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Second African Conference on Fundamental and Applied Physics

ORAL PRESENTATION

Soil gas radon, indoor radon and its diurnal variation in Northern region of Cameroon

Presented by

SADJO

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PLAN

1. INTRODUCTION
2. MATERIAL AND METHODS
3. RESULTS AND DISCUSSION
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1. INTRODUCTION

A. Aim of the study

The present study was aimed at assessing radon exposure to the public in two Divisions located in the Northen region of Cameroon.

1. INTRODUCTION

A. Previous work

- Radon by WHO, ICRP and et IAEA (2019)
- Saidou 2019 (poli), Saidou 2020 (adamaoua), Bineng 2020 (lolodorf)
- Evelise 2013 (Brésil), Vistas 2019(Irak), Deborah,2020(Nigeria),...

C. National radon action plan in Cameroon

2. MATERIAL AND METHODS

A. STUDY AREA

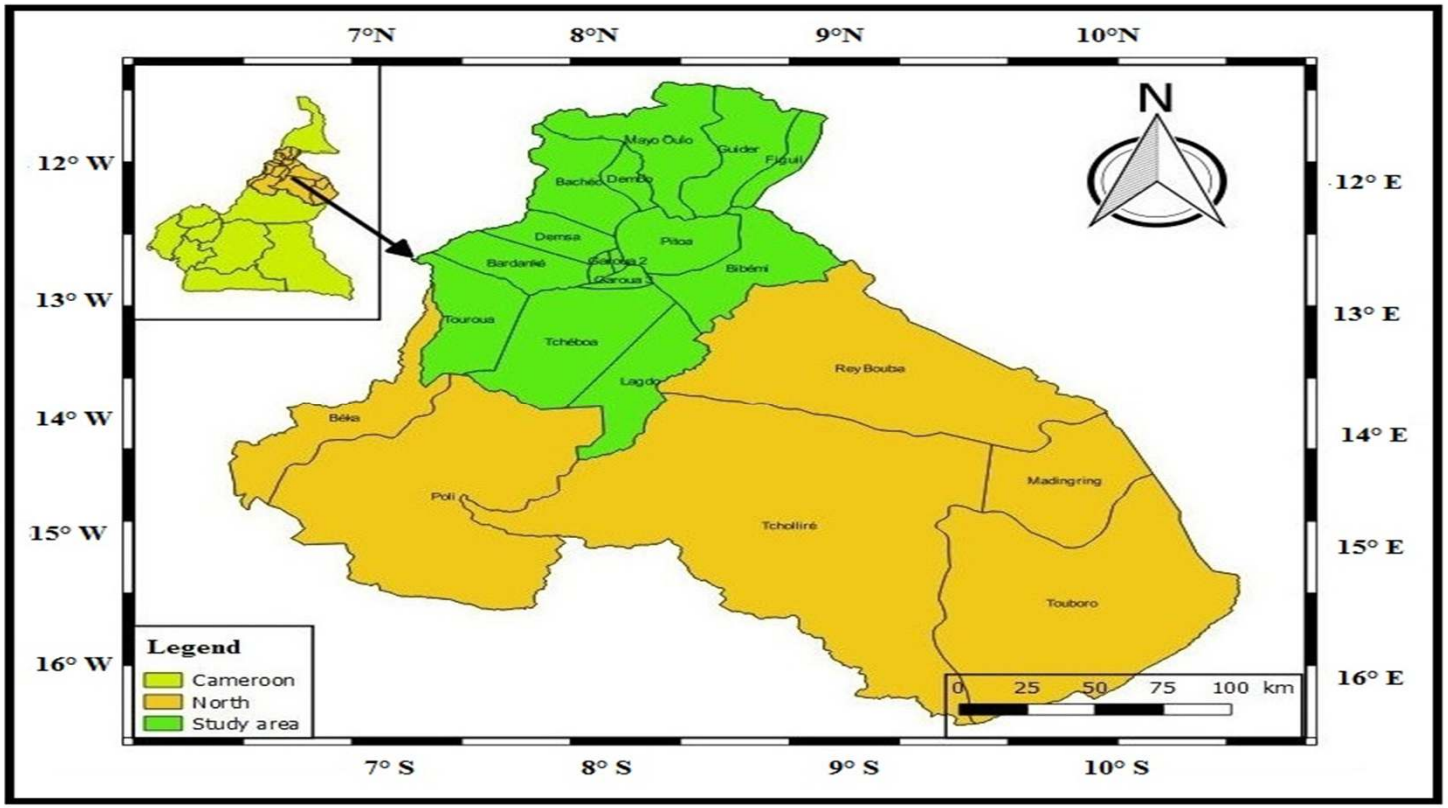

Figure 1. Map of the northern region of Cameroon.

