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Testing of various approaches for determining geogenic radon potential

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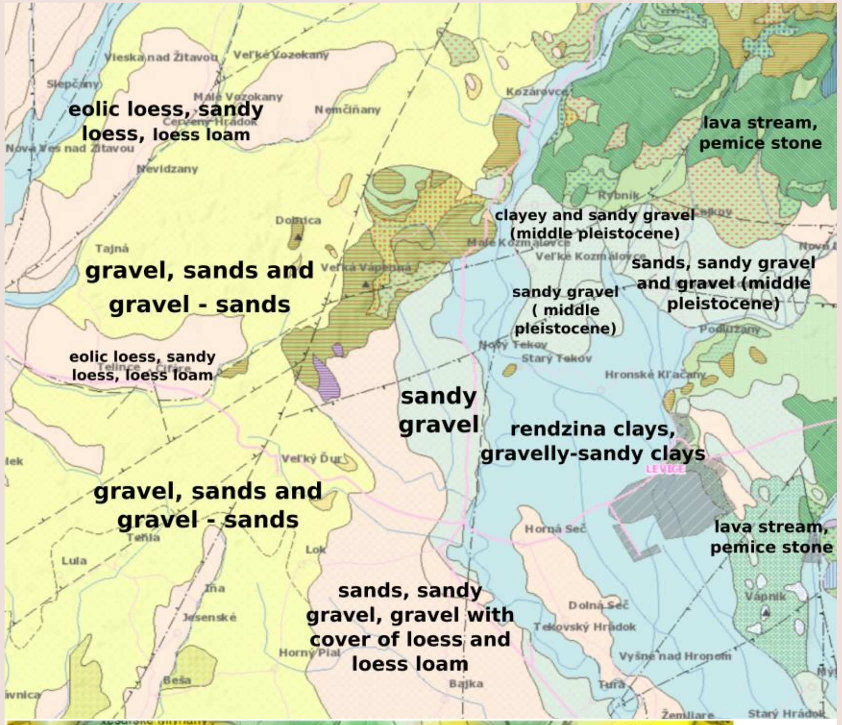
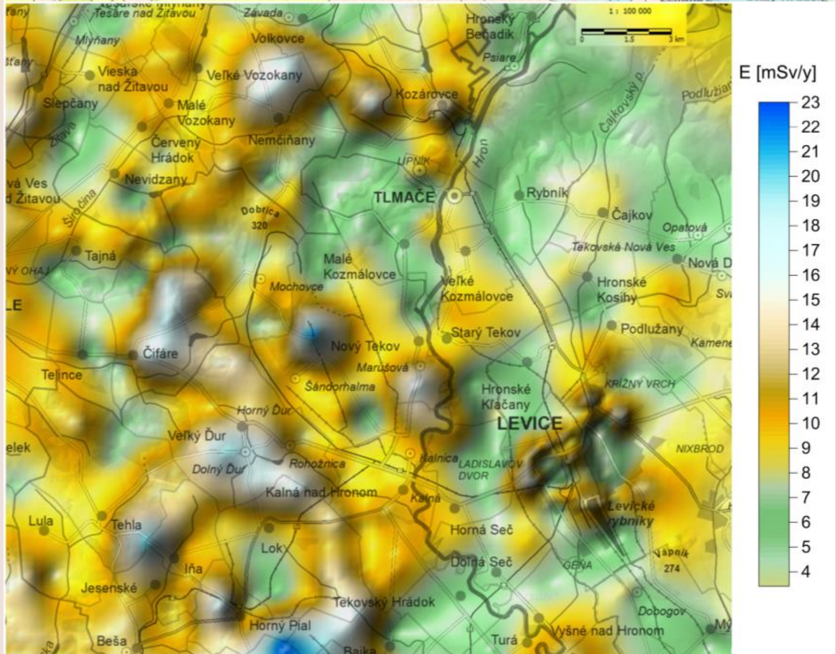
Introduction

- the **EU Council Directive 2013/59/Euratom** – establishment of ***national action plans*** addressing long-term risks from radon exposures in buildings
- identification of the areas where the radon concentration in buildings exceeds the relevant ***national reference level*** *– 300 Bq/m*^{3}
- regions, where indoor radon concentration is increased for natural (geogenic) reasons = **radon prone areas** [Bossew, 2014], are identified:
  - **directly** – indoor measurements [WHO handbook, 2009]
  - **indirectly** – ^{226}Ra, ^{222}Rn concentrations, porosity, permeability, water content, soil type, etc.

