A Study of Outdoor and Indoor Environmental Gamma Radiation Level in and Around Sagara and Soraba Taluk, Shimoga, Karnataka, India.

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***ABSTRACT*- The outdoor and indoor environmental gamma radiation level has been measured systematically in several parts of Sagara and Soraba taluk ,Shimoga district, Karnataka, INDIA., using a calibrated radiation gamma survey monitor. The measurement was made during winter and summer seasons. The gamma radiation dose rate in outdoor environ range from 43.5 nGy/h to 287.1nGy/h. No significant variation in gamma dose is observed in different seasons. Similar to the observations made elsewhere, the higher gamma dose rate is found in the places where granitic outcrops are prominent. Indoor gamma dose measurement were also carried out systematically in various houses situated in the study area having different types of flooring tiles. The gamma radiation dose rate in indoor measurement range from 43.5 nGy/h to 261 nGy/h. The higher dose rate was recorded in the houses having granitic flooring and lower dose rate in the houses having white marble flooring. All these findings are presented in this paper.**

***Key Words*- Environmental gamma radiation, Gamma radiation survey meter, Granites, Outdoor and indoor gamma dose rate.**

1.INTRODUCTION

The study area Sagara and Soraba are the taluk head quarters of Shimoga district, Karnataka, INDIA. **Sagara** taluk lies between 13°51'07"N and 14°20'35"N , 74°31'16"E and 74°17'56"E with an elevation of 606.78m above the mean sea level situated near Sahyadri mountains of the western ghats. It belongs to malnad region which is characterized by mountainous terrain, heavy rain fall and rich in vegetation. This region is covered with semi evergreen deciduous forest. River Varada is the main water source in this area. **Soraba** taluk lies between 14°13'12"N and 14°39'2"1N, 74°52'25"E and 75°17'48"E with an average elevation 591.71m above the mean sea level. It belongs to semi-malnad region which is characterized by mountainous terrain, medium to heavy rain fall and medium vegetation. [4]

The entire Shimoga district consists of ancient rock formation of Archean age group. The present study area composed of multiple geological compositions. Laterites are found in the northern and southern region of the study area, Migmatites and Gniesses are noticed in the north-western part, patches of granites and metabesalt occur in the western part. Quartz and greywacke formation extends to the eastern and north-eastern part of the study area.

Man has always been exposed to ionizing radiation from various natural sources, of which dose received is mainly from natural sources ([2]). About (97.7%)of the radiation exposure is from the natural sources,[1][15]. The radioactive nuclides U^{238},Th^{232} and K^{40} in the earth's crust, cosmic radiation and radio nuclides present in the environment due to atmospheric fallout, Radon/Thoron gases present in the atmosphere due to emanation from the earth's crust, ([1][12]).Thus the assessment of the radiation doses to man from the natural sources is of particular importance because natural radiation is the largest contributor to the collective dose of the world population ([3]). Furthermore, the study of the extent of the variation of natural radiation with location is of practical interest, since it may influence attitudes towards any additional exposure caused by manmade sources. As a preliminary attempt in this direction of measurement of the ambient outdoor and indoor gamma radiation exposure level at Sagara and Soraba taluk, has been carried out since no such study has been carried out in this part of country, this happens to be first of its kind.

2. MATERIALS AND METHODS

The ambient outdoor and indoor environmental gamma radiation level has been measured using a calibrated G M tube based radiation survey meter with a digital display. The instrument has a sensitivity of 1μR/h procured from Electronics Enterprises India Private Limited (EEIPL), Hyderabad a knowhow from Bhabha Atomic Research Centre (BARC), Mumbai. The instrument was pre-calibrated by Mirion Technologies using standard sources, as per recommendations of radiation and nuclear safety authority of Finland and later by EEIPL laboratory, Hyderabad.

2.1 Outdoor dose rate measurement :

The ambient outdoor gamma radiation measurement were made during summer and winter seasons, at Sagara and Soraba taluk of Shimoga district, covering an area approximately about 1960 km^2 by considering Sagara town as center. Forty seven locations were selected for the measurement and the locations are of both undisturbed and disturbed types covering all varieties of regional geology in the study area. Measurements were made 1m above the ground level. Due to the random nature of the radioactive decay, the radiation exposure rate changes rapidly with time. In order to average out the exposure level in a given location, 10-15 readings for 10-15 minutes were recorded at each point in a given location. This was repeated at many locations within the given area in order to obtain a representative value for that region. The geometric mean value of all the values was calculated so as to reduce small scale variation of the exposure rate within the site. Similar type of measurement was made in some granitic quarries present in the study area. The survey meter readings obtained in μR/h was converted using the conversion factor 1μR/h = 8.7 nGy/h ([10] [18]).

