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of Ukraine"

RADON EXPOSURE CONTROL IN THE REPUBLIC OF MOLDOVA

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National Agency for Public Health, Republic of Moldova

ANSP
AGENŢIA NAŢIONALĂ PENTRU SĂNĂTATE PUBLICĂ

CONTROL RADON

Radiation Hygiene and Radiobiology Scientific Laboratory of the National Agency for Public Health

- The Radiation Hygiene and Radiobiology Scientific Laboratory (RHRL) is a scientific subdivision of NAPH, which carries out scientific and practical research in the field of public health, having health as a strategic priority, with an emphasis on the development of measures and programs, in order to reduce the risks of exposure to ionizing radiation (IR).
- The *general purpose* of the laboratory is to contribute to the research and monitoring of IR-related hazards in the field of public health, in order to protect health and improve the control practices of exposure to natural, medical, accidental and occupational IR by reducing the number of lung cancers attributed to ionizing radiation, caused by radon.

Participation in scientific forums and events of the Laboratory's collaborators

- Training courses
- International exhibitions of inventions
- Workshops
- Webinars
- Scientific-practical symposia
- National and international scientific-practical conferences
- Meeting of the society of professionals

Collaboration at national and international level

National organizations:

- Oncology Institute, Chisinau, MD
- "Nicolae Testemitanu" State University of Medicine and Pharmacy, Chisinau, MD
- National Agency for the Regulation of Nuclear and Radiological Activities, Chisinau, MD
- Institute of Ecology and Geography of USM, Chisinau, MD
- Institute of Genetics, Physiology and Plant Protection of USM, Chisinau, MD
- Technical University of Moldova, Chisinau, MD
- Construction Materials and Furniture Certification Body (CertMatCon), Chisinau, MD
- Public Institution Office of Territorial Planning, Urbanism, Construction and Housing, Chisinau, MI
- Regional Public Health Centers, MD

International organizations:

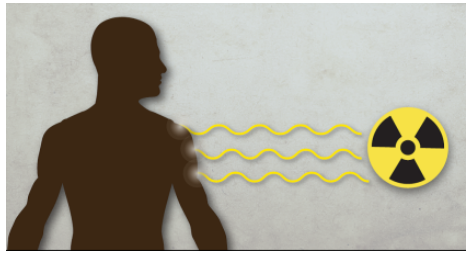
- WHO, IAEA, IRPA
- RADONOVA Scientific Ltd., Sweden
- Romanian Society of Radioprotection (SRRp, Bucharest, RO),
- National Institute of Public Health (Bucharest, RO)
- National Institute for Research and Development for Nuclear Physics and Engineering "Horia Hulubei" - IFIN-HH, Bucharest, RO
- Babeș-Bolyai University, Cluj-Napoca, RO
- Dunărea de Jos University, Galați, RO

Radiation Hygiene and Radiobiology Scientific Laboratory 30 years of scientific contribution (1995–2025)

- In almost three decades, Radiation Hygiene and Radiobiology Scientific Laboratory (RHRL) has carried out over 15 major projects, including the assessment of population exposure to natural and artificial ionizing radiation, monitoring of post-Chernobyl consequences, identification of radiological risk factors, quantification and reduction of radon exposure, studies on the impact of radionuclides on the environment and health
- The results are summarized in over 500 publications (monographs, *ISI/SCOPUS* articles, guides, methodologies), 30 patents and certificates, awards and medals (gold, silver, bronze) at international invention salons. The laboratory trains researchers through doctoral theses and collaborates with institutions in Romania, Ukraine, Poland, Germany, WHO, IAEA and other international organizations.
- Through its research, RHRL has contributed to strengthening the national radiation protection regulatory framework, increasing the response capacity in radiological situations and promoting public health by reducing population exposure to radiation.

Areas of activity of the Radiation Hygiene and Radiobiology Laboratory

- Scientific research in the field of radiation protection, radiation hygiene and radiobiology
- Monitoring the exposure of natural and artificial ionizing radiation
- Assessment of radon concentrations in housings, public buildings, and in the main environmental factors (air, water and soil)
- Study of the medical-biological effects of IR in case of occupational and accidental exposure: cytogenetic effects, DNA polymorphism
- Study of the influence of radon on the development of bronchopulmonary cancer *in vivo* in cancer patients
- *In situ* research on soil radioactivity, including radon, in the conditions of the Republic of Moldova
- Scientific expertise and consultancy in the field of radiology



Why Radon Matters

Radon – current public health problem, related to the increase in the incidence of bronchopulmonary cancer.
Radon has a synergistic effect with other risk factors → cumulative effect on health.
Affects the national economy and the medical system.

Need:

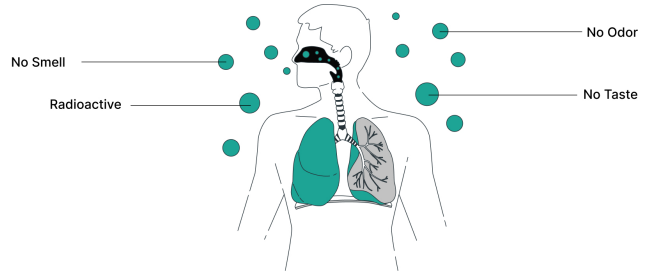
- National studies and assessments of exposure;
- Communication of the risk of exposure to radon;
- Prioritization of public health strategies;
- Implementation of monitoring and exposure reduction programs.

