The Austrian Radon Mapping Strategies
– Status, Approaches, Experiences and Perspectives

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12th International Workshop GARRM, Prague, 16-19 September 2014

Legal Background

- 1992: **Austrian Radiation Protection Commission:** *„Recommendation concerning reference levels for indoor radon*"(based on 1990 publications by EC and ICRP):
  - Ÿ Set up radon potential map (one recommendation among others)

- 2004: **Radiation protection law** (StrSchG, amendment, §38b):
  - Ÿ The responsible ministry is legally obliged, among other points, to set up radon maps and to inform the public on regions with eleveated radon potential

Ÿ Work for radon map started already in 1992 in Austria

- 2014: **EURATOM BSS**

Ÿ Article 103 (3): Member states shall **identify areas** where the radon concentration (as an annual average) in a significant number of buildings is expected to exceed the relevant national reference level

Ÿ Article 54 (2): Member states shall require **that radon measurements** are carried out in **workplaces** within the areas identified in accordance with article 103 (3)

Ÿ Identification of „radon areas" will be basis for legal decisions and future measures

Purpose of the radon map

Present

Graded approach and graded measures according to level of radon risk for

- Type of preventive measures (simple to complex, Austrian standard ÖNORM S 5280-2)
- Financial aid (eg. for preventive measures or radon measurements in radon prone areas)
- Measurement campaigns (focus on radon prone areas)
- Risk communication (focus on radon prone areas)

Future (EU-BSS)

In addition:

- Radon measurements at workplaces in the basement and at ground floor in radon prone areas

First Austrian Radon map (1992-2004)

Scientific coordinator: Prof. Harry Friedmann (University of Vienna)

Starting point: Recommendation by the Austrian Radiation Protection Commission to set up a radon map (1992)

Austrian National Radon Project (ÖNRAP) – to evaluate the radon concentration in Austrian dwellings and identify areas with high radon concentrations

Strategy:

Applied:

1. Indoor radon measurement
2. Radon gas
3. Random selection of homes
4. Measurement in the most used rooms
5. Measurement density proportional to population density

Denied:

1. Analysis of geology
2. Radon progeny
3. Selected groups (teacher, fire-fighters, …)
4. Measurements in the basement
5. Measurement density constant (e.g. on a grid)

Ÿ *Results representative for inhabited areas, no prediction for future settlement areas*

First Austrian Radon map (1992-2004)

- All Austrian institutions which have experience in radon measurement should participate Ÿ **different measurement systems** used (test and comparison measurements carried out; track etch, electret, charcoal/LSC)

- The results should be published on **basis of municipalities**

- The **sample** was taken from the **telephone register** with a fixed step size (within the questionnaire several questions were the same as in the last national census Ÿ The distributions of the answers were the same Ÿ unbiased sample)

- The distribution was made by **interviewers** Ÿ Interviewers have to be informed and trained about project and radon; all data must be checked carefully on reliability

- The **questionnaire** shall be kept short (one page) and questions shall be short and clear (multiple choice questions preferable) and repeatedly **tested and improved** before using in a survey and the testing should include members of **different social groups**

First Austrian Radon map (1992-2004)

