# House characteristics in the Finnish indoor radon database

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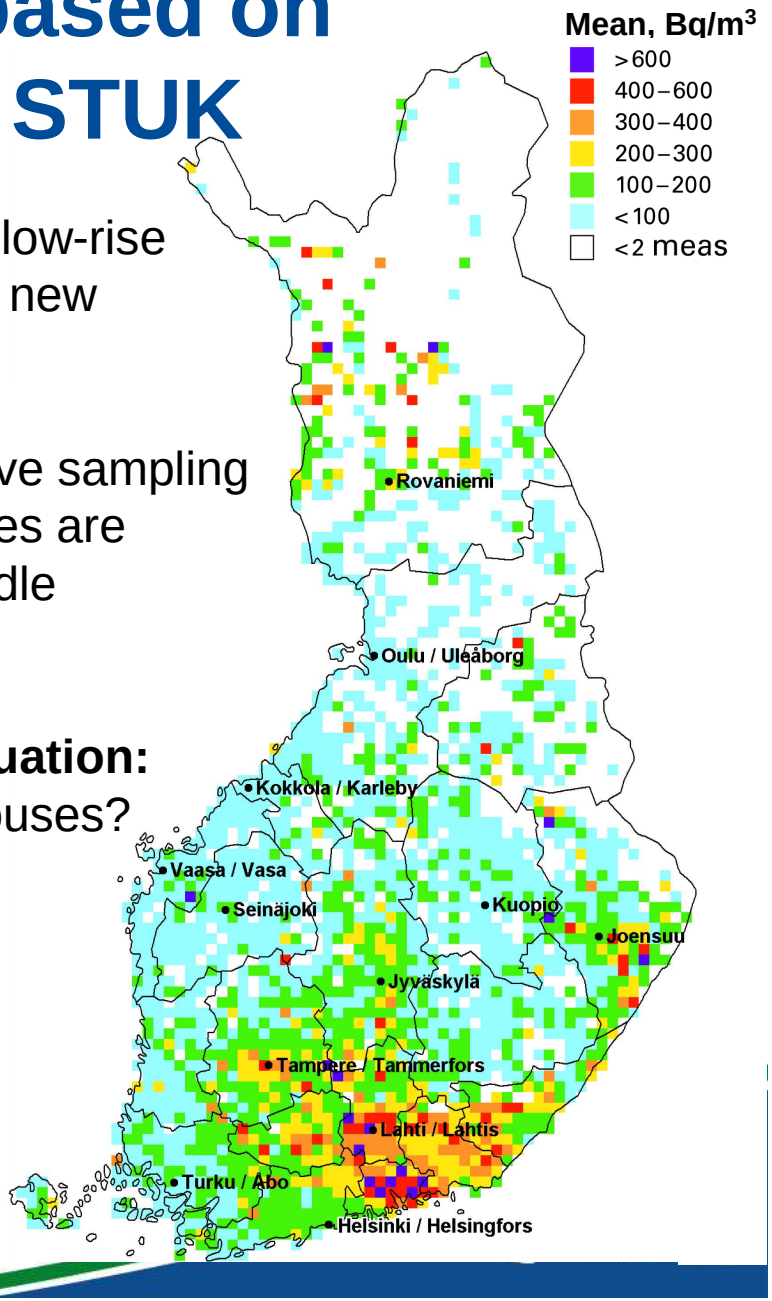
# Finnish radon maps are based on indoor measurements by STUK

- STUK database contains 75 270 dwellings in low-rise buildings with a known location (thousands of new dwellings every year)

- Measurements are not based on representative sampling but are sold to customers => some house types are overrepresented in the database. How to handle the situation when data is applied to

**1. Studying the regional/national radon situation:**
What is the concentration in the existing houses?
***Bias in the database material skews the result, if not compensated for.***

