NORMIX 2019: NINTH INTERNATIONAL SYMPOSIUM ON NATURALLY OCCURRING RADIOACTIVE MATERIAL

23 – 27 Denver, COLORADO - 2019

Study on Indoor Radon Measurements with Passive Method in Schools and Workplaces in Tirana City

KOZETA TUSHE[1], ELIDA BYLYKU[1], DRITAN PRIFTI[1], BRUNILDA DACI[1],
[1] Institute of Applied Nuclear Physics, Tirana, Albania

ABSTRACT

The study of Radon measurements in Albania has been concentrated in schools and workplaces where radon is considered as an existing exposure situation. The measurements are carried out in the city of Tirana, where lives about one-third of the population of Albania. The geological structure of Tirana territory comprises recent volcanic rocks, granitic areas and high permeability soils located in the vicinity of seismic areas. Therefore, every increase of indoor radon concentration is related to a higher exposure, which can cause a higher risk of detriment to human health. In this survey are included 80 schools and 70 different workplaces on the first floors and basements. According to the principles of the methodology, the radon passive detectors CR-39 has been located in the workplaces and schools for a three-month exposure for two different period distribution respectively during December 2012 – February 2013 and February 2013 – April 2013. The measurements are performed by passive method in Institute of Applied Nuclear Physics. In schools the detectors are placed mainly in different cabinets, libraries and gym room, whereas in workplaces the detectors are placed in offices, meeting rooms and laboratories. It is observed that the level of indoor radon concentration in many cases exceeds the reference level of 300 Bq.m^{-3}. The values of radon concentrations are found to vary from 24 Bq.m^{-3} to 1000 Bq.m^{-3} in schools and 22 Bq.m^{-3} to 400 Bq.m^{-3} in workplaces. The descriptive analysis shows a positively skewed and peaked distribution indicating that the radon concentration records follow a log-normal distribution. The reported values for radon concentrations in schools and workplaces indicate that immediate mitigation options such as putting in efficiency the ventilation system and periodically measurements. We recommend a continuous monitoring of radon concentration as a necessary tool to keep under control the radon concentrations. It is important to increase the awareness against radiation hazards among the critical population groups.

INTRODUCTION

Radon in indoor dwellings has a special attention in many countries worldwide, which in some countries have been already established national radon plans for addressing such issue. However, this issue has not yet been approached in a systematic way in Albania. Also, Albania as a candidate for membership in the EU is obliged to harmonize its legislation, including the field of radiation protection in which the exposure due to radon has an important contribution. Regarding the role - term plans, the establishment and implementation of the radon national strategy with the primary goal of raising awareness about the harmful effects to public exposure to radon and implementing a set of measures for its reduction, must be achieved the collaboration between national organizations responsible for public health and radiation protection.

Exposure to radon and radon decay products in dwellings and workplaces constitutes one of the greatest health risks from exposure to ionizing radiation due to natural radioactivity (WHO 2009; UNSCEAR 2010).
Therefore, it is important to develop a radon national strategy and raise the awareness of national authorities and the public about the risks related to radon. The last is also envisaged in the action plan for the primary prevention of cancer, in the framework of the National Programme of Cancer Control 2011-2020 launched by the Ministry of Health.
The Albanian legislation addresses the exposure to radon issue in V.K.M. 957 (2015) and issues reference levels for radon concentration at dwellings and workplaces of 300 Bq.m^{-3} respectively.

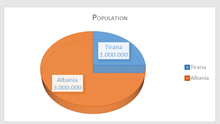
These levels are conforming to the requirements of the International Basic Safety Standards (GSR Part 3) for laying down basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionizing radiation.

The objective of this study is to evaluate the radon concentration in Tirana city and to increase the number of measurements, verify the compliance of the results with the different parameters for indoor radon concentration in from legal requirements.

MATERIALS & METHODS

Studied area

The measurements of radon concentration at schools and workplaces are performed randomly in different areas of Tirana city, where lives about one-third of the population of Albania.

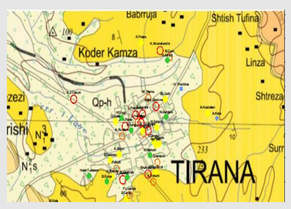


Map of Albania

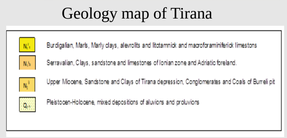
In this survey are included 80 schools and 70 different workplaces on the first floors and basements. In schools the detectors are placed mainly in different cabinets, libraries and gym room, whereas in workplaces the detectors are placed in offices, meeting rooms and laboratories.

The geological structure of Tirana territory comprises recent volcanic rocks, granitic areas and high permeability soils located in the vicinity of seismic areas. The study area of this paper is located in a geological formation where dominate the depositions of Early Holocene (Holocene starts from 11,700 years), which are represented by the aluvions and proluvions deposits that build the entire field of Tirana and are products formed by the streams of Erzeni, Tiranë, Tërkuzë, Lanë etj.

The thickness of these deposits is up to 70-80 m. Lithological they consist of clay, alevrolite, fine sand to thick and rounded gravel. Therefore, every increase of indoor radon concentration is related to a higher exposure, which can cause a higher risk of detriment to human health.



