An updated map on radon risk in Estonia

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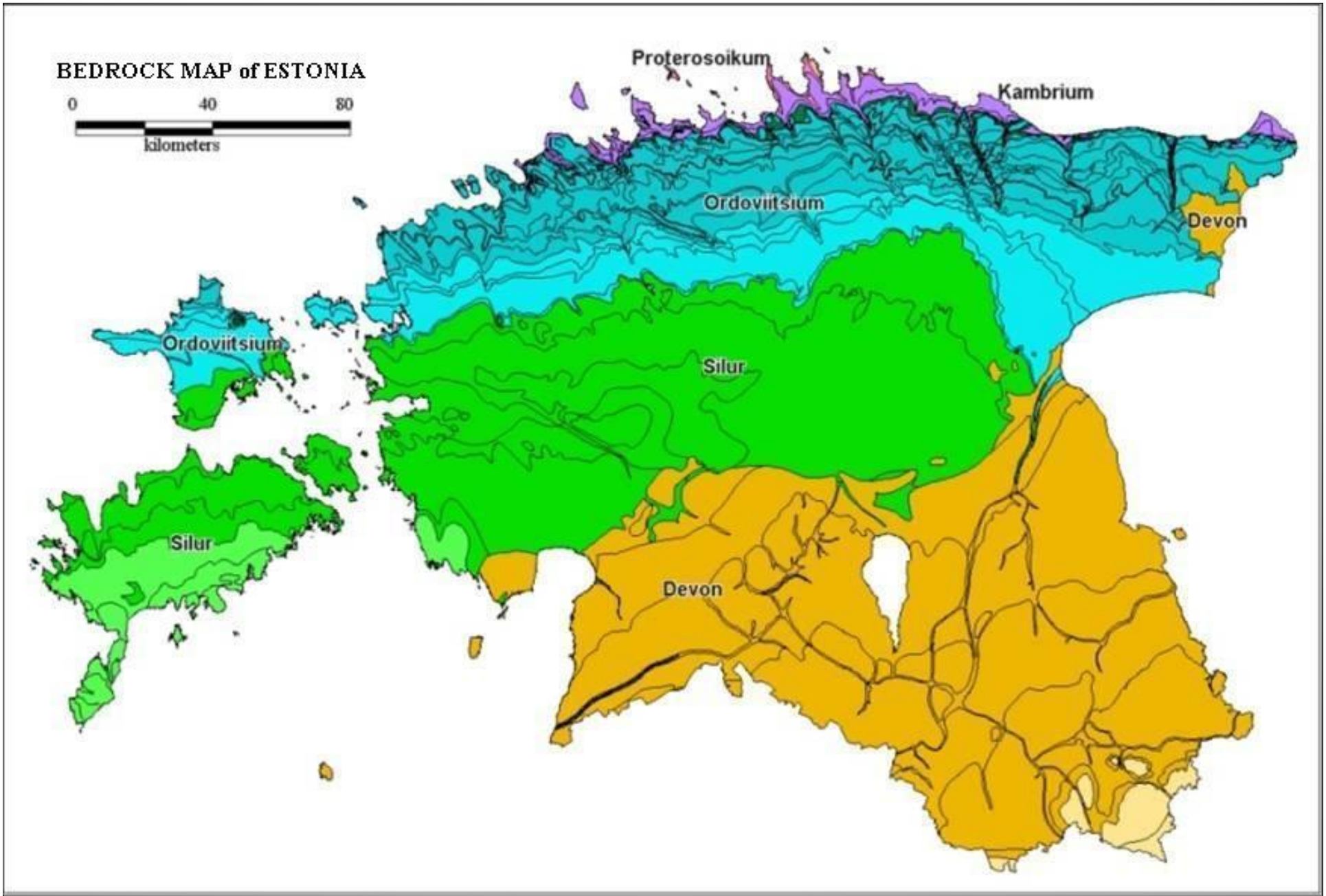
2014