2.2 Indoor dose rate measurement:

To measure the indoor gamma dose rate, various houses were selected having different types of flooring materials. The main purpose of this study is know the variation of gamma dose due to different types of flooring materials. The measurements were made for a period of 5-6 hours in a house. For this purpose, the G M survey meter was directly coupled to a computer system and using CSW31 software, the readings were noted. The detector was preconfigured to record the data for every 10 minutes. The geometric mean of all such readings was taken as a representative data for that house. This type of measurement was repeated for various houses.

UNSCEAR, 1988 recommended the outdoor and indoor occupancy factor of 0.2 and 0.8 respectively.The occupancy factor is the proportion of the total time during which an individual is exposed to a radiation field,[[2]]. When converting the outdoor and indoor readings to annual equivalent doses in mSv/y, the following equations were used [[8] [9] [11]].

Annual dose for Outdoor = Dose rate × 0.2 × 8760hr/yr which is expressed in nGy and then expressed in mSv.

Annual dose for Indoor = Dose rate × 0.8 × 8760hr/yr which is expressed in nGy and then expressed in mSv.

2.3 Result and Discussions:

The environmental gamma radiations in the outdoor measurement were made for forty locations in and around Sagara and Soraba taluk, and the results are summarized in table-1. It is found that the overall outdoor gamma dose rate at various places in sagara and Soraba taluk ranges 43.5nGy/h and 287.1 nGy/h. The highest gamma dose rate was measured at Bastikoppa hill (287.1nGy/h) may be attributed to the presence of granitic outcrops. The lowest gamma dose rate was recorded at Athavadi (43.5 nGy/h) may be due to regional geology of Migmatites. In those places where the regional geology is composed of granites, gamma dose rate ranges from 69.6 nGy/h to 287.1 nGy/h. The region which comprises laterites as its regional geology showed gamma dose rate range of 60.9 nGy/h to 104.4nGy/h. Migmatites and Gnissess region showed the gamma dose rate 43.5nGy/h to 113.1nGy/h and for Greywacke region the gamma dose rate recorded was 52.2nGy/h to 113.3nGy/h. Similarly the Quartz and Mafics region recorded the gamma dose rate of 60.9 nGy/h to 104.4 nGy/h and

in metabesalt region, gamma dose rate of 60.9nGy/h to 78.3 nGy/h was found which is of lowest range recorded in the present study.

The indoor gamma radiation dose rate measured in various houses at Sagara and Soraba taluk is summarized in the table – 2. The gamma dose rate for different flooring materials range 70.72nGy/h to156.64 nGy/h. The highest gamma dose rate was found in the houses those have granitic flooring and the lower dose rate for white marble flooring.

The possible gamma dose rate in the indoor environment is attributed to distinct type of building material used in the building construction, Radon, thoron and their progeny present in the indoor environment etc. The factors like radon escape, ventilation aspects, etc has not been taken into consideration in the present work. However the work is in progress to determine the concentration of primordial radionuclide present in the building materials.