**2. Locating radon-prone areas:**
What would be the concentration in a standard house?

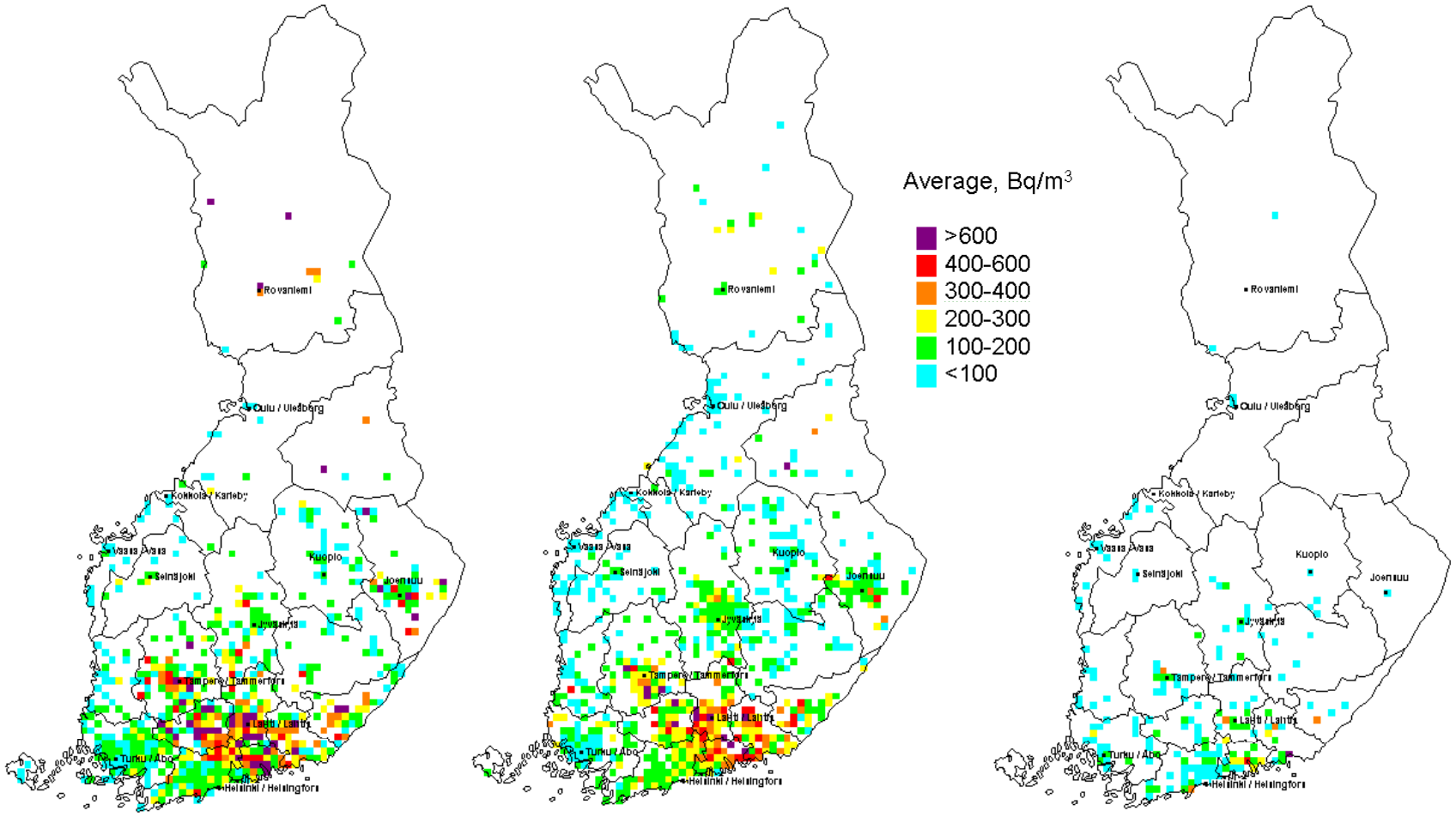