- Comparison of four different **indirect approaches** for determining the geogenic radon potential
- **area:** Mochovce, Slovakia (22 x 22 km^2)
- **high density** of measurement points:
  - ~0.6 measurement points per km^2 (**soil air ^{222}Rn** concentrations)
  - ~2 points per km^2 (**^{238}U, ^{232}Th** and **^{40}K** concentrations obtained by gamma spectrometry) [ŠGÚDŠ, 2018]
- increased incidence of deaths due to lung cancer (higher than Slovak national average) – **not caused by Mochovce NPP**
- analysis of effective dose to the population [Bulko et al. RPD, 2017]
- visualization of the **radon potential distribution** in the form of a map – using the geostatical software *Surfer 11*

Geology of the given locality





Results

$$RP = \frac{C_A - 1}{-\log k - 10}$$

Radon index category (RI)	Soil gas radon concentration C_A [kBq/m³]		
Low	$C_A < 30$	$C_A < 20$	$C_A < 10$
Medium	$30 \le C_A < 100$	$20 \le C_A < 70$	$10 \le C_A < 30$
High	$C_A \ge 100$	$C_A \ge 70$	$C_A \ge 30$
Permeability	Low	Medium	High

RP	Radon index category (RI)
RP < 10	Low
10 < RP < 35	Medium
35 < RP	High

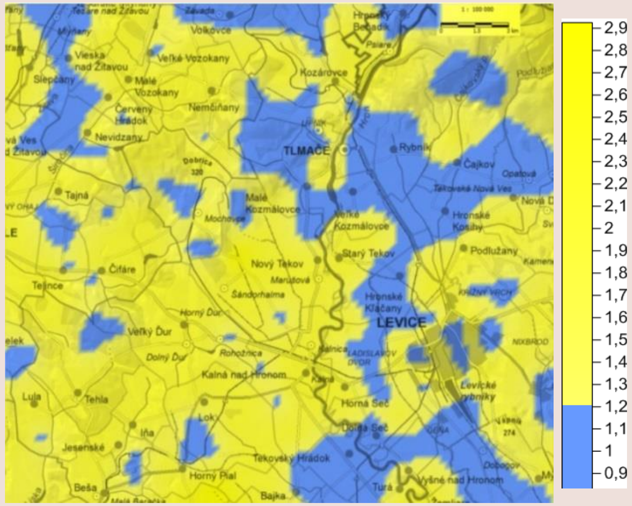
$$Rn_a = \log_{10}(6 C_{sb} k^{0{,}077}) - 3$$

Rn_a	Radon risk category
$Rn_a < 1$	Negligible
$1 < Rn_a < 2$	Low
$2 < Rn_a < 3$	High
$3 < Rn_a$	Very high

(Slunga: RPD, 24. 1-4, 39-42, 1988)

$$RAN = C_\infty M$$

(Tanner: RPD, 24. 1-4, 79-83, 1988)

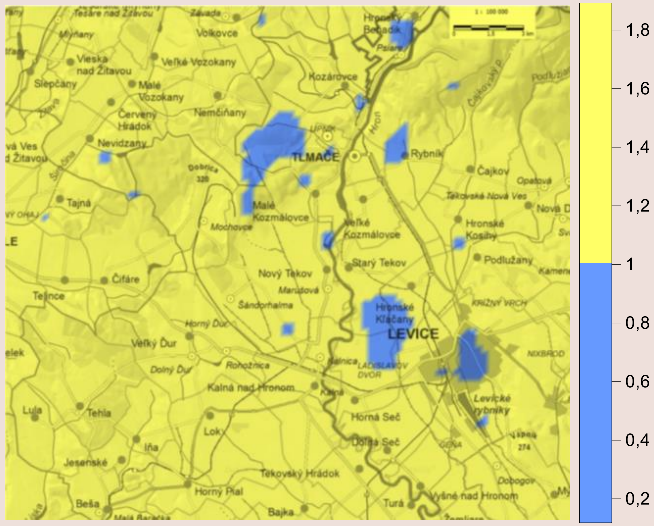


(Neznal et al., Czech Geol. Survey Special Papers, 2004)

1 = low
2 = medium
3 = high

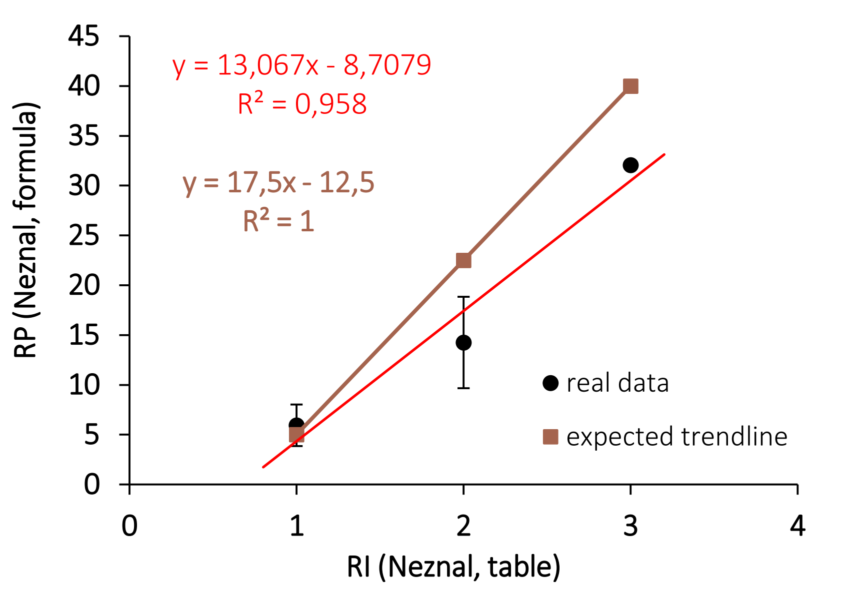
C_A – the radon activity concentration in soil at a depth of 0.8 m [kBq.m^{-3}]
k – the permeability [m^2]

