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Study the Concentrations of Radon indoor in Axum Town, Tigray, Ethiopia.

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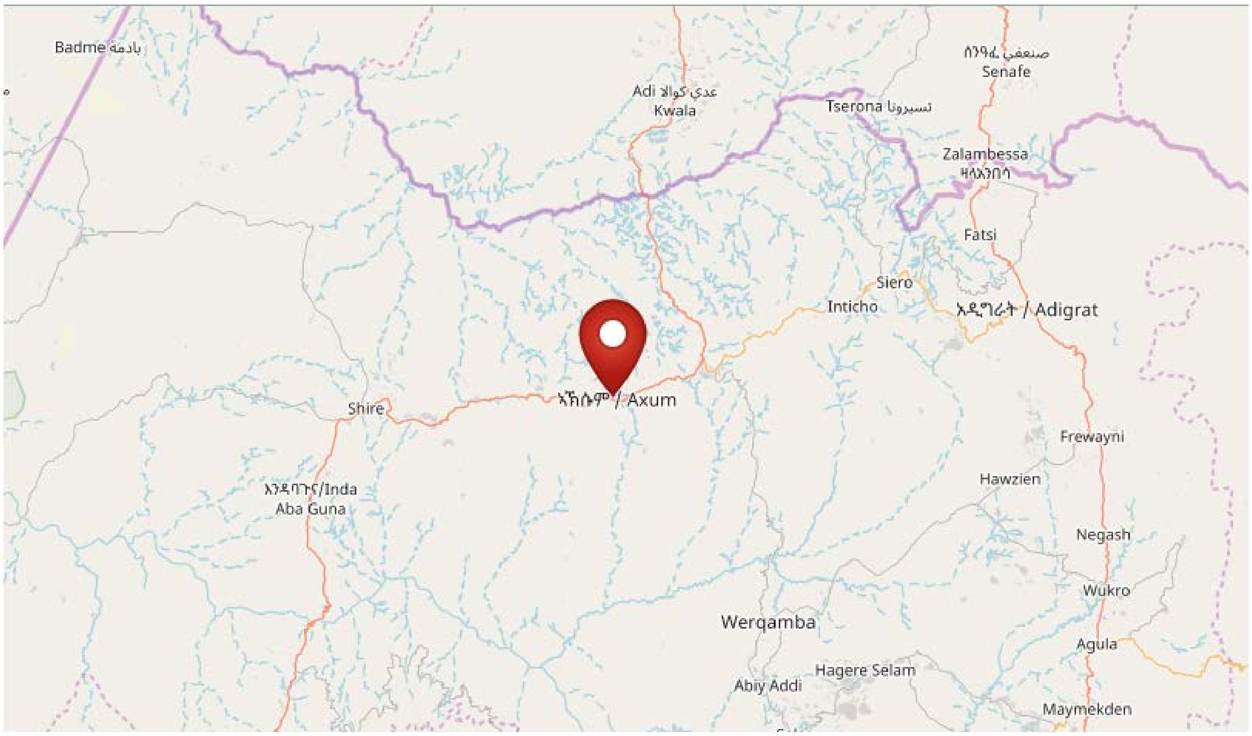
Abstract:
Long term indoor radon concentration in dwellings in Axum town, randomly selected, were performed by SSNTD (LR-115 films) track etch detectors during a year 2017/2018 for a period of 4 months. Results of preliminary investigation presented in this paper show that radon activities vary from 39 Bq.m^{-3} to 116 Bq.m^{-3} with mean concentration 76.3Bq.m^{-3} and standard deviation of 22.5Bq.m^{-3} while the inhalation dose rate varies from 0.35 mSv.y^{-1} to1.04 mSv.y^{-1} with an average of 0.69 mSv.y^{-1} and standard deviation of 0.21mSv.y$^{-1.}$ In all the dwellings the concentration of radon and inhalation dose is found less than the lower limit recommended by ICRP. Risk of lung cancer related to radon is expected to be negligible in these dwellings.

Keywords: Radon; Axum; alpha particle; lung cancer; LR-115 type II; inhalation dose.

Introduction:
Radon (^{222}Rn) is a naturally occurring radioactive gas, emitted from the disintegration of ^{226}Ra in the decay series of ^{238}U [1]. It is considered to be the second leading cause of lung cancer after tobacco smoking.Radon and its progeny decay to generate high energy radiations, alpha particles which bombard the body cells upon exposure and damage the DNA of the cells [2,3]. The main sources of indoor radon are soil and rocks underneath the buildings, cooking gas, water sources and building materials which contain traces of ^{238}Uand ^{226}Ra [4,5]. Once the gas is released into indoor environments, it may get accumulated to a harmful level especially in poorly designed dwellings with inadequate ventilation systems.This study seeks to report the activity concentrations of indoor radon and examine any possible health effects from exposure to the gas from selected dwellings of Axum town, Ehiopia.