# Foundation type makes a difference

Semi-basement

Slab-on-ground

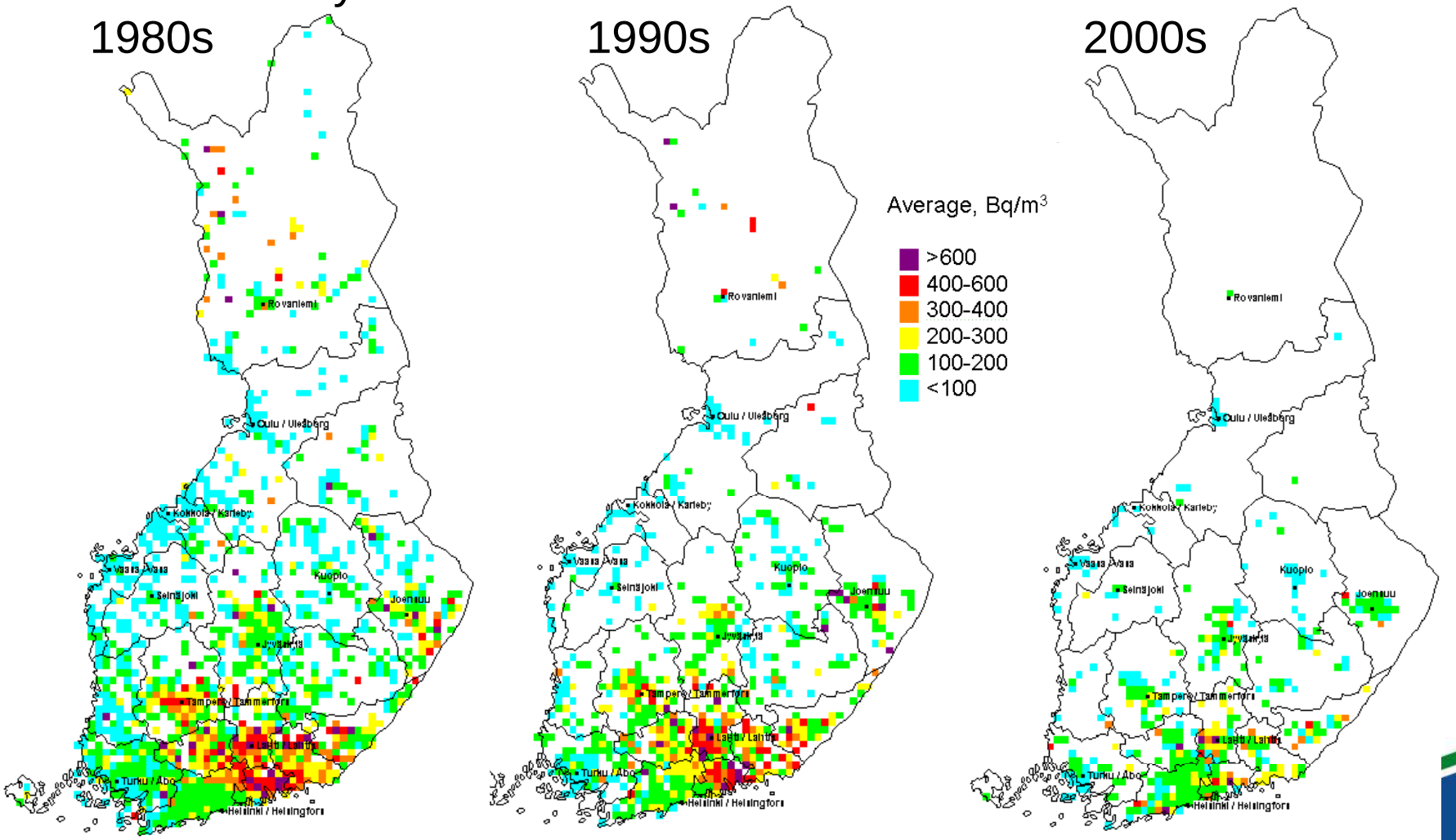
Crawl space



