



11th International Workshop on the Geological Aspects
of Radon Risk Mapping, 17 – 20 September 2012, Prague, Czech Republic



FIRST PRELIMINARY INDOOR RADON MAP IN ROMANIA AND FUTURE PERSPECTIVES

**Alexandra Cucuș (Dinu), Constantin Cosma, Tiberius Dicu,
Bety Burghele**

**Babeş-Bolyai University
Faculty of Environmental Science and Engineering
Cluj-Napoca, ROMANIA**

ROMANIA – IN THE EU COUNTRIES



DESIGN OF SURVEY

Long term Indoor radon data - **from 2000 to 2012**

- collected by the **BABEȘ-BOLYAI UNIVERSITY (UBB) Faculty of Environmental Science and Engineering**

The source of the indoor radon data set represents **the sum of several different surveys and research projects:**

- **Studying the regional radon situation**
- **Exhaustive sampling in radon-prone areas**
- **Geographical distribution of Rn levels in territory**



MEASUREMENT TECHNIQUES

- **CR-39 detectors** (RadoSys, Hungary)
- exposed on **ground floor levels of dwellings** according to the NRPB EU measurements protocols
- **exposed period: 3-12 months** -annual mean was reported for all data, by using seasonal correction factors of HPA (Miles J *et al*)
- **the processing of results** and the automatic reading of detectors was performed in the UBB laboratory - equipment RadoSys-2000
- **sampling points were selected randomly in each location** (based on telephone directory and inhabitants registry)
- **standardized questionnaire** has been applied: to collect information about the measurement site (e.g. house type, building materials, living habits)



RESULTS

DISTRIBUTION OF MEASUREMENTS:

1890 locations (August 2012)

98% Dwellings + 2% Schools

- 0.18% of all dwellings of Transylvania
- 0.02% of all dwellings of Romania
- 0.15% of all schools of Romania



Fig.1. Geographical location of study (12 counties).

Our database is based on the assessment of annual mean Rn concentration in ground floor rooms of houses

(about 400 results of measured houses were eliminated because do not fully comply with the technical specifications)

- high fraction (95-96%) of detectors recovered
- 12 counties represents 29% of the total of 42 Romanian regions

FIRST ROMANIAN INDOOR RADON MAP

AM = 125 Bq/m³ (without Ștei-Băița)