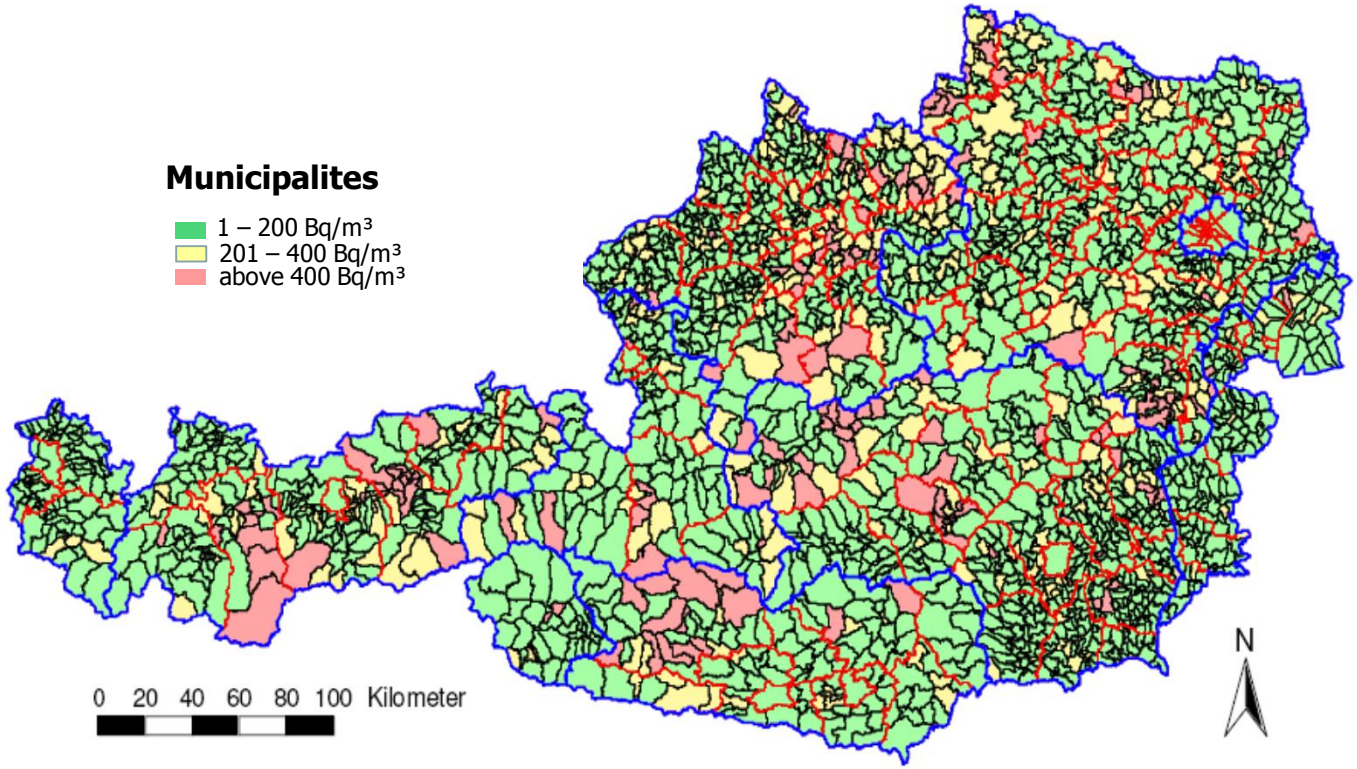
Calculation of the Radon Potential

- Indoor radon concentration depends on many parameters (house type, floor where the measurement was made, social behavior, …)
  Ÿ do not get direct information on the radon risk from the ground (geogenic radon risk)

- Introduction of the "Radon Potential": Annual mean radon concentration in a standard situation (living room or bed room at ground floor, no basement, number of adults + children, …); computed for each dwelling, mean of radon potential of all measured dwellings in a municipality is the radon potential assigned to that municipality

- 3 classes (I – low: < 200 Bq/m³, II – medium: 200-400 Bq/m³, III – high radon risk area: > 400 Bq/m³)

First Austrian Radon map (until 2012)

