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Original Article

Assessment of Outdoor Gamma Radiation Dose Rates in 49 Cities of Guilan Province, IRAN

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Abstract

Introduction
Guilan is one of the provinces in North of Iran, with population of 2,480,874 and a total area of 14,042 square kilometers. This study assesses the outdoor natural gamma dose rates in the air of 49 cities in Guilan and calculates corresponding average annual effective dose.
Materials and Methods
A total of 260 different sample points measurements were carried out. The results include both terrestrial and cosmic ray components of gamma radiation level.
Results
The outdoor gamma dose rates range from 65 to 127 nSv h-1 with the mean of 94 ± 24 nSv h-1.
Conclusion
The average outdoor gamma dose rate for Guilan determined in this study is significantly higher in comparison with values reported by UNSCEAR 2000 from different countries with the mean of 59 nSv although in comparison with many provinces of Iran, it is lower.

Keywords: Background Radiation; Guilan; IRAN; Outdoor Dose Rate.

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1. Introduction

All living organisms are exposed to ionizing radiation from natural sources. Radiation sources that affect the body organs during the day includecosmic rays that come from space and the solar surfaceand terrestrial radionuclide which are present in the Earth crust materials, construction materials, air, water, and human body. The radiation of these sources is called natural radiation and environmental gamma is one of the major components of this radiation [1].

Due to the destructive effects on living organisms, measurement of the ionizing radiation doses is very important. Ionization process in the body of organisms causes changes in atoms and molecules. Despite the instability of these changes, they may cause cellular damages. If cellular damage occurs and the cell is not able to repair itself, it may lead to the cell death, prevention of its normal function or production of the necessary products. If ionizing radiation is enough to kill large number of cells, significant damage will occur and it can even lead to organ failure. If these injuries occur in DNA molecules, cancer may ensue. DNA damages may occur in genital cells that can be transmitted to the next generations, which is the hereditary effect of radiation [2].

Some levels of exposure are constant for all the individuals (for example the dose from ingested ^{40}K in foods) but the other types strongly depend on the location [3]. Cosmic radiation is more in the higher altitude areas, and terrestrial radioactive concentration is various in the soil of different locations. Global dose for outdoor background radiation is in the range of 18 - 93 nSv h^{-1} (with the mean of 59 nSv h^{-1}) [3].

Effective dose is a dosimetric quantity used to estimate the total risk of exposure from any types of radiation [3, 4]. United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) has determined the mean annual global effective dose due to natural radiation sources, 2.4 mSv [3]. If natural radiation dose rate in an area rises up to 10 mSv y^{-1}, the place is exposed to High Levels of Natural Radiation (HLNR) including Brasilia, India, and Ramsar in Iran that are internationally well known [3, 5-7]. For discovering HLNR, environmental gamma radiation in many areas of the world has been measured and map of natural radiation of these regions is plotted. These places have been studied extensively to find causes of high natural radiation and effects on residents.

In Iran, studies of natural radiation doses and dose rates have been done in some places of Mashhad, Azarbayjan, Khorasan, Kordistan, Mazandaran, Kerman, Kermanshah, Boushehr, Yazd, Chahar Mahal and Bakhtiari, Isfahan, Ardebil, Zanjan, and Lorestan [8-22]. Since there was no comprehensive study on outdoor gamma radiation dose rate levels in Guilan, the levels were measured in 49 cities of this province to provide a map of external gamma background radiation dose rates at populated urban areas and to estimate the average annual effective dose to the residents. Guilan is one of the Northern provinces of Iran with population of 2,480,874 and a total area of 14,042 km^2 [23]. At the center of the province is the main city of Rasht.

2. Materials and Methods

Dosimeter used in this study was a multi-purpose survey meter (RDS-110) which was made and calibrated by Rados Company in Finland. The detector is able to measure dose rate from 0.05 μSv h^{-1} to 99.99 mSv h^{-1} with accuracy of 5% [24]. The measurements were accomplished during daylight from September to October 2009.