AM = 287 Bq/m³

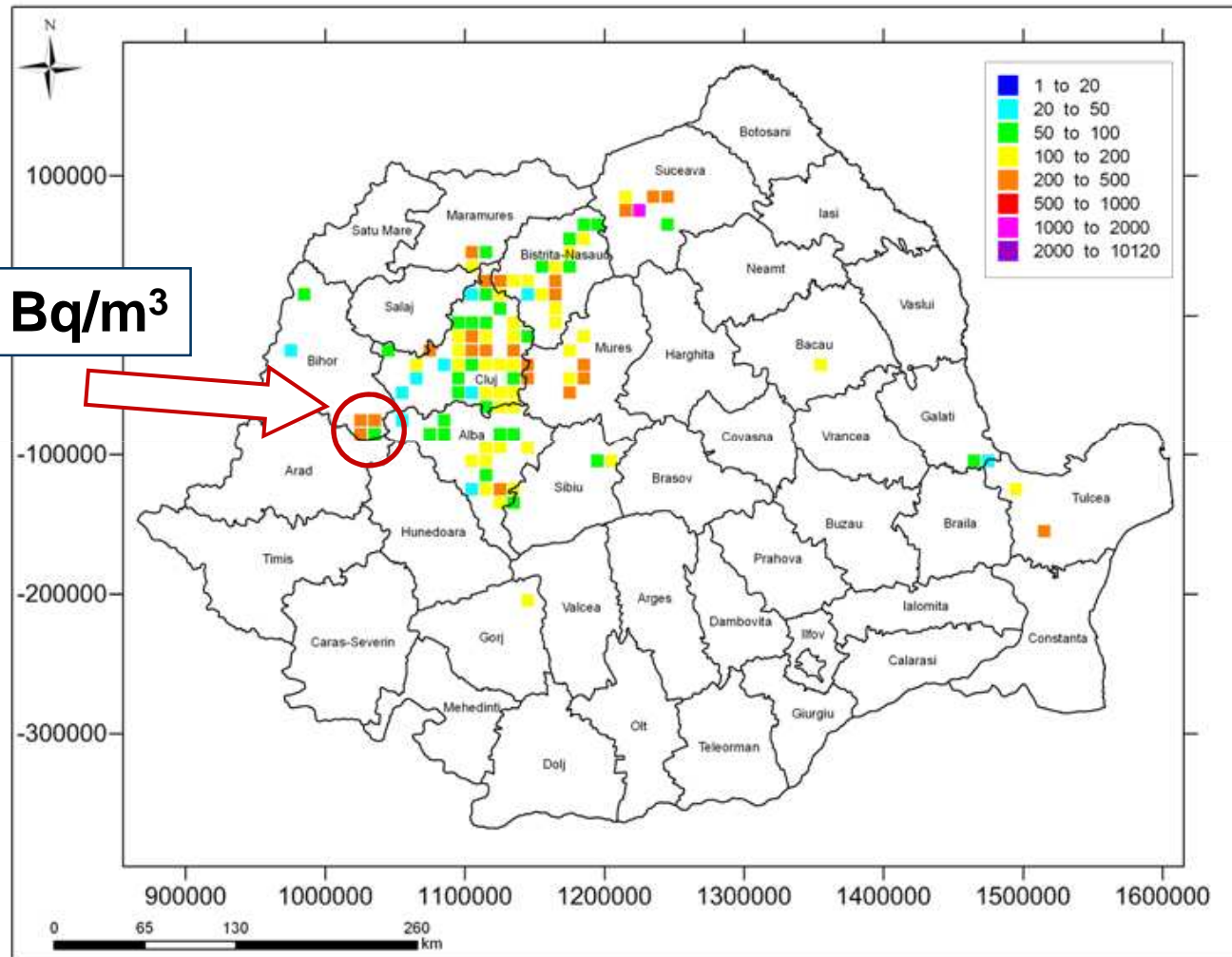


Fig. 3. The arithmetic mean of indoor radon concentrations in Romania ground floor rooms in 10 km x 10 km grid cells.

INDOOR RADON MAP: Ștei-Băița radon-prone area

- 4100 measurements
- 905 typical houses with 4-6 ground floor rooms



Main radon sources:

- high Rn concentrations in soil
- **high RP** in 85% of houses (**200**)
- uranium tailing and local material (sand, gravel) used as building material

