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Radon Pollution in Romania – A Serious and Issuficiently Known Problem

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Abstract: Radon is a natural, colorless, odorless and tasteless radioactive gas that comes from the disintegration of uranium in soil and rocks. Although it is naturally present in the environment, high concentrations of radon in inhabited habitats, such as homes, schools, workplaces, can represent a major risk to the health of the population. In Romania, radon pollution is a serious environmental problem but insufficiently known and often ignored in public health policies. At the European level, some EU or non-EU countries, such as the United Kingdom, are more advanced in studying this phenomenon and in regulations to mitigate the consequences of pollution with this inert gas. Romania is one of the European countries with high radon levels, due to the geological characteristics of the geological substratum or soil. High-risk regions include mountainous and submountainous areas, as well as areas with uranium-rich soils, such as some areas in the counties of Suceava, Bihor, Caraș-Severin and others. However, monitoring of radon concentration in homes and public buildings is still sporadic, and awareness among the population is very low. This needs to be addressed through environmental and

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health policies at the national level. Radon becomes dangerous when it accumulates inside buildings, especially in poorly ventilated spaces. Prolonged inhalation of this gas can cause serious conditions, especially lung cancer. It has been found that this problem is not only national, but also global, for example, approximately one fifth, perhaps even more, of lung cancers worldwide are caused by radon pollution of the inhabited habitat. In fact, the World Health Organization (WHO) classifies radon as the second leading risk factor for lung cancer, after smoking. Estimates show that hundreds of deaths annually in Romania can be correlated with radon exposure. Although European legislation (through Directive 2013/59/EURATOM) obliges member states to take concrete measures to reduce the population's exposure to radon, the application of these regulations in Romania is delayed. Although there are initiatives to measure and map radon levels (such as the "RomRad" project), the lack of funds, specialists and political interest is holding back progress. Compared to other European countries, Romania is at a much more backward stage in terms of monitoring this parameter at national level. For now, measurements and monitoring have started in the western part of Romania and have expanded very slowly to the other regions. National authorities have the obligation to implement a coherent environmental policy in this area, but together with public health policies, finding solutions and regulations that should be legislated and applied in the construction sector. First of all, however, it is very important to raise awareness of the problem, in order to find solutions to a problem, it must first be recognized that the problem exists! Some solutions are more accessible, simpler, such as implementing ventilation habits, natural ventilation of the inhabited habitat, while other solutions are more expensive and complicated, requiring financing. The first step, however, is to inform the population and the authorities about the real danger posed by radon. The second step would be to develop a coherent and sustained national strategy to identify problem areas and then find a set of solutions to reduce radon pollution. Radon pollution will likely continue to silently affect the health of Romanians for a long time, remaining one of the most underestimated environmental threats in the country, but this is true not only for Romania, but also for many other countries in Europe and on other continents.

Keywords: indoor radon level; reducing radon poluttion; danger awareness

1. Introduction

Radon (^{222}Rn) is a naturally occurring radioactive noble gas, produced in the decay chain of uranium-238 (^{238}U) through radium-226 (^{226}Ra). Its half-life of 3.82 days allows it to migrate from soil and rocks into the atmosphere and into human-built structures. Being chemically inert, it cannot be detected by smell, taste, or sight, and its hazard lies entirely in the alpha radiation emitted by its short-lived decay products, such as polonium-218 (^{218}Po) and polonium-214 (^{214}Po), which attach to aerosols and can be inhaled deep into the lungs. The health impact of radon exposure is well documented. The International Agency for Research on Cancer (IARC) and the WHO (World Health Organization) have classified radon as a Group 1 carcinogen[1]. The WHO states that radon is the second leading cause of lung cancer after smoking, responsible for an estimated 3–14% of all lung cancer cases globally, depending on the national average radon levels and smoking prevalence. Epidemiological studies indicate that prolonged exposure to radon, even at relatively low concentrations, increases lung cancer risk in a dose-dependent manner. Radon is a naturally occurring radioactive gas that poses significant health risks, especially in certain regions of Romania due to geological factors (Florică et al., 2020). Despite its presence worldwide, awareness and mitigation efforts remain insufficient both in Romania and, to some extent, across Europe (European Commission, 2018). High concentrations of radon inside homes, schools, and workplaces can seriously affect public health by increasing the risk of lung cancer (United States Environmental Protection Agency - USEPA, 2016). Romania is particularly vulnerable due to its geological substratum, with mountainous and uranium-rich areas such as Suceava, Bihor, and Caraș-Severin counties exhibiting elevated radon levels (Cosma et al., 2013). However, monitoring and public awareness campaigns remain sporadic and poorly funded.