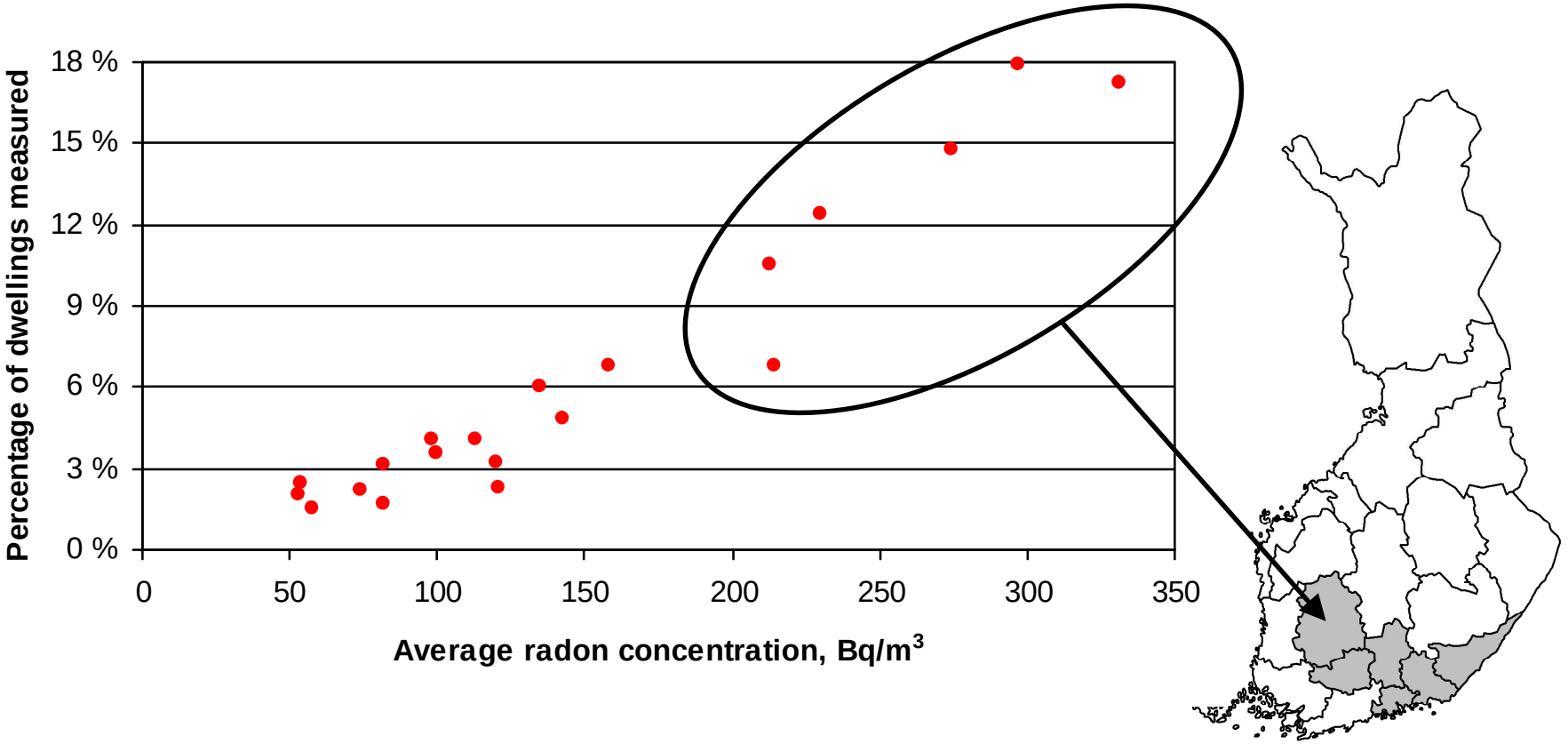

All Radon maps from Valmari et al. **Radon Atlas of Finland 2010** (download from www.stuk.fi)