AM = 287 Bq/m³
Max Val = 3653 Bq/m³

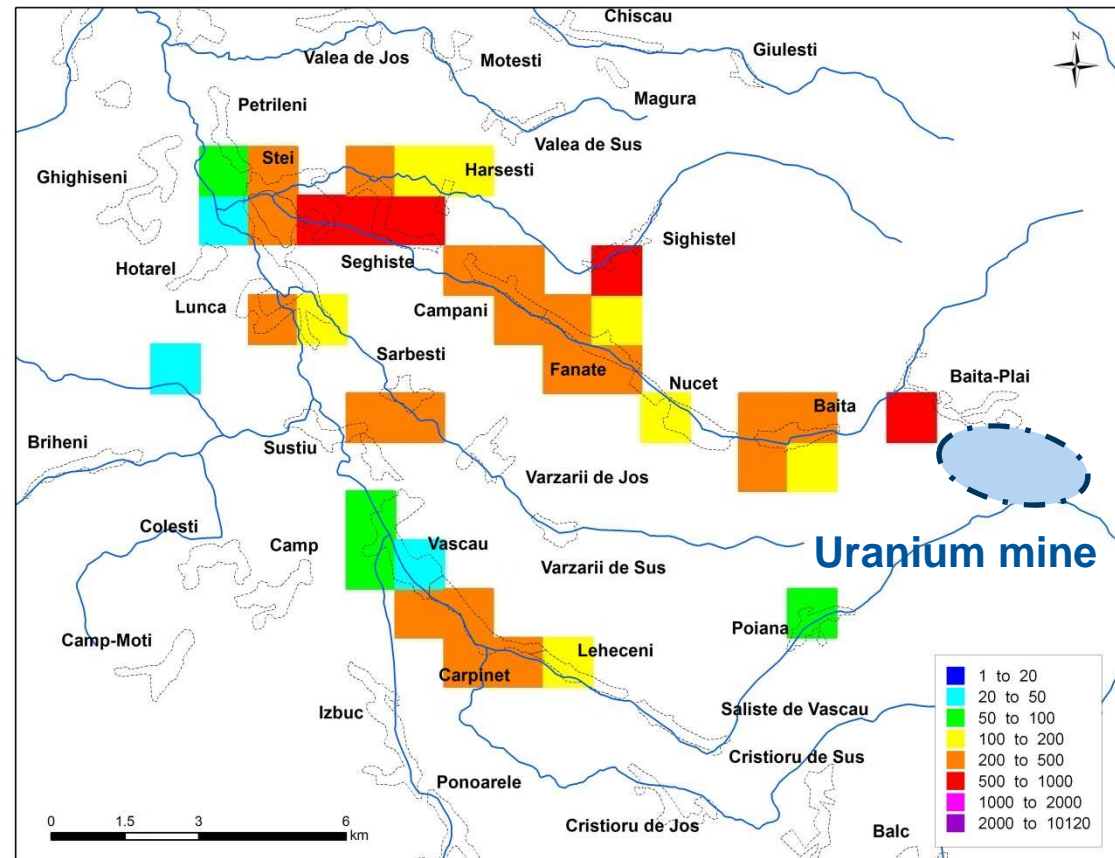


Fig. 4. The arithmetic mean of indoor radon concentrations in Ștei-Băița radon-prone area, 1 km x 1 km grid cells.

DESCRIPTIVE STATISTICS OF DATA

County	Number of dwellings	AM \pm SD (Bq/m ³)	Max (Bq/m ³)	Nr. houses > 400 Bq/m ³	% houses > 400 Bq/m ³
Maramureș	22	231 \pm 186	608	6	27
Tulcea	14	205 \pm 134	507	1	7
Suceava	39	269 \pm 288	1140	3	21
Bacău	15	119 \pm 62	237	-	-
Galați	12	53 \pm 22	104	-	-
Gorj	28	107 \pm 97	361	-	-
Sibiu	71	95 \pm 69	361	-	-
Bistrița-Năsăud	123	117 \pm 123	897	3	2
Alba	169	116 \pm 97	604	3	3
Mureș	20	202 \pm 152	696	1	5
Cluj	392	124 \pm 144	1050	18	5
Bihor	985	287 \pm 362	3653	185	21
Total	1890 (755)*	214 \pm 293 (125 \pm 135)*	3653 (1140)*	220 (35)*	13% (4,6%)*

*without Ștei-Băița radon-prone area

- **220 houses (13%)** exceeds the Action Level of 400 Bq/m³, of which 85% in the Ștei-Băița radon-prone area
- more than 65% of the non-empty cells have an AM above 100 Bq/m³ and 10% of them above 300 Bq/m³

VARIABILITY OF DATA

Different geology, house styles, insulation, mitigation or living habits

Ex: high Rn concentrations in regions of **uranium mine** – Bihor (Băița)