2. MATERIAL AND METHODS

B. ANALYSIS EQUIPMENT

1. Camputer (RAM 500 Go, 64 bit)
2. Miscrosoft office Excel 2010
3. Origin Lab 2018
4. Q.sis

2. MATERIAL AND METHODS

B. MEASURING EQUIPMENT

1- RADTRAK

2- RadonEye plus 2

3- MARKUS 10

2. MATERIAL AND METHODS

C. RADON CONCENTRATIONS

$$C'_{Rn} = C_{SG}\sqrt{\frac{d}{D}} \quad (1)$$

$$\bar{C} = (n_g - \bar{n}_b)\frac{1}{t.S_{SSNTD}.F_c} = (n_g - \bar{n}_b).\omega \quad (2)$$

$$\omega = \frac{1}{t.S_{SSNTD}.F_c} \quad (3)$$

2. MATERIAL AND METHODS

C. RADON CONCENTRATIONS

$$GM = \sqrt[n]{\prod_{i=1}^{n} \bar{C}_i} \quad (4)$$

$$GSD = \frac{1}{n} GM \sqrt{\sum_{i=1}^{n} \left(\frac{u_{\bar{C}_i}}{\bar{C}_i} \right)^2} \quad (5)$$

$$AM = \frac{1}{n} \sum_{i=1}^{n} \bar{C}_i \quad (6)$$

$$SD = \frac{1}{n} \sqrt{\sum_{i=1}^{N} u_{\bar{C}_i}} \quad (7)$$

2. MATERIAL AND METHODS

D. EXHALATION RATE AND ANNUAL EFFECTIVE DOSE

$$\tau = C_{SG} \times \lambda \sqrt{\frac{d}{\lambda}} \quad (8)$$

$$E'_{Rn} = e_{Rn} \times F'_{eqRn} \times C'_{Rn} \times (1 - F_{occ}) \times t \quad (9)$$

$$E_{Rn} = e_{Rn} \times F_{eqRn} \times C_{Rn} \times F_{occ} \times t \quad (10)$$

$$E_{TRn} = E_{Rn} + E'_{Rn} \quad (11)$$

3. RESULTS AND DISCUSSION

A. Indoor radon distribution using RADTYRAK detectors

- Majority of dwellings are new: built in mud (which are regularly renewed), cement block (current constructions) or cement mud block.
- 37.1% of the dwellings where the measurements were taken are built in mud, 60.1% in cement block and 2.8% in cement mud block
- Dwellings are naturally ventilated but some in addition to natural ventilation use mechanical ventilation
- 100% of dwellings built with mud and cement block, and 99.3% of dwellings built with mud cement block have radon concentration below 100 Bq m−3.

3. RESULTS AND DISCUSSION

Table 1. The range, arithmetic mean, geometric mean and median of the indoor radon

Statistical parameters	Indoor radon concentrations (Bq m^{-3})					
	Whole study area	Guider	Figuil	Garoua	Bibemi	Ngong
Range	15-104	15-67	21-51	22-104	20-53	17-77
AM ± SD	40 ± 2	38 ± 2	32 ± 2	48 ± 2	33 ± 3	48 ± 3
GM (GSD)	38(1.5)	36 (2.2)	31 (1.5)	45(2.0)	32 (2.9)	39 (2.9)
Median	38	38	31	49	31	38
N	143	32	22	44	20	25

WHO, ICRP: 100 Bq m^{-3} , 300 Bq m^{-3}

3. RESULTS AND DISCUSSION

- Daily measurements carried out by RadonEye+[2] show that radon concentration varies from dwelling to dwelling. According to Table 2

Table 2: ^{222}Rn levels and different environmental parameters inside the different dwellings.