3. TABLES AND FIGURES

TABLE 1: OUTDOOR GAMMA DOSE RATE MEASUREMENT

Regional geology	Locations	Total no of readings taken	Gamma dose rate (nGy/h)			Annual effective dose due to gamma radiation (mSv)
			Range	Geometric mean	Geometric standard deviation	
Laterites	Absi	194	69.6-104.4	92.67	1.12	0.16235
	Bhadrapura	168	60.9-78.3	68.6	1.13	0.12018
	Hechhe	164	69.6-104.4	90.12	1.15	0.15789
	Gunjanur	168	60.9-78.3	71.55	1.20	0.12535
	Gudavi	144	60.9-78.3	71.23	1.11	0.12479
	Shirur	184	69.6-78.3	75.43	1.05	0.13215
	Kanle	192	87-95.7	90.13	1.05	0.15790
	Baradavalli	196	78.3-95.7	89.52	1.09	0.15683
	Hirenallur	182	78.3-104.4	88.65	1.10	0.15531
	Masur	160	60.9-69.6	67.16	1.06	0.11766
	Telagundli	144	69.6-95.7	86.12	1.12	0.15088
	Chandragutti	170	69.6-104.4	92.45	1.13	0.16197
Granite	Bastikoppa	260	147.9-174	161.82	1.05	0.28530
	Kamalapura	170	104.4-121.8	115.14	1.06	0.20173
	Mangalore	168	78.3-113.1	99.18	1.14	0.17376
	Horabylu	174	69.6-95.7	86.22	1.12	0.15015
	Mannatti	164	69.6-87	81.33	1.09	0.14249
	Narchi	280	174-200.1	193.8	1.05	0.33593
	Mavina balli koppa	190	95.7-121.8	113.36	1.09	0.19860
	Hosabale	154	78.3-104.4	94.28	1.09	0.16517
	Kamalapura quarry	360	261-382.8	320.9	1.11	0.56221
	Bastikoppa Hill	288	200.1-287.1	247.5	1.11	0.44362
	Narchi Hill	270	147.9-243.6	200.53	1.16	0.35132
Migmatites and Gniesses	Adur	220	43.5-60.9	53.985	1.12	0.09458
	Athavadi	210	43.5-52.2	47.84	1.09	0.08381
	Tumari	190	95.7-113.1	105.21	1.06	0.18432
	Kargal	170	69.6-78.3	75.43	1.06	0.13215
	Laviggere	210	69.6-113.1	93.17	1.16	0.16323
	Avalagodu	150	52.2-69.6	63.85	1.10	0.11186
	Nadakalasi	210	69.6-104.4	93.04	1.12	0.16300
	Kappagalale	148	78.3-87	84.30	1.05	0.14769
	Kuppagadde	162	69.6-78.3	73.16	1.06	0.12817

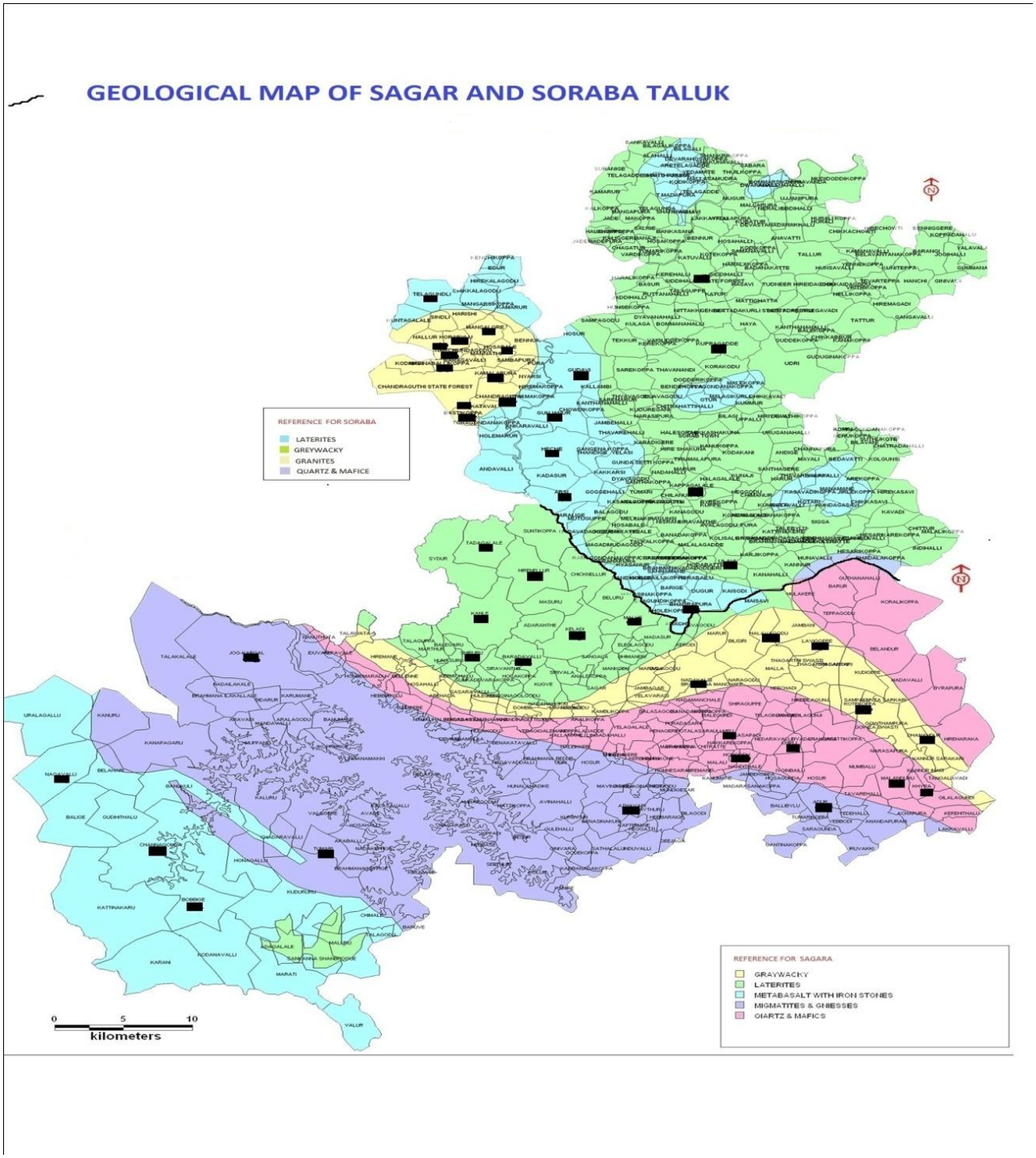
	Siddi halli forest	144	78.3-95.9	88.78	1.07	0.15554
	Ulavi	194	52.2-78.3	64.63	1.13	0.11323
Quartz and Mafics	Ullur	152	69.6-78.3	74.99	1.06	0.13138
	Harogoppa	160	60.9-69.6	64.29	1.06	0.11263
	Malandur	180	78.3-104.4	89.66	1.12	0.15708
Metabesalt	Bobbige	140	69.6-78.3	75.64	1.06	0.13252
	Sullalli	162	60.9-78.3	70.63	1.10	0.12374
	Chanagonda	184	60.9-69.6	67.16	1.06	0.11766
	Chandemane	180	60.9-69.6	65.51	1.07	0.11477