# Lower radon levels in new houses

Construction year

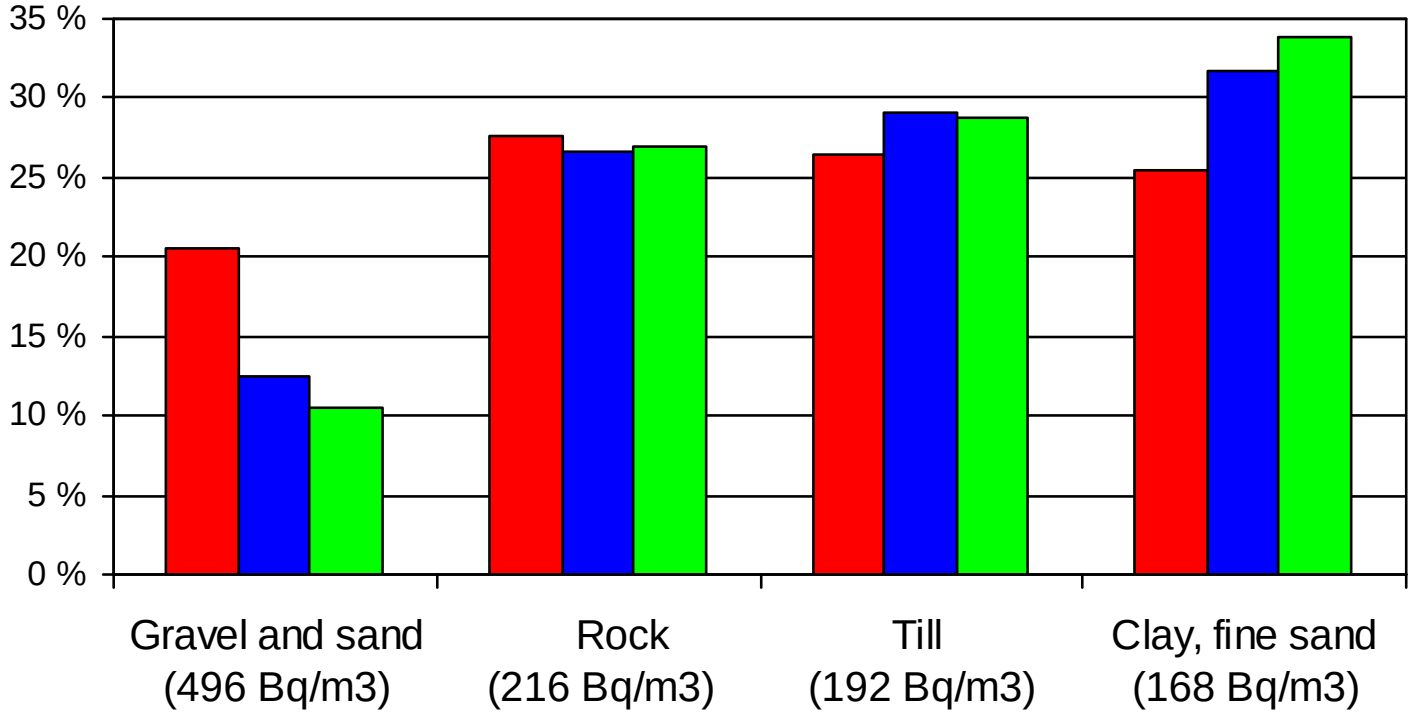


# Measurement activity is the highest in radon-prone areas




**AM, measured houses** **227 Bq/m$^3$**
**Estimated national AM, all houses 137 Bq/m$^3$** (AM in 1 km$^{-2}$ grid cells, weighted by dwelling-density).