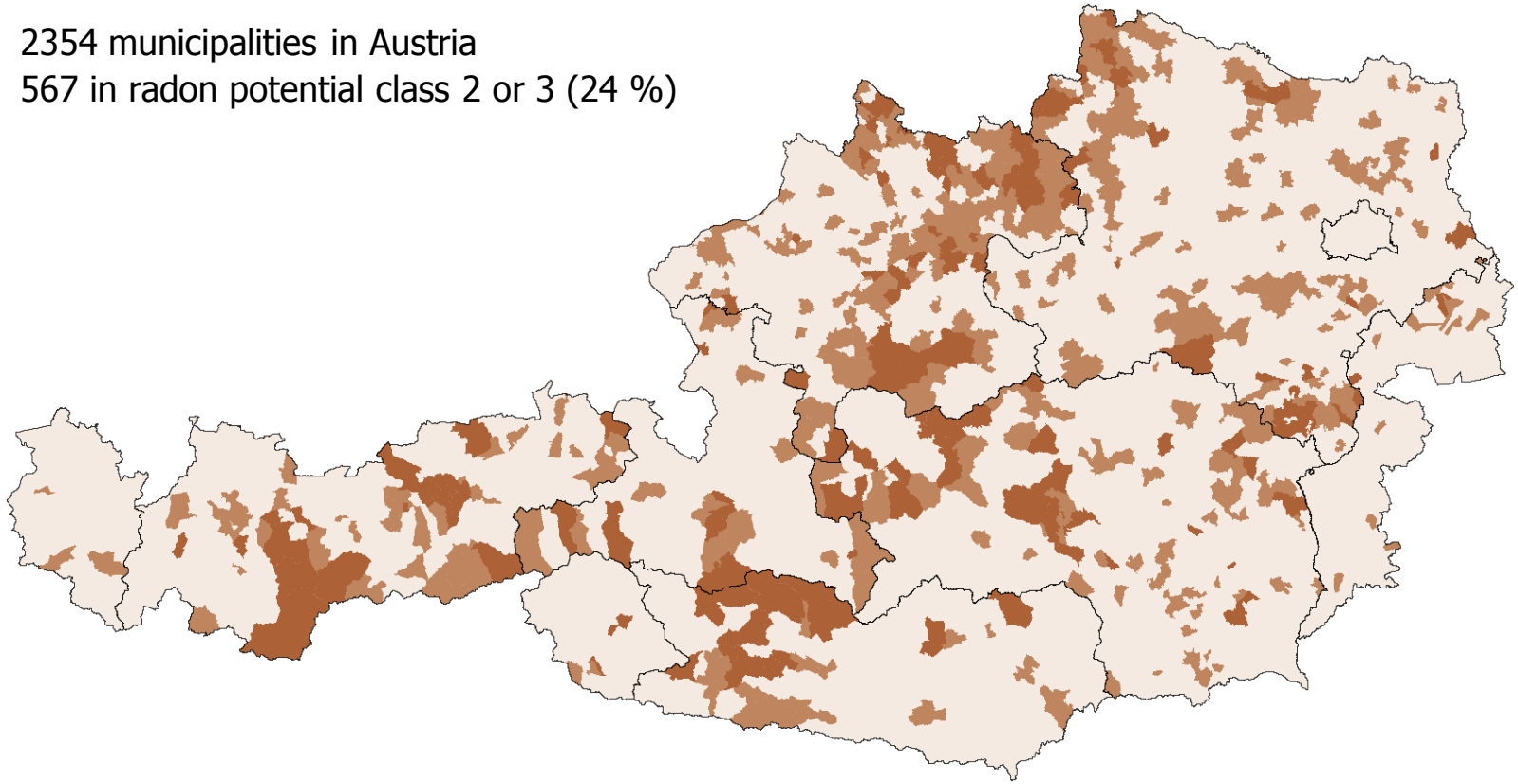


Population weighted mean radon concentration (ÖNRAP): 102 Bq/m³
Geometric mean: 61 Bq/m³

First Austrian Radon Map – Update 2012

Same principle but includes all indoor radon measurements of previous years (different colours)

2354 municipalities in Austria
567 in radon potential class 2 or 3 (24 %)



