (mSv)		ELCR x 10^{3}
		Indoor	Outdoor	
1	26.1	0.12803616	0.03200904	0.11203164
2	17.4	0.08535744	0.02133936	0.07468776
3	26.1	0.12803616	0.03200904	0.11203164
4	26.1	0.12803616	0.03200904	0.11203164
5	34.8	0.17071488	0.04267872	0.14937552
Mean	**26.1**	**0.12803616**	**0.03200904**	**0.11203164**

Table 8. Sampling location of dose rate

Sampling Location								
Dose Values								
Sl.no	**Radiation points**	**Reading 1**	**Reading 2**	**Reading 3**	**Reading 4**	**Reading 5**	**Latitude**	**Longitude**
1	RRR1	3μR/h	3μR/h	3μR/h	2μR/h	3μR/h	12.02492	75.22371
2	RRR2	3μR/h	1μR/h	2μR/h	3μR/h	2μR/h	12.01087	75.20951
3	RRR3	3μR/h	2μR/h	3μR/h	3μR/h	2μR/h	12.01069	75.20895
4	RRR4	1μR/h	2μR/h	2μR/h	1μR/h	1μR/h	12.01089	75.21112
5	RRR5	4μR/h	3μR/h	4μR/h	4μR/h	3μR/h	12.01072	75.21224
6	RRR6	4μR/h	3μR/h	3μR/h	4μR/h	3μR/h	12.01077	75.21221

Table 9. Radiological parameters at sampling point 7 (S7)

Sl.no	Absorbed dose rate(nGyh^{-3})	Annual effective dose rate		ELCR x 10^{3}
		Indoor	Outdoor	
1	26.1	0.12803616	0.03200904	0.11203164
2	26.1	0.12803616	0.03200904	0.11203164
3	26.1	0.12803616	0.03200904	0.11203164
4	17.4	0.08535744	0.02133936	0.07468776
5	26.1	0.12803616	0.03200904	0.11203164
Mean	**24.36**	**0.119500416**	**0.029875104**	**0.104562864**

Table 10. 0: Radiological parameters at sampling point 8 (S8)

Sl.no	Absorbed dose rate (nGyh^{-3})	Annual effective dose rate		ELCR x 10^{3}
		Indoor	Outdoor	
1	26.1	0.12803616	0.03200904	0.11203164
2	8.7	0.04267872	0.01066968	0.03734388
3	17.4	0.08535744	0.02133936	0.07468776
4	26.1	0.12803616	0.03200904	0.11203164
5	17.4	0.08535744	0.02133936	0.07468776
Mean	**19.14**	**0.093893184**	**0.023473296**	**0.082156536**

Table 11. Radiological parameters at sampling point 9 (S9)

Sl.no	Absorbed dose rate ($nGyh^{-3}$)	Annual effective dose rate		ELCR x 10^3
		Indoor	Outdoor	
1	26.1	0.12803616	0.03200904	0.11203164
2	17.4	0.08535744	0.02133936	0.07468776
3	26.1	0.12803616	0.03200904	0.11203164
4	26.1	0.12803616	0.03200904	0.11203164
5	17.4	0.08535744	0.02133936	0.07468776
Mean	**22.62**	**0.110964672**	**0.027741168**	**0.097094088**

Table 12. Radiological parameters at sampling point 10 (S10)

Sl.no	Absorbed dose rate ($nGyh^{-3}$)	Annual effective dose rate(indoor)		ELCR x 10^3
		Indoor	Outdoor	
1	8.7	0.04267872	0.01066968	0.03734388
2	17.4	0.08535744	0.02133936	0.07468776
3	17.4	0.08535744	0.02133936	0.07468776
4	8.7	0.04267872	0.01066968	0.03734388
5	8.7	0.04267872	0.01066968	0.03734388
Mean	**12.18**	**0.059750208**	**0.014937552**	**0.052281432**

Table 13. Radiological parameters at sampling point 11 (S11)

Sl.no	Absorbed dose rate ($nGyh^{-3}$)	Annual effective dose rate		ELCR x 10^3
		Indoor	Outdoor	
1	34.8	0.17071488	0.04267872	0.14937552
2	26.1	0.12803616	0.03200904	0.11203164
3	34.8	0.17071488	0.04267872	0.14937552
4	34.8	0.17071488	0.04267872	0.14937552
5	26.1	0.12803616	0.03200904	0.11203164
Mean	**31.32**	**0.153643392**	**0.038410848**	**0.134437968**

Table 14. Radiological parameters at sampling point 12 (S12)

Sl.no	Absorbed dose rate ($nGyh^{-3}$)	Annual effective dose rate		ELCR x 10^3
		Indoor	Outdoor	
1	34.8	0.17071488	0.04267872	0.14937552
2	26.1	0.12803616	0.03200904	0.11203164
3	26.1	0.12803616	0.03200904	0.11203164
4	34.8	0.17071488	0.04267872	0.14937552
5	26.1	0.12803616	0.03200904	0.11203164
Mean	**29.58**	**0.145107648**	**0.036276912**	**0.126969192**

Table 15. Comparison between mean values of Chootad beach and Ettikulam beach

Radiological parameters	Chootad beach	Ettikulam beach
Absorbed dose rate	55.628	27.84
Indoor annual effective dose rate	0.272	0.135
Outdoor annual effective dose rate	0.067	0.033
Excess lifetime cancer risk	0.238	0.119

Fig. 2.

the acute radiation syndrome (ARS) or cutaneous radiation injuries (CRI). Monitoring of radioactive elements is the uttermost importance for the humankind and environmental protection. Similarly it also provides helpful information to evaluate the dose to the humankind to identify the health risk and to have baseline data for future changes. And it give the radiological parameters such as the absorbed dose rate, indoor annual effective dose rate, outdoor annual effective dose rate, excess lifetime cancer risk for analyses the lifetime risk in that region.

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