^{222}Rn concentration (Bq m^{-3})			Air temperature (°C)			Relative humidity (%)		
Min	Max	Average	Min	Max	Average	Min	Max	Average
7	60	17	32.0	37.4	34.4	40.0	55.0	48.1

3. RESULTS AND DISCUSSION

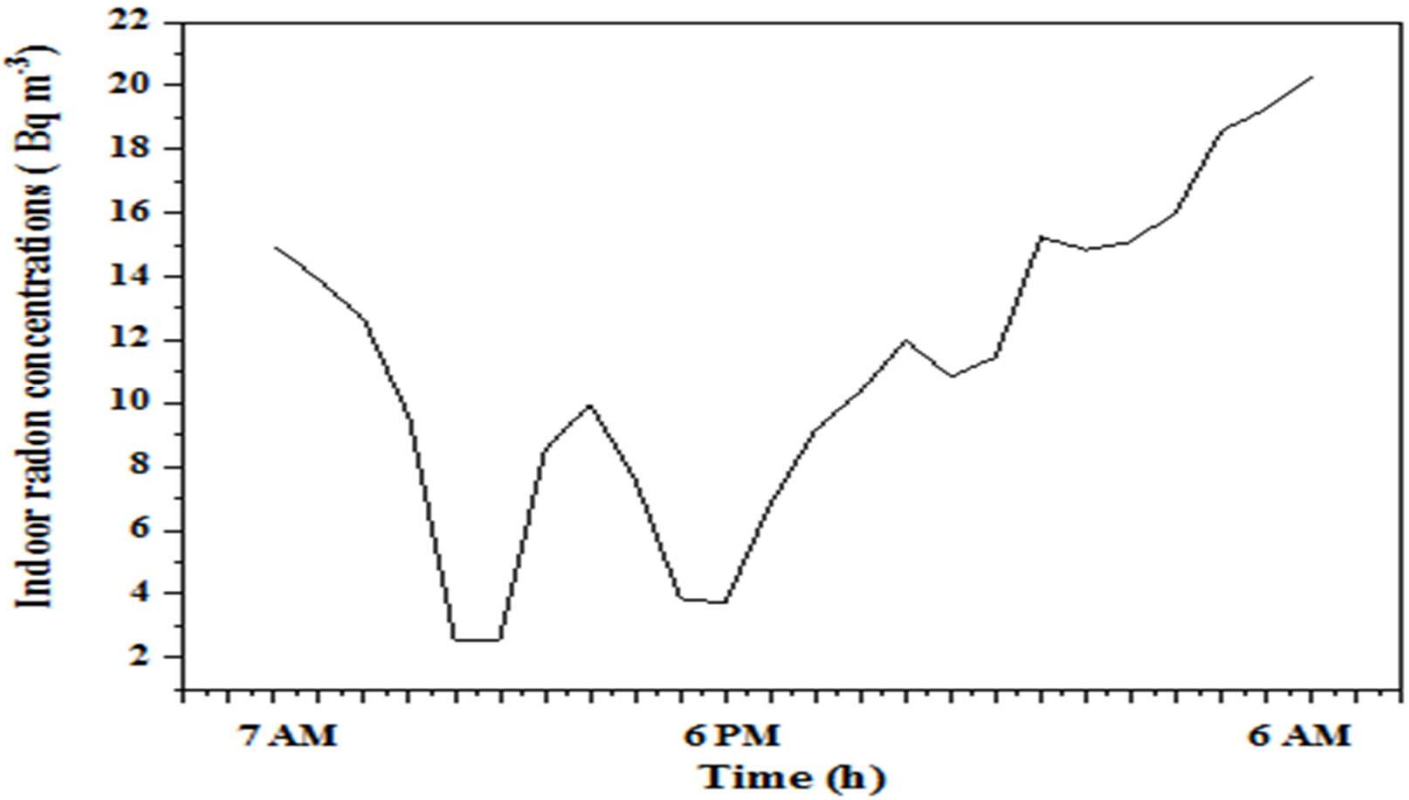

