The annual change of environmental gamma radiation in Bitlis

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ABSTRACT

In this study, the environmental gamma radiation starting at December, 2014 through November, 2015 were measured at different 16 points. The environmental gamma radiation measurement was made from the ground and one meter above the surface by using portable gamma survey meter which consisted of NaI(Tl) scintillation detector. The lowest values of environmental gamma radiation are 0.041 μSv/h at ground level and 0.035 μSv/h at the one-meter level on the location XIII, the highest values of environmental gamma radiation are 0.478 μSv/h at the ground level and 0.453 μSv/h at the one-meter level on the location XVI.

1. Introduction

There are two main contributions determining the level of exposure to natural radiation. The first of these are high-energy cosmic rays reaching to the earth's atmosphere. The other is that there are radioactive elements in the crust of the World (environment, even in the human body) [1]. The contribution of natural radiation of cosmic rays varies with altitude, as one climbs up from sea level to remain constant in certain latitude [2].

The basic level of natural radiation varies depending on the geological and geographical features of area. Soil and rock mineralogical structure with geographical altitude affects the basic radiation levels in the region [3].

Natural radionuclides as ^{238}U, ^{232}Th and ^{40}K in the soil causes to be radioactive of the soil. Natural radionuclides are mostly found in high concentrations in volcanic rocks (especially in granite), pegmatites and hydrothermal deposits. Water constantly interacts with the soil and rocks around it. Therefore, the transfer possibility of interacting waters with them of the natural radionuclides in the soil and rocks is very high [4].

The soil contains an amount of radiation because the main materials of it carry radioactive isotopes. Radionuclides that are naturally present in the Earth's crust formation and their degradation products from the major part of the environmental radiation emitting gamma rays. α, β and γ as long-lived radionuclides such as ^{238}U, ^{232}Th and ^{40}K are the starting radioisotopes of source of the radiation of terrestrial. The mass activity concentration of these natural radionuclides varies according to the type of soil and rock [5-7]. The mass activity concentration is radiation intensity corresponds to the absorbed dose in the air on 1 m height from the ground [5]. Thus, the measured radiation dose in the air is closely related to concentrations of radionuclides in the soil.

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2. Experimental

The environmental gamma measurements in the various locations (16 points) was made by Dose Rate Meter that it is containing scintillation counter having to 2"x2" NaI (Tl) crystal at ground and 1m level height [8]. The city center and its districts were easily screened because of the system used is portable.

Locations of 16 points in Bitlis area, where the environmental gamma measurements conducted, are presented in Table 1.

Table 1. Location of environmental gamma measurement points [9].

	Latitude (North)	Longitude (East)
I	38.33451	42.00472
II	38.32286	42.01657
III	38.33052	42.01483
IV	38.41749	41.91641
V	38.41745	41.91586
VI	38.41175	42.11722
VII	38.58592	42.00056
VIII	38.39302	42.26883
IX	38.39928	42.26320
X	38.48519	42.32428
XI	38.63133	42.44054
XII	38.84262	42.82970
XIII	38.78785	42.69599
XIV	38.74583	42.45415
XV	38.66603	42.30422
XVI	38.63527	42.24807

3. Results and Discussion

Environmental gamma measurements were taken monthly periods on the ground and 1m above the ground levels. The measurements made 1 m above the soil level and the ground are presented in Table 2 and Table 3.

The measurements made in 1 m above the soil level and the ground from December to November is shown in Figure 1-Figure 6, from the data given in Table 2 and Table 3.

It is understood from Table 2, Table 3 and from Figure 2-Figure 6 that the values in ground level, where gamma radiation is directly emitted from the soil, were higher (43.23 %) than the values that were measured at 1 m level. However, it was found that the measured environmental gamma values in August on measurement points in the both ground and 1 m height level were highest value and the measured environmental gamma values both in January and in February on measurement points in both ground and 1 m height level were the lowest value.

The number XVIth measuring point is located higher than the other measuring points. The point XVI was chosen above one of volcanic mountains (height is 2.935 m) that the latest active in Turkey. To be this way of results is the expected case because the contribution to natural radiation of cosmic rays varies with height; this contribution remains constant moving up sea level on certain latitude [2], more elevation locations are exposed to more radiation than less elevation locations [10].