National studies and assessments of Rn exposure

- A comprehensive study on the exposure of the population to natural sources of ionizing radiation.

  Results:

  - The need for a new normative act on radiological protection;
  - Development of practical recommendations on reducing Rn exposure.
- Determination of radon concentrations in: air, water, soil.



Outputs of Radon awareness survey under IAEA/WHO STEAM project in the Republic of Moldova

- Public awareness of radon in the Republic of Moldova is low.
- Misinformation and myths persist.
- High testing interest offers communication opportunity.
- Need for clear, evidence-based campaigns to:
- Educate accurately; encourage testing & mitigation.
- Strengthen risk-communication capacity.

RISK COMMUNICATION OF THE RADON EXPOSURE

The main objectives of radon risk communication are:

- the growth of stakeholders
- promotion of radon testing and remediation of dwellings
- encouraging support for decision makers

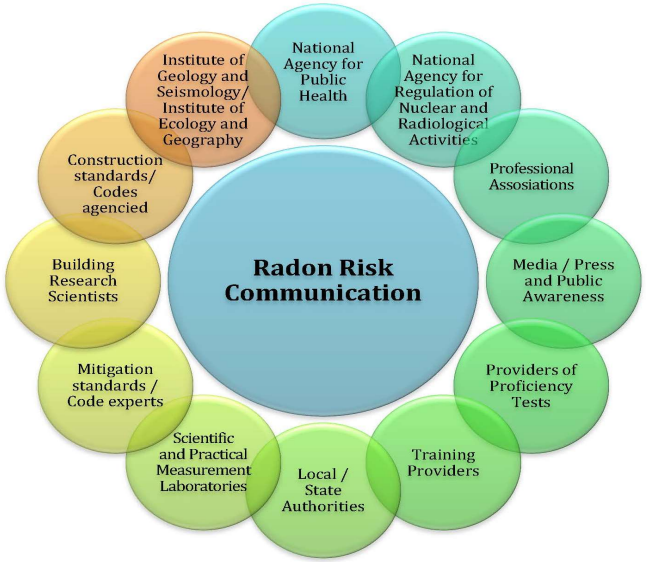
The Communications Campaign Framework establishes:

- participating organizations
- responsibilities of organizations
- activities
- implementation timeline
- monitoring and evaluation tools
- expected results

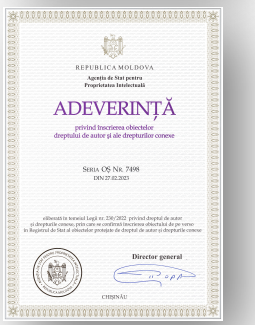
Information support:

- Hierarchy of target groups
- Creation of a specific web page on the National Agency for Public Health platform https://ansp.md/control_radon/
- Development of a set of leaflets for target groups
- Guidelines on radon risk communication

The developed **Risk communication of the radon exposure** guide refers to radon exposure risk communication campaigns, target audience identification; risk communication messages and channels for the general public, professionals, etc.; the activities of institutions participating in the radon risk communication campaign; monitoring and risk assessment of radon exposure.