Figure 1: Daily variation of indoor radon concentrations depending on the time

3. RESULTS AND DISCUSSION

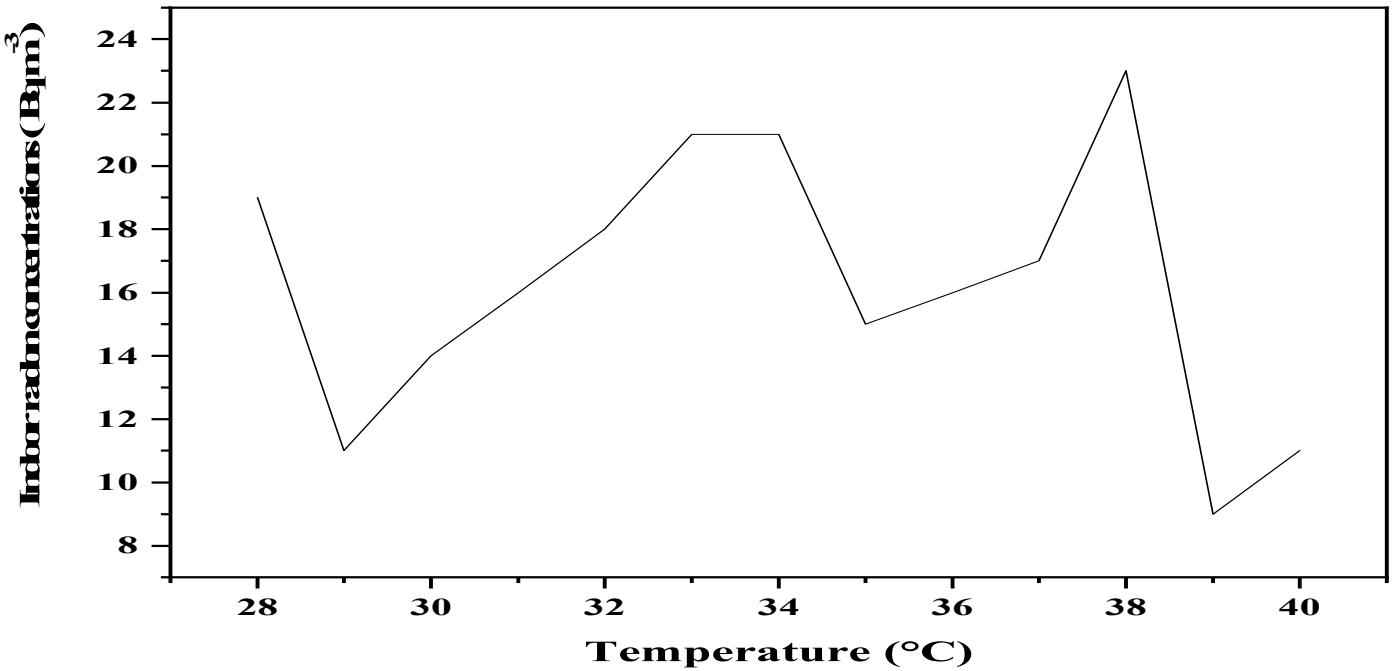

Figure 2: Daily variation of indoor radon concentrations depending on the temperature