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Home > Radon Suche

Suche über PLZ oder Name der Gemeinde

linz Suche

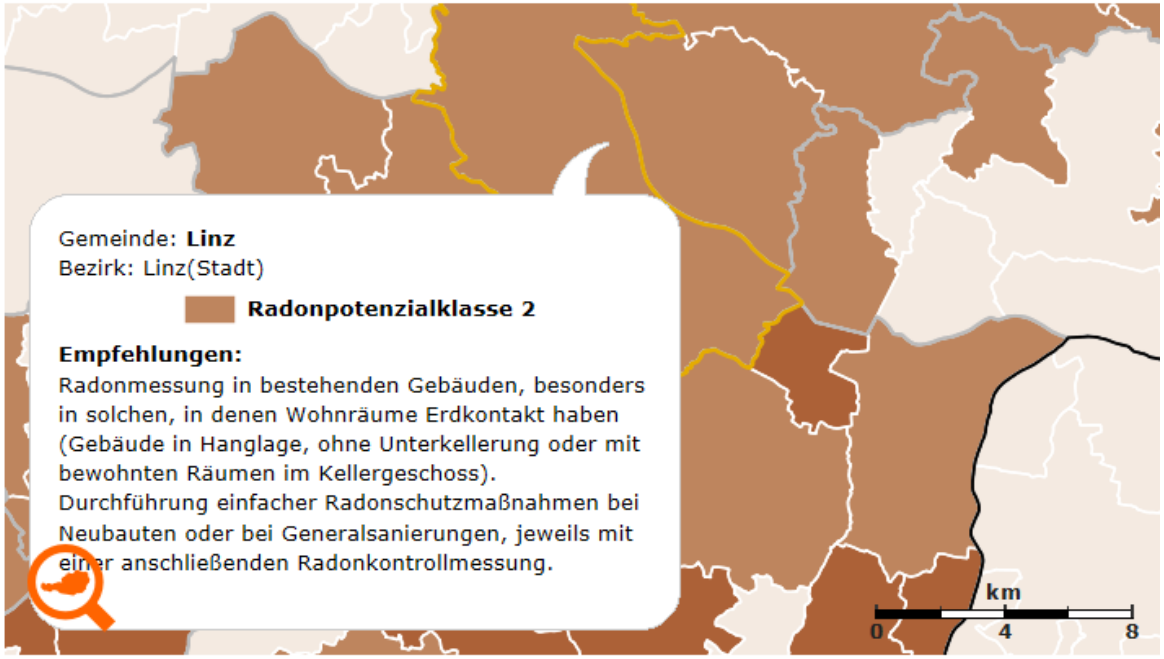
PLZ	Name
4030	Linz
4040	Linz
4020	Linz

Seite 1

Radon Suche

Die Österreichische Radonpotenzialkarte wurde auf Basis von über 20.000 Radonmessungen in Wohnhäusern erstellt und gibt Auskunft, wo in Österreich mit erhöhten Radonkonzentrationen in Gebäuden gerechnet werden muss.

In etwa 500 Gemeinden liegt ein erhöhtes Radonpotenzial vor. Abhängig vom Radonpotenzial sollten die Empfehlungen sowohl für bestehende Gebäude als auch für Neubauten und Generalsanierungen beachtet werden.



Legende

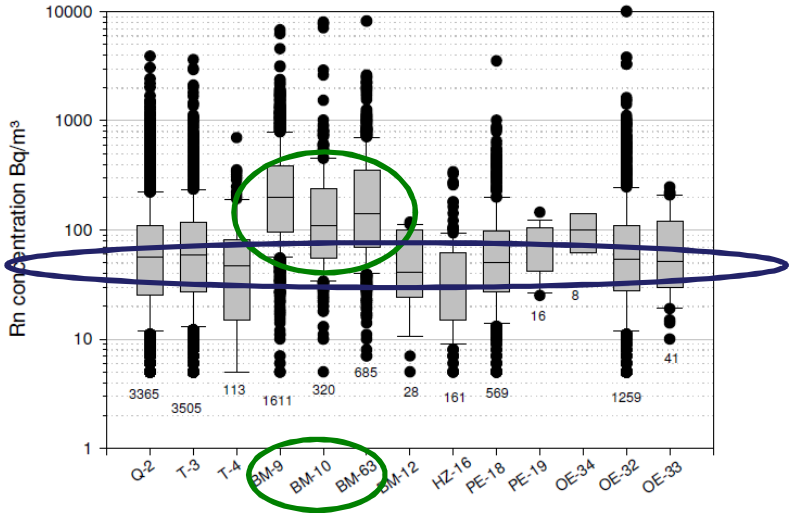
Radonpotenzialklasse 1 | Radonpotenzialklasse 2 | Radonpotenzialklasse 3

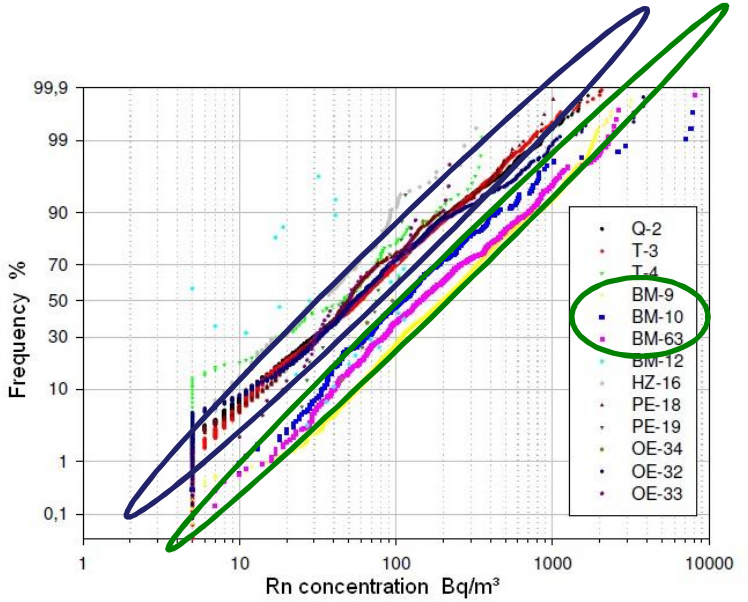
On the way to a new Austrian Radon Map – New Radon survey (2013ff)