Organizations involved in Radon Risk Communication

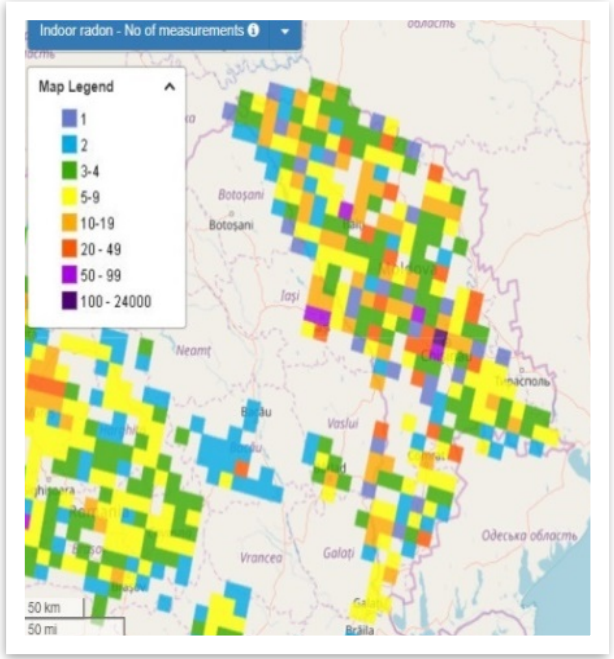


National and EU Community regulatory framework in radiological protection

1	EUROPEAN COMMISSION, FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, INTERNATIONAL ATOMIC ENERGY AGENCY, INTERNATIONAL LABOUR ORGANIZATION, OECD NUCLEAR ENERGY AGENCY, PAN AMERICAN HEALTH ORGANIZATION, UNITED NATIONS ENVIRONMENT PROGRAMME, WORLD HEALTH ORGANIZATION, Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards, IAEA Safety Standards Series No. GSR Part 3, IAEA, Vienna (2014)
2	COUNCIL DIRECTIVE 2013/59/EURATOM laying down basic safety standards for protection against the dangers arising from exposure to ionizing radiation. EU Document 32013L0059. 2013. 104 p.
3	LAW of the Republic of Moldova No. 289 of 20-10-2022 on basic requirements in radiological safety (Official Gazette No. 383 art. 719 of 26.11.2022)
4	LAW of the Republic of Moldova No. 84 of 30-04-2025 amending Law No. 182/2019 on the quality of drinking water
5	CODUL Urbanismului și Construcțiilor Nr. 434 din 28-12-2023
6	URBAN PLANNING AND CONSTRUCTION CODE No. 434 of 28-12-2023GOVERNMENT DECISION of the Republic of Moldova no. 1210 of 03.11.2016 on the approval of the Sanitary Regulation on ensuring radiation protection and radiological security in nuclear medicine practices (Monitor Oficial no. 388-398 art. no. 1309 of 11.11.2016)
7	GUIDE "Radon Monitoring Methodology in Early Childhood Education Institutions and Primary, Secondary and High School Educational Institutions", approved by the Minister of MSMPS Mrs. Silvia Radu, order no. 1344 of November 26, 2018, 45 p.
8	REGULATION AND HYGIENIC NORMS on the regulation of radiation exposure of the population from natural sources no. 06-5.3.35 of 05.03.2001 (Monitor Oficial no. 92-93/239 of 03.08.2001)
9	FUNDAMENTAL NORMS of Radioprotection, Requirements and Hygienic Rules (NFRP-2000) no. 06.5.3.34 of 27.02.2001 (Monitor Oficial no. 40-41, 2001)
10	COREȚCHI, L., VÎRLAN, S., BAHNAREL, I., URSULEAN, I., ROŞCA, A., APOSTOL, I. Methodology of monitoring natural sources of radon (222Rn) and assessment of radiological risk for the exposed population. Chisinau, 2014, 50 p. ISBN 978-9975-4027-6-7
11	COREȚCHI, L., BAHNAREL, I., URSULEAN, I., COJOCARI, A., PLĂVAN, I., VÎRLAN, S. Guide "Monitoring sources of ionizing radiation". Chisinau, 2017, 46 p.
12	COREȚCHI, L., GÎNCU, A., CĂPĂȚÎNA, A., POPESCU, I.-A., ABABII, A. Biological dosimetry of personnel professionally and accidentally exposed to sources of ionizing radiation. Guide. Chisinau, Typography "Sirius", 2021, 113 p. ISBN 978-9975-57-290-3
13	COREȚCHI, L., OVERCENCO, A., ȘARGU, V., GÎNCU, M., ABABII, A., ȘALARU, I., BAHNAREL, I. Scientific and methodological guide Communication of the risk of exposure to radon. Scientific and methodological guide Communication of the risk of exposure to radon. Chisinau, Typography No. 1, 2022, 59 p. ISBN 978-9975-3566-4-0
14	COREȚCHI, L., ABABII, A., APOSTOL, I., BAHNAREL, I., BOGDAN, M., ȘARGU, V., CAPAȚÎNA, A., RĂDULESCU, I., CALIN, R., LINCA, B., BORSOS, A. Determination of radon concentration in the air inside buildings (homes, workplaces), soil and water. Chișinău, Tipografia no.1, 2024, 168 p. ISBN 978-9975-57-371-9

Radon monitoring in the country (2018–2019)

- Monitoring in about 2500 homes (North, Center, South).
- Method: RADTRACK2® Alpha Track passive detectors (3 months exposure).
- Influential factors:
  - type and location of homes;
  - construction materials;
  - soil type;
  - ventilation.
- 25% of homes – exceedances of national/European standards.
- Average concentration per country: >200 Bq/m³, with some cases over 1000 Bq/m³.
- Regional averages:
  - South – 330 Bq/m³
  - Center – 250 Bq/m³
  - North – 240 Bq/m³
- Highest concentration – in the South.



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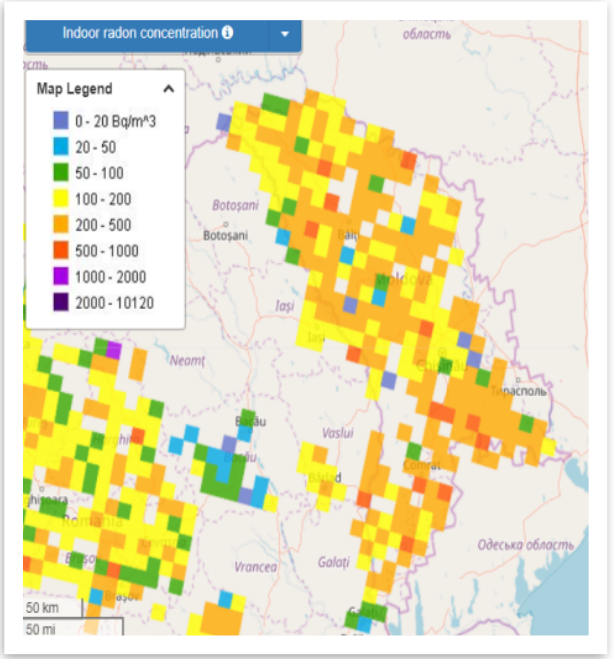


