SCIENCE SET
OPEN ACCESS PUBLISHERS

*Research Article*

World Journal of Sensors Network Research

# Proposal for the Creation of National Radon Activity Monitoring Networks Based on the National Pre-university School Network. Information, Education, Research

**Sándor CSEGZI***

*Hungarian Technical Scientific Association from Transylvania, (EMT), Târgu Mureș Branch, Romania*

***Corresponding author:** Sándor CSEGZI, Hungarian Technical Scientific Association from Transylvania, (EMT), Târgu Mureș Branch, Romania.

**Submitted:** 23 December 2024 **Accepted:** 28 December 2024 **Published:** 06 January 2025

***Citation:** Csegzi, S. (2025). Proposal for the Creation of National Radon Activity Monitoring Networks Based on the National Pre-university School Network. Information, Education, Research. Wor Jour of Sens Net Res, 2(1), 01-10.*

***Abstract***

*This paper proposes a method of mapping radon concentration using the same measurement method as accredited laboratories in Romania (and not only), but the applied statistical method allows assessing the number of homes with a certain level of radon activity concentration for a locality. It is important to emphasize that this method manages to inform the population and decision-makers in a locality about radon but also about radioactivity in general. The presented material contains the results, conclusions and proposals following more than 25 years of activity based on collaboration with the Local Authority and the schools in the corresponding localities.*

**Keywords:** Radon, Lung Cancer, Radon Activity Map, Citizen Scientist

## Introduction

### Motivation

The discoveries related to the atom, later those related to the nucleus at the beginning of the last century made the 20th century go down in history under the name "nuclear era". Of course, the two bombs launched on the two Japanese cities of Hiroshima and Nagasaki with effects far beyond expectations on both the affected population and the impact on the evolution of the Second World War demonstrated the importance of research in these fields. The interest was not only scientific but also political.

The peaceful development of nuclear power applications followed. In 2022, 440 nuclear power plants were operating in the world. There were also accidents due to natural causes (Fukosima-2011) others caused by human errors (Three Mile Island-1979, Chernobyl-1986). Such accidents highlight the serious risks of using nuclear power and the importance of safety measures. Under the pressure of environmental activists, Germany, Austria and other countries also gave up this source of energy (political measures). Other countries such as Romania or Hungary want to increase the production capacity of nuclear energy for reasons of energy security.

Meanwhile nuclear radiation is widely applied in medicine, food industry, defectoscopy, etc. that is, not only the specialists but also the common citizen is exposed to situations when it would be good to have basic knowledge about the procedures and the effects of nuclear radiation on the human body.

Unfortunately, however, in the times when research brings to the surface more and more information about the atom and the nucleus, when the medical applications of radioactivity are increasingly applied, when information through the mass media reports about nuclear catastrophes but also the current return of nuclear power plants as a solution to energy crisis or as threats due to war (Zaporozhie, threat of radioactive cloud), the common citizen, and even more sadly, the student of our days (citizen of the future) unfortunately does not receive enough knowledge about this subject to help understand the news from the mass media ( reactions to events) or possible consequences of medical treatments.

On the other hand, Radon, a radioactive gas, an important carcinogenic factor, naturally present in our lives is little known to the general public. The National Radon Action Plan (H.G.526/2018). [20, 21] represents a huge potential for informing citizens about radioactivity in general and an ideal means of involving students in information activities and real research by determining the level of radon activity in homes and workplaces (schools).

The International Agency for Research on Cancer (IARC) classifies radon as the leading environmental carcinogen for the population. Inhalation of the short-lived progeny of radon contributes approximately 50% to the total effective dose received by humans from ionizing radiation, according to UNSCEAR 2000. [17, 18].

By going through a vast bibliography, participating in numerous conferences, I was able to draw the following conclusions:

- The study of the influence of Radon on lung cancer is considered of major importance throughout the world, Hundreds of thousands of measurements were made all over the world, but the samples were not collected under the conditions of a statistical processing, It is still necessary to collect data, in order to be able to formulate concrete conclusions regarding the influence of Radon on human health, The measurement methods are multiple, but the solid trace detector seems to be the most effective solution for this purpose, In Romania there are extensive geographical areas (Carpathian Bend, Apuseni Mountains) where Radon in the soil exists "abundantly", (mining, mineral water springs, mofetas).
- The construction materials used in Romania, in many situations, are the main sources of Radon, [13].
- The thermal isolation of homes, which has gained momentum recently, favors the increase in radon concentration due to the decrease in the degree of natural ventilation of the residence, [13].
- The creation of a national network for monitoring the concentration of Radon activity is possible under the conditions of the existing physics laboratories in the pre-university education system.
- In this context we can think of the development of a work methodology that is reproducible under identical conditions whenever desired, using the same integrated measurement method for determining the concentration of radon activity on a national scale in order to have intercomparability between the data obtained, -realization of the practical conditions in order to operationalize the program for measuring radon activities in houses in Romania, in order to complete the "Radon Maps of Romania" program coordinated by National Commission for Nuclear Activities Control (CNCAN).