Many sources of uncertainty:

- Different measurement systems used (charcoal, electrets, track etch)
  - Å Track etch detectors only
- Calculation of the annual mean (extrapolation)
  - Å 6-month measurements (half winter-time, half summer-time)
- Small number of dwellings per municipality (3 – 5)
  - Å At least 12 dwellings per municipality (uncertainty down to 30%)
- Variation of radon potential within municipality not taken into account
  - Å Square grid (2x2 km);
  - Å consider geology
- Renormalization to a standard situation (radon potential)
  - Å Re-evaluation

Excursus: ÖNRAP data and Geology



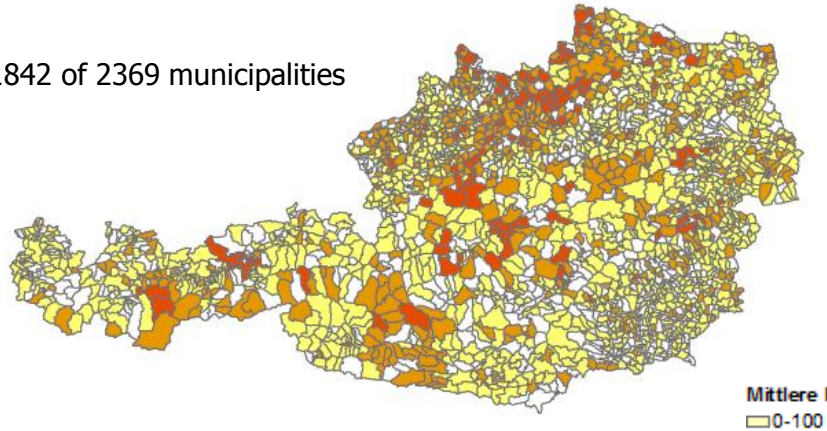


Upper Austria

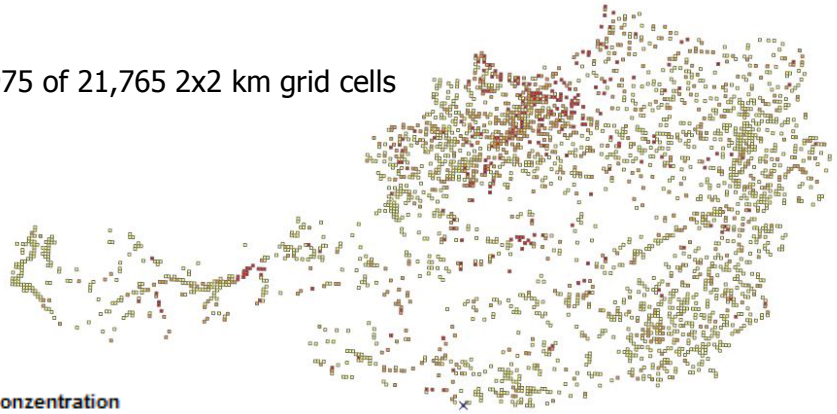
Excursus: Radon mapping for different scales and purposes