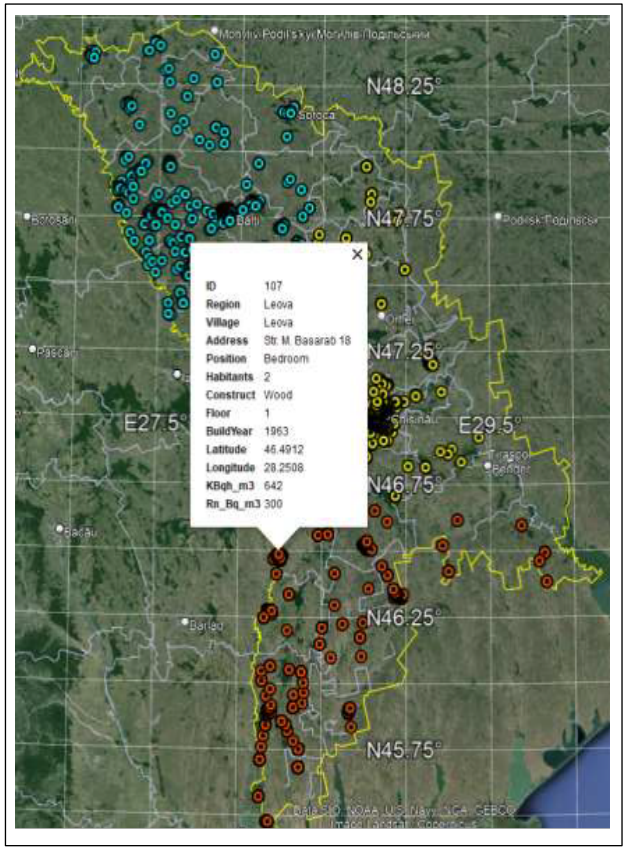
2

Number of indoor radon measurements in air (1) and radon concentration in air (2) in different types of dwellings in the Republic of Moldova
(Source: JRC atlas of natural radiation - https://remap.jrc.ec.europa.eu/Atlas.aspx)

The reference level for indoor radon activity concentration must not exceed 300 Bq/m³ as an annual average of radon concentration in air.

Radon monitoring in the country (2020–2022)

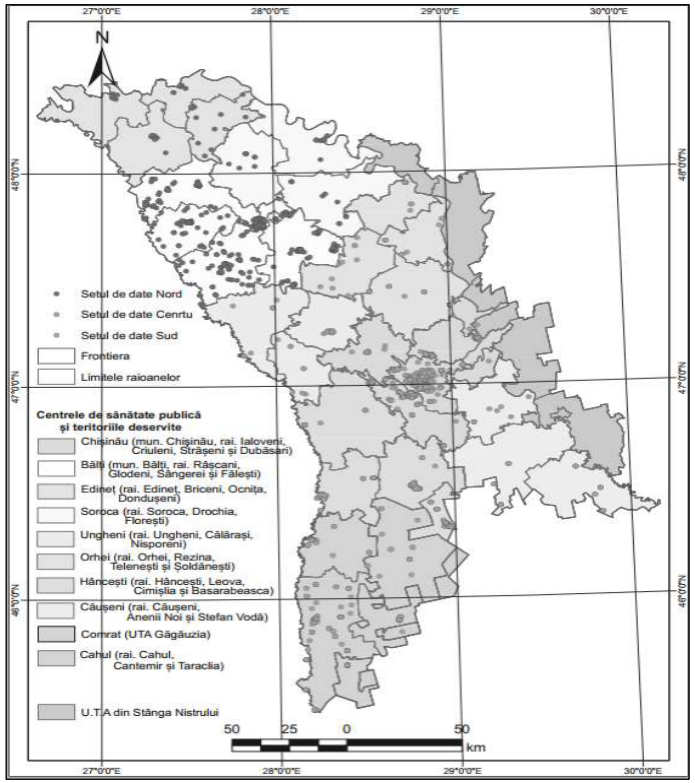
- Sample: ≈1100 homes nationwide.
- Maximum values:
  - Center – 1160 Bq/m³
  - North – 1260 Bq/m³
  - South – 950 Bq/m³
- Regional averages:
  - Center – 211.7 Bq/m³
  - North – 240.6 Bq/m³
  - South – 285.6 Bq/m³
- Above the reference level (300 Bq/m³):
  - Center – 25.3%
  - North – 31.1%
  - South – 38.6%
- Results by municipalities (2020–2022)
  - For Bălți, Chișinău and Cahul, the average values do not exceed 300 Bq/m³.
- Confirms the existence of regional variations and the influence of geological and construction conditions.