Geological Setting

Axum is a city in the northern part of Ethiopia. The town has a population of 56,500 residents and is governed as an urban wäräda. The original capital of the Kingdom of Aksum, it is one of the oldest continuously inhabited places in Africa. In 1980, UNESCO added Axum's archaeological sites to its list of World Heritage Sites due to their historic value. It has an elevation of 2,131 meters and located at 14 degree, 7 minute and 15 seconds North and 38 degree, 43 minute and 40 seconds East.



Experiment and measurement:

The measurements of radon were carried out by using the LR-115 Type II, plastic track detector. Twelve small pieces of LR-115 Type II plastic track detector of size 2 cm x 3 cm are fixed in selected dwellings. Films are suspended inside the house at a height of about 1.5m from the floor. After an exposure time of about four months, films are removed and etched in 2.5 N NaoH solutions for 90 minutes at 65 ^oC in a constant temperature bath. The films are then washed with distilled water and allowed to dry for 24 Hrs and the tracks were counted using an optical microscope at a magnification of 400x.

The track density ρ (in Track.cm^{-2}) was calculated using the following relations [6][7]

$$\rho = \frac{N}{A} \text{ ---------------------------- (1)}$$

Where, N is number of tracks and A is the area of the detector film (LR-115 type II).

And the potential alpha energy concentration Cp (mWL) was estimated using the expression

$$C_p\ (\text{mWL}) = \frac{\rho}{KT} \text{ -------------------------- } (2)$$

Where, mWL is mili working level which is the unit of the potential alpha energy concentration.
K is the average value of the calibration factor of ^{222}Rn in (tracks.cm^{-2})/ (days.Bq.m^{3}) and
T is the exposure time (days).
The concentration of radon and the potential alpha energy concentrations were calculated using the following equation:

$$C_{Rn}\ (\text{Bq.m-}^{3}) = \frac{3.7C_p}{F} \text{ -------------------- } (3)$$

Where;
$C_{p:}$ potential alpha energy concentration
F: is equilibrium factor (0.4).
The inhalation dose D_{in} (in mSv.y^{-1}) was obtained using the equation;

$$D_{in}\ (\text{in mSv.y}^{-1}) = 0.009C_{Rn} \text{ -- } (4)$$

Results and Discussion

Table: Observed values of track density, potential alpha energy concentration C_P (MwL), Radon concentrations C_{Rn}(Bq.m^{-3}) and inhalation dose D_{in}(mSv/y).

Detector code	Track density ρ(tracks.cm^{-2})	Nature of ventilation	C_P(MwL)	C_{Rn}(Bq.m^{-3})	D_{in}(mSv/y)
Ak-1	23.33	Partially vent.	9.72	90	0.80
Ak-2	28	Poor	11.67	108	1.00
Ak- 3	20	Partially vent.	8.33	77	0.70
Ak- 4	16	Partially vent.	6.67	62	0.60
Ak- 5	18.33	Partially vent.	7.64	71	0.64
Ak- 6	22.33	Partially vent.	9.3	86	0.80
Ak- 7	17	Partially vent.	7.08	66	0.60
Ak- 8	14.67	Partially vent.	6.11	57	0.50

Ak- 9	30	Poor	12.5	116	1.04
Ak- 10	24.67	Partially vent.	10.28	95	0.85
Ak- 11	12.67	Good vent.	5.28	49	0.40
Ak- 12	10	Good vent.	4.17	39	0.35
		Mean	8.23	76.3	0.69
		Standard deviation	2.44	22.5	0.21