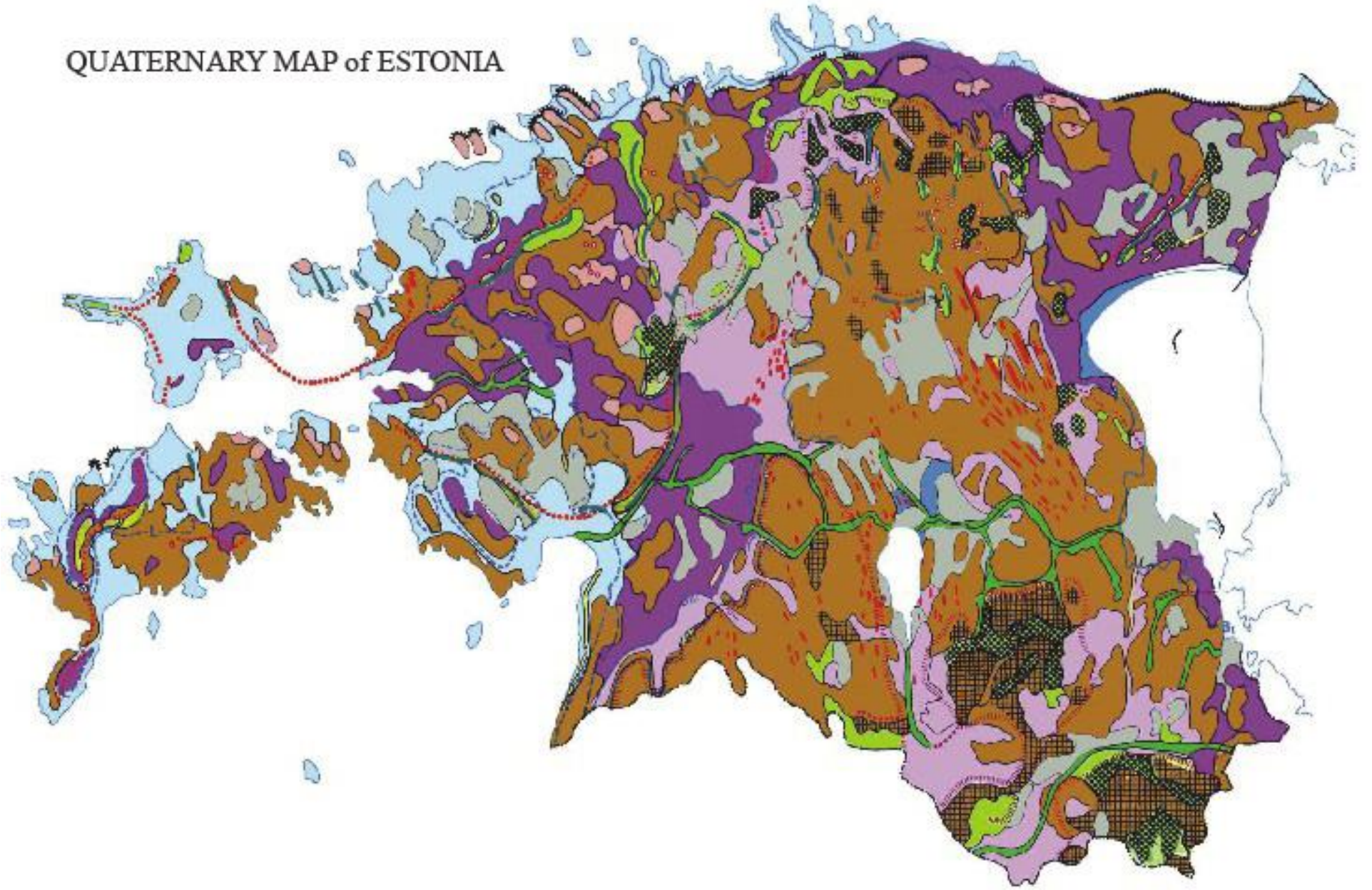
Radon risk mapping in Estonia

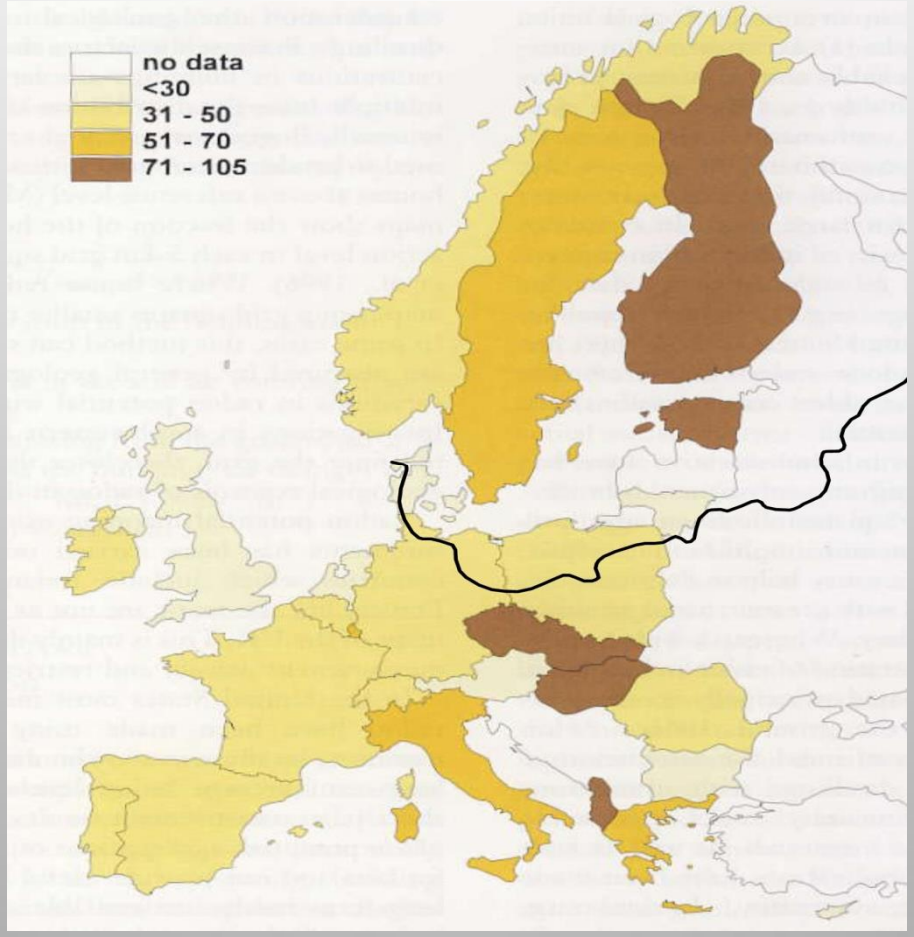
- Geological backround
- Backround of indoor radon
- History
- Methodology
- Preliminary, updated radon risk map


BEDROCK MAP of ESTONIA
0
40
80
kilometers
Proterosoikum
Kambrium
Ordoviitsium
Devon
Ordoviitsium
Silur
Silur
Devon

North-Estonian klint

Graptoliitargilliidi ajutine paljand KUMU kunstimuuseumi juures Kadriorus, Tallinnas


QUATERNARY MAP of ESTONIA



Indoor measurement of **Rn**
The geometric means of indoor Rn (Bq/m^3)
According to data of UNSCEAR, 2000, The black line marks the southern porter of Weichsseli glaciation

In almost **30%** of dwellings Rn content **exceeds** the **200 Bq/m^3** (limit for indoor air according to Estonian law), sometimes up to 3000 Bq/m^3 (Pahapill et al., 2003).