2. Radon Characteristics and Sources

Radon (Rn-222) is a colorless, odorless, and tasteless radioactive noble gas produced naturally by the radioactive decay of uranium and thorium in soils and rocks; because it is chemically inert and invisible, radon easily infiltrates buildings through cracks in foundations, walls, and floors. The concentration of radon indoors depends on geological conditions, building characteristics, and ventilation habits (USEPA, 2016). The half-life of radon is approximately 3.8 days, which allows it to accumulate indoors when ventilation is poor; the gas decays into radioactive progeny that attach to dust particles and, when inhaled, irradiate lung tissue, significantly increasing the risk of lung cancer. The World Health Organization classifies radon as a Group 1 carcinogen (IARC, 2012). Radon levels vary significantly across Europe due to geological differences, building practices, and climate conditions. According to the European Commission's Joint Research Centre (JRC), radon-prone areas are concentrated in central and eastern Europe, with particularly high values recorded in the Czech Republic, Finland, and parts of Romania (Cinelli et al., 2019). In Romania, radon hotspots are strongly correlated with uranium-rich geological formations, granite-based soils, and mountainous regions. Studies by Cosma and

[1] www.who.int/publications/i/item/9789241547673.

collaborators have shown that in this area, the average indoor air concentration can reach values of 292 Bq/m^3, compared to the national average of 126 Bq/m^3. Other areas with high values include parts of Transylvania, where the average indoor concentration is approximately 82.5 Bq/m^3 (Cosma et al., 2009a).

The highest concentrations have been reported in Suceava, Bihor, and Caraș-Severin counties, as well as in certain parts of Transylvania[1]. Despite the existence of these high-risk areas, comprehensive radon mapping in Romania remains incomplete. Thus, in a recent paper, the authors mention that measurements have been made for only approximately 45% of Romania's surface. (Cucoș et al., 2024). Many EU member states have already implemented extensive radon mapping programs, whereas Romania's efforts lag behind both in scope and policy integration (European Commission, 2018).

A series of pioneering researchers in the issue of radon pollution in Romania have made remarkable efforts to research the phenomenon, to create a more detailed map of this danger. Unfortunately, however, their efforts are overshadowed by insufficient funding, and progress is slow. The radon pollution map shows this, most measurements have been concentrated in the western part of the country. It is true that the geology of that area predisposes to a higher probability of radon pollution of the inhabited habitat. But we cannot believe that for the rest of the territory this danger does not exist, but simply that measurements have not yet been carried out or they have been insufficient in number.

3. Health Effects of Radon Exposure

Radon is the second leading cause of lung cancer after smoking, responsible for an estimated 3% to 14% of all lung cancer cases globally, depending on average indoor radon levels and smoking prevalence (WHO, 2009)[2]. The synergistic effect between radon exposure and tobacco smoking dramatically increases the risk of lung cancer. Smokers exposed to elevated radon concentrations have a much higher probability of developing lung cancer than non-smokers under the same conditions (Darby et al., 2005). Radon progeny emit alpha particles that damage the DNA of lung epithelial cells. Unlike many other environmental pollutants, radon exposure produces no immediate symptoms; instead, its health effects may appear years after

[1] www.cncan.ro.
[2] www.smartradon.ro.

initial exposure. According to the International Agency for Research on Cancer (IARC, 2012), radon is classified as a Group 1 carcinogen, meaning there is sufficient evidence of its carcinogenicity in humans. In Romania, epidemiological data indicate that hundreds of lung cancer cases annually could be linked to radon exposure (Cosma et al., 2009b). However, due to limited radon testing and low public awareness, the real extent of the problem is likely underestimated.