3. RESULTS AND DISCUSSION

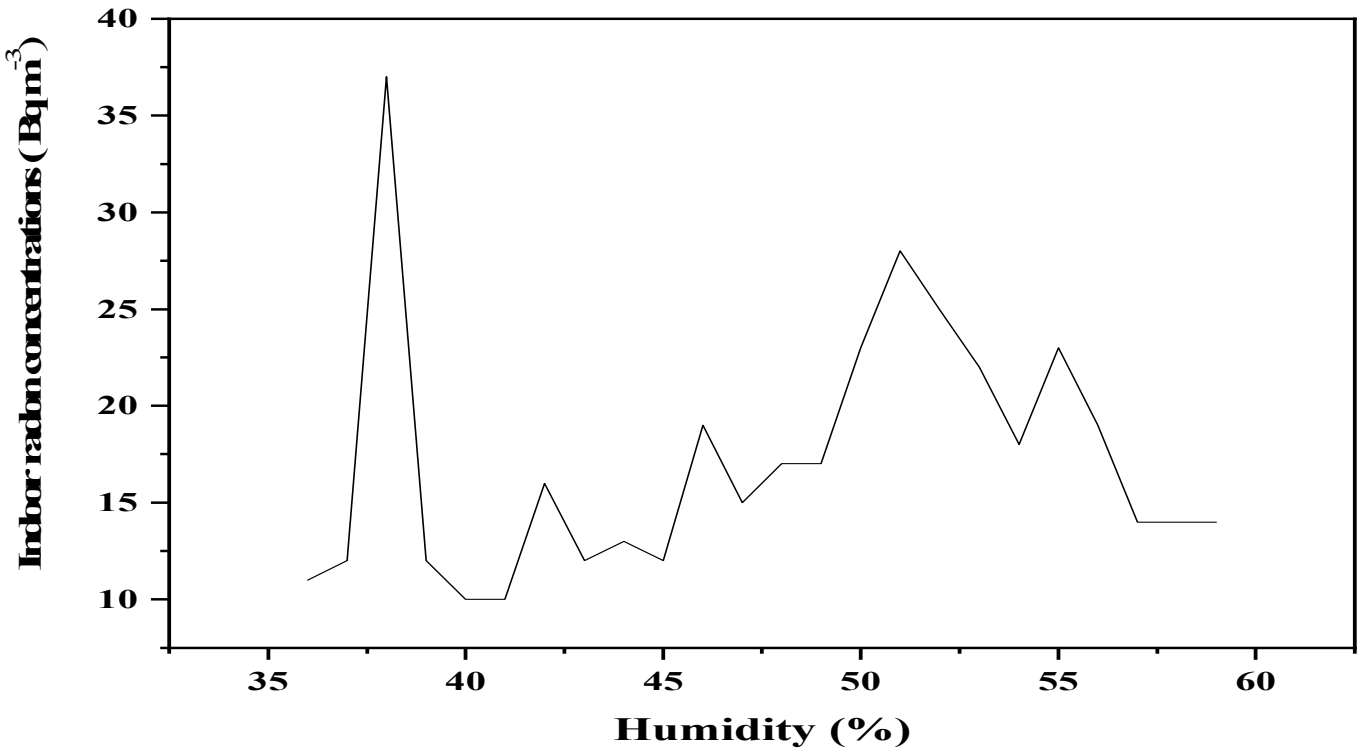

Figure 3: Daily variation of indoor radon concentrations depending on the humidity

3. RESULTS AND DISCUSSION

- Soil gas radon measured in the whole study area are presented in Table 3. Radon concentrations vary from to 0.9-13.9 kBq m^{-3} with a mean value of 4.6 kBq m^{-3}

- 50% of measurement points have radon concentration in soil higher than the world mean value

Table 3. Radon concentrations in soil and corresponding effective dose.

Radon concentrations			
Soil gas	Exhalation rate	Outdoor	Effective dose
C_{SG} (k Bq m^{-3})	(mBq. $m^{-2}.s^{-1}$)	C'_{Rn} (Bq m^{-3})	E'_{Rn} (mSv y^{-1})
4.6	14.91	4.6	0.09

UNSCEAR 2000: (4 k Bq m^{-3}); CIRP 2007 (1 mSv)