Type of flooring	No of samples studied	Total no of readings taken	Gamma exposure rate(nGy/h)			Annual effective dose rate due to gamma radiation in mSv
			Range	Geometric Mean	GSD	
White marble	5	237	43.5-104.4	70.72	1.17	0.4956057
Black Marble	3	173	52.2-121.8	80.05	1.18	0.5609904
Redox	3	121	60.9-139.2	92.39	1.01	0.6474691
Granite	14	1583	104.4-261	156.64	1.18	1.0971779
Mosaic	2	107	78.3-121.8	95.35	1.11	0.6682128
Vitrified Tiles	7	284	69.6-130.5	94.32	1.14	0.6609945

TABLE 2: THE INDOOR GAMMA DOSE RATE

TABLE 3: COMPARISON OF GAMMA ABSORBED DOSE IN AIR WITH OTHER ENVIRONS

Gamma Absoebed dose in nGy/h		Region	Reference
Present work	Literature Values		
47.84-247.5	77.4-146.2	Shimoga	Anandram 1998
	50-250	mysore	Nagaiah 1996
	43.5-3480	Ullal beach*	Radhakrishan et al 1993
	30-87.8	Goa	Avadhani 1998
	44-2012	Kalpakkam beach*	Iyengar et al 1994
	130.5-10579.5	Chavara Kerala*	Ramachandran et al 1994
	19.3-24.3	Nigeria	A A Sadiq et al 2012
	75	Kanataka average	Nambi et al 1989
	89	All India average	Nambi et al 1989
	28-45	World average	UNSCEAR 1988