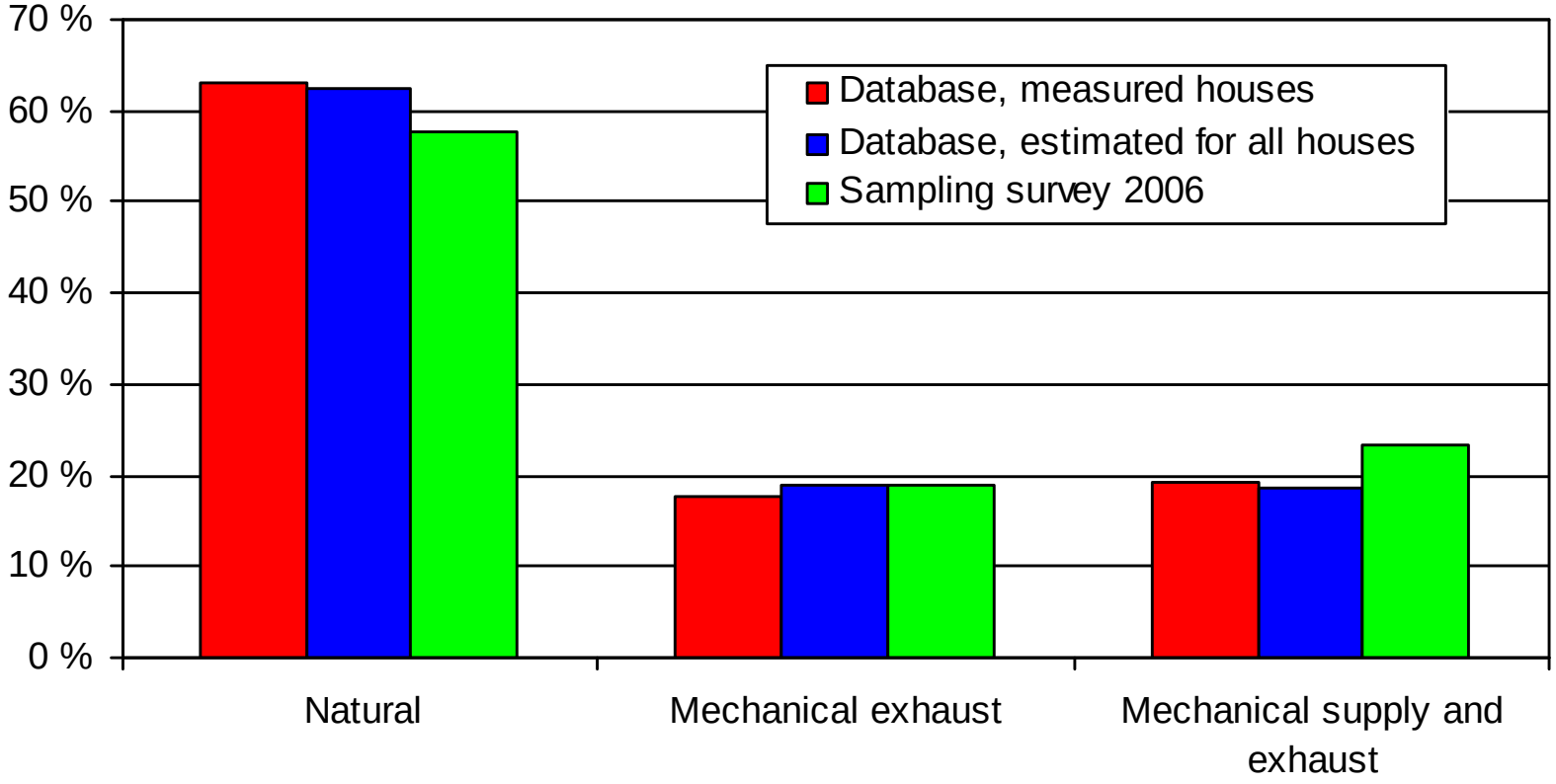
# Database vs. representative sampling survey: Soil type




- = Measured houses (6% of all the houses)
- = All houses, assuming non-measured houses to be similar to the measured houses within each 1-km$^2$ square
- = Random sampling survey 2006