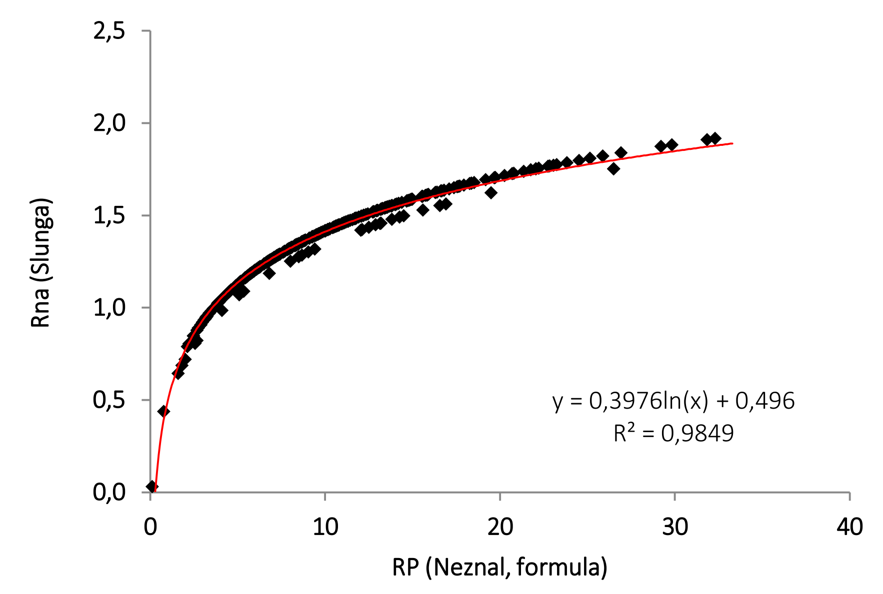
(Neznal et al., Czech Geol. Survey Special Papers, 2004)

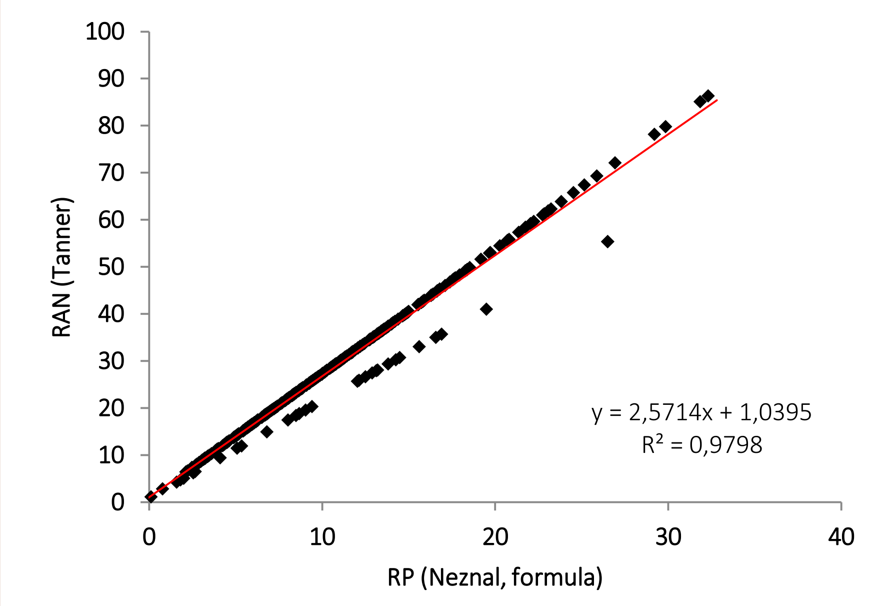


C_{sb} – the saturated radon activity concentration in the soil air [Bq.m^{-3}]
k – the permeability of the soil [m^2]

C_∞ – the saturated radon activity concentration in the soil air [kBq.m^{-3}]
M – the mean migration distance [m]







- **weak correlation** between individual map data
- **strong correlation** between the calculated values of individual approaches
- possibility to change the color scale in order to **show more risky localities**...

Thank you for your attention and I invite you to see our poster.