High indoor **Rn** is caused by a high **U** content in Quarternary sediments and in some layers of bedrocks.

The major ones are the **Lower-Ordovician U-rich graptolite argillite** (Dictyonema shale) and **obolus sandstone spreading** in the klint zone.

First Rn risk map of Estonia

- scale **1:500 000**
- compiled during **2001– 2005**
- based on data from **566 measuring** points.
- In accordance with Estonian Standards, the **Radon-222 Risk**.

Auxiliary maps

- **eU, *e*Th** and ***e*K** content in the most relevant **lithotypes of Quaternary cover**
- **Natural radiation**
- Map of factual material **(Observation points on Quaternary map)**

The updated Rn risk map of Estonia

- scale **1:500 000**
- compiled during **2001ï 2014**
- based on data from approx. **1054 measuring** points.
- in accordance with Estonian standards, the **Radon-222 Risk**.

Auxiliary maps

- **eU, *e*Th** and ***e*K** content in the most relevant **lithotypes of Quaternary cover**
- **Natural radiation**
- Map of factual material **(Observation points on Quaternary map)**

Important concepts used in this presentation

Radon - 222 (Rn)

U-238 Ÿ Ra-226 Ÿ Rn-222

Natural radiation
∑ = U-238 + Thï 232 + K-40 (followig Estonian legislation)

Uranium (U)
∑ = U-238 (99,27%) + U-235 (0,72%) (isotopes)
.
***e*U --** balance between **Ra-226 and U-238** content
***e*Th** -- balance between **Th-232** and **Th**
eK -- balance between **K-40** and **K**

RnG -- maximum Rn content originating from the **Ra ï 226** decay process
RnM -- Rn content preserved in the soil air

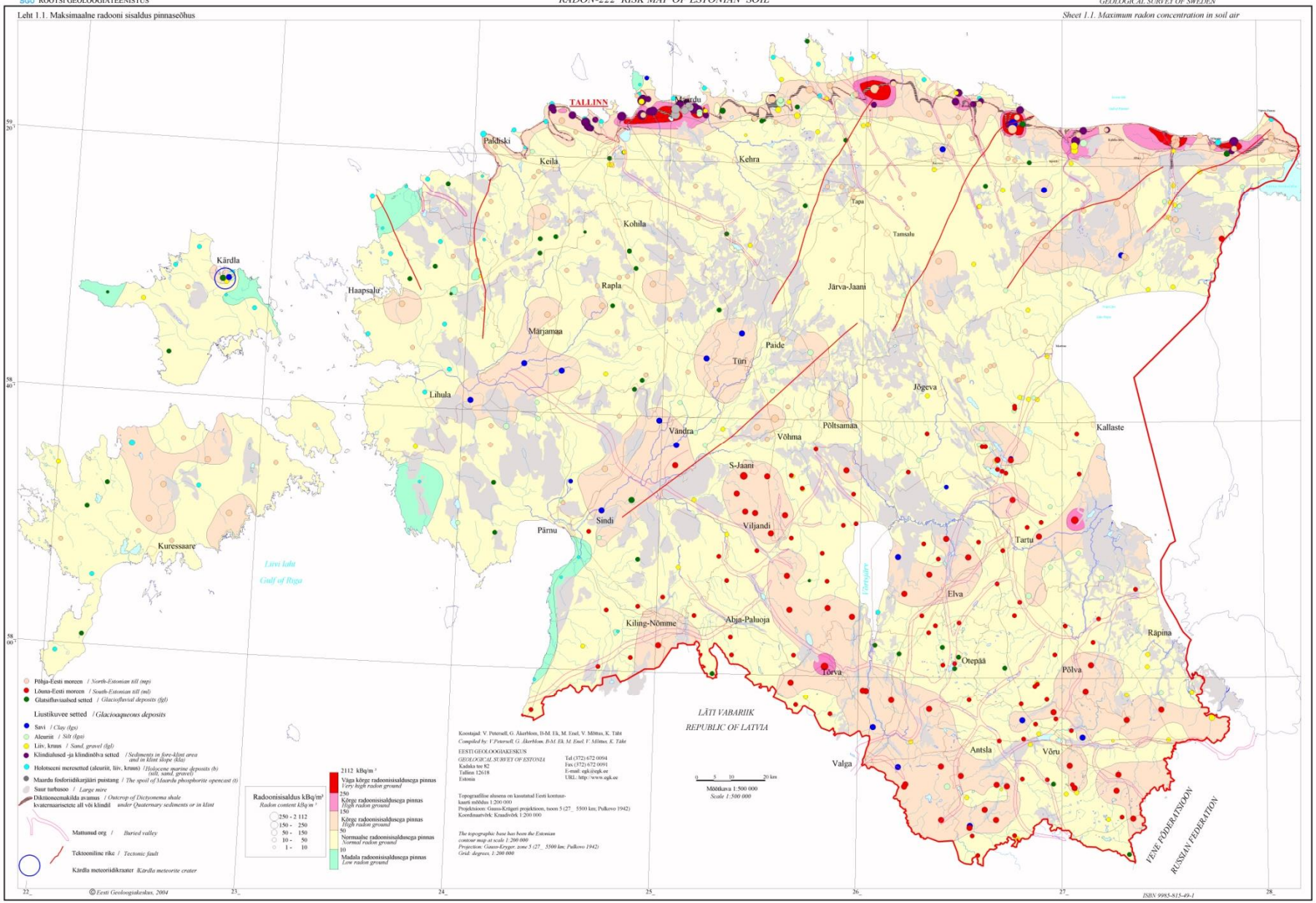
EESTI GEOLOOGIAKESKUS
ROOTSI KIIRGUSKAITSE INSTITUUT
SGU ROOTSI GEOLOOGIATEENISTUS