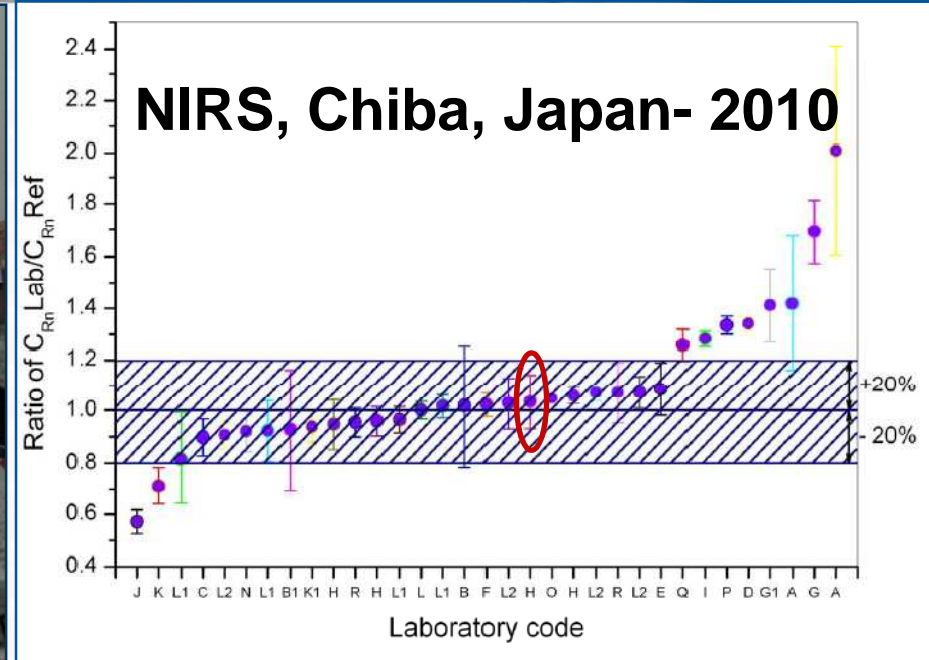
Measurements period

- short- or medium-time measurements which take less than a year were included by applying a **seasonal correction model** in accordance with the protocols of measurements HPA in order to estimate **annual mean**

Data quality assurance

- statistics of **annual estimates** of measurements made on ground floors were used to fill the grid
- with respect to **the quality of the data collection and procedures**

VALIDATION OF RADON MEASUREMENTS: INTERNATIONAL INTERCOMPARISON EXERCISES



1st International Intercomparison exercise on Natural Radiation organised by LaRUC in Saelices el Chico, Spain - 2011

National Institute of Radiological Sciences NIRS, Chiba, Japan - international intercomparison tests- 2007- 2012

Institute of Nuclear Physics PAN, Krakow, Poland - 2010

Charles University of Prague, Czech Republic - 2010

LaRUC (Radon Group, University of Cantabria, Spain), Santander, Spain - 2009

University of Pannonia, Veszprem, Hungary – 2007- 2009

IFIN-HH Bucharest, Romania - national intercomparison tests – 2006-2011

Very good result with **individual errors under 10%** - confirms the reliability of measurements performed by our laboratory.

OTHER RADON/ NATURAL-RADIOACTIVITY RELATED SURVEYS IN OUR LABORATORY

Radiation protection

- **Radon in living and working environment:** diagnostic in houses of Ștei-Băița radon-prone area, identification of radon sources, mitigations
- **Radon in touristic underground environments**
- **Thoron concentrations monitoring**
- **Radon dosimetry:** optimization of methodology for dose calculations and health impacts assessment
- **Radon Chamber:** calibration of equipment used in radon measurement
- **Radon in water:** drinking water, ground water, surface water (1600 measurements in Transylvania)
- **Survey on Radium content in soil**

Radon transport

- **Radon soil-gas measurements**
- **Radon exhalation studies:** soil and building materials

FUTURE PERSPECTIVES

Improvement of preliminary radon map for Romania

which will presumably be complete in the 2013

- the article: **Cosma Constantin, Cucuș (Dinu) Alexandra, Dicu Tiberius, (2012), *Towards the first map of residential radon concentration in Romania***, in press Radiation Protection Dosimetry
- in process 500 new radon data....

- **further SURVEYS and indoor measurements campaigns** to identify buildings with a high radon level, correlation with geology.
- **establishment of the coordinating authority on the national level:** until now, only regional measurements of indoor radon have been performed in Romania: by **Radon Group of “Babeș-Bolyai” University (Prof. Dr. C. Cosma & team)** from Cluj-Napoca and **Public Health and Hygiene Institutes** for Bucharest, Iasi, Timisoara or Cluj-Napoca

