INDOOR RADON, THORON AND THEIR PROGENY CONCENTRATIONS IN HIGH THORON RURAL SERBIA ENVIRONMENTS

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Ξ **AIM**
- simultaneous measurement of Radon (Rn) and Thoron (Tn) gases and their progeny (EER &EET) concentrations in rural dwellings by passive method with the nuclear track detectors (RADUET) and (DRPS/DTPS)
- to examine variations and correlations between concentrations in the four villages (Blendija, Jezero, Josanica i Sokobanja) and compare them to the already published results related to this region (Mishra et al 2014, Rad. Prot. Dosim. 160:164–168, 2014)
- to trigger the similar pattern of the research with the same detectors throughout countries of Balkan region.

Ξ **Field work:** Rn, Tn, EERC&EETC, 4 villages, 40 houses: **Blendija** (5), **Jezero** (15), **Josanica** (7), **Sokobanja** (13)

Ξ ORGANIZATION OF RADON SURVEY DESIGN AND IMPLEMENTATION

√ **Administrative structure of Serbia**   √ **The study region - Sokobanja municipality**   √ **Experimental tools**

Figure 1. Geographical position of Sokobanja municipality within Zajecarski district which is one of 29 districts in Serbia
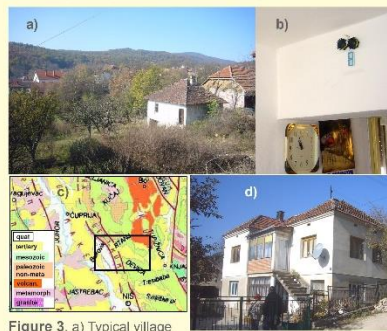
Figure 2. Sokobanja municipality - field villages (Jošanica, Blendija, Sokobanja, Jezero). Location of dwellings (full circles) and schools (open triangles), and village/town names. Coordinates: m; GISCO Lambert azimuthal equal area projection, zero point: 48°N, 9°E, as used for the European Indoor Rn Map, (Tollefsen et al. 2014. Rad. Prot. Dosim. 162: (1-2), 129 – 134).

Figure 3. a) Typical village landscape b) Deployed detectors c) Geology d) Typical house

Japan NIRS's RADUET detector (CR39)
India BARC's DRPS/DTPS detector (LR115)

Figure 4. The measurements were conducted in 40 dwellings from October 2011 to October 2012.

Ξ RESULT 1

Table 1. Descriptive statistics of indoor Radon, Thoron and its progeny concentrations, measured in 40 houses.

Statistics	Rn (Bq/m³)	Tn (Bq/m³)	EERC (Bq/m³)	EETC (Bq/m³)
No. of observations	40.00	40.00	40.00	40.00
Minimum	8.00	10.00	5.21	0.13
Maximum	189.00	412.00	21.93	3.37
Median	47.00	103.00	11.20	1.00
Arithmetic mean	55.00	116.00	10.99	1.09
Standard deviation	38.00	79.00	4.17	0.72
CV (%)	69.00	69.00	38.00	66.00
Geometric mean	43.00	89.00	10.22	0.86
Geometric standard deviation	2.11	2.26	1.48	2.14

■ *Comparing the results on the previous similar survey (Mishra et al 2014) Tn (Bq/m³) were generally higher than the Rn (Bq/m³) in 32 out of 40 indoor measurements. The values of the GM for Rn, EERC and EETC obtained are similar to those measured in previous study (49 Bq/m³, 11 Bq/m³ and 0.8 Bq/m³, respectively). The value for Tn (Bq/m³) is lower than the previously Tn (135 Bq/m³) (Mishra et al., 2014).*

Ξ RESULT 3

Regression of Rn vs EERC (Spearman R=0.08, p>0.1)
EERC=0.0006·Rn+10 (slope factor insignificant, p>0.1)
loss function: (ln(OBS)-ln(PRED))²

Regression of Tn vs EETC (Spearman R=0.37, p<0.05)
EETC=0.005 (=0.003)·Tn+0.34 (+0.06) (with 95% CI)
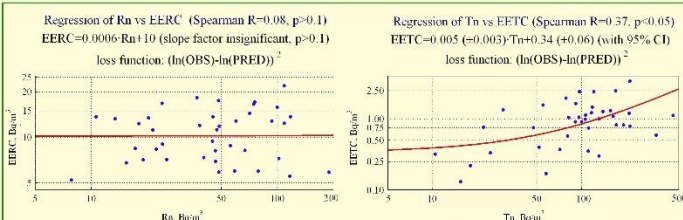loss function: (ln(OBS)-ln(PRED))²

Figure 6. Linear regression models of Rn vs EETC (left) and Tn vs EETC (right) (all villages)

■ There is no significant correlation between Rn vs EERC. Positive correlation was found between EETC and Tn. Significant correlation EETC vs Tn was observed in Sokobanja and Josanica. Different relationship between EETC and Tn can be associated with difference in ventilation rates and aerosoles concentration.
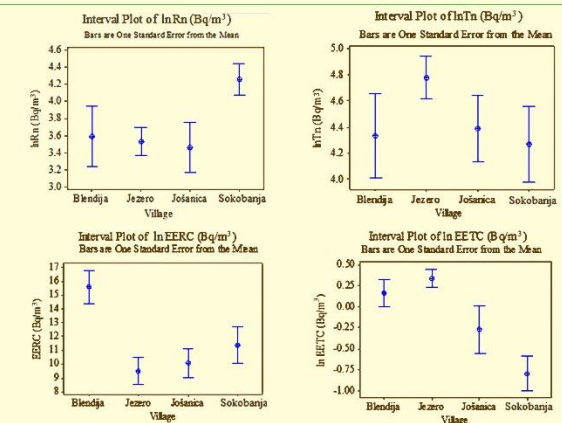
Ξ RESULT 2

Figure 5 Interval plots of ln transformed Rn, Tn, EER and EET concentrations within the four villages of investigated area

■ *The difference between ln transformed concentration measured in different villages and type of rooms were tested by the non-parametric Kruskal-Wallis test. The only effect of village was significant at the 95 % level for Rn, EERC and EETC.*

Ξ CONCLUSION

This work presents simultaneous long-term measurements of Rn, Tn, EER and EET concentrations in rural houses with nuclear track detectors. Average Rn concentration in the region are compatible with the worldwide value. At the same time, relatively high EET was found. High Tn concentrations may indicate elevated Th-232 concentration in the building materials. The EERC concentrations showed lower variations than the other measured concentrations. GSD=1.48 is not in agreement with GSD=2.11 for indoor Rn concentration. Low GSD for EERC can not be expected considering heterogeneity of the houses' locations. Moreover, there is no correlation between the Rn concentration and EERC. This requires further investigation. The correlation between Tn concentration and EETC is reasonable as can be expected.