■ The regions where the gamma radiation measurements were made

Courtesy : NRDMS Centre, Shimoga

FIG 1: GEOLOGICAL MAP OF SAGARA AND SORABA TALUK

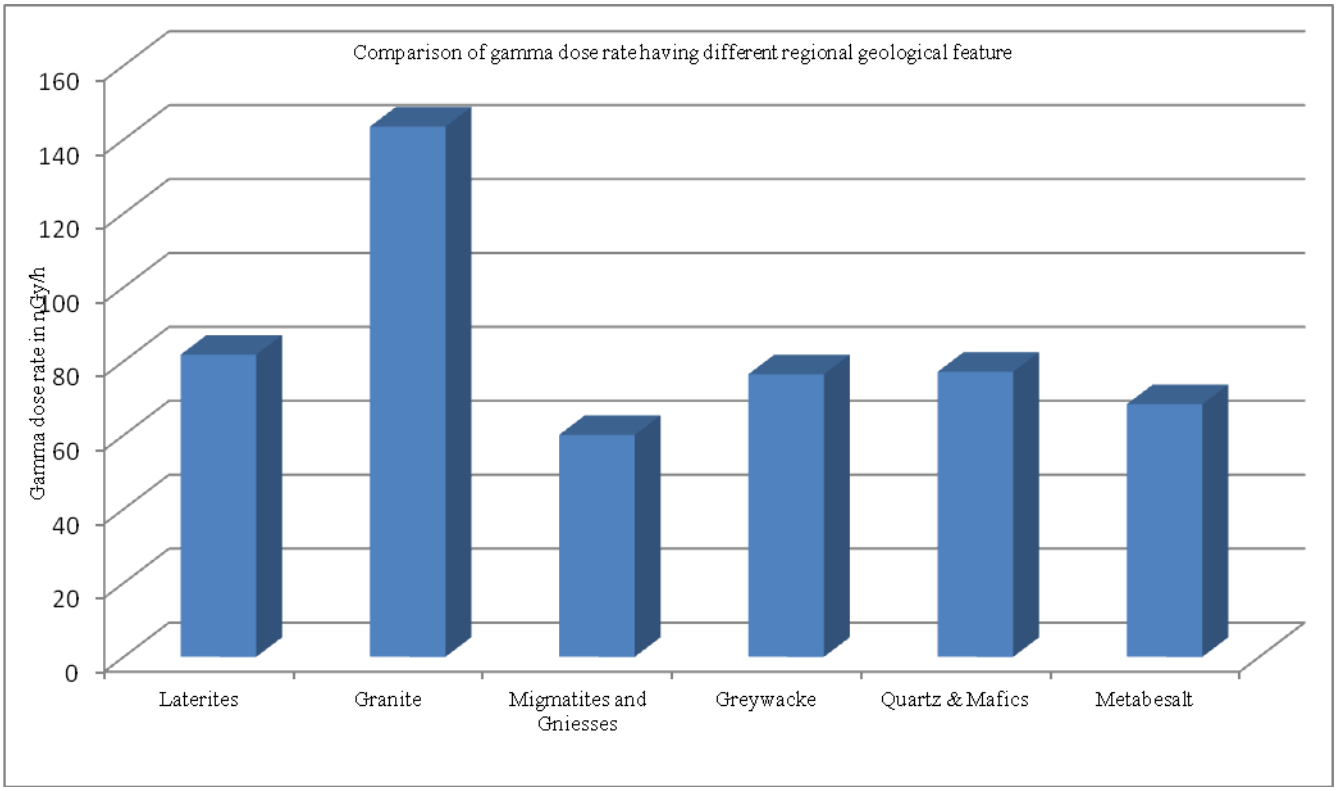


FIG. 2: OUTDOOR GAMMA DOSE RATE MEASUREMENT

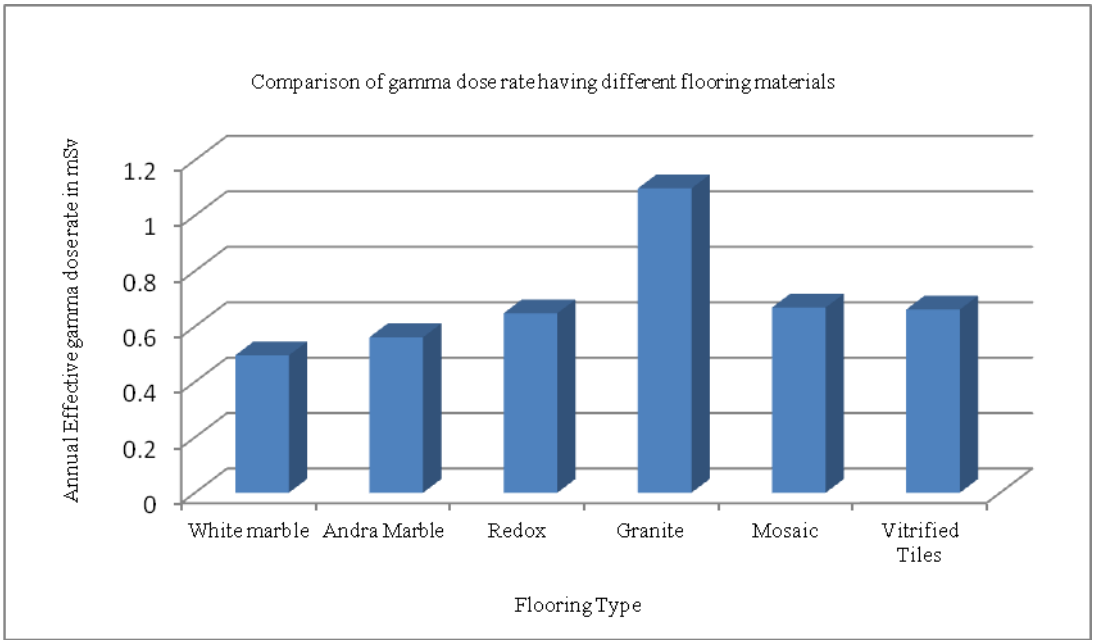


FIG. 3: INDOOR GAMMA DOSE RATE MEASUREMENT

4. CONCLUSION

It can be concluded that, the places having the regional geology of granites show higher radiation dose rate which is similar to the observations made