Legislation in the field, respectively European Directive 2013/59/EURATOM, articles 54, 74 and 103 transposed into national legislation by Law no. 63/2018, H.G. no. 526/2018 for the approval of the National Radon Action Plan, Order no. 185/22.07.2019 which was replaced by CNCAN President's Order no. 153/27.07.2023 on the Methodology for determining the concentration of radon activity in the air inside buildings and from workplaces, as well as the provisions established by community and national public policies related to climate and sustainable development even provide for the obligation to measure the concentration of radon in residential buildings, buildings of public interest and utility and at workplaces and to establish appropriate measures to reduce radon concentrations, when reference levels are found to be exceeded, or preventive measures for radon penetration in new buildings.

## Methods Applied and Materials Used

### Procedure Method

The following target groups are essential for the implementation of the proposed methodology:

1. The City Hall and the Mayor: It has legal obligations and financial resources to run a program. Can use communication opportunities offered by local media (cable TV, local newspaper, etc.). But anyway, he must be notified of an activity that involves the community. And this is the main purpose.
2. School:
   - The experience of the teaching staff, their professionalism, their notoriety in the locality and their work with the students are indispensable in such an activity.
   - Students: who place the detectors on the sites. They are curious and can become interested by encouraging the teacher, they can show skills that were not possible before, because we do not only work with students with outstanding academic results. They are helped by family and relatives.
3. Family: supports their child, believes in him and is happy to help.
4. Specialists (doctors, geologists, etc.). Local people are wanted, because people know them and trust them. They have important knowledge about the locality.
5. Last but not least, an accredited laboratory for measuring radon activity is needed as a partner for an intercomparison activity.

### Thus, The Working Group is Formed

### Preliminary Activities

1. The Mayor must be convinced: in my experience, this is not a problem because they see the importance of the activity. It does not represent a large financial burden on the budget and has a large social impact. But they expect professional guarantees.
2. The school principal must be co-opted: usually this is not a problem if the mayor already supports the activity, as it is not a financial burden and offers the school, teachers and students the opportunity for professional affirmation. This is a plus for the director in front of the school inspectorate, for the teacher in the school and for the student in front of the teacher.
3. The student must be conquered. They have a serious task, because they put the detectors in the appropriate locations, communicate with the family and local citizens. They must be well informed and persuasive.
   This requires preparation including extracurricular activities. Not all students are willing to do this, so stimulation is needed. This can be the evaluation of a teacher (plus points for an answer, praise in front of the community, etc.), distinctive items (t-shirts, badges, pens, etc.), participation in a scientific conference (school, county). They need to feel that they are part of real research work that requires accountability and benefits the community.
4. The accredited laboratory: is interested in an intercomparison activity in general. Obtain additional locality data without financial effort and without additional mobilization of laboratory personnel. It lends credibility to data collected from the field. Over the years I have collaborated with the Radon Laboratory of the Hungarian Academy of Sciences in Debrețin, Hungary (Hunyadi Ilona, Csige István) [1], IFIN-HH Bucharest-Măgurele, (Ana Daniș, Romeo Călin)[8],

University of Bucharest, Faculty of Physics, (Călin Beşliu, Alexandru Jipa), Babeş-Bolyai University, "Constantin Cosma" Radon Testing Laboratory (LiRaCC), Cluj-Napoca, (Alexandra Cucoş, Kinga Szacsvai).

**Training and Information Activities (Theoretical Training)**

1. The mayor and principal will receive background knowledge during preliminary discussions.
2. Students are trained in several stages:

- Formation of groups (usually at class level), students and the specialist teacher or supervisors.
- Basic knowledge about radioactivity: activity, risk factor, effective dose, measurement units, values, etc.
- About radon. Properties, measurement, protection, legislation.
- Description and learning of the measurement method used.
- Presentation of the applied measurement methodology.

**Practical Activities**

1. Random selection of locations. Addresses of students and teachers and public buildings and employees, respectively, are probably sufficient.
2. Placement of detectors. Recommended period six months, October-March.
3. Periodic checking of the detectors (if they are in their initial positions). We recommend at least once every two months.
4. Collecting detectors. We are hoping for 75-80% efficiency.
5. Etching detectors, counting tracks. We recommend this in two ways. Once with the automatic counting device (Radosys) and then with an observation-counting optical microscope. The results (differences) must be evaluated.
6. Evaluation and mapping of results. The final document.