5. National and European Policies on Radon

European legislation, particularly Directive 2013/59/EURATOM, obliges member states to develop national radon action plans, establish reference levels for indoor radon, and promote public awareness. While countries like the UK, Sweden, and the Czech Republic have comprehensive radon control programs, Romania remains in an early stage of implementation (European Commission, 2014). The *Romanian National Radon Action Plan* exists on paper but is not fully enforced. Although researchers discovered the problem of radon pollution twenty years ago (Cosma et al., 1996), things have been slow to move forward. Funding limitations, insufficient trained personnel, and low political prioritization hinder progress. As proof of the slow progress of research, due to underfunding, there is also the graph in figures 1-7 which shows us that there are counties where in one year the problem is not researched at all, no measurements are made. Public campaigns are sporadic, and radon testing is often left to individual homeowners or academic research projects rather than being coordinated nationally. The best evidence of the slowness with which measurements are made is given by the graphs in Figures 1-7, for each year from 2018-2024; although they seem redundant, their insertion was made precisely to show that vast territories in Romania are completely unmonitored. We do not take into account the density of measurements, which is extremely important. Considering that for adjacent homes, for reasons of construction, ventilation, etc., the radon concentration may be different, a large number of measurements is also necessary for the conclusions to be relevant.

6. Strategies for Mitigation and Public Awareness

Public awareness remains the most critical factor. Many Romanians have never heard of radon, and those who have rarely understand its health implications. Educational campaigns, subsidized radon testing kits, and integration of radon mitigation into building codes are urgently needed. Radon mitigation strategies include improving natural and mechanical ventilation, sealing cracks in floors and walls, and installing underfloor depressurization systems. For new construction, radon barriers and specific ventilation designs can prevent gas infiltration (US EPA, 2016). Public awareness remains the most important factor. The media has reported on this hazard quite often, but not enough. Ultimately, the problem is at the political level. The decision to invest sufficient funds in analyzing this hazard nationwide depends on political factors.

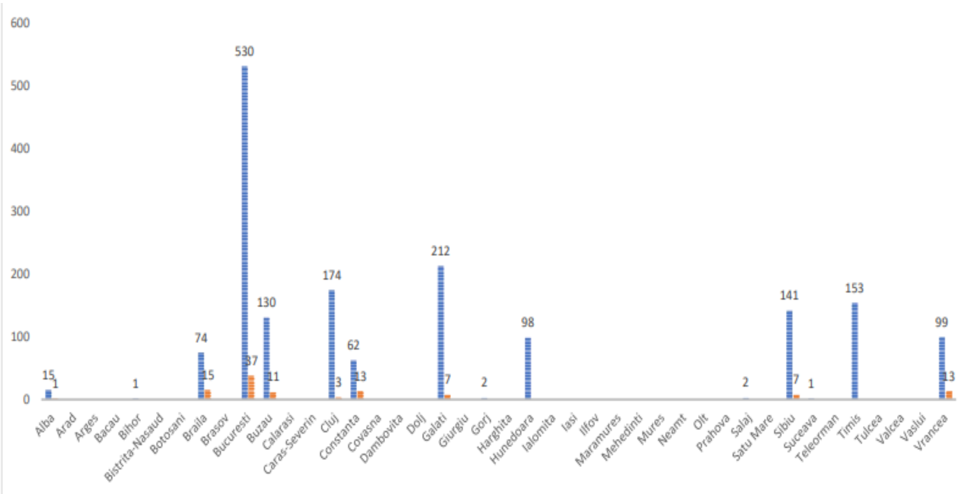

Figure 1. Number of measurements by county, 2024 (blue - number of measurements; orange - number of measurements above the reference level)