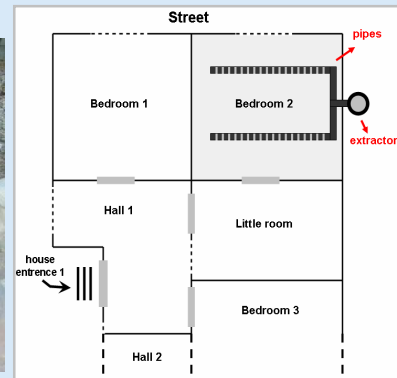
FUTURE PERSPECTIVES

IRART PROJECT: “Implementation of Radon Remediation Techniques in Dwellings of Băița Uranium Mine Area”

- **2010 - 2013** (Project Directors Prof. C. Cosma and C.Sainz)

Main objective: development, test (PILOT HOUSE) and implementation of remedial measures in 20 houses of Ștei-Băița radon-prone area

FIRST MITIGATION IN ROMANIA, with EU expertise – C. Cosma, C. Sainz, M. & M. Neznal, L. Quindos:



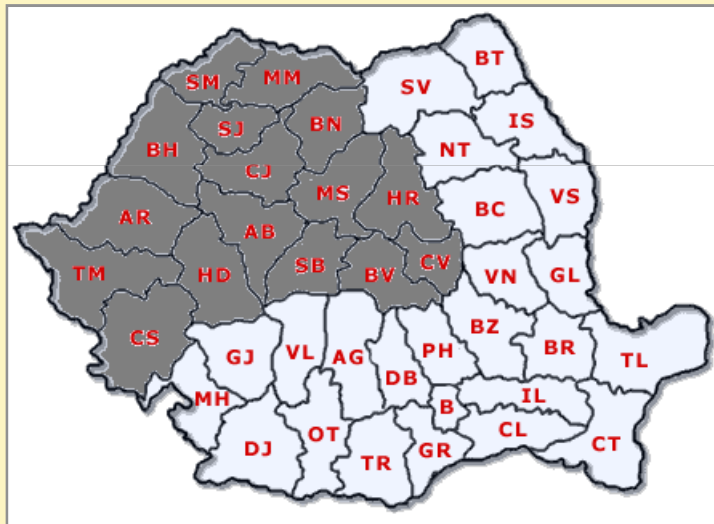
[article Alexandra Cucuș (Dinu), C. Cosma, T. Dicu, R. Begy, M. Moldovan, B. Papp, D. Niță, B. Burghele, C. Sainz, (2012), *Thorough investigation on indoor radon in Băița radon-prone area (Romania)*, Science of The Total Environment, 431 (2012) 78–83.]

FUTURE PERSPECTIVES

RAMARO PROJECT: “Radon Map (residential, geogenic, water) for Center, West and NorthWest regions from Romania”

– 2012 - 2015 (Project Manager Prof. C. Cosma)

Main objective: developing radon maps in 16 investigated counties of Central, North-West and West regions (covering 41% of the Romanian territory) according to EU recommendations, based on systematic indoor, soil and water radon measurements



- **indoor radon map ~5,500 dwellings** (min. 3 measurement/ 10x10 km² grid)
- **mapping the geogenic radon potential ~3,000 radon in soil measurements** (3-4 measurement/ 10x10 km² grid)
- **a map of radon levels distribution in water ~3,000 water samples**
- **mapping indoor and outdoor environmental gamma dose rates ~5,000 indoor and 3,000 outdoor measurements**

FORTHCOMING CHALLENGES

NATIONAL INDOOR RADON MONITORING PROGRAM

- a **National Radon Survey is necessary** in order to have a significant and reliable assessment regarding the Radon situation and to define areas where further targeted indoor survey should have priority and a remediation could be expected

To set-up specific radon legislation

- national guidelines to perform indoor radon measurements
- national reference levels concerning population exposure to indoor radon in Romania
- **clear assignment of responsibilities to competent authorities**
- incorporate the radon control requirements in national building codes
- an **effective radon policy** - financial resources required for evaluation and monitoring of the radon situation

Information campaigns to raise awareness of the population



We kindly thank you for attending



FIRST EAST EUROPEAN RADON SYMPOSIUM FERAS 2012

2nd – 5th September 2012

CLUJ-NAPOCA and BĂIȚA (uranium mine area), ROMANIA





THANKS FOR YOUR



ATTENTION!