Interactive map of radon in the air of different types of homes in the Republic of Moldova

Indoor Radon Measurements (2024) – Influence of Construction Age

- 84 homes investigated in the North, Center, South.
- Results:
  - Constructions 1956–1980 → 28.8–853.7 Bq/m³ (6 exceedances);
  - Constructions 1981–2000 → 15.6–760.4 Bq/m³ (2 exceedances);
  - Constructions 2002–2017 → 28.8–248.3 Bq/m³ (no exceedances).
- Older homes present higher risks of radon accumulation.



Harta repartiției spațiale a radonului în aerul din diferite tipuri de locuințe pe teritoriul Republicii Moldova

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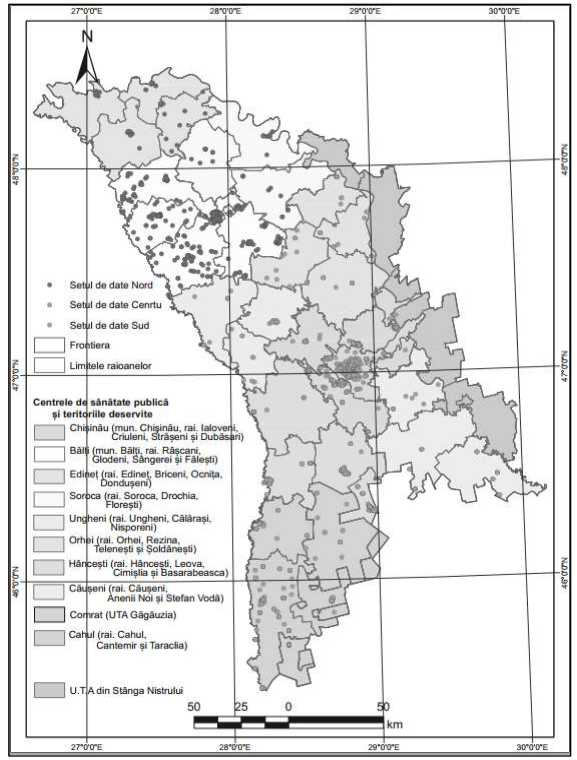


Map of the spatial distribution of radon in the air of different types of housing on the territory of the Republic of Moldova, 2024 y.

Figure Average radon concentration detected in kindergartens in the Republic of Moldova (n=223)