Source: www.cncan.ro

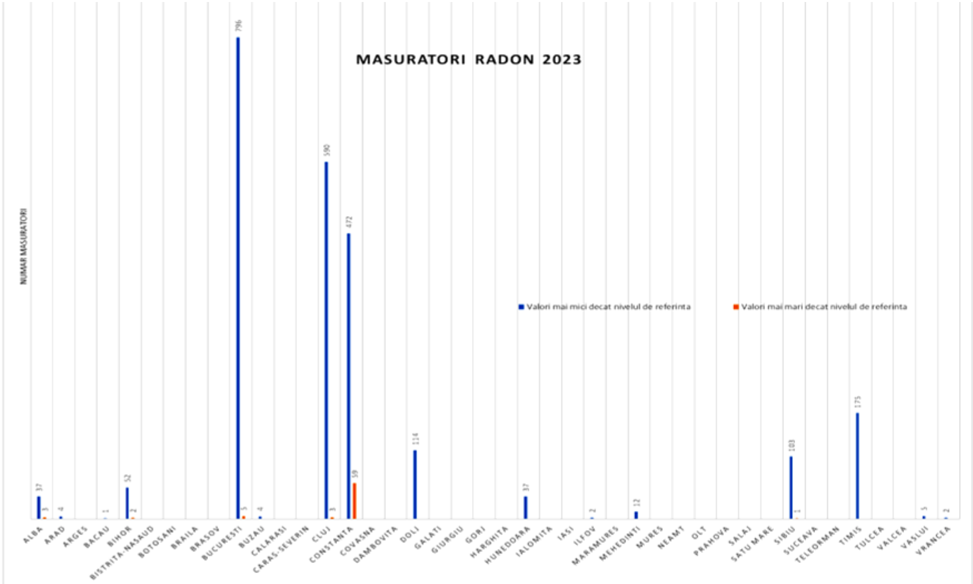

Figure 2. Number of measurements by county, 2023 (blue - values lower than the reference level; orange - values higher than the reference level)

Source: www.cncan.ro

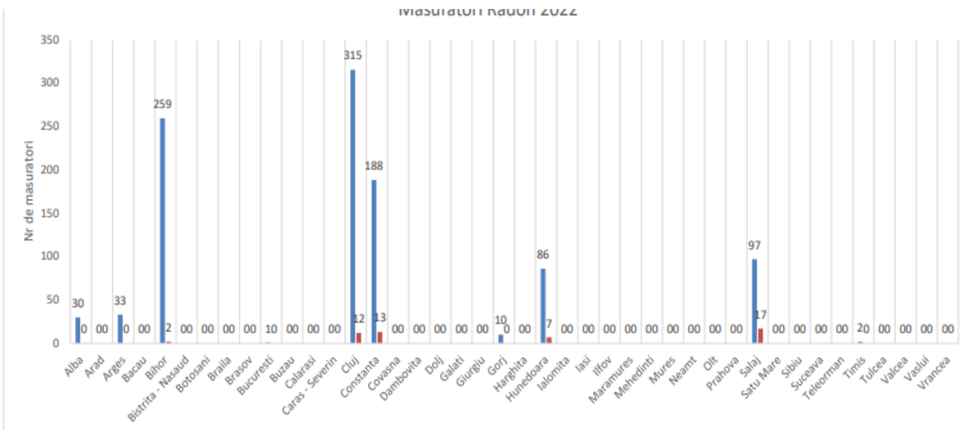

Figure 3. Number of measurements by county, 2022 (blue - values lower than the reference level; orange - values higher than the reference level)