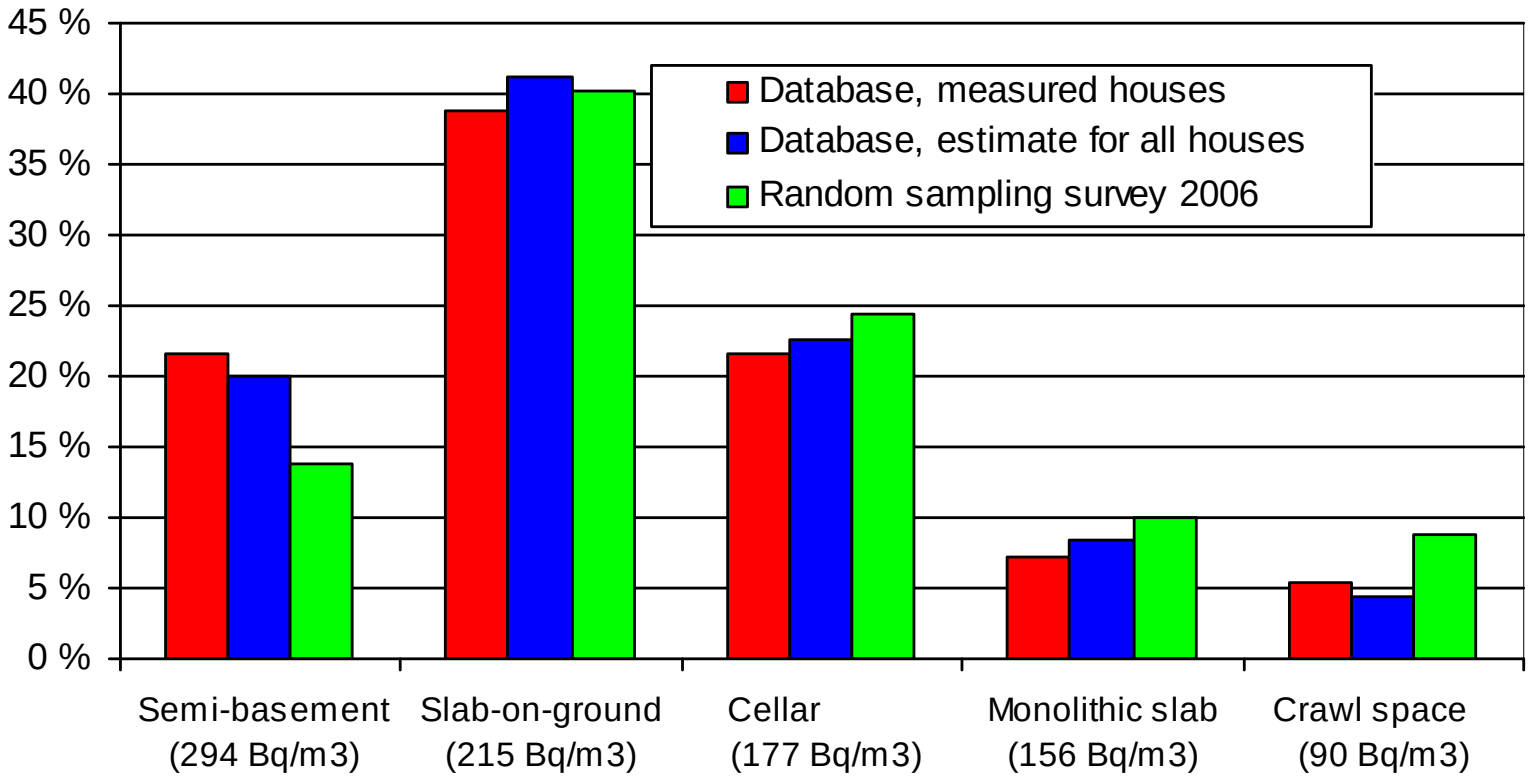
**Houses built on gravel and sand are overrepresented because these soil types are associated with radon-prone areas where the measurement activity is high.**