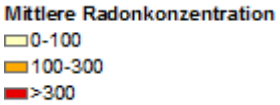
Basis: 15,035 ÖNRAP radon measurements

1842 of 2369 municipalities

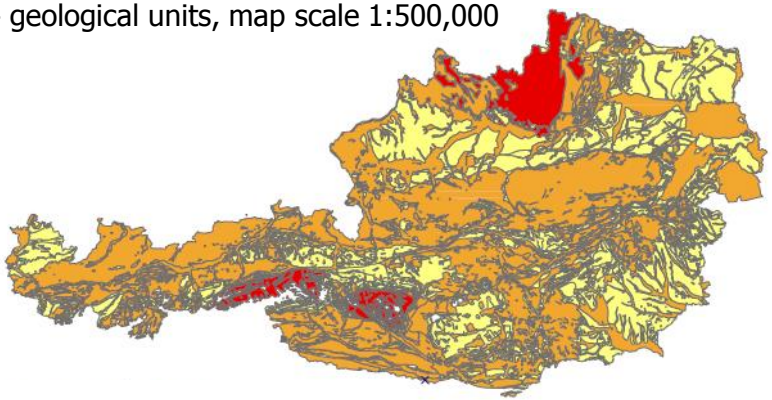


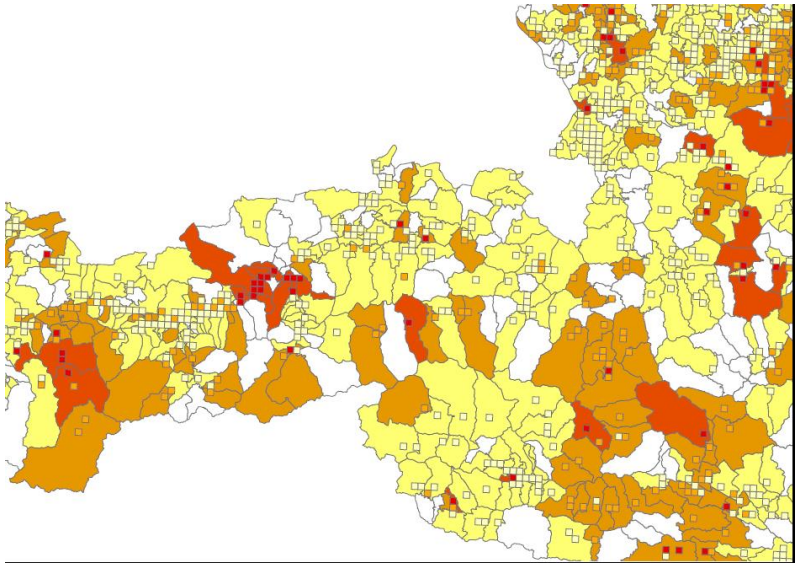
2975 of 21,765 2x2 km grid cells





44 of 64 geological units, map scale 1:500,000



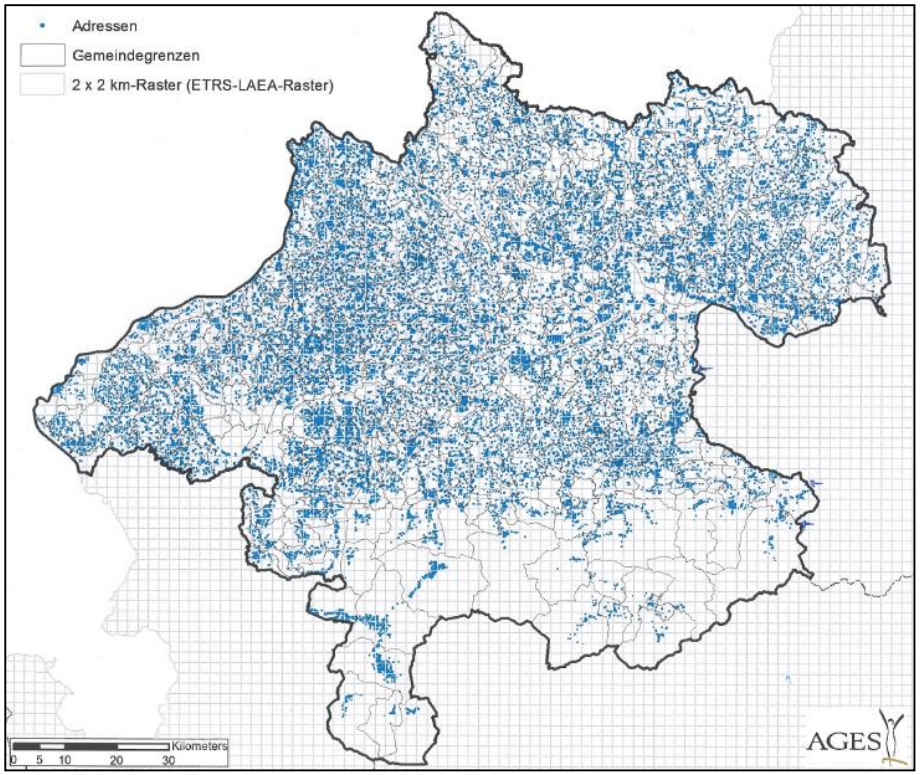


On the way to a new Austrian Radon Map

First step: Pilot project in Upper Austria

- 444 municipalities Ÿ 6 500 dwellings (13 000 measurements)