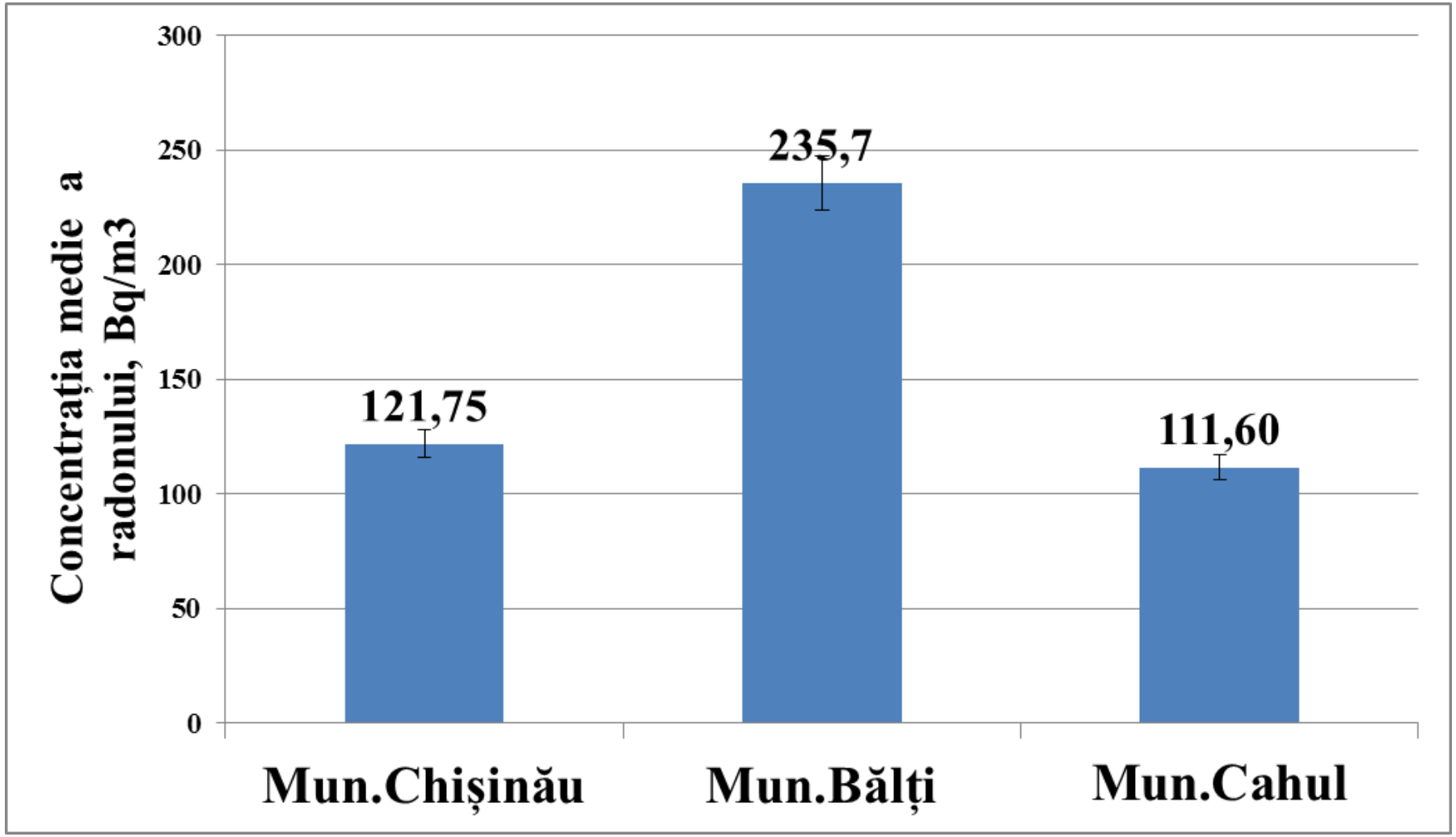


Figure Average radon concentration detected in kindergartens in the Republic of Moldova (n=223)

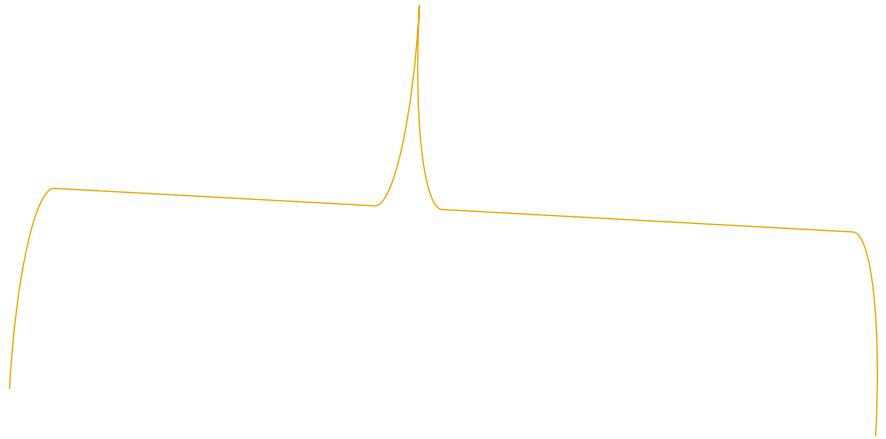
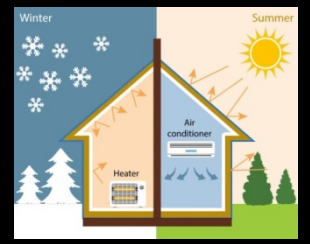


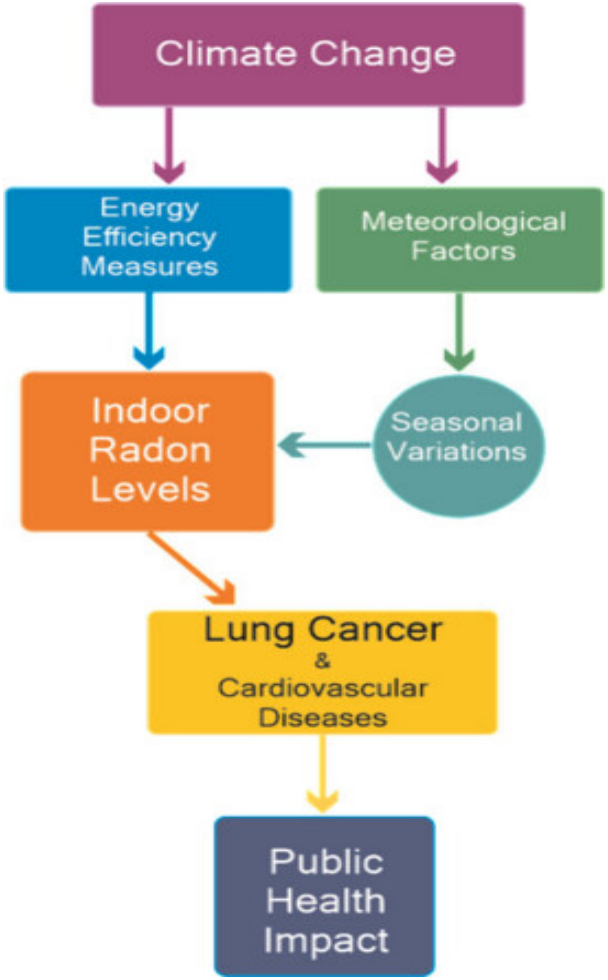
Figure Average radon concentration detected in scools in the Republic of Moldova (n=156)