According to international standards, in each city, five points along the main geographical directions were selected randomly (North, South, East, West, and center) [3, 25]. In the provincial capital of Rasht due to the large area, 20 geographical points were chosen. According to the protocol, for each measurement, the device was placed at height of 1 meter from ground level in the SouthNorth direction and in 6 meters far from any building in order to reduce their effects on the radiation field. Because cosmic rays and terrestrial radionuclide decay changes slightly

in time, radiation dose rates were recorded every one minute until 30 minutes. Mean and standard deviation of all recorded data for each city were computed. Possible confounding parameters such as height of city, date, and time of measurements were also recorded in registration forms.

SPSS software (version 17.0) was used to calculate correlation coefficient and ANOVA test and to analyze the results and comparison with standard values and results of other studies.

3. Results

Figure 1 shows the map of external background gamma dose rates in 49 cities of Guilan. The mean and standard deviation of the natural radiation dose rates in outdoor of the cities are shown in Table 1. Based on the results, the highest and lowest dose rates were 127 nSv h^{-1} and 65 nSv h^{-1}, which were measured in Masouleh and Kela Chay, respectively. The mean and standard deviation of the outdoor gamma background radiation dose rate in urban areas of Guilan province was 94 ± 24 nSv h^{-1}.

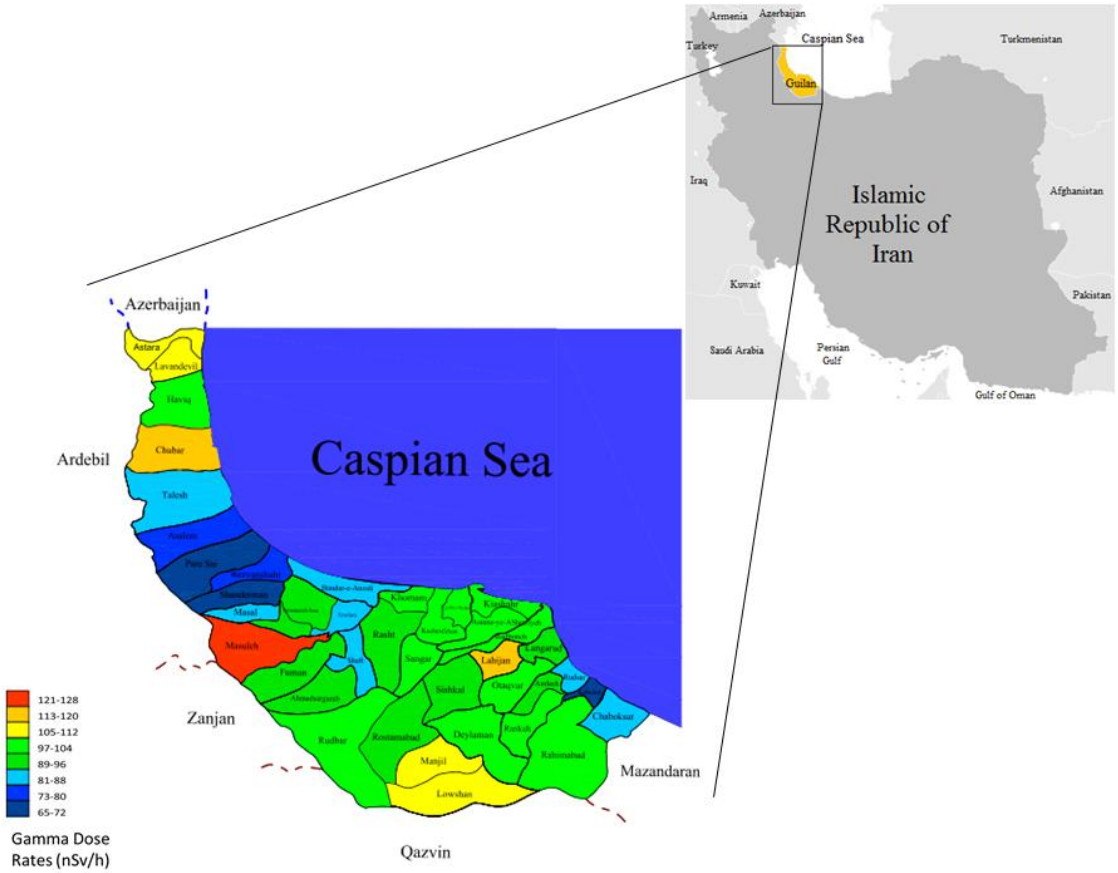

Figure 1. Sites and amounts of external background gamma dose rates in 49 cities of Guilan province.