- Measurements in dwellings of members of the voluntary fire brigades
  - strong hierarchy
  - cost efficient
  - motivated
  - multipliers
  - 90,000 members!

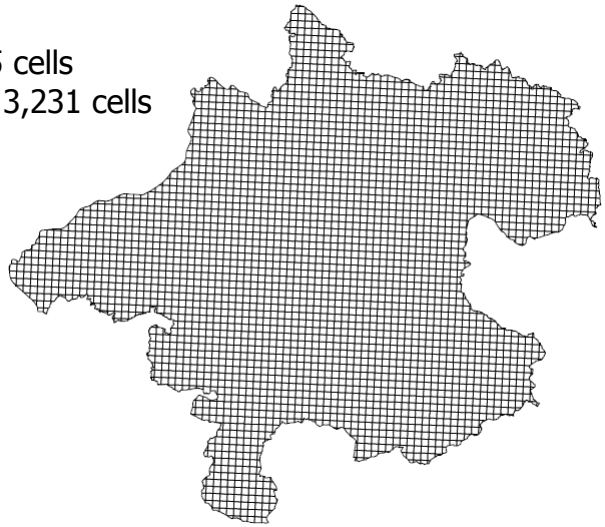


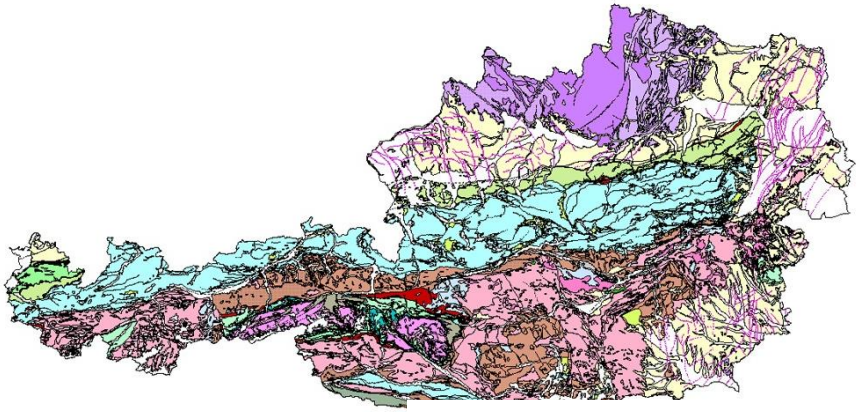
On the way to a new Austrian Radon Map

Grid (2 x 2 km)

Lambert-azimuthal equal area projected (ETRS-LAEA) grid for Europe
(based on EU-directive INSPIRE)
Advantage: Data exchange or combination with neighl

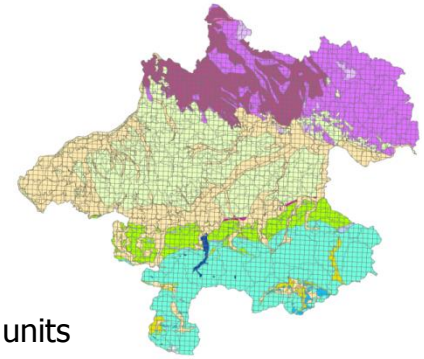
Austria: 21,765 cells
Upper Austria: 3,231 cells





Geology

Geological map 1 : 500,000



Austria: 64 geological units
Upper Austria: 15 geological units

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On the way to a new Austrian Radon Map

Selection of measurement points (dwellings)