- The values obtained must be analyzed (small, large, intervention is necessary, etc.)
- If intervention is required, how to manage the results. Who manages the information?
- How does data protection work? (law 363/2018)
- Preparation and delivery of the document to the City Hall.

**Communication Activities with Target Groups**

With the students:

- Presentations with illustrative materials and practical demonstrations.
- The experiences of previous activities are presented. Examples of video-films from previous group activities.

**With Parents**

- At meetings with parents.
- With informative materials through students.

1. With the residents of the community:

- We advertise through the local TV channel, through informative materials (advertisements).
- Through the local print media (the informative newspaper distributed by the City Hall).
- At public hearings (this is less recommended, as other conflicting topics usually come up, pushing the radon issue to the background).

**The Method of Measuring the Concentration of Radon Activity**

Measurement methods over the years have been in constant search and development. Of course, the objective also matters. For soil, for water, for air there is a wide variety of devices and methods for each specific requirement. A series of electronic devices (active detectors) have been developed that, in addition to the level of radon activity, also measure air humidity, temperature, atmospheric pressure, factors on which the level of radon concentration in a room depends. These devices are expensive and are intended for scientific activities. There are active measuring devices on the market intended for the population, but whose data can only be used for informational purposes.

There remained the issue of intercomparability of data using different measurement methods. Obviously, the main objective is to measure the concentration of radon activity in the workplace and residential spaces. Worldwide, it was concluded that the most practical way to monitor the radon level inside homes is through the integrated method using solid state nuclear track detectors (SSNTD) CR-39. Solid body trace detectors, in accordance with internationally validated measurement protocols. This method consists in the passive measurement of the radon concentration in the air inside the buildings with CR-39 trace detectors, for 3-6 months.

The methodology is described by: Order of the President of CNCAN No. 185/2019 which was replaced by Order no. 153/27.07.2023 for the approval of the Methodology for determining the concentration of radon in the air inside buildings and at workplaces. It is the method used by us, relatively cheap, easily reproducible and intercomparable. It should be noted that this methodology is based on a vast international experience, and thanks to our international collaborations, we have also applied it to the measurements prior to the communication of this Order.

The laboratories accredited for measuring the concentration of radon activity by CNCAN (IFIN-HH, Bucharest, LiRaCC, Cluj-Napoca) use the RadoSys system developed in Hungary and as a result we have also oriented towards this measurement system. The detection is based on the solid trace detector CR-39 and has an automated counting system, the data processing being carried out by a software also provided by the company. The chemical processing is done in a device provided by the company together with the appropriate recipe. [Fig.1,2,3.]

**Figure 1:** RadoSys RSKS detector

**Figure 2:** Optical microscope Nano Reader

**Figure 3:** The Nano Bath device

**Data Processing Method**

In the period 1998-2007, the counting of traces on the detector was carried out with the help of the optical microscope by counting based on observation (manual counting). The relationship between the activity and the number of traces is given by the relationship:

$CRn = \rho \cdot Fc/t$,

where: CRn - calculated radon concentration (Bq/ m3), ρ - measured trace density (traces/ mm2), Fc - the calibration factor communicated by the manufacturer for each series of detectors,t - exposure time (days) [1].

After 2009 I had access to the RadoSys brand measurement system with automatic counting of traces including error calculation but which results were also verified by manual counting for each sample of detectors.

The detector samples were also processed (trace counting) by the IFIN-HH, LiRaCC and Sapientia University laboratories in Cluj-Napoca. They all have the RadoSys system but only Sapientia's is identical to ours. We had situations when each laboratory had its own detector in the field, in other situations the laboratories worked with our laboratory's detectors.

The comparison of the results was made based on the following relationships:

For the two random and independent values, k1 and k2, with a normal distribution, their difference, k1-k2, represents a normal distribution with standard deviation:

$\sigma(k1-k2)^2 = \sigma^2 k1 + \sigma^2 k2$

These two values can differ significantly, if their difference is greater than 3 standard deviations σ(k1-k2):

$k1 - k2 > 3\sigma(k1 - k2)$

according to the theory of propagation of statistical variations [5,6].

The condition of representativeness is ensured by collecting data in statistical conditions by applying a model in which the sample is formed by the singular participation of individuals in the crowd.

This is the hypergeometric model under which the relations are valid:

$$P\left[P_0 - 1{,}96\sqrt{\frac{P_0 q_0}{n}\left(1-\frac{n}{N}\right)} < P < P_0 + 1{,}96\sqrt{\frac{P_0 q_0}{n}\left(1-\frac{n}{N}\right)}\right] = 0{,}95$$

Where: $P_0 = \alpha/n$ and $q_0 = 1 - P_0$ .