Școols mun.Chișinău	Total nr of measurements	No. of exceedances of the reference level	%	Average Rn value, Bq/m3	Minimum value of Rn, Bq/m3	Maximum value of Rn, Bq/m3	Average annual effective dose value, mSv/y	Minimum annual effective dose value mSv/y	Maximum annual effective dose value, mSv/y
sec.Botanica	37	4	10,8	119,4	21,82	562,9	5,6	1,02	26,4
sec.Buiucani	40	3	7,5	112,23	23,6	500,6	5,26	1,11	23,48
sec.Centru	22	2	9,1	129,4	22,9	716,6	6,1	1,1	33,6
sec.Ciocana	19	2	10,5	145,21	12,4	728,6	6,81	0,58	34,17
sec.Rîșcani	38	Under investigation							

The impact of climate change on indoor radon concentrations as a current public health challenge



In the Republic of Moldova, the problem of residential radon in relation to internal and external factors can be linked to fluctuations in external meteorological conditions depending on the season either through the way of maintaining thermal balance in buildings (*in winter – houses "sealed" from the cold, in summer – houses "sealed" due to the heat*), or through the direct influence of meteorological parameters on radon concentrations.



PROIECT BILATERAL RO MD 21ROMD „Creșterea capacității digitale de flux de date între România și R. Moldova privind monitorizarea radioactivității solurilor si a radonului””, PN-IV-P8-8.3-ROMD-2023-0241:

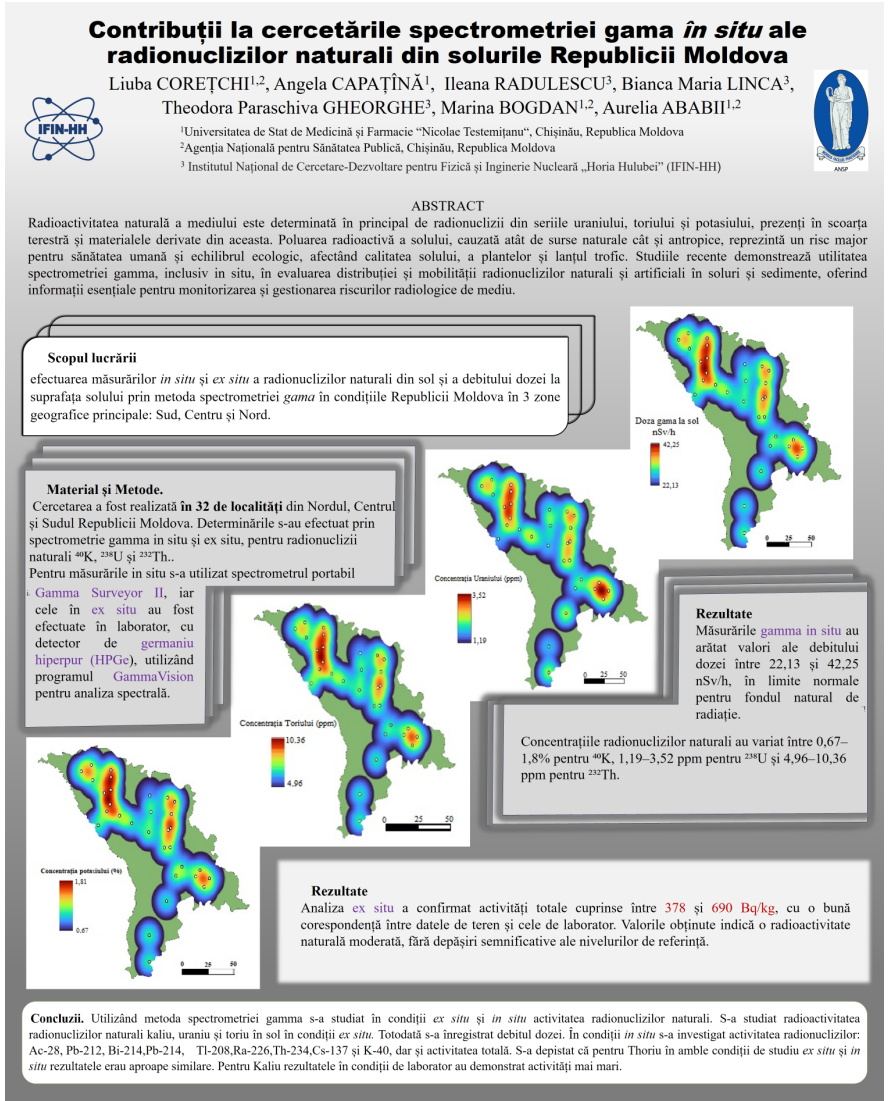
√ **Elaborarea Acordului de parteneriat cu coordonatorul proiectului - Institutul Național de Cercetare-Dezvoltare pentru Fizică și Inginerie Nucleară „Horia Hulubei” – IFIN-HH**;

√ **Desfășurarea stagiului de cercetare la IFIN-HH (Coretchi L., Ababii A., Bogdan M., Țurcanu Gh.)**

√ **Etapa 1: Proiectarea și dezvoltarea soluției tehnice pentru crearea unei platforme digitală intermediară, gata de utilizare de către utilizatorii finali, furnizarea unei hărți spațiale pentru Republica Moldova care va fi integrată în platformă.**