3. RESULTS AND DISCUSSION

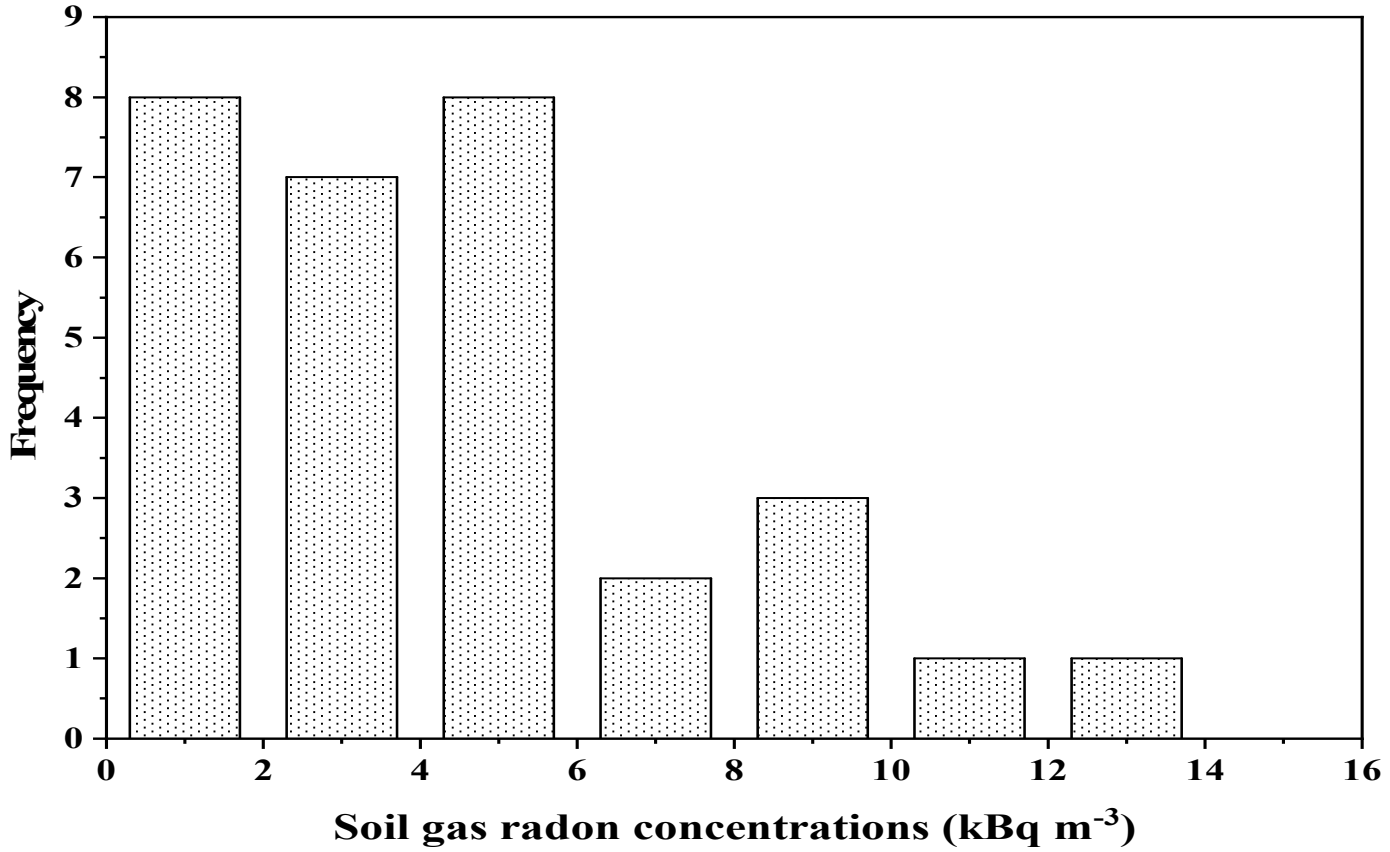

Figure 2. Distribution of soil gas radon

3. RESULTS AND DISCUSSION

Table 4. Indoor inhalation dose due to radon

Statistical parameters	Indoor inhalation dose (mSv a^{-1})					
	Whole study area	Guider	Figuil	Garoua	Bibemi	Ngong
Range	0.28-1.97	0.28-1.27	0.40-0.96	0.42-1.97	0.38-1.	0.32-1.46
AM ± SD	0.76 ± 0.04	0.73 ± 0.04	0.60 ± 0.03	0.91 ± 0.03	0.62 ± 0.05	0.8 ± 0.05
GM (GSD)	0.72 (0.03)	0.69 (0.04)	0.57 (0.03)	0.85 (0.04)	0.71 (0.05)	0.74 (0.05)
Median	0.72	0.72	0.57	0.94	0.59	0.72
N	143	32	22	44	20	25

CIRP 2014, UNSCEAR 2008: (1.15 mSv)