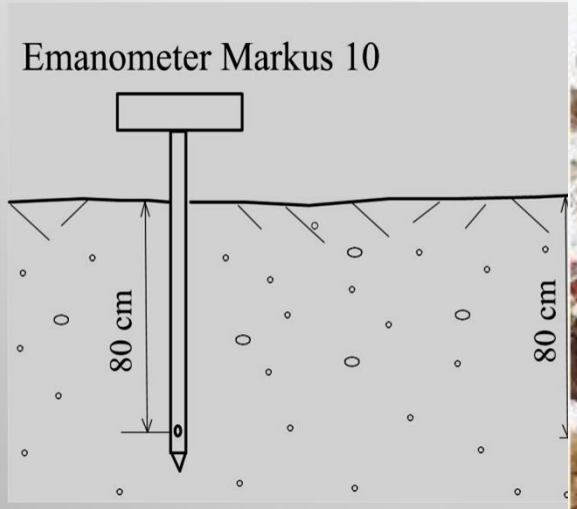
EESTI PINNASE RADOONI-222 SISALDUSE KAART
RADON-222 RISK MAP OF ESTONIAN SOIL

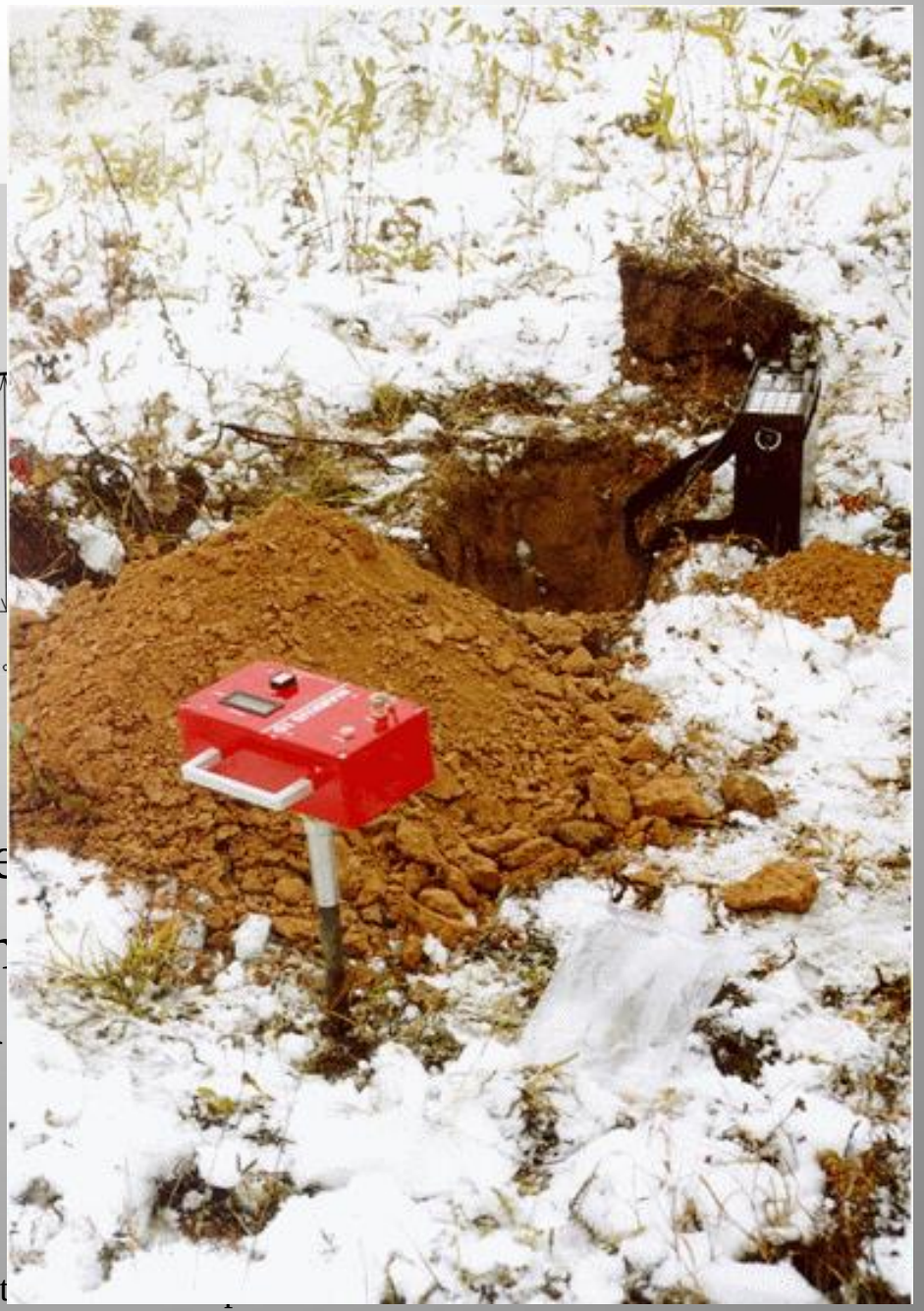
GEOLOGICAL SURVEY OF ESTONIA
SWEDISH RADIATION PROTECTION AUTHORITY
GEOLOGICAL SURVEY OF SWEDEN

Leht 1.1. Maksimaalne radooni sisaldus pinnaseõhus

Sheet 1.1. Maximum radon concentration in soil air







- Markus 10 - **Rn** content prese
- Portable gamma ray spectrom
  uranium ***e*U**), from which **Rn**