For example, for Remetea, the problem was formulated as follows:

If the number of houses in the village is N=2046, the number of recovered detectors is n=115, the number of houses where the radon concentration exceeds 100 Bq/m3 is α=38 (result of determinations), how many such houses are where is the village?

Applying the model, we obtain the following results:

$P\,[0{,}201 < P < 0{,}458] = 0{,}997$

and

$P\,[483 < N_P\ \ 1103] = 0{,}497$

These mean that we can state with a precision of 3 o/oo, that the number of houses where the radon concentration exceeds 100 Bq/m3 is between 483 and 1103. Or we can say with the same precision that the number of houses where the concentration exceeds 200 Bg/m3 is between 82 and 179 [1].

## Results Examples

**Remetea, Harghita County (1999-2000)**

Here we managed to implement the methodology proposed in this paper for the first time. Together with the working group (researchers, doctors, teachers, students) we also succeeded in a collaboration with "Radon Group, Institute of nuclear Research, led by Mrs. Hunyadi Ilona and Mr. Csige Istvan, from ATOMKI-Debreţin, Hungary, in order to could use their measurement method, internationally approved, a method based on solid trace detectors in the course of two years (1999-2000), we succeeded for the first time in Romania in creating the "Map of Radon activities in homes" of a locality. This result was reported in Radiation Measurements 34 (2001) 437-440. [1]. (Fig. 4.)

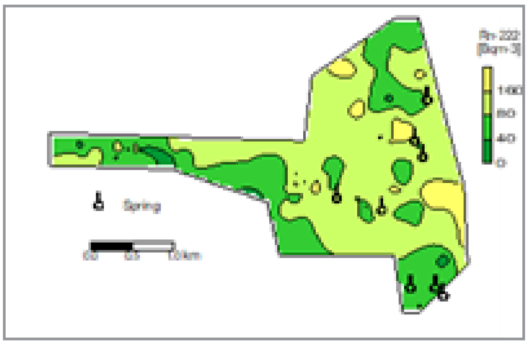


**Figure 4:** Map of the concentration of radon activity in Remetea, Harghita county, 2000

**Covasna, Covasna County (2000-2001)**
The next objective was to develop an own method of measuring the concentration of radon activity. In this sense, we had a close collaboration with the Group for radon measurement from IFIN-HH-Bucharest, led by Dr. Ana Daniş.

The measurements were made in the city of Covasna, Covasna county, using the methodology applied in Remetea and we applied the intercomparison method, placing two detectors Radamon (Debreţin) and IFIN-HH (Măgurele-Bucharest) in the same place, using as a standard the result given by the Radamon detector (this is the name of the device developed in Debreţin, already passed international tests).

The calibration of our own detectors was done in a device made in Măgurele, the device developed for measurement allowing obtaining traces on both sides of the detector (an advantage over Radamon - where only one side of the detector is used). [3-8]

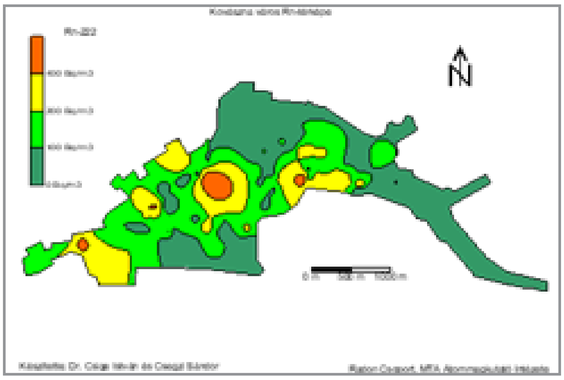


**Figure 5:** Map of the concentration of radon activity in Covasna, Covasna county, 2001

**Vintila Vodă, Buzau County (2002-2003)**
The first two locations from 4.1. and 4.2. are in the area of mineral water springs and mofeta inside the Carpathian Bend (natural emanations), Vintilă Vodă is located "symmetrically" outside the Carpathian Bend but still in an area with natural emanations (mud volcanoes). In this case we had in mind and the thermal insulation situation of the houses (it is encouraged for reasons of energy saving) because natural ventilation (or the lack of it) is essential from the point of view of the radon concentration. And here we went through an intercomparison activity.In all three localities, we placed 120 detectors in homes, chosen by drawing lots.