3. RESULTS AND DISCUSSION

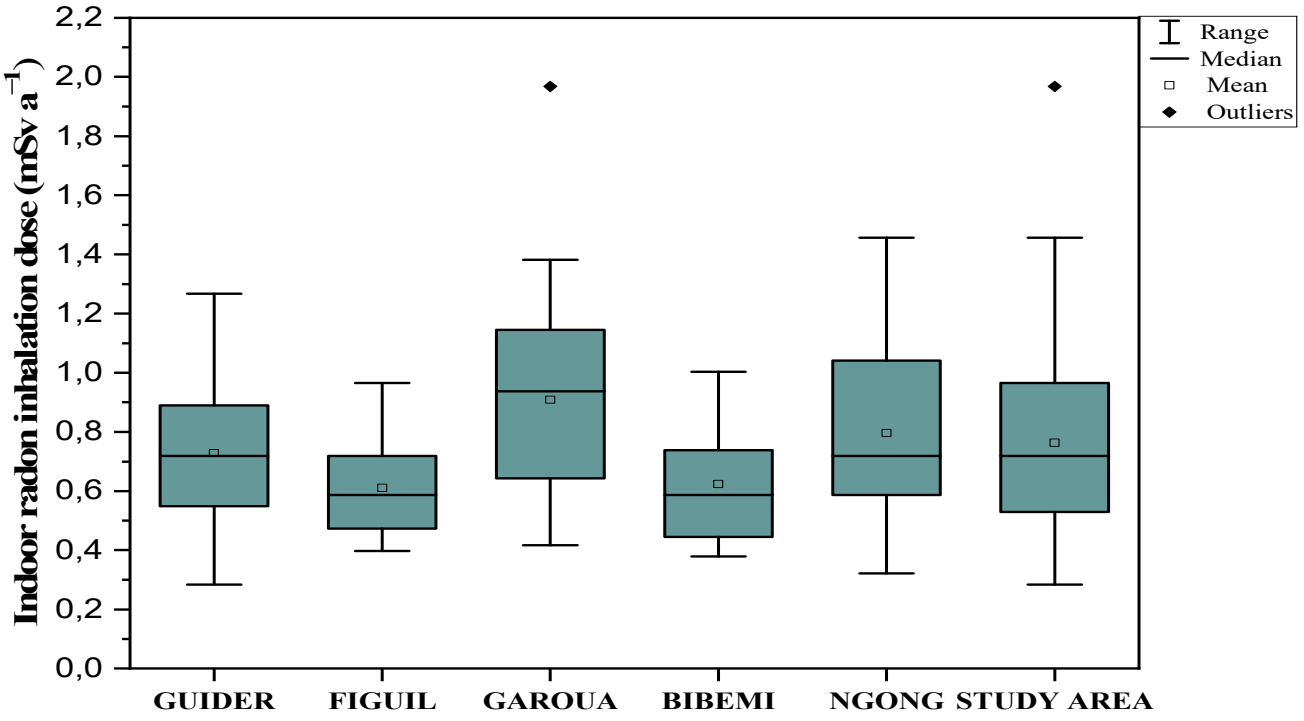

Figure 3. Box plot of inhalation dose in the study areas located in Northern Cameroon

3. RESULTS AND DISCUSSION

Table 5. Comparison of indoor radon and inhalation dose with other studies.

Indoor radon concentrations (Bq m^{-3})				Effective dose (mSv y^{-1})		Reference
Range	AM	GM (GSD)	N	Range	Mean	
41-176.3	57 ± 39	-	82	-	0.12	Doris K et al.2012
15-2166	-	114 (2.3)	350	0.8-13.3	8.2	Maria Q. et al.2015
31-436	139 ± 47	118 (1.3)	71	0.6-9	2.6	Serge D. et al., 2016
20-1110	-	-	2407	-	-	Alijev et al., 2017
46-137	82 ± 20	79 (1.3)	92	0.87-2.6	1.5	Saidou et al., 2019
28-976	103 ± 2	89 (2)	173	0.03-0.87	0.09	Bineng et al 2020
36-697	-	175 (16)	90	0.8-5	2	Saidou et al., 2020
43-270	-	101 (21)	175	0.3-1.8	0.7	
15-104	55 ± 2	38 (1.1)	143	0.28-42.84	**0.72**	Present study
1-60	17 ± 1	14 (0.1)	21	0.13-1.14	**0.27**	

3. RESULTS AND DISCUSSION

Table 6. Comparison of radon gas soil and outdoor inhalation dose with other studies.

Pays	C_{SG} (kBq m^{-3})		Outdoor effective dose (mSv y^{-1})		Reference
	Range	Mean	Range	Mean	
Brazil	7-93	-	-	-	Evelise G. et al.2011
Bulgaria	3-97		-	-	Bista K. et al.2013
India	0.72-10.4		-	-	Vitas D. et al.2014
Turkey	0.098-8.594	1.92	-.	-	Tabar E. et al.2017
Iraq	0.0869-6.448	1.963	0.000826	0.01866	Ahmed A. et al.2019
Nigeria	0.4-190	14	-	-	Deborah T. et al.2020
Cameroon	0.9-13.8	4.6	0.02-0.26	0.09	Present study

4. CONCLUSION

Radon soil gas (kBq m^{-3})	4.6
Exhalation rate	14.91
Indoor radon concentrations	38
Oudoor inhalation dose	0.09
Indoor inhalation dose	0.72
Annual effective dose	0.81

5. OUTLOOK

- Assess the risk of lung cancer induction
- Map the radon risk in the Northern region
- Measure the concentrations of primordial radionuclides in the ground and in the air to study public exposure

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THANK YOU FOR YOUR ATTENTION !!!