Cosmic radiation consists of electromagnetic radiation or released particles at different energy and different charges. Their origins are also different. Their density decreases when it reaches the upper layers of the atmosphere to sea level [2, 11]. Being the lowest of environmental gamma values measured at the measurement point XIII may be caused by less effect of electromagnetic waves (this point is further away from the other point of to residential areas) and not intense electromagnetic reflections.

Table 2. The values of environmental gamma measurement in the ground and 1 m height level (December 2014-May 2015).

	December (µSv/h)		January (µSv/h)		February (µSv/h)		March (µSv/h)		April (µSv/h)		May (µSv/h)	
	Ground	1m	Ground	1m	Ground	1m	Ground	1m	Ground	1m	Ground	1m
I	0.229	0.227	0.179	0.172	0.169	0.165	0.170	0.166	0.211	0.207	0.183	0.171
II	0.208	0.216	-	-	0.173	0.169	0.197	0.182	0.241	0.220	0.234	0.237
III	0.221	0.198	0.141	0.157	0.194	0.183	0.193	0.181	0.215	0.206	0.213	0.215
IV	0.217	0.205	0.205	0.199	0.159	0.145	0.182	0.172	0.206	0.194	0.219	0.209
V	0.140	0.147	0.126	0.133	0.129	0.122	0.131	0.129	0.146	0.145	0.156	0.160
VI	0.350	0.357	0.340	0.375	0.323	0.257	0.442	0.305	0.364	0.368	0.362	0.356
VII	0.232	0.221	0.090	0.098	0.155	0.142	0.170	0.157	0.165	0.151	0.158	0.146
VIII	0.199	0.194	0.145	0.137	0.162	0.156	0.189	0.175	0.198	0.194	0.218	0.195
IX	0.234	0.221	0.150	0.146	0.175	0.165	0.209	0.200	0.197	0.184	0.223	0.206
X	0.268	0.244	0.165	0.147	0.194	0.186	0.241	0.208	0.223	0.196	0.264	0.248
XI	0.242	0.217	0.204	0.202	0.234	0.223	0.260	0.231	0.300	0.263	0.272	0.240
XII	0.251	0.226	0.199	0.197	0.177	0.165	0.146	0.168	0.235	0.232	0.314	0.278
XIII	0.134	0.133	0.105	0.101	0.095	0.086	0.093	0.086	0.135	0.129	0.127	0.115
XIV	0.227	0.204	0.230	0.211	0.222	0.198	0.217	0.207	0.247	0.245	0.235	0.211
XV	0.252	0.226	-	-	-	-	0.244	0.215	0.198	0.204	0.296	0.256
XVI	0.404	0.375	0.478	0.453	-	-	-	-	-	-	0.356	0.317

Table 3. The values of environmental gamma measurement in the ground and 1 m height level (June- November 2015).