In the intercomparison process at Covasna and Vintilă Vodă, we deposited 40 IFIN-HH detectors each at the addresses chosen according to the "three by three" principle. The processing of the detectors was done in the corresponding laboratories: Radamon in Debreţin, IFIN-HH in Măgurele. The conclusions based on the numerical results are multiple [7, 8] but the main conclusion is that in the case of 74% of the results there are no significant differences, and a part of the causes of the differences that appear in 26% of the cases can be eliminated by repeating the measurements.

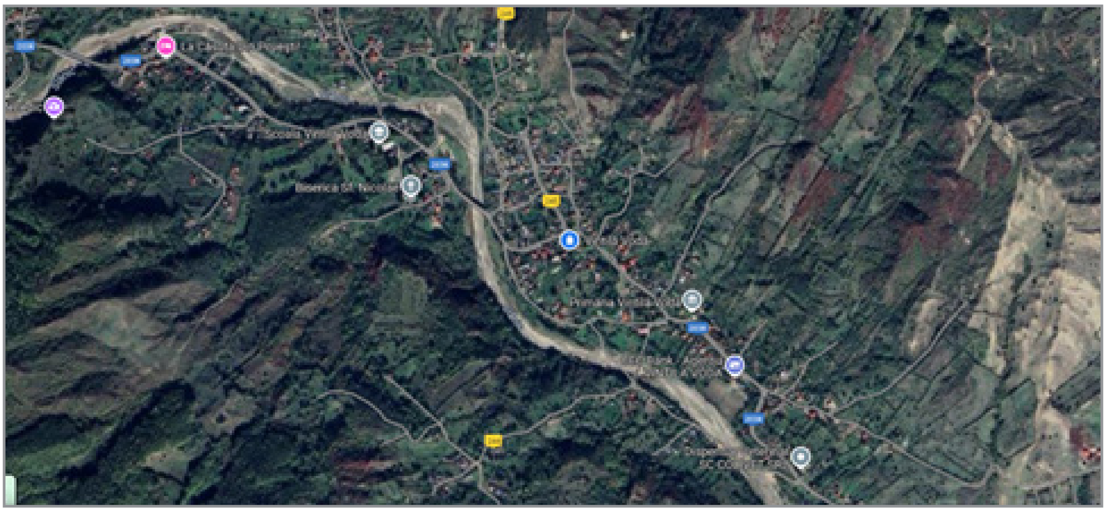

**Figure 6:** Distribution of detectors at Vintilă Vodă, Buzău county, 2003

**Târgu Mureș Mureș County (2019-2020)**

The objectives of this work were the monitoring of all educational institutions (nurseries, kindergartens, general schools and high schools) subordinated to the Local Authority and the testing of the RadoSys Nano Reader data detection and processing system recently purchased by our institution. That means 40 locations and the work was carried out by the Cultural Scientific University, an institution also subordinates to the City Council. The measurements were made in collaboration with IFIN-HH Măgurele and LiRaCC-Cluj-Napoca. Each laboratory sent its own detectors and their processing was carried out separately. In each location, three detectors were placed together for the same time interval (6 months). We all used the same type of detector (RadoSys, Hungary) but a different counting device, but also produced by RadoSys. The measurement results and the conclusions resulting from the incomparison will be presented in another paper.

The locations where the detectors were distributed can be seen on the map of the municipality (Fig.7.) and can even be approximated with a statistical distribution.

The detectors were placed in the basement of the buildings and in the rooms on the ground floor. The results in several of the locations gave values above 200 Bq/m3 where new measurements have to be made, but we could not continue the project because the Cultural Scientific University was abolished by the City Council for financial reasons.