# Database vs. representative sampling survey: Ventilation strategy




**Database material agrees well with the random sampling survey.**

# Database vs. representative sampling survey: Foundation type



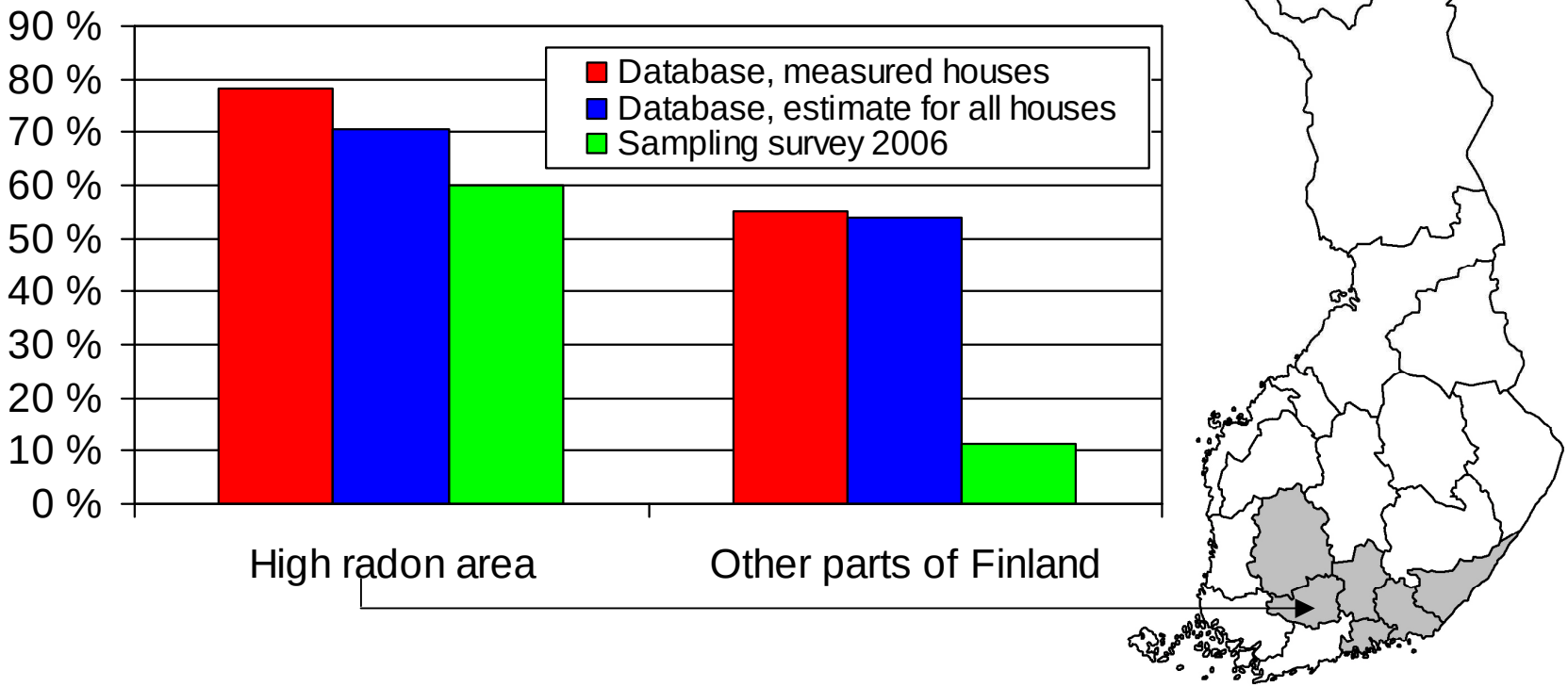

**Semi-basement houses are overrepresented.**

# Correction of foundation type distribution by selecting a modified sub-sample => 4 Bq/m$^3$ decrease in national arithmetic mean

| | Foundation type distribution similar to the | |
|---|---|---|
| | **Database** | **Random sampling survey** |
| No basement, slab-on-ground | 1 854 | 7 103 |
| No basement, other type of foundation | 812 | 3 800 |
| No basement, foundation type n.a. | 4 058 | 0 |
| Cellar or partial cellar | 2 601 | 4 303 |
| Semi-basement | 2 571 | 2 425 |
| Not known | 5 735 | 0 |
| Total | 17 631 | 17 631 |
| **AM (calculated in 1-km$^2$ cells, weighted by dwelling-density):** | **141 Bq/m$^3$** | **137 Bq/m$^3$** |

# Database vs. representative sampling survey: Radon prevention

**Figure: Radon piping installed on slab-on-ground houses built since 1995**




**Houses with radon prevention are strongly overrepresented, especially outside the high-radon area.**

# Radon preventive measures implemented in new houses - implications for the database material utilisation

**Areas with low radon prevention activity (14 provinces)**

- Finding local radon-prone areas remains important
- Standard house-maps for more comparability

**Areas with high radon prevention activity (6 provinces)**

- are already considered radon-prone
- The data from new houses can be used to verify the effectiveness of the radon preventive measures (the data from old houses before preventive measures form a baseline).

# Representative radon maps based on standard house- approach

- To demonstrate the risk, the standard house should not have active radon preventive measures implemented

- Otherwise, it should have the properties of a typical present-day Finnish house:
  - Slab-on-ground
  - Mechanical supply and exhaust ventilation

- Generating a standard house-map:
  - Houses with different foundation and ventilation can be included using correction factors evaluated by analysing the database material.
  - Exclude houses with radon preventive measures implemented.

# Conclusions

- Houses most likely to be measured:
  Located in radon-prone areas, radon-prone foundation type and radon prevention implemented

- Bias in the database material can be compensated for, if the correct distribution is known (random sampling surveys).

- Local increase in radon prevention changes the objective of the measurement data utilisation
  **from** locating radon-prone areas
  **to** evaluating the effectiveness of the radon prevention