|	June (µSv/h)		July (µSv/h)		August (µSv/h)		September (µSv/h)		October (µSv/h)		November (µSv/h)	
	Ground	1m	Ground	1m	Ground	1m	Ground	1m	Ground	1m	Ground	1m
I	0.117	0.162	0.192	0.191	0.207	0.189	0.234	0.211	0.157	0.150	0.108	0.092
II	0.249	0.240	0.287	0.261	0.254	0.238	0.245	0.227	0.169	0.162	0.186	0.157
III	0.192	0.185	0.188	0.196	0.264	0.262	0.211	0.190	0.148	0.139	0.097	0.094
IV	0.218	0.199	0.310	0.285	0.289	0.285	0.252	0.246	0.139	0.125	0.125	0.103
V	0.185	0.177	0.225	0.228	0.235	0.220	0.193	0.173	0.073	0.075	0.063	0.044
VI	0.345	0.341	0.449	0.435	0.451	0.431	0.424	0.407	0.268	0.253	0.264	0.254
VII	0.243	0.226	0.296	0.272	0.251	0.225	0.281	0.268	0.175	0.163	0.144	0.134
VIII	0.255	0.247	0.310	0.313	0.261	0.243	0.251	0.239	0.164	0.145	0.134	0.125
IX	0.275	0.264	0.272	0.280	0.243	0.239	0.302	0.288	0.193	0.165	0.164	0.144
X	0.302	0.291	0.313	0.280	0.295	0.282	0.314	0.306	0.255	0.236	0.201	0.165
XI	0.319	0.305	0.386	0.377	0.361	0.328	0.398	0.369	0.280	0.253	0.197	0.164
XII	0.375	0.336	0.400	0.357	0.345	0.311	0.335	0.325	0.248	0.207	0.253	0.219
XIII	0.198	0.178	0.196	0.186	0.154	0151	0.137	0.121	0.079	0.068	0.041	0.035
XIV	0.359	0.309	0.374	0.344	0.313	0.301	0.295	0.266	0.192	0.174	0.177	0.167
XV	0.343	0.315	0.460	0.410	0.318	0.283	0.297	0.281	0.204	0.187	0.120	0.145
XVI	0.397	0.378	0.287	0.332	0.448	0.403	0.426	0.399	0.325	0.293	0.315	0.260
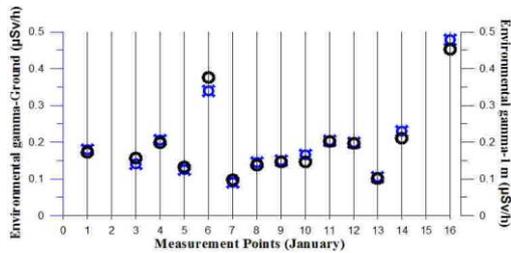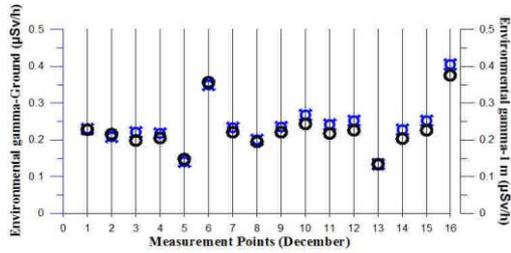
Figure 1. Environmental gamma variation at ground (¤) and 1m level (○) on the 16 points in December and January.

Figure 2. Environmental gamma variation at ground (¤) and 1m level (○) on the 16 points in February and March.
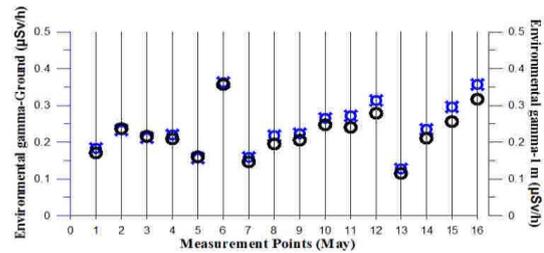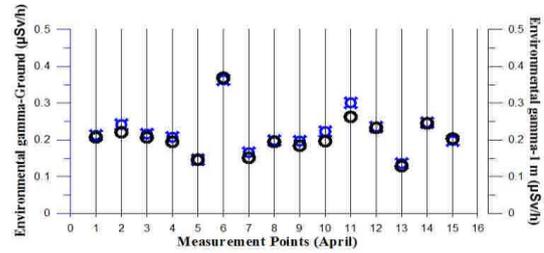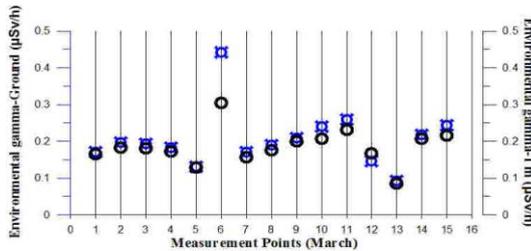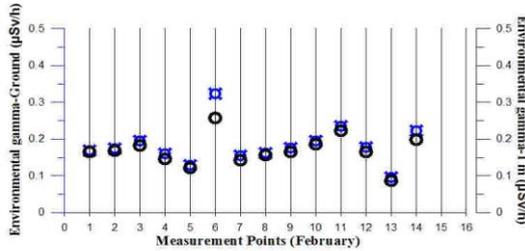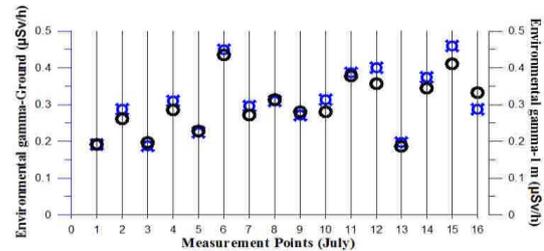