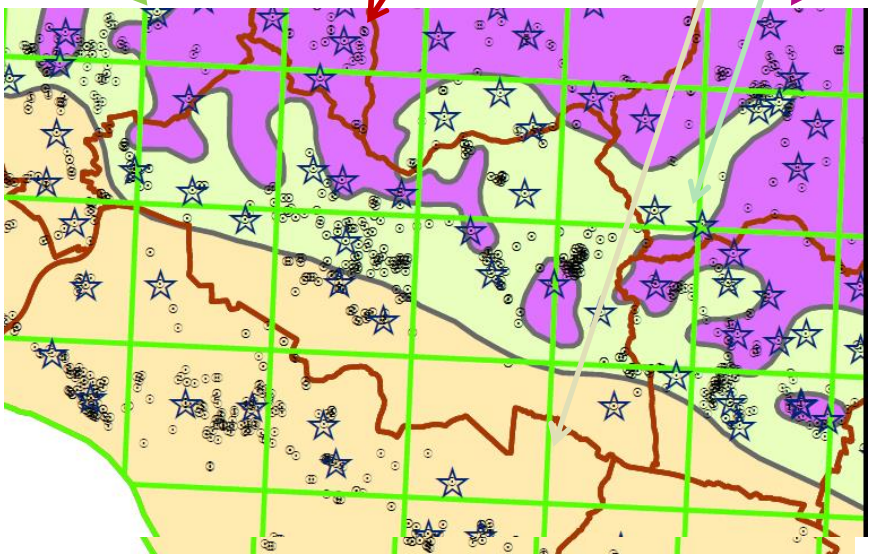
dwellings of fire brigade members

selected dwellings

Municipalities
(at least 12 dwellings)

grid (2x2)
1-3 dwellings/cell depending on versatility of geology in the cell

geological units



On the way to a new Austrian Radon Map

Procedure of the measurement campaign

- 6 500 dwellings selected (according to above criteria)
- Letter to chiefs of voluntary fire brigades and mayors of all 444 municipalities
- Chiefs of voluntary fire brigades distribute the radon measurement instruments to the selected members
- June 2014 – February 2015: Radon measurement (passive track-etch detector, two rooms per dwelling, ground floor, questionnaire for additional information about the house characteristics)
- Participants receive results for their dwelling
- Updating the radon potential map for Upper Austria – new radon potential for municipalities, evaluation for cells and geology (2015)
- Extending the survey to the other federal states (2015 ff)

Further possible strategies for radon mapping in Austria

- Evaluation, if radon measurements from other buildings than dwellings can be used for mapping or be integrated in the data pool for dwellings for mapping purposes
  - 800 kindergartens
  - 350 schools
  - 450 town halls

  Ÿ Friedmann: Radon potential calculated from ÖNRAP data (dwellings) best correlations with schools and town halls (built after 1945), weak correlation with kindergartens

- Include/use additional data to classify radon areas or improve radon maps
  - Predictors or proxies: e.g. gamma dose rate, geology, soil permeability, radon in soil gas, radium/uranium content in soil

  Ÿ Evaluations are ongoing in Austria (based on results of extensive surveys in 6 municipalities)

- Possible approach: Include all these parameters to classify a defined unit (municipality, grid cell, geology unit) – e.g. (weighted) classification scheme

  Ÿ applied already in e.g. US, possible method for European geogenic radon map

Questions to decide/discuss…

- **Further Analysis** of indoor radon measurement results Ÿ annual mean? seasonal correction factors? potential?, standardised house?, statistical methods?, year-to-year correction?

- **What to display**? – Mean radon concentration, radon potential, % of houses above level, risk,…

- Map(s) for **different scales** (geology based, grid based, administrative units based) and **purposes** (public buildings, workplaces) or only one map (which scale)?

- How to define „**Radon prone areas**"?

- ICRP 65 - radon prone areas could be defined as those where more than a certain percentage (e.g. 1%) of dwellings have a concentration of ^{222}Rn exceeding ten times the national average value.
- ICRP 103 - an area in which the concentration of radon in buildings is likely to be higher than the national average.
- ICRP 115/126 - a geographic area or an administrative region defined on the basis of surveys indicating a significantly higher level of radon concentration than in other parts of the country
- EU-BSS 2013/59 - Member states shall identify areas where the radon concentration (as an annual average) in a significant number of buildings is expected to exceed the relevant national reference level

- **Combine data** (indoor radon, gamma dose rate, geology, soil permeability, radon in soil gas, radium/uranium content) to better classify areas (e.g. US, approach European Geogenic map)?

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