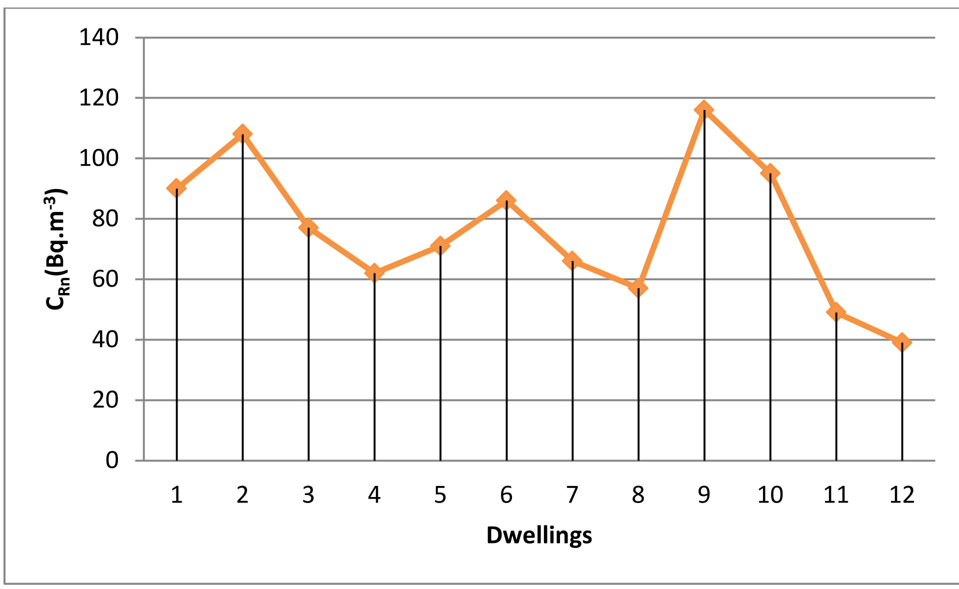


Fig : Frequency distribution of radon concentrations in dwellings

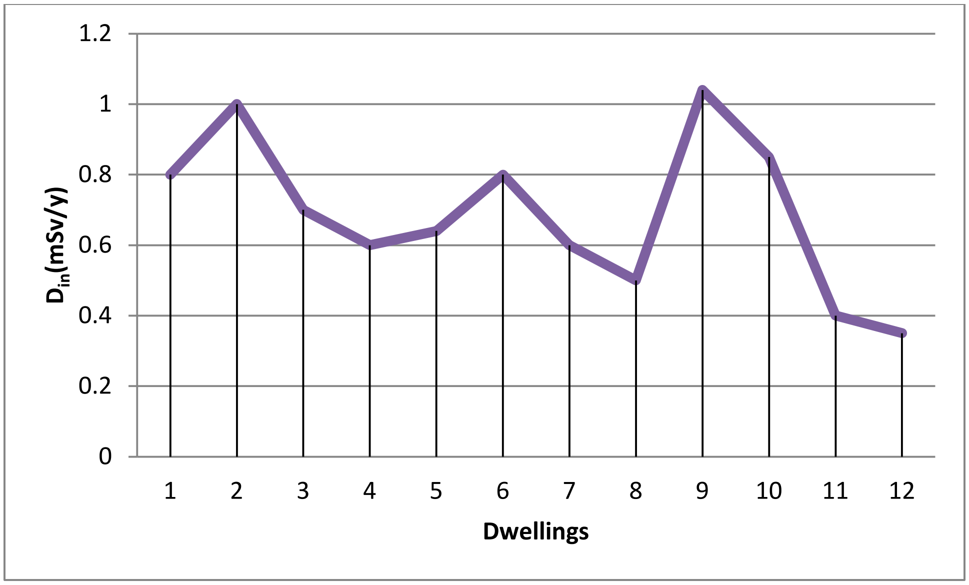


Fig : Frequency distribution of inhalation dose in dwellings

Measurements of radon concentration in air were conducted from 12 selected Dwellings in Axum, Ethiopia. The radon track density, potential alpha energy concentration, radon concentrations and dose inhalation over a period of 4 months was then calculated using Equations 1, 2, 3 and 4. Results obtained show that radon activities vary from 39 $Bq.m^{-3}$ to 116 $Bq.m^{-3}$ with mean concentration 76.3$Bq.m^{-3}$ and standard deviation of 22.5$Bq.m^{-3}$ while the inhalation dose rate varies from 0.35 $mSv.y^{-1}$ to1.04 $mSv.y^{-1}$ with an average of 0.69 $mSv.y^{-1}$ and standard deviation of 0.21$mSv.y^{-1}$ .It is observed that there is a significant increase in concentration in dwellings Ak-9 and Ak-2. Higher value of concentration in Ak-9 and Ak-2 may be attributed to the presence of less air current in the atmosphere. It may also be due to the reason that the doors and windows in these dwellings remain closed for most part of the day, causing poor ventilation or the building construction materials used. To draw any conclusion regarding the higher value of radon concentrations in the dwellings, measurement of radon concentration should be carried out for outdoor radon. An effort will be made to perform these experiments in future as further studies.

Conclusion

The values of radon concentratios was found to be in the range of 39 $Bq.m^{-3}$ to 116 $Bq.m^{-3}$ with mean concentration 76.3$Bq.m^{-3}$. The level of radon concentration was found to be much below the level specified by ICRP 1993[8]. Hence, the area is safe as far the health hazard effects are concerned.

Acknowledgment

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