Figure 3. Environmental gamma variation at ground (¤) and 1m level (○) on the 16 points in April and May.
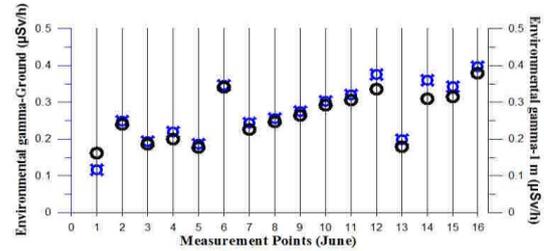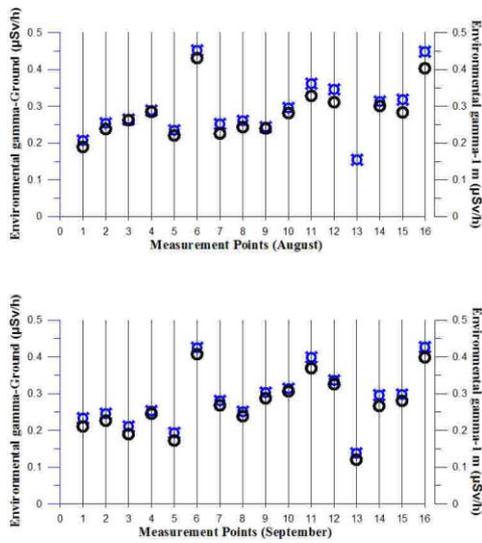

Figure 4. Environmental gamma variation at ground (¤) and 1m level (○) on the 16 points in June and July.

4. Conclusion

Environmental gamma values were measured low progressed towards the winter season due to not to perpendicular and of an angle the sun's rays begin to come to earth.

Environmental gamma values measured at 1 m distance gives information about the concentration of radioactivity in the soil of the measurement point [7]. According to this study, the average gamma dose rate values were measured approximately 0.23 μSvh^{-1}.

According to UNSCEAR (1993, 2000) report, the global average of the measured gamma dose rate ranged from 10 to 200 $nGyh^{-1}$. In this study, the averages of measurements taken at ground level are 233.15 $nGyh^{-1}$ and the averages of measurements taken at 1 m level are 218.79 $nGyh^{-1}$. When the obtained results are compared with gamma dose rate average values world; it is seen that the gamma dose rates is at a level above the world average. The cause of the high levels of gamma dose rates may be geological features of the region, the absence of fault zones and the residential area of higher altitudes. The radioactivity on the fault zone is generally higher than other places, and radioactivity can be changed with the seismological aspects of activity of the fault [7].

Figure 5. Environmental gamma variation at ground (¤) and 1m level (○) on the 16 points in August and September.
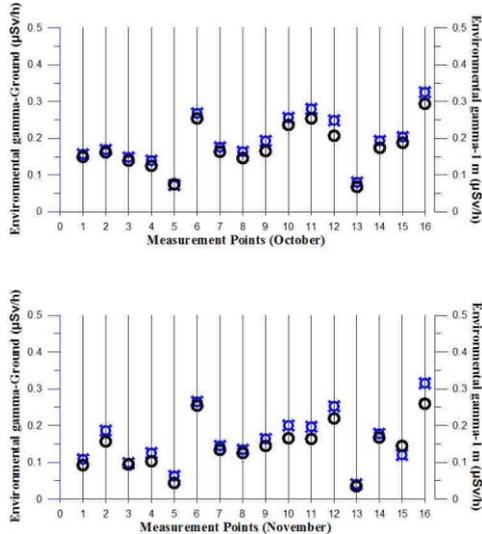
Figure 6. Environmental gamma variation at ground (¤) and 1m level (○) on the 16 points in October and November.

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