√ **Etapa 2: Implementarea metodologiei de eșantionare în teren pentru metode radiometrice și radon măsurători. Participarea și la lucrările de laborator pentru a obține cunoștințe despre procedurile de laborator pentru toate metodele.**

Obiectivul acestei sarcini este de a implementa eșantionarea pentru tehnici de măsurare și livrarea probei pentru lucrarea descrisă. Vor fi stabiliți tipul probei, parametrii primari care trebuie înregistrați, tipul procedurii aplicate la pregătirea probei, tipul măsurătorilor aplicate. Analiza datelor colectate în teren din măsurători in situ, măsurători în laboratorul de probe recoltate şi analiza datelor. Observații paralele ale aceeași tipuri de masuratori cu mai multe instrumente, de exemplu măsurători comparative ale ratei dozei cu diferite instrumente, de asemenea din mostre de date. Tabelele de date/foi de calcul vor fi introduse in platforma digitală Partea 1.



Contribuții la cercetările spectrometriei gama *în situ* ale radionuclizilor naturali din solurile Republicii Moldova

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[1]Universitatea de Stat de Medicină și Farmacie “Nicolae Testemițanu“, Chișinău, Republica Moldova
[2]Agenția Națională pentru Sănătatea Publică, Chișinău, Republica Moldova
[3] Institutul Național de Cercetare-Dezvoltare pentru Fizică și Inginerie Nucleară „Horia Hulubei” (IFIN-HH)

ABSTRACT
Radioactivitatea naturală a mediului este determinată în principal de radionuclizii din seriile uraniului, toriului și potasiului, prezenți în scoarța terestră și materialele derivate din aceasta. Poluarea radioactivă a solului, cauzată atât de surse naturale cât și antropice, reprezintă un risc major pentru sănătatea umană și echilibrul ecologic, afectând calitatea solului, a plantelor și lanțul trofic. Studiile recente demonstrează utilitatea spectrometriei gamma, inclusiv in situ, în evaluarea distribuției și mobilității radionuclizilor naturali și artificiali în soluri și sedimente, oferind informații esențiale pentru monitorizarea și gestionarea riscurilor radiologice de mediu.

Scopul lucrării
efectuarea măsurărilor *in situ* și *ex situ* a radionuclizilor naturali din sol și a debitului dozei la suprafața solului prin metoda spectrometriei *gama* în condițiile Republicii Moldova în 3 zone geografice principale: Sud, Centru și Nord.

Material și Metode.
Cercetarea a fost realizată **în 32 de localități** din Nordul, Centrul și Sudul Republicii Moldova. Determinările s-au efectuat prin spectrometrie gamma in situ și ex situ, pentru radionuclizii naturali ^{40}K, ^{238}U și ^{232}Th..
Pentru măsurările in situ s-a utilizat spectrometrul portabil Gamma Surveyor II, iar cele în ex situ au fost efectuate în laborator, cu detector de germaniu hiperpur (HPGe), utilizând programul GammaVision pentru analiza spectrală.

Rezultate
Măsurările gamma in situ au arătat valori ale debitului dozei între 22,13 și 42,25 nSv/h, în limite normale pentru fondul natural de radiație.
Concentrațiile radionuclizilor naturali au variat între 0,67–1,8% pentru ^{40}K, 1,19–3,52 ppm pentru ^{238}U și 4,96–10,36 ppm pentru ^{232}Th.

Rezultate
Analiza ex situ a confirmat activități totale cuprinse între 378 și 690 Bq/kg, cu o bună corespondență între datele de teren și cele de laborator. Valorile obținute indică o radioactivitate naturală moderată, fără depășiri semnificative ale nivelurilor de referință.

Concluzii. Utilizând metoda spectrometriei gamma s-a studiat în condiții *ex situ* și *in situ* activitatea radionuclizilor naturali. S-a studiat radioactivitatea radionuclizilor naturali kaliu, uraniu și toriu în sol în condiții *ex situ*. Totodată s-a înregistrat debitul dozei. În condiții *in situ* s-a investigat activitatea radionuclizilor: Ac-28, Pb-212, Bi-214,Pb-214, Tl-208,Ra-226,Th-234,Cs-137 și K-40, dar și activitatea totală. S-a depistat că pentru Thoriu în amble condiții de studiu *ex situ* și *in situ* rezultatele erau aproape similare. Pentru Kaliu rezultatele în condiții de laborator au demonstrat activități mai mari.

Conclusions

! Radon is a serious health threat. The development of lung cancer and death can be reduced by controlling a person's exposure to radon.

! Indoor exposure to radon can be caused by both natural and anthropogenic activities. Human activities can increase or decrease exposure (i.e., through mitigation). The latter message indicates that radon-related risks can be managed.

! Radon testing is easy; mitigation is effective, and there are ways to address mitigation costs.

! The only way to know if there are problems with radon exposure is to test, as radon concentrations can vary from home to home. A radon distribution map is needed so that regulators can target their resources and appropriate measures.

Thank you for your atention !!!