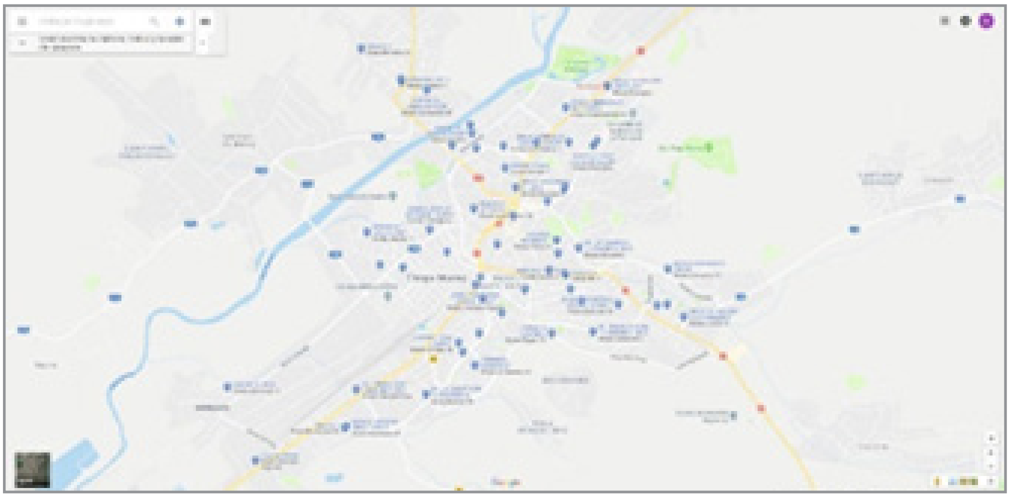

**Figure 7:** Distribution of detectors in Târgu Mureș Municipality, 2019

**Târgug Mureș Metropolitan Area, (2020-2021)**

The Târgu Mureș Metropolitan Area consists of the county seat and 12 communes, meaning a population of over 204,000 inhabitants (2011). The Cultural and Scientific University proposed monitoring the concentration of radon activity in all 12 municipalities, meaning a population of over 80,000 inhabitants. At this time, we already had HG no. 526/2018 for the approval of the national radon action plan and Minister's Order no. 185/22.07.2019 regarding the Methodology for determining the concentration of radon in the air inside buildings and at workplaces. The mayors of the communes were open to collaboration, as were the school principals, teachers and students.

In the first phase, we chose 4 municipalities along the main geographical directions: Ernei (Est), Gheorghe Doja (Vest), Pănet (Nord), Acățari (Ssud), (Fig.8.)

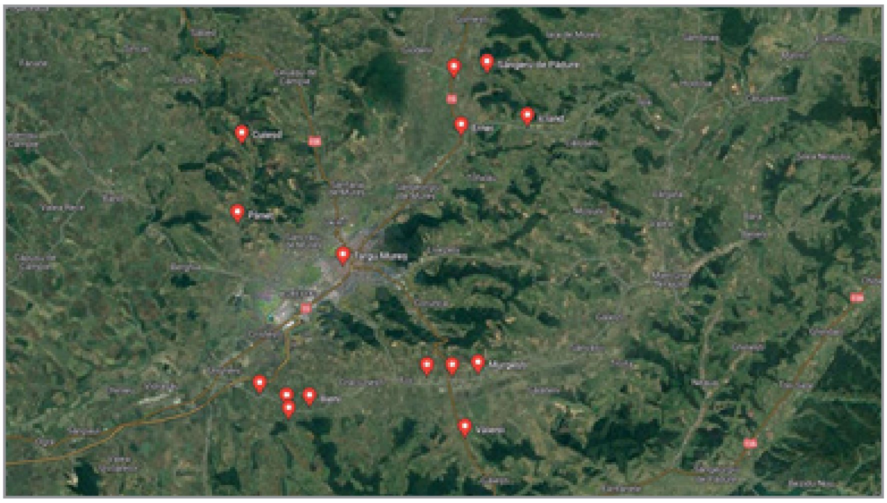

**Figure 8:** Distribution of localities of Târgu Mureș Metropolitan Area,communes where detectors were placed, 2020-2021

100 detectors were distributed in each commune according to the requirements of statistical procedures and legal procedures.

In order to ensure the conditions for positioning the detectors, there were several rounds of information and training of teachers and students (grades VII-VIII) corresponding to the employees appointed by the Mayor to facilitate the actions of leaving the detectors in public spaces. Aspects of these activities can be seen in Fig. .8. The detector recovery rate used to be 75-80%, which can be considered good.

**Figure 9:** Aspects of the training activities with students from the 7th and 8th grades.

For each commune, a report was prepared with the results obtained and submitted to the Mayor. It should be noted that for personal data security reasons (Law 363/2018) the only document containing the addresses and personal data related to them is the report submitted to the Mayor. In all other documents only, figures assigned to the addresses in question appear. Based on the model and methodology presented in the work, for the four localities cumulatively we can state: the number of homes where the concentration of radon activity is greater than 100 Bq/m3 is between 376 and 2148. Taking the arithmetic mean means 1262 homes and considering the average of 3 people/dwelling, means that the risk of lung cancer is 16% higher according to WHO [17]. for at least 3786 people.

**Praid and Corund, Harghita County (2023-2024)**

There are two interesting localities from a geological point of view. Praid is located on a mountain of salt, so we shouldn't have radon. Corund, a few kilometers away already have several springs of mineral water, a sign that there are cracks in the crust, so in addition to water we must also find emanations of gases including radon.

**Figure 10:** Distribution of localities of Praid and Corund communes where detectors were placed

**Figure 11:** Aspects of the training activities with students from the 7th and 8th grades.

## Discussion

**Comparative Dates. Conclusions. Proposal**

The examples listed show a variety of ways in which school activities can be harnessed for both community and scientific purposes. At the same time, it can be seen that the method can be applied to all types of localities: municipality, commune.