elsewhere. The measured outdoor gamma dose rate in the present study is comparable with the all India average and world average as shown in the table-3. The measured indoor gamma dose rate depends on the type of building material. The houses having the granite flooring shows higher gamma dose rate.

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REFERENCE*:*

[1] M. Eisenbud "*Environmental Radioactivity*" III Edition Newyork Academic press (1987)

[2] "*Sources, effects and risks of ionizing radiation.ŧ United Nations Scientific Committee* On The Effects Of Atomic Radiation (UNSCEAR) (1988)

[3] *"Sources, effects and risks of ionizing radiation.ŧ United Nations Scientific Committee* On The Effects Of Atomic Radiation (UNSCEAR) (2000)

[4] "*Shimoga district at a glance 2012-13* " A statistical review of Shimoga district, published by district statistical office, Shimoga.

[5] Nambi K S, Bapat V N, David M, Sundaram V K, Sunta C M and Soman D "*Countrywide environmental radiation monitoring using Thermoluminscence dosimeters*" Radiation Protection Dosimetry, Vol. 18 No 1, pp31-37 (1987)

[6] Radhakrishna A P, Somasheksrappa H M, Narayana Y and Siddappa K "*A new natural background radiation area in Kerala*" Health physics, 65(4) 390-395. (1993)

[7] Avadhani D N,Mahesh H M,Karunaka N,Narayana Y,Balakrishna K M and Siddappa K) "*Radiation level and radionuclide distribution in the environment of Goa*". Proc.Of NSRP-12, PP 253-255. (1998)

[8] M Gholami, SMirzaei, A Jomehzadeh, "*Gamma back ground radiation measurement in Lorestan province, Iran*" Iran.J.Radiat., 9(2): 89-93, (2011)

[9] A A Sadiq, E.H.Agba, "*Indoor and outdoor ambient radiation levels in keffi, Nigeria*". Facta Universities Series: workings and living Environmental protection Vol.9, No1, pp.19-26.(2012)

[10] K M Nagaraju, M S Chandrashekar, K S Pruthvi Rani, L Paramesh, "*Measurement of gamma natural Chamaraja Nagar district, Karnataka state, India*". Radiat Prot Environ [serial online]; 35: 73-6(2013)

[11] Nnamdi N Jibiri and Sunday T U obarhuna)."*Indoor and Outdoor gamma dose rate exposure levels in major commercial Building material distribution outlets and their radiological implications its occupants in Ibaden Nigeria*". Journal of Natural sciences research, ISSN 2224-3186(paper) ISSN 2225-0921 (online)Vol-3 No.3(2013)

[12] B N Anandaram "*Study of environmental radioactivity in and around Shimoga*". Ph.D thesis Mysore University,Mysore,India (1998).

[13] Nagaiah N "*Study of environmental radiation around Mysore*" Ph.D thesis, Mysore University,Mysore,India (1996)

[14] Bruno Sensoni, "*Natural high background areas at Fichtelgebrge*", Natural Radiation environment proc. Of 2nd spec. Symp., Bombay, (Edited by Vohra K G, Mishra U C, Pillai K C and Sadashivan S), Wiley Eastern Ltd.,New Delhi, India, PP 78-84. (1982)

[15] Narayana K K, Krishnan D and Subbaramu M C, "*Population exposure of ionizing radiation in India*" ISRP(k)-BR-3, (1991)

[16] Iyengar, "*Natural radiation aspects in the high background areas Kalpakkam*", Proc. Of 3rd National Symposium on environment, pp 48-55, (1994).

[17] Ramachandran T P,Boban T G and Jayadevan S, *"Radiation measurements in a high background radiation area in Kerala*", proc. Of 4th National symposium on environment, pp 43-47, (1994).

[18] B. N Anandaram,S Manjunatha and P Venkataramaiah, "*Study of environmental gamma radiation level in and around Shimoga Karnataka, India*", Proc.Nat. sym.Rad. phys. 11,119 (1995).