Geology map of Tirana



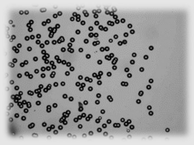
The indoor radon concentration measurements are conducted using passive radon detectors, Solid State Nuclear Track Detectors (SSNTD) provided by Radonova (Landauer Nordic, Sweden).


CR-39

The radon passive detectors **CR -39** have been located in the workplaces and schools for a three-month exposure during the period distribution, respectively December 2012 – February 2013 and February 2013 – April 2013.

After exposure all detectors are chemically etched using a solution of 6 M NaOH at 75 °C for 10 hours.

The tracks are counted using digital optical microscope readings (x150) based on random screening of 30 areas (field of view of the microscope) of 0.75 mm^2.


tracks


Digital microscope

The radon concentration (in Bq m^{-3}) is calculated using the equation (1):

$$C_{Rn}(Bqm^{-3}) = \frac{N - N_B}{\varepsilon \times t} \quad (1)$$

where

N is the gross track density per unit area (track m^{-2}),

N_B is the background track density per unit area (track m^{-2}),

ε is the calibration factor (track cm^{-2} (Bq h m^{-3})$^{-1}$),

t is the exposure time (h),

The minimum detection of indoor radon concentration is approximately 12 Bq m^{-3} for a three-month exposure time.

RESULTS & DISCUSSIONS

This study presents the findings of the indoor radon concentration in schools and workplaces in Tirana city, capital of Albania. In this survey are included 80 schools and 70 different workplaces on the first floors and basements during December 2012 – February 2013 and February 2013 – April 2013.
The descriptive analysis shows a positively skewed and peaked distribution indicating that the radon concentration records follow a log-normal distribution in both cases, checked by the Kolmogorov–Smirnov test (P > 0.05), that is shown in Figure 1.

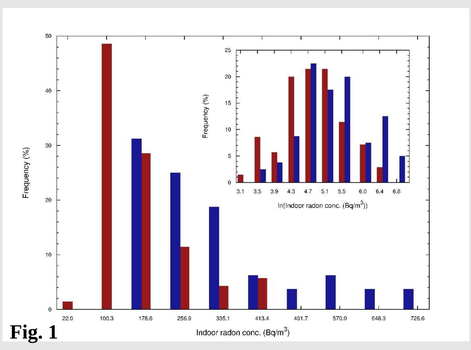


Fig. 1

The frequency distribution of radon concentration in schools is presented with blue color while the frequency distribution of radon concentration in workplaces is presented in red color.

In about 14 % of measurements of the radon concentration in schools exceeds the reference level of 300 Bq m^{-3} compared with 4% of measurements of radon concentration in workplaces.

The descriptive statistics of indoor radon concentration in workplaces and schools are shown in Table I.

Measurement category	Workplaces Rn conc. Bq m^{-3}	ln(Rn conc.)	Schools Rn conc. Bq m^{-3}	ln(Rn conc.)
No.	70		80	
Range	22-405	3.1-6.0	24-677	3.2-6.5
Average (AM)	126	4.6	208	5.1
Median	103	4.6	149	5.0
Standard dev.	91	0.7	163	0.8
Skewness	1.4	-0.1	1.3	<0.1
Kurtosis	1.7	-0.4	0.9	-0.5

Table I

These results are in accordance with previous studies in Albania and in some Country on Balkan region; Bulgaria; Greece; Serbia; Montenegro; North Macedonia; Italy. For comparison, the results from radon surveys performed in the region are given in Table II.

Country	Workplaces Schools All. Country	C_{Rn} (Bq/m^3) Max (SD)	AM	GM (GSD)	Reference
Albania	Schools	633	136 (113)	111(1.8)	Dhoqina et al. (2019)
Albania	All. country	1238	120 (67)	103 (1.8)	Bode et al. (2016)
Bulgaria	Kindergarten	1415	132 (118)	101(2.08)	Ivanova et al. (2014)
Serbia	Schools	550	128 (48)	120(1.43)	Bossew et al. (2014)
Greece	Workplaces	695	123	106	Clouvas et al. (2007)
Montenegro	All. Country	2321	110 (182)	58 (2.91)	Vukotic et al. (2019)
North Macedonia	All. Country	260	94 (54)	82 (1.7)	Stojanovska et al. (2017)
Italy	Schools	1608	214 (187)	162	Trevisi et al. (2012)

Table II

CONCLUSIONS

- In this study the measurements of indoor radon concentration in public buildings include 70 workplaces and 80 schools in Tirana city where live one-third of the population.
- Based on these results the arithmetic mean of radon concentration is calculated to be 126 ± 91 Bq m^{-3} and 208 ± 163 Bq m^{-3} respectively, workplaces and schools.
- The distribution of indoor radon concentration in both cases is found to be log-normal distributed and statistical results are found to be comparable with different studies in the region.
- The survey of indoor radon concentration in workplaces and schools should be continued in order to start nation strategy of radon in Albania.

*Corresponding author: kozetabode2002@yahoo.ca