Source: www.cncan.ro

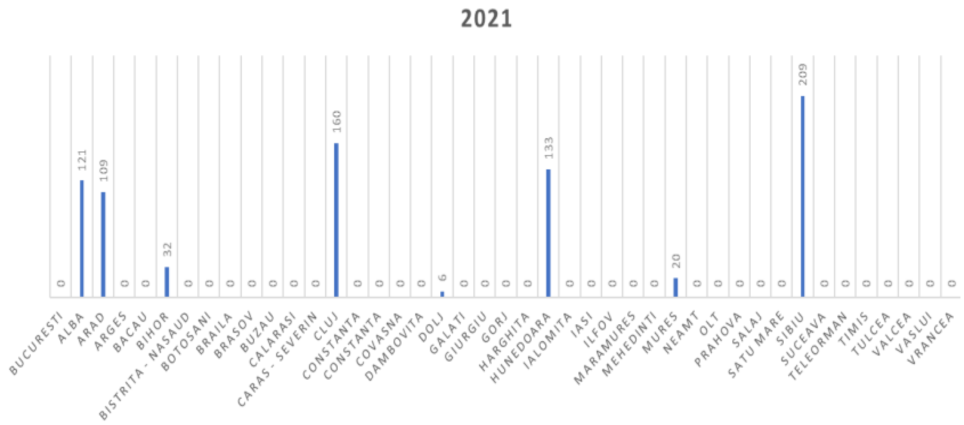

Figure 4. Number of measurements by county, 2021

Source: www.cncan.ro

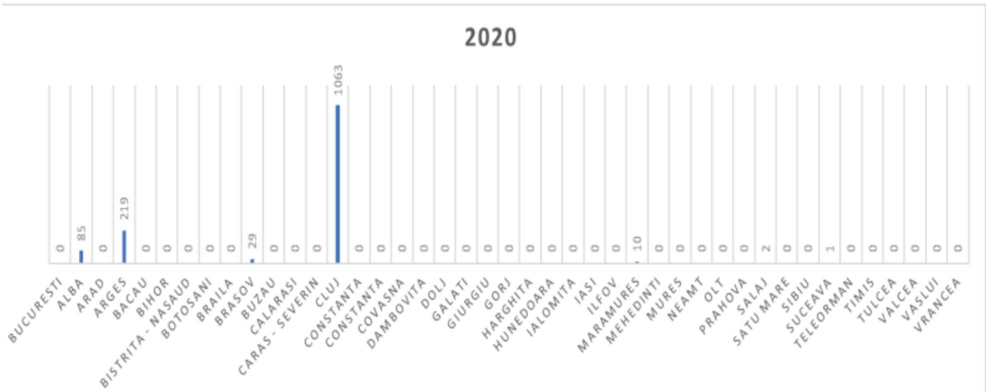

Figure 5. Number of measurements by county, 2020.