Measurements

ÅRnM was measured at a depth of 80 cm with the emanometer Markus 10.
ÅRnG measured in soil with a **gamma spectrometer** in the bottom of a hole at the same depth.
ÅIn addition, with the **gamma spectrometer**, the concentration of ***e*Th** as calculated from ^{232}Th and ***e*K** as calculated from ^{40}K were measured in soil.
Å**Lithology** was defined visually

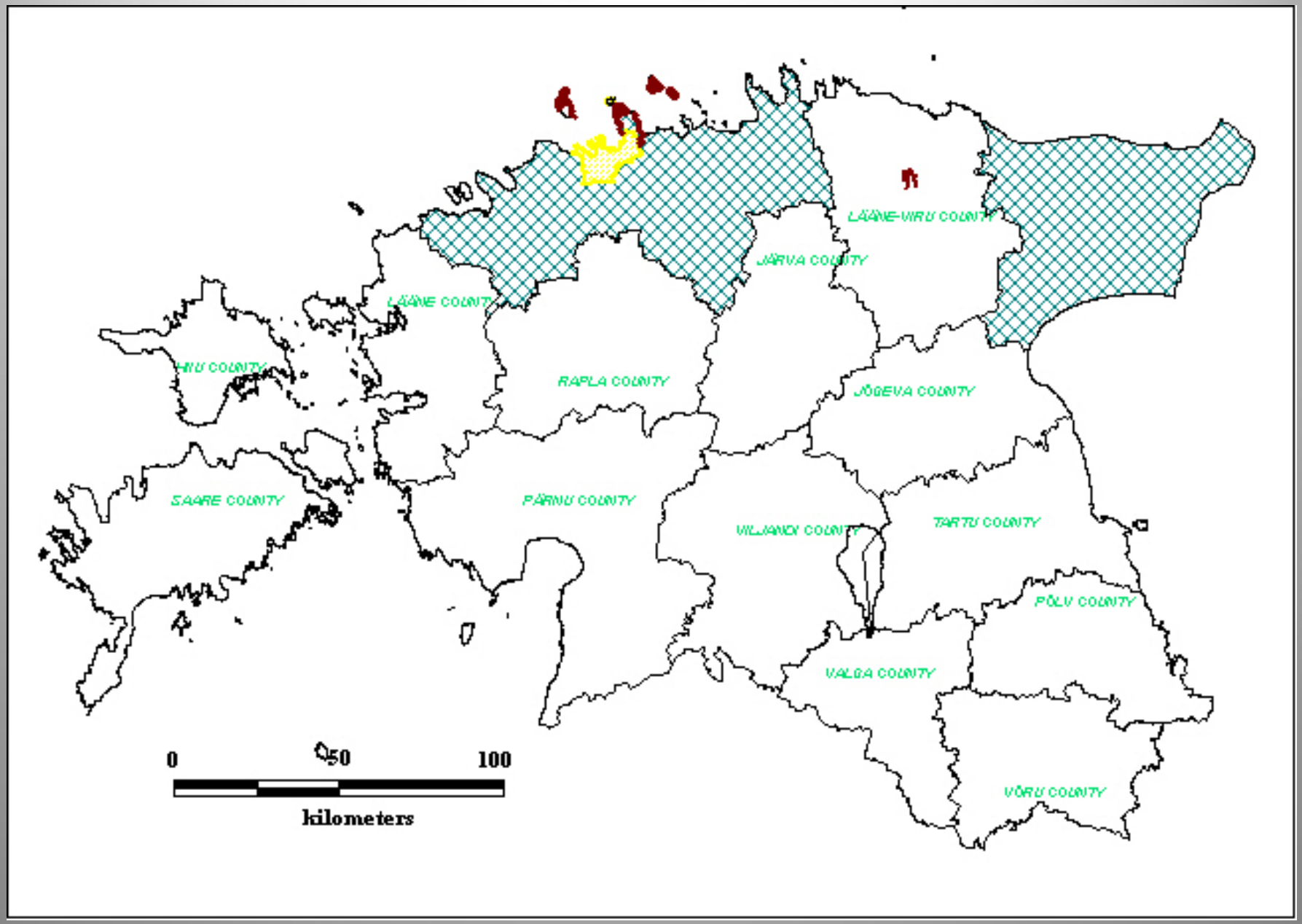
Control measurements were made using the same and a parallel set of instruments. In addition U, Th and K and *e*U, *e*Th and *e*K contents of soil samples were analysed in a **laboratory conditions**.

LEGAL CONTEXT

There is an Estonian **regulation** limiting **indoor** radon concentrations in new dwellings to **200 Bq/m^3**

