calculate the activity, the corrected counts for detector efficiency and yield of the corresponding line, per second are divided by the total area of detector and it is converted per meter square. The calculations carried out on the data at the place Dodamarg are presented in Table No.3. Due to the low resolution of the detector, the activity calculated from each line show deviation but within the limit of resolution, obtained activity from each line in decay series matches good. The calculation of uranium and thorium activity for the data at Dodamarg (presented in Fig.2) is presented in the Table No. 3. To calculate the activity, the observed corrected counts per second are divided by detector area and it is converted per square meter.

Table 2: Calculation of effective dose at the place of Natal.

Baseline voltage (V)	*Observed counts*	*Energy (keV)*	*Conversion factor (PSv.cm^2)*	*Efficiency of detector*	*Corrected counts for efficiency*	*Fluence (cm^{-2})*	*dose in mSv/year*
0.5	235	75.6	0.5200	0.9500	247.4	3.4414	0.001870
1.0	166	151.2	0.8900	0.9500	174.7	2.4309	0.002272
1.5	183	226.8	1.3220	0.9338	196.0	2.7264	0.003785
2.0	104	302.4	1.8000	0.8354	124.5	1.7319	0.003274
2.5	54	378	2.2270	0.7360	73.4	1.0207	0.002387
3.0	66	453	2.6850	0.5923	111.4	1.5502	0.004371
3.5	23	529.2	3.0779	0.4779	48.1	0.6695	0.002164
4.0	29	604.8	3.4400	0.4276	67.8	0.9435	0.003408
4.5	17	680.4	3.4688	0.3840	44.3	0.6159	0.002244
5.0	23	756	4.1732	0.3477	66.1	0.9202	0.004033
5.5	11	831.6	4.5071	0.3120	35.3	0.4904	0.002322
6.0	14	907.2	4.7900	0.2747	51.0	0.7090	0.003567
6.5	12	982.7	5.1262	0.2446	49.1	0.6825	0.003674
7.0	10	1158.4	5.3700	0.2309	43.3	0.6025	0.003398
7.5	14	1133.9	5.6420	0.2145	65.3	0.9080	0.005380
8.0	0	1209.6	5.8800	0.2018	0.0	0.0000	0.000000
8.5	19	1285.1	6.1860	0.1963	96.8	1.3465	0.008748
9.0	13	1360.7	6.4240	0.1796	72.4	1.0070	0.006793
9.5	5	1436.3	6.6960	0.1637	30.5	0.4249	0.002988
10.5	0	1511.9	6.9340	0.1557	0.0	0.0000	0.000000
10.5	20	2000.0	7.0360	0.1188	168.4	2.3421	0.017305
	15	2500.0	8.6000	0.0988	151.8	2.1121	0.019075
	7	3000.0	11.1000	0.0850	82.4	1.1457	0.013355

Table 3: Activity calculation of observed data

Nuclei in Uranium Series

Sr.No	Nuclei in the decay series	Energy keV	% Yield	Efficiency of detector at corresponding energy	Position of line on the graph (at baseline voltage)	Observed counts for 90 Sec.	Corrected Counts for Efficiency and Yield	Mean corrected counts per 90 Sec.	Calculated Activity KBq / m^2
1.	Pb^{214}	295.3	18.50	0.8360	1.2	45.0	290	257.5	0.941
2.	Pb^{214}	352.0	35.60	0.7560	1.5	76.0	282		
3.	Bi^{214}	609.3	45.49	0.4270	3.2	31.0	159		
4.	Bi^{214}	1120.0	14.90	0.2245	6.6	10.0	299		
Nuclei in Thorium Series									
1.	Pb212	238.0	43.00	0.9333	0.9	120.0	272	230.0	0.841
2.	Tl208	510.0	13.80	0.4879	2.5	15.0	222		
3.	Tl208	583.0	30.60	0.4370	2.8	29.0	216		
4.	Bi212	727.0	6.27	0.3770	4.0	6.2	244		
5	Ac228	911.0	25.80	0.2747	5.2	12.0	169		
6.	Ac228	965.0	15.80	0.2546	5.6	10.4	258		

3. Results and Discussion

The observed average gamma radiation effective dose from terrestrial radioactive sources and cosmic rays, at one foot above the earth surface in open atmosphere, in mSv/y and nSv/h at twenty six different places in Sindhudurg district of Maharashtra state is presented in Table No.4.The activity of U-238 and Th-232 and the uranium thorium activity ratio at the places is also presented in Table No.4

The mean effective gamma radiation dose at the places of observation is found to be 0.5244 mSv/y with range of variation, from 0.2864 mSv/y to 0.8044 mSv/y. The mean effective dose is slightly higher than the effective mean dose reported for Maharashtra state and is close to the mean value reported for Goa state.[4,9] For the costal places such as Vijayadurg, Devgad, Chidar, Vengurla, Parule the effective dose is found to be higher while for the places near to the Sahyadri ghat mountain such as Bhuibawada, Nandgaon, Phonda, Natal, Dukanwad, Godagewadi have lower value of effective dose. The coastal region contain porous rocks, in local language called as Jamba and the soil formed from it while the region near the Sahyadri ghat contain black and hard igneous rocks and soil formed from it. Uranium-238 activity varies from 0.466 KBq/m2 to 1.133 KBq/m2 with mean value of 0.751 KBq/m2. Thorium-232 activity varies from 0.552 KBq/m2 to 1.267 KBq/m2 with mean 0.8466 KBq/m2. The U238 to Th232 activity ratio varies from 0.494 to 1.2 with mean 0.886. The variation in uranium thorium ratio is found to be high than the global ratio of 0.3