Table 1. The mean and standard deviation of the natural radiation dose rates in outdoor of the 49 cities of Guilan, Iran.

Geographical Data of Cities				Dose Rate (nSv/h)	
Name	Altitude (m)	Latitude (degrees)	Longitude (degrees)	Mean	SD
Ahmad Sargurab	40	37.13	49.36	93	21
Amlash	30	37.10	50.17	88	21
Asalem	49	37.73	48.95	74	17
Astaneh-ye- Ashrafiyeh	-8	37.26	49.94	103	19
Astara	-28	38.41	48.88	105	15
Bandar-e-Anzali	-15	37.47	49.45	86	14
Barasar	1418	36.78	49.80	101	29
Chabok Sar	24	36.95	50.58	71	16
Choobar	463	38.18	48.85	116	13
Deylaman	1511	36.89	49.95	99	27
Fuman	27	37.22	49.31	93	20
Gurab Zarmikh	26	37.30	49.22	103	23
Haviq	1	38.16	48.88	103	22
Jirandeh	1603	36.69	49.80	110	19
Kela Chay	-17	37.06	50.41	65	13
Khomam	-12	37.38	49.66	104	14
Khoshk-e-Bijar	-8	37.36	49.76	107	30
Kiashahr	-20	37.41	49.96	104	28
Koomleh	1	37.14	50.17	92	20
Kuchesfahan	1	37.27	49.77	98	15
Lahijan	1	37.20	50.00	113	24
Langrud	-8	37.18	50.15	94	22
Lasht Nesha	-16	37.35	49.85	100	24
Lavandevil	-19	38.31	48.86	112	16
Lisar	7	37.96	48.92	99	11
Loshan	344	36.63	49.52	106	14
Manjil	397	36.73	49.42	106	22
Masal	62	37.38	49.12	87	17
Masuleh	1134	37.15	48.99	127	28
Otaqvar	213	37.10	50.12	80	16
Pareh Sar	41	37.61	49.05	67	15
Rahimabad	56	37.02	50.33	80	16
Ran Kooh	50	37.04	50.24	140	27
Rasht	-4	37.28	49.59	94	18
Rezvan Shahr	18	37.54	49.14	75	17
Rostam Abad	94	38.89	49.50	95	14
Rudbar	757	36.81	49.38	99	19
Rudbeneh	-12	37.25	50.01	103	27
Rudsar	-2	37.13	50.28	84	14
Sangar	18	37.18	49.69	102	19
Shaft	50	37.16	49.41	87	18
Shalman	-14	37.09	50.13	74	10

Shanderman	31	37.45	49.13	72	17
Siahkal	40	37.15	49.87	94	20
Someeh Sara	9	37.30	49.31	89	17
Talesh	45	37.80	48.90	85	20
Tolam Shahr	-2	37.28	49.38	87	11
Tutkabon	269	36.88	49.53	97	22
Vajargah	24	37.03	50.41	65	10
Guilan Province				94	24

4. Discussion

Background radiation measurements have special importance in most of the countries [26, 27]. The result showed higher values in comparison with the values reported by UNSCEAR 2000 from different countries as Global (with the mean of 59 nSv h^{-1} in the range of 18- 93 nSv h^{-1}) [3] . As shown in Figure 2, our result is lower than the values which were reported from the other provinces in Iran such as Kerman, Yazd, Lorestan, Kordestan, Zanjan, and Ardebil, but it is higher than values of some other provinces in Iran such as Chaharmahal and Bakhtiari, Hormozgan, Bushehr, Sistan and Blochestan, Mazandaran (except for Ramsar), and Khorasan (North, South, and Razavi)[11-13,15-18, 20-22, 28].