The chosen geometric area is well argued from a geological point of view regarding the existence of radon (Fig.11.).


**Figure 11:** Geographic areas of our activities,10 settlements (2 cities, 8 willages) (total 24 localities), 1999-2024

**Figure 12: Cumulative and comparative table with the results of measurements (651 detectors) of radon concentrations in homes and workplaces in the period 1999-2024.**

| Locality | Nr.of Meassurements | Arithmetic Mean (Bq/m3) | AMLOG | Standard Deviation | Geometric Standard Deviation | Median (Bq/m3) | MAX (Bq/m3) | MIN (Bq/m3) |
|---|---|---|---|---|---|---|---|---|
| PANET | 37 | 47 | 1.56 | 31,65 | 0,393 | 39 | 113 | 10 |
| GH.DOJA | 42 | 54 | 1,69 | 54,08 | 1,4 | 45 | 232 | 10 |
| ACATARI | 56 | 63 | 1,67 | 50,83 | 1,39 | 50 | 278 | 10 |
| PRAID | 50 | 92 | 1,84 | 68,77 | 1,34 | 61 | 288 | 11 |
| REMETEA | 115 | 95 | 1,846 | 68 | 1,92 | 85 | 570 | 10 |
| ERNEI | 71 | 106 | 1,85 | 97,72 | 1,49 | 74 | 515 | 10 |
| CORUND | 71 | 110 | 1,92 | 95,48 | 1,359 | 90 | 486 | 19 |
| TGM | 40 | 128 | 1,94 | 77,33 | 1,37 | 111 | 515 | 10 |
| VINTILA V | 51 | 165 | 2,11 | 137,68 | 1,33 | 124 | 774 | 35 |
| COVASNA | 117 | 294 | 2,05 | 120,9 | 1,39 | 117 | 608 | 22 |
| TGM | 40 | 128 | 1,94 | 77,33 | 1,37 | 111 | 515 | 10 |
| VINTILA V | 51 | 165 | 2,11 | 137,68 | 1,33 | 124 | 774 | 35 |
| COVASNA | 117 | 294 | 2,05 | 120,9 | 1,39 | 117 | 608 | 22 |

The results in the cumulative table (Fig. 12.) prove our expectations regarding the concentration of radon activity, knowing the geology of the respective area and the results of some measurements made in the skunks in the area and the study of the mineral waters of the springs. It should be noted that the incidence of lung cancer in the area is above the national average.

From a scientific point of view, we have developed a methodology for monitoring and mapping the radon activity in homes and workplaces, obtaining statistically and representative data. We rely on national legislation including the measurement method (solid trace detector, CR-39) and the form of data presentation is the table proposed by national legislation, (Fig. 12.).

From the point of view of communication with the Local Authority and the citizens, the statistics are very conclusive. I worked with the mayor of the Municipality (Târgu Mureş, 130,000 inhabitants, 40 schools and kindergartens, of city (Covasna, over 10,000 inhabitants), of communes (Remetea, Vintila Voda, Acățari, Pănet, Gheorghe Doja, Ernei, Praid, Corund, each with over 3000 inhabitants). We involved in our information activities 30 teachers, approximate 1000 students together with their parents. We have developed an informative material with general knowledge about radioactivity in general and about radon in particular to inform citizens.At the same time, we have developed a material with this content for teachers, group leaders for those involved in data collection, more complex regarding the measurement method, data processing and interpretation, calculation of errors, etc.

All the results obtained were presented to the Local Authorities (mayors), respectively, and were included in scientific articles and conferences in the field of radioactivity or dedicated to the study of radon it should also be mentioned that each activity also allowed a collaboration with specialized laboratories in Romania (LiRaCC, Cluj-Napoca, IFIN-HH, Bucharest) and Hungary (ATOMKI, Debrețin, ELTE-Budapest).

Thus, we can affirm that our citizen information, didactic and scientific objectives have been touched. It is also proven that radon can be used for educational purposes in schools even at the secondary level for familiarization with notions related to radioactivity and students can play an important role as multipliers of knowledge to the community they belong to by collecting data of scientific value. It should be highlighted that the way of working proposed in this work also involves activities for decision-making factors in the community (Mayor, director of a public institution, etc.) people who in turn need information in this field.

**In this Context we Propose**

- Introducing at least one lesson about radon in the school curriculum for the 7th or 8th grade.
- Creating a national network for monitoring the concentration of radon activity in homes using a statistical method (the one presented in this paper for example) based on the huge potential that exists in schools even at the secondary level.