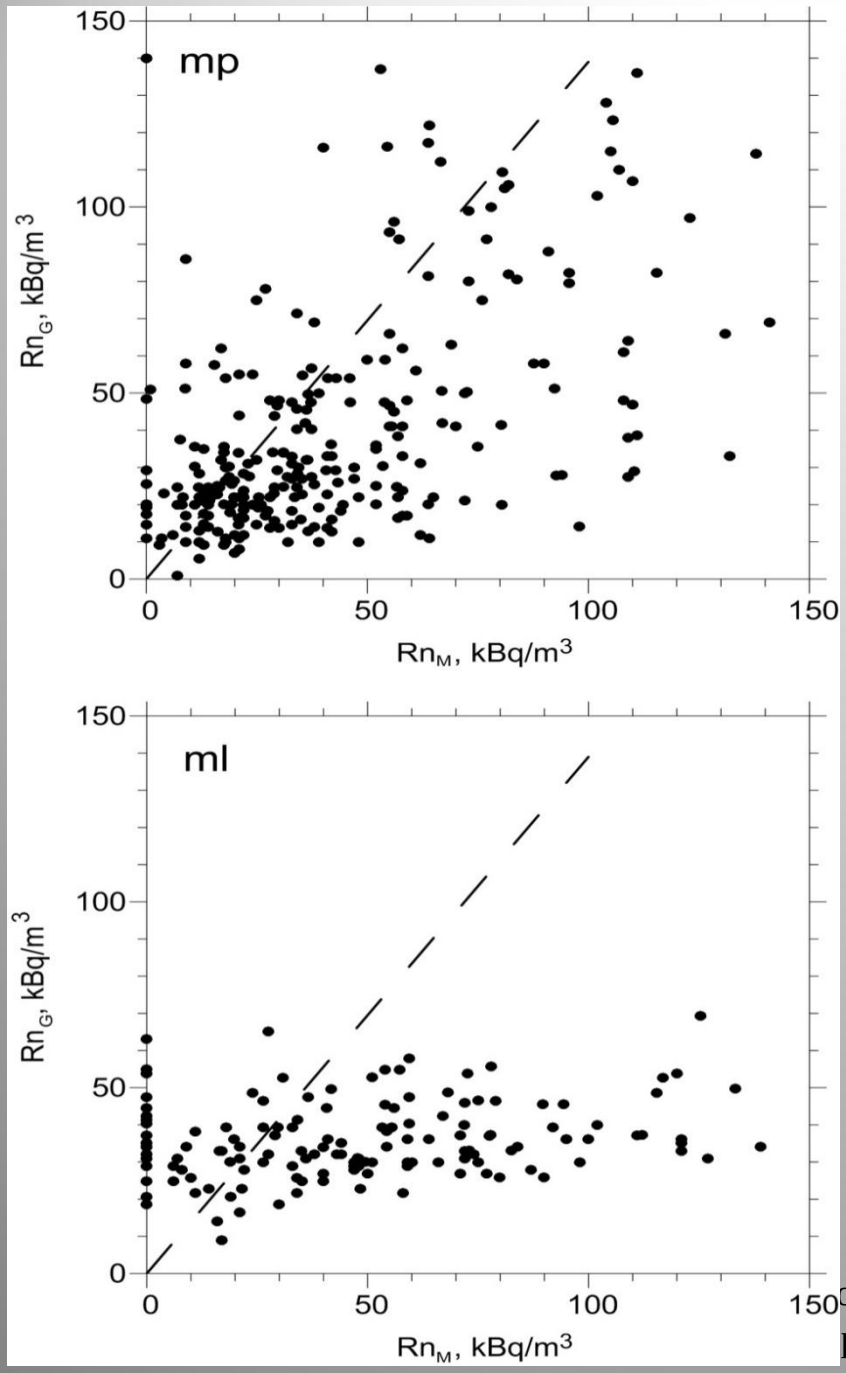
Equally, in Estonia, there is **legislation** for **outdoor** Radon concentrations that need to be respected.

A Rn concentration of up to **50 kBq/m^3** does not require **remedial action** against in-leakage, but higher results indeed require action against high Rn.


LÄÄNE-VIRU COUNTY
JÄRVA COUNTY
LÄÄNE COUNTY
HIU COUNTY
RAPLA COUNTY
JÕGEVA COUNTY
SAARE COUNTY
PÄRNU COUNTY
VILJANDI COUNTY
TARTU COUNTY
PÕLVA COUNTY
VALGA COUNTY
VÕRU COUNTY
0
50
100
kilometers

Problems

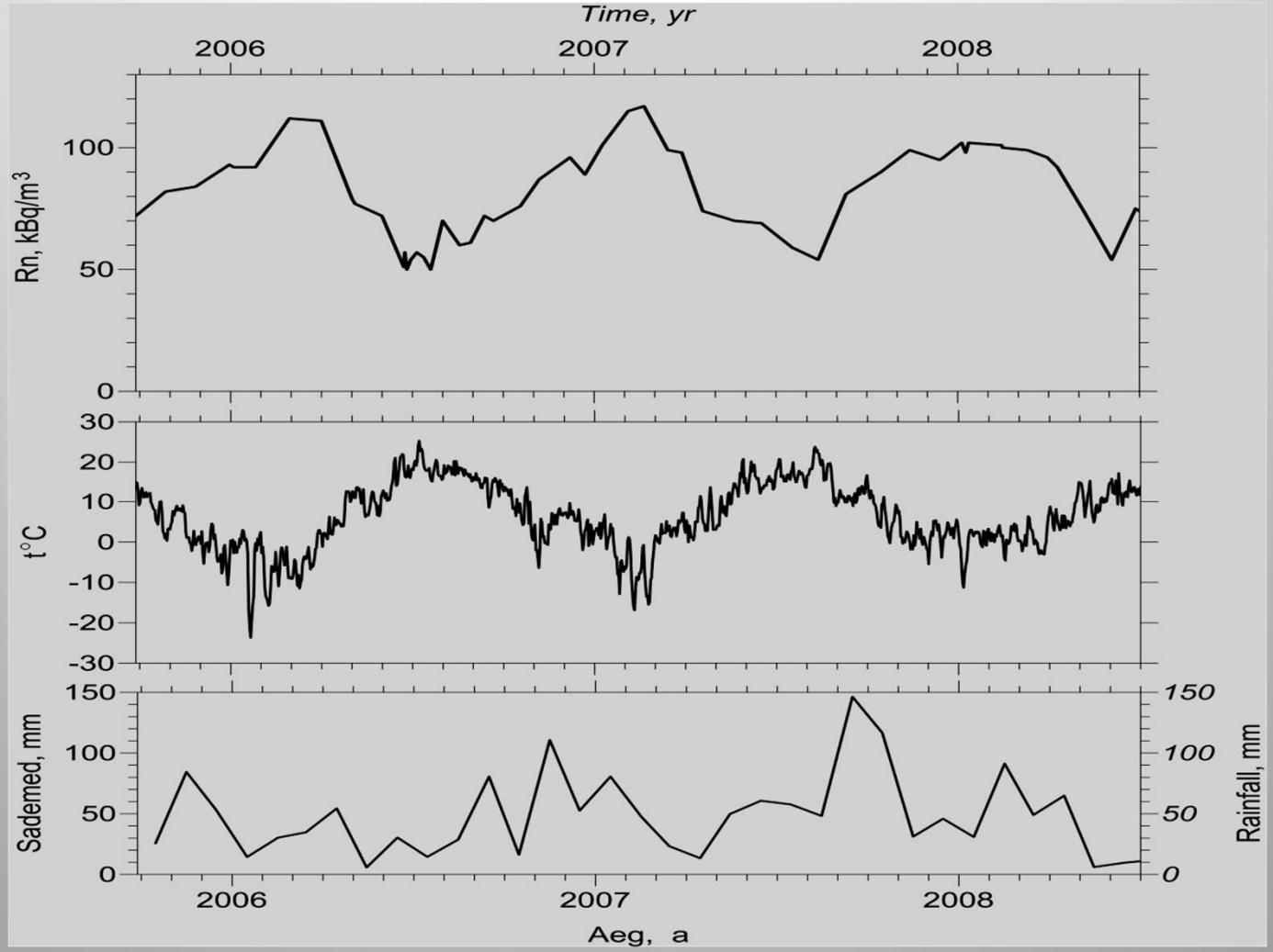
- The results obtained by the two different methods can vary significantly.
- In addition results depend on different types of soil and on the weather et cetera