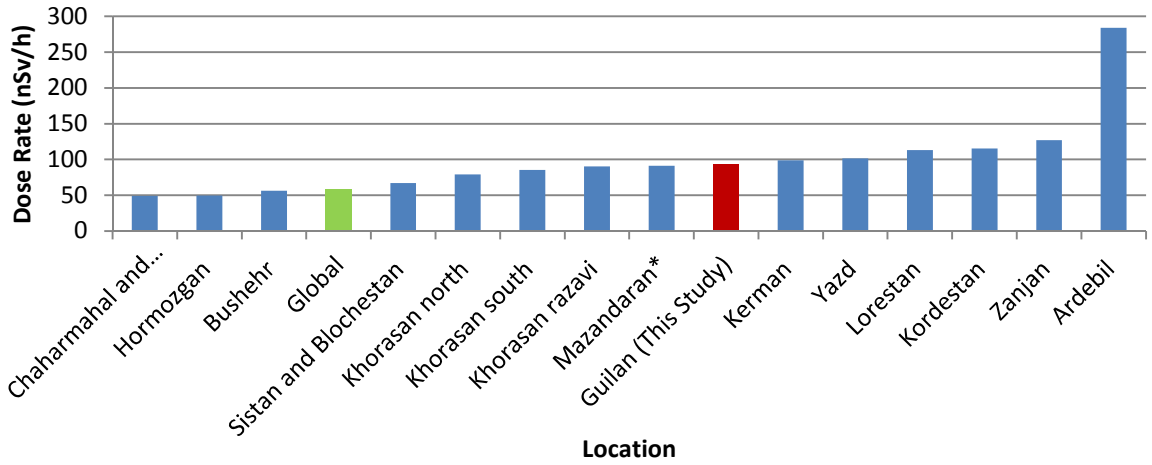

Figure 2. Comparison of mean outdoor Gamma radiation dose rates in some provinces of Iran and global value.
* Ramsar excluded because of high background radiation.

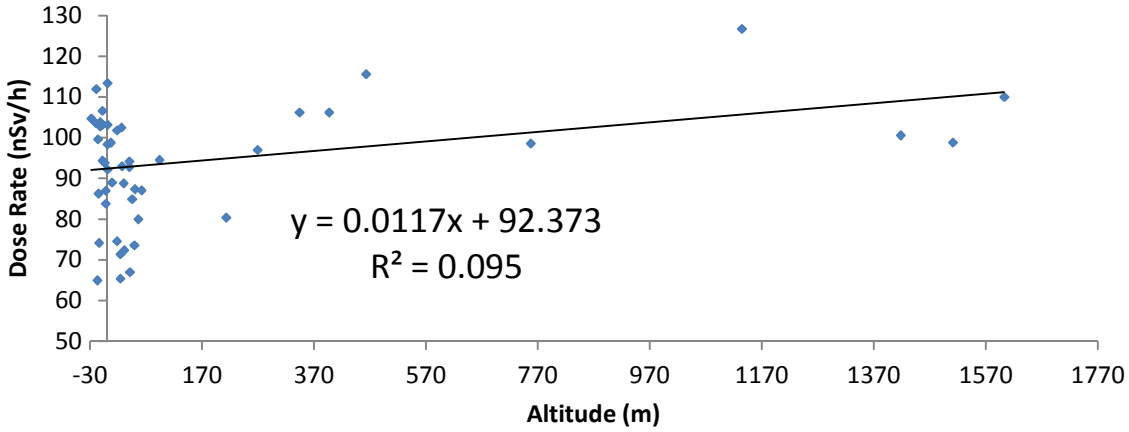

Figure 3. Correlation between the altitude and the dose rate in 49 cities of Guilan province, Iran.

Each 1500 meter increase in altitude doubles the amount of background radiation [3]. The altitude of the cities studied, is in the range of -28 to 1600 meters but as it is shown in Figure 3, our data has shown poor correlation between the altitude of the cities and the dose rate values. Some cities such as Astara, Kiashahr, and Lavandevil showed high background radiation in spite of their low altitude. This is probably the reason for the poor correlation between altitude and dose rate. This finding is in contrast with the results of measurements summarized in 10 provinces of Iran and in agreement with the results of the study in Zanjan province [21, 28].

Surveyed cities were in the range of latitudes 36-39 degrees. No significant relationship between latitude and the dose rate values was obtained ($R^2 = 0.002$). This result is consistent with previous studies that such a relationship has been shown only in cities located in the latitudes lower than 35 degrees [26].

5. Conclusion

Although the values of outdoor dose rate in urban areas of Guilan province are much higher than the global average, these values are lower in comparison with many provinces of Iran. Guilan is not considered as an HLNR region and the natural ionizing radiations which expose the people of this province is less than or within the range of other provinces of Iran.

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