## Argument

"Although for the recognition of areas with radon it is important nformation about geology area, we consider that in radon programs, cel a little in the first phase, the most credible way of identifying areas is measuring radon concentrations in dwellings. "International comission on radiological protection (icrp-1995-pag.19, par. 63).

## References


1. Csige I., Csegzi S. (2001). The Radamon radon detector and an example of aplication, Radiation Measurements 34, 437-440.
2. Daniş A., M. (2003). Ciubotariu. Metodă de determinare a concentraţiei de activitate a radonului indoor folosind detectori solizi de urme. Raport PN 03-20 05 01, Contract nr.10/2003, IFIN-HH, Bucureşti, 2003.

3. Daniş, A., Oncescu, M., Ciubotariu, M. (2001). System for calibration of track detectors used in gaseous and solid alfa radionuclides monitoring. Radiation Measurements 34, 155-159.
4. Daniş., A. (2002). Omologare sursă 226Ra - 222Rn. Caiet de Sarcini nr.1118/2002 IFIN-HH, Bucureşti, B.I. Nr.1727.
5. Ciorăscu F., M.Oncescu. (1964). Detectarea şi Măsurarea Radiaţiilor Nucleare. Capitolul 10, Fluctuaţii Statistice, Ed. Academiei Romane.
6. Ispăşoiu., Gh. P. (2002). Evaluarea incertitudinii de măsurare şi raportarea rezultatului măsurării mărimilor fizice. Ed. Asociaţia de Standardizare din Romania (ASRO).
7. Csegzi., S. (2013). Further Arguments Regarding the Importance of Implementing the Houses Radon Activity Map in Romania,Rom. Journ. Phys. 58, 84-89.
8. Csegzi, S., Danis., A. (2008). Indoor Radon Measurements - Using Two Variants of the Track Detectors 'Method, Technical Review of Hungarian Technical Scientific Society of Transylvania, 42, 31-40.
9. Csegzi., S. (2007). Radioactivitatea in curbura Carpatica, Radonul din locuinte, Editura didactica si pedagogica.
10. Danis, A., Ciubotariu., M. (2003). Method for the radon indoor activity concentration measurements using etched track detectors. Report PN 03-20 05 01, Contract nr.10/2003, National Institute for Physics and Nuclear Engineering, IFIN-HH, Bucharest.
11. Cosma, C., Szacsvai, K., Dinu, A., Ciorba, D., Dicu, T., Suciu., L. (2009). Preliminary integrated indoor radon measurements in Transylvania (Romania), Isot. Env. Health Studies 45(3), 259-268.
12. Cosma, C., Ciorba, D., Timar, A., Szacsvai, K., Dinu., A. (2009). Radon exposure and lung cancer risk in Romania, Jurn. Env. Prot. Ecol., ISSN 1311-5065, 94-104.
13. Cucos., A. (2022). Analiza stadiului actual al studiilor și cercetărilor privind problematica radonului în clădiri publice și private și măsurile implementate pentru îmbunătățirea calității aerului interior din clădiri, în contextul cadrului legislativ național și european, Proiect ”Creșterea coerenței cadrului normativ și a eficienței reglementărilor tehnice în domeniul construcțiilor”, cod SIPOCA 731.
14. Howarth, C.B., Miles, J.C.H. (2000). Results of the 1999 European Commission inter-comparison of passive radon detector. Report EUR- Draft.
15. Czexit., S. (2001). Activitatea ştiinţifică în şcoală-Radonul este la îndemână, EMT-Zilele Fizicii-Kormoczi Janos,Tg. Mureş,21-23.
16. Csegzi, S., Belie., C. (2001). The map of radon – An Investigation method of Natural Radioactivity National Physics Conference, Iaşi,11-20.
17. https://www.who.int/news-room/fact-sheets/detail/radon-and-health, (2023)
18. https://www.epa.gov/radon/health-risk-radon, (June 2003, 402-R-03-003, PDF)
19. S. Csegzi., I. Buglea. (2023). Propunere pentru realizarea unei rețele naționale de monitorizare a concentrației activității de radon din locuințe și locurile de muncă folosind rețeaua şcolară naţională preuniversitară, bazată pe H.G. 526/2018 și Ordinul 153/2023, Conferința Națională a Societății Române de Radioprotecție,5-6, Octombrie 2023, (ttps://remotealpha.drmr.nipne.ro/documents/1_october2023.pdf).
20. HOTARARE, 526/ 12/07/2018, https://legislatie.just.ro/Public/DetaliiDocument/203132
21. http://www.cncan.ro/assets/Radon/2023/Ordin-153-din-2023-Metodologie-radon.pdf

***Copyright:*** *©2025 Sándor CSEGZI. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.*