Comparison of **Rn** content in soil air by direct measurements (**RnM**, **X**-axis) and calculated after
***e*U** (RnG, **Y**-axis), kBq/m^3;

mp ï till in northern Estonia
ml ï till in southern Estonia.

*The dashed line marks natural equilibrium between the contents

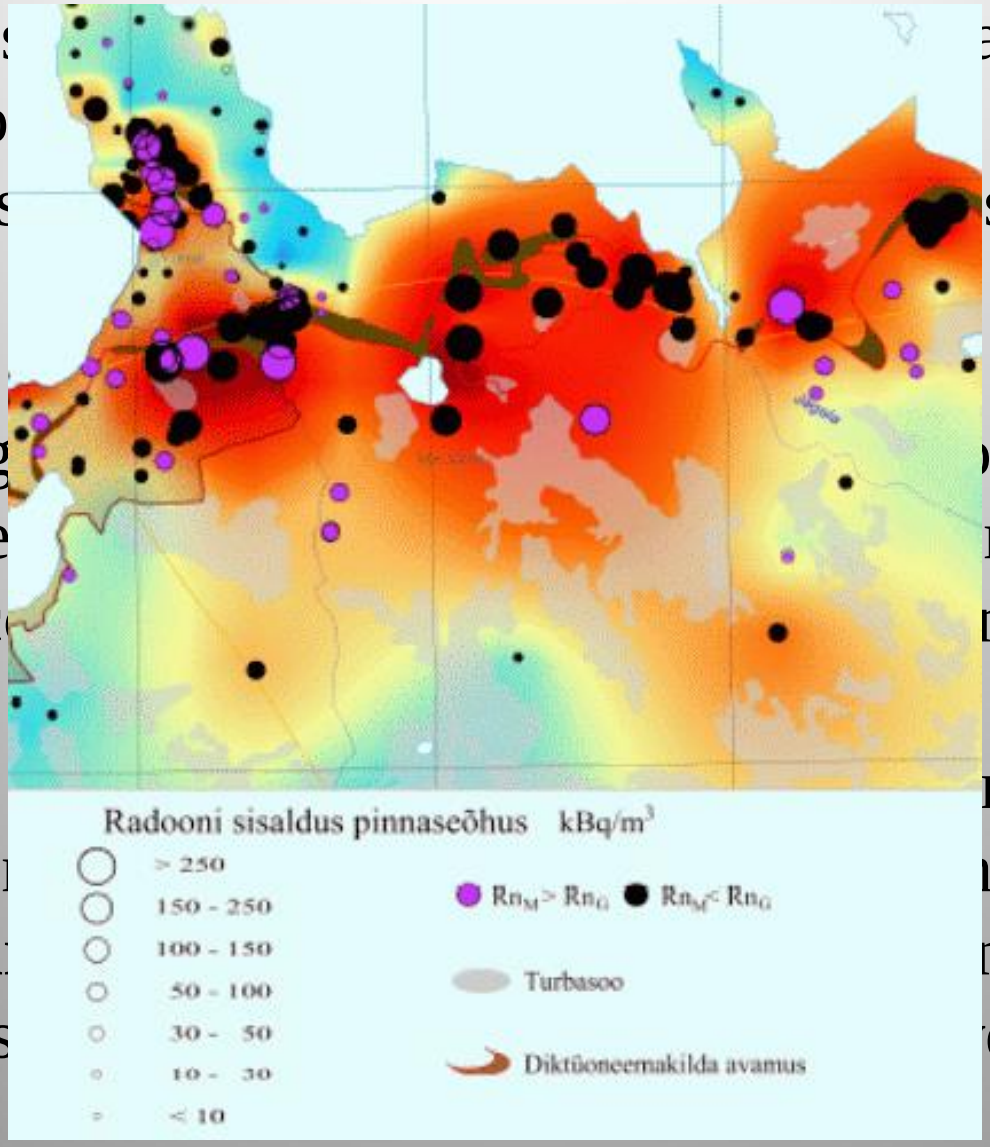


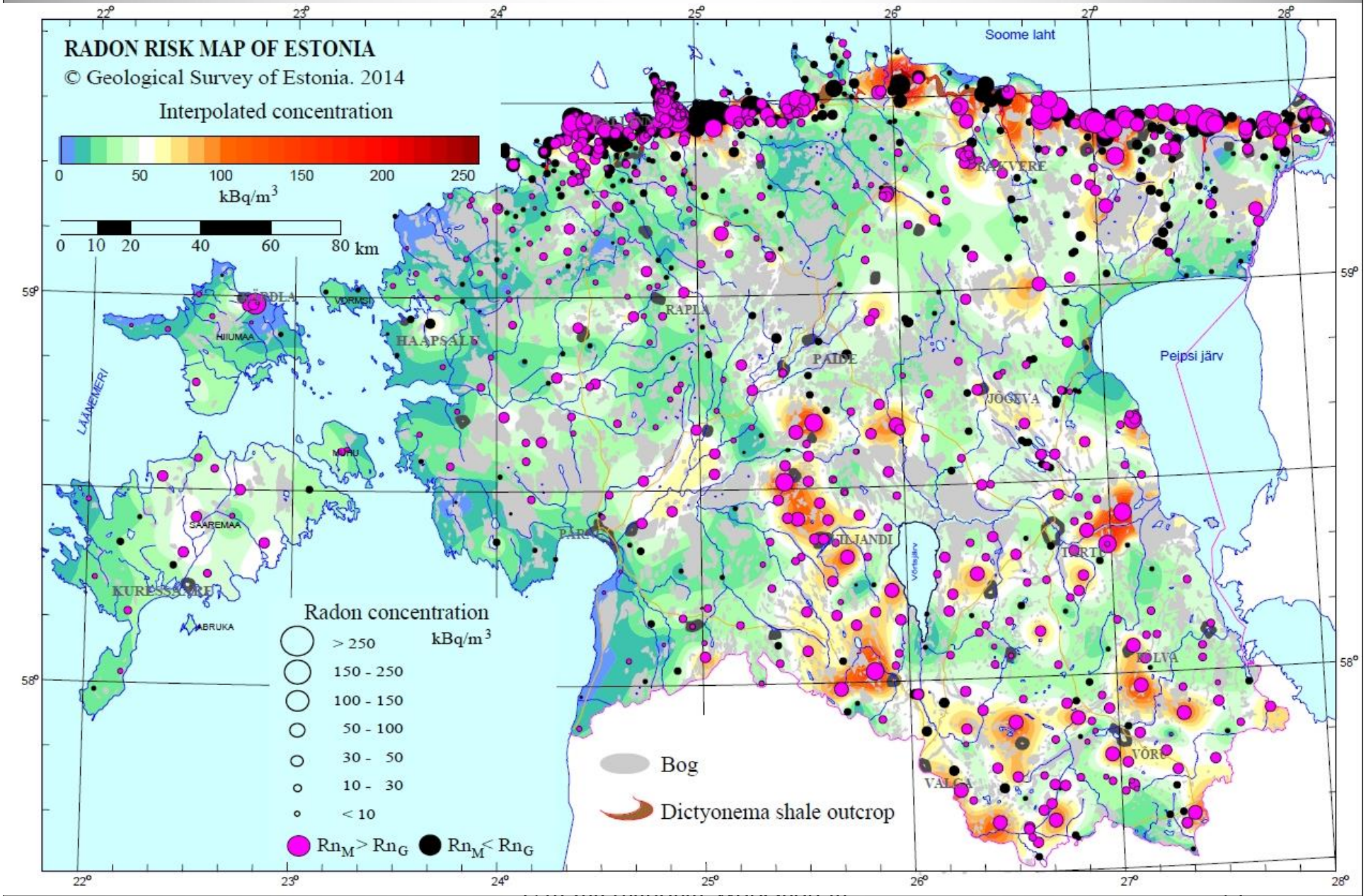
Monitoring points on Kadaka tee (EGK premises Tallinn)
RnM-content, air temperature and precipitation
RnG at a depth of 80 cm : 50-56 kBq/m3; at a depth of 160 cm 110 kBq/m^3

The studie ache on the surface fro et al., 2012), mos s (N, He, etc.).

Depending om these depths, the may exceed the **RnG** c mes.

On the Rn ntent is plotted usi in soil air, with the **ci** n source and the circleôs **el** of Rn risk.




RADON RISK MAP OF ESTONIA
© Geological Survey of Estonia. 2014
Interpolated concentration
0 50 100 150 200 250
kBq/m3
0 10 20 40 60 80 km
Radon concentration
kBq/m3
> 250
150 - 250
100 - 150
50 - 100
30 - 50
10 - 30
< 10
RnM > RnG
RnM < RnG
Bog
Dictyonema shale outcrop
Soome laht
Peipsi järv
LÄÄNEMERI
HIIUMAA
SAAREMAA
KURESSAARE
ABRUKA
HAAPSALU
RAPLA
PÄRNU
PÕLVA
VÕRU
VALGA
TARTU
JÕGEVA
RAKVERE
VORMSI
22°
23°
24°
25°
26°
27°
28°
59°
58°

Results after update of the radon map

33% of the Estonian territory the radon risk exceeds the limet considered safe for unrestricted construction i.e.50 kBq/m^3.

In such high Rn ri sk areas the Rn ranges from 50 to 400 kBq/m^3 and in a few cases up to 1802 kBq/m^3.

Areas of Rn risk are found all over Estonia, however the most hazardous areas are situated along the North Estonian Klint.

The updated map on radon risk in Estonia deepens and confirms the findings of the first map!

THANK YOU!!!