Source: www.cncan.ro

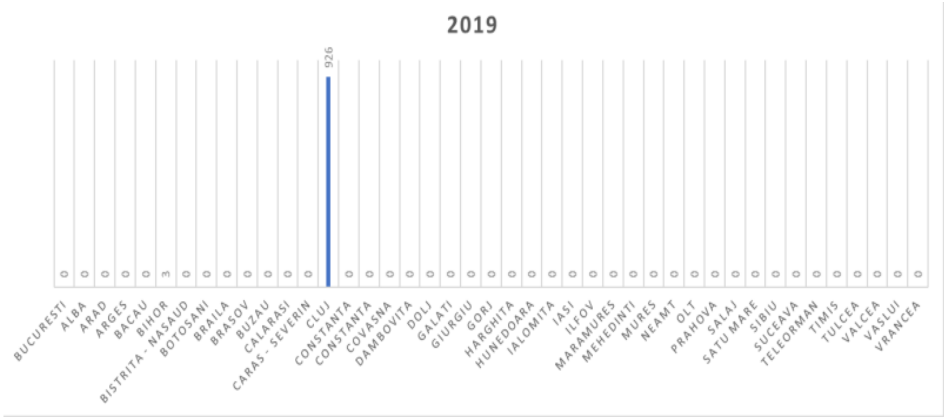

Figure 6. Number of measurements by county, 2019

Source: www.cncan.ro

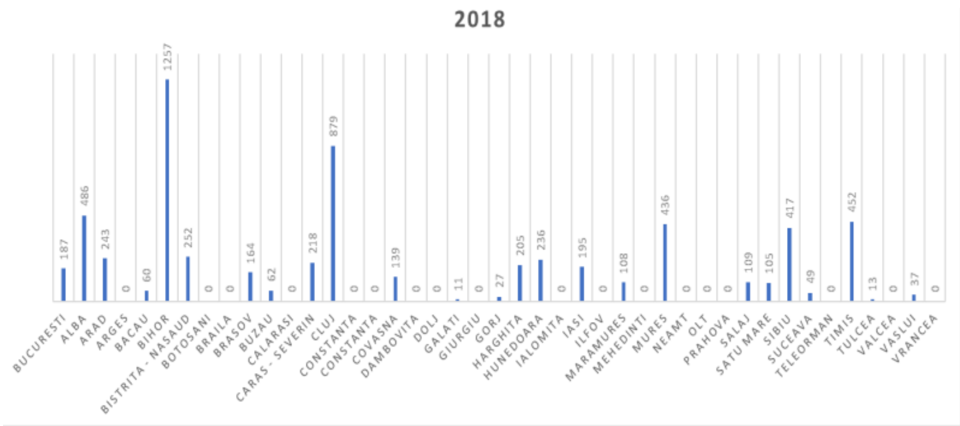

Figure 7. Number of measurements by county, 2018

Source: www.cncan.ro

Perhaps, if the population were massively aware of the existence of the hazard, pressure would be put on policymakers to invest in various programs to monitor radon concentrations in the inhabited habitat. Ultimately, the problem is at the political level. The decision to invest sufficient funds in analyzing this danger at the level of the entire country depends on political factors. Perhaps, if the population were massively aware of the existence of the danger, pressure would be put on political decision-makers to invest in various programs to monitor radon concentrations in the inhabited habitat. Maps of "contaminated" buildings could be made and solutions and funds could be found to solve the problem. Otherwise, we doubt that politicians would be interested, without pressure from society. The well-known expression is: there are no funds! But if we analyze the situation from another angle, then we do not realize that for society, the costs of illnesses, treatments, deaths of those affected by radon are much higher. Once a detailed monitoring of this danger is carried out, it should be invested in finding viable solutions, technical or otherwise, and these should be popularized and implemented. Technical solutions should be implemented from the construction phase, where the danger requires it. Mandatory regulations should be legislated in this regard. Other solutions could be minimal or more expensive modifications to already built buildings, installation of ventilation systems, etc. but, we repeat: the most important thing is that the danger is publicized by researchers, scientists, not by unauthorized people and alarmists. Many Romanians have never heard of radon, and those who have rarely understand its health implications. After all, in order to protect yourself from a danger, you first need to be aware of its existence. Educational campaigns, subsidized radon testing kits, and the integration of radon mitigation procedures into building codes are urgently needed. Another problem is also the monitoring of the effects of long-term radon exposure in certain socio-professional categories, such as speleologists, miners, tour guides for some caves, and other underground workers. Any illness they may develop due to radon exposure should be recognized in legislation as an occupational disease.

7. Conclusions and Recommendations

Radon pollution is a significant yet underrecognized environmental health hazard in Romania. It is insufficiently addressed at both the public policy and societal awareness levels, even though scientific evidence clearly establishes its carcinogenic risks.

Immediate priorities should include:

- Expanding radon mapping to cover the entire country, but with a higher density of easurements.
- Integrating radon-resistant construction techniques into building codes.
- Developing legislation that would make the implementation of technical solutions mandatory.

- Allocating funding for remediation in high-risk areas.
- Developing labor legislation with measures for the labor protection of workers in radon-contaminated environments and recognizing possible illnesses due to this cause as occupational diseases.
- Implementing sustained campaigns to inform citizens about this problem and the fact that there are solutions, and stimulating the mass media to be vectors for the efficient transmission of this official information.
- The development at the government level of integrated, long-term plans that include sufficient funding for all the points listed above.

Without such measures, radon will continue to silently contribute to preventable cases of lung cancer in Romania.

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