Table 4: Effective gamma radiation dose, U-238 and Th-232 activity and activity ratio

Sr. No.	Place of observation	Effective gamma dose In mSv/y	Effective gamma dose In nSv/h	Activity of U-238 KBq/m^2	Activity of Th-232 KBq/m^2	U-238 to Th-232 Activity Ratio
1	Vijayadurg	0.6025±0.0540	68.77	0.929	1.267	0.733
2	Padel	0.5379±0.0409	61.40	0.757	0.636	1.189
3	Devgad	0.5925±0.0312	67.63	1.133	1.111	1.019
4	Talebazar	0.4889±0.0364	55.81	0.937	1.009	0.928
5	Phanasgaon	0.4866±0.0224	55.54			
6	Nandgaon	0.3301±0.0224	37.68	0.493	0.592	0.833
7	Bhuibawada	0.3670±0.0220	41.89	0.466	0 .702	0.664
8	Vaibhavwadi	0.4428 ± 0.0340	50.54	0.870	0.899	0.967
9	Phonda	0.3630±0.0156	41.43	0.811	0.522	1.470
10	Kankavali	0.4936±0.0770	56.34	0.658	0.632	1.040
11	Nathal	0.2864± 0.0046	32.69	0.533	0 .705	0.756
12	Chindar	0.7510±.03180	85.73	0.949	1.053	0.901
13	Malvan	0.3847±0.0115	43.91	0.576	1.168	0.492
14	Kasal	0.7408±0.0239	84.56	0.875	0.934	0.936
15	Oros	0.3815±0.0270	43.55			
16	Salagaon	0.8044±0.0424	91.82	0.674	1.053	0.640
17	Dukanwad	0.4665±.01500	53.25	0.751	0.828	0.907
18	Vetora	0.6269±0.0610	71.76	0.746	0.887	0.755
19	Vengurla	0.5843±0.0190	66.70	0.789	0.658	1.2
20	Kerawada	0.5259±0.0380	60.03	0.727	0.972	0.748
21	Parule	0.7627±0.0280	87.06	1.115	1.103	1.011
22	Sangeli	0.4258±0.0300	48.60	0.676	1.162	0.848
23	Majagaon	0.6868±0.0540	78.40	0.746	0.927	0.804
24	Dodamarg	0.5595±0.0210	63.86	0.650	0 .727	0 .894
25	Banda	0.5466±0.0384	62.39			
26	Godagewadi	0.3973±0.0210	45.35	0.614	0.731	0.84

4. Conclusions

The measured absolute activities of U-238 and Th-232 at different places of observation have presented in this paper and it forms the baseline data for these places. The variation in U-238 to Th-232 ratio is larger; the change in activity of U-238 is smaller while Th-232 activity changes by larger amount. Effective gamma radiation dose changes from place to place. Higher level is observed for the coastal region and lower level in the region near to the Sahyadri Mountain. At all these places radiation level is well within prescribed limits recommended by ICRP.

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References

[1] K. Patra, J. Sudhakar, P. M. Ravi, J.P. James, A. G. Hedge, M. L. Joshi; Natural radioactivity in the geological matrices around Kaiga environment. J. of radioanalytical and nuclear chemistry. Vol 270, No.2 2006, 307-312.

[2] Al-Trabulsy H.A..et al F.I.2011Radioactivitylevels and radiological hazards indices at the Saudi coastline of the gulf of aquba. Radiation physics chemistry.80,343-347.

[3] Avadhani D. N., Mahesh H. M., Karunakara N., Narayana Y, Somashekarappa H. M., Siddappa K., 2005. Distribution and behavior of natural radionuclides in soil samples of Goa on the South- West coast of India. The natural radiation environment, VII. Elsevier's science and technology rights department, ISBN, 0-08-044137, 1131-1140.

[4] Baranwal V. C., Sharma S. P., Sengupta D., Sandilya M. K., Bhaumik B. K., Guin R., Saha S. K., 2006. A new high background area in the geothermal region of Eastern Mobile Belt (EGMB) of Orissa, India. ELSEVIER, Radiation Measurement, 41, 602-610.

[5] G Pinto, N Karunakara H. M. Somashekarappa, C. Rao, u. Prabhu, I. Yashodhara , Natural radioactivity in Udupi and Karkala Talukas of coastal Karnataka: Indian J. of pure and applied physics; Vol. 48, July 2011 527-529.

[6] Nambi et.al. Natural Background radiation and population dose distribution in India, BARC 1986 proc.1986
[7] Practical Gamma-ray Spectrometry–2nd Edition Gordon R. Gilmore Appendix D: Gamma-Ray Energies in the Detector
[8] Background and the Environment© 2008 John Wiley & Sons, Ltd. ISBN 978-0-470-86196-7.
[9] United National Scientific Committee on the effects of Atomic Radiation, Sources and Effects of Ionizing Radiation, Report to the General assembly with annexes. United Nations New York.1993.
[10] United National Scientific Committee on the Effects of Atomic Radiation, Sources and Effects of Ionizing Radiation, Report to the General Assembly with annexes. United Nations, New York. Report 2000 Vo.I. 10.ICRP 2010. Conversion Coefficients for radiological Protection Quantities for External Radiation exosures.ICRP Publication 116, Ann. ICRP 40 (2–5).
[11] United National Scientific Committee on the Effects of Atomic Radiation, Sources and Effects of Ionizing Radiation, Report to the General Assembly with annexes. United Nations, New York. UN SCEAR Report 2008 Vol. II.
[12] Mannual of saint Gobain crystal for efficiency calculations.
[13] MATLAB software.

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