

Overview of radon maps and data in Europe: differences and challenges for harmonization

European Radon Week 2020_MetroRADON workshop



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Activity 4.4.3

JRC, BfS and UC **will identify the obstacles** that currently exist with regard to **harmonisation of RPA maps and data** and will investigate the possibilities **to construct an RPA map on the European scale**. In general different countries use different methodologies to identify radon priority areas due to the different input data that is available to them. For this reason it will be important to **identify the "obstacles" (differences) and to find a way of reducing them through harmonisation**. Given the political sensitivity of the subject, the potential proposals for harmonisation must be communicated properly, including - importantly – to NGOs, stakeholders and the media. JRC, BfS and UC will develop a questionnaire which will be sent to national authorities involved in radon mapping-communication to obtain information on their positions and views towards harmonisation. The responses will be collected by JRC, BfS and UC and analysed.

What is a radon map?

*“A map is a drawing that gives you a **particular type of information (on radon)** about **a particular area (town, region, country, continent)**”*
(Cambridge dictionary)

To prepare “radon information” to be displayed is not a simple task as for somebody to cook a pizza (between so many different pizzas)....



PIZZE		NUOVE	NUOVE
01 - AMODO MIO (pomodoro, mozzarella, quattro formaggi, peperoni arrostiti, cipolla)	€ 7,00 € 6,00	25 - GENOVESE (mozzarella, pesto)	€ 5,50 € 4,50
02 - AMBRA (pomodoro, fresco, ricotta, prosciutto crudo, rucola)	€ 8,00 € 7,00	26 - GIO' ⁺ (pomodoro, fresco, mozzarella, basilico)	€ 5,00 € 4,00
03 - ARIANNA (pomodoro, mozzarella, pancetta, pomodoro fresco)	€ 6,00 € 5,00	27 - GOGO' ⁺ (pomodoro, mozzarella, salvia, speck)	€ 6,50 € 5,50
04 - BIANCANEVE (mozzarella)	€ 4,00 € 3,00	28 - GOLOSA (pomodoro, mozzarella, funghi, salvia, grana)	€ 6,50 € 5,50
05 - BIM BUM BAM (quattro formaggi, pancetta, griglia, pomodoro fresco)	€ 7,00 € 6,00	29 - GIANNI (pomodoro, mozzarella, prosciutto crudo, peperoni, crema di formaggio)	€ 8,00 € 7,00
06 - BISMARCK (quattro formaggi, prosciutto, salsiccia)	€ 6,50 € 5,50	30 - GRAZIA (mozzarella, funghi, peperoni, salvia, di grana)	€ 7,00 € 6,00
07 - BOLOGNESE (pomodoro, mozzarella, melanzane, cipolla, grana)	€ 6,00 € 5,00	31 - HOT DOG (pomodoro, mozzarella, salsiccia, cipolla, rucola)	€ 5,50 € 4,50
08 - BOSCAIOLA (pomodoro, mozzarella, funghi)	€ 5,00 € 4,00	32 - INFERNO (pomodoro, mozzarella, salvia, salsiccia, rucola, peperoni, cipolla)	€ 7,00 € 6,00
09 - BRACCIO DI FERRO (pomodoro, mozzarella, grana, salame)	€ 5,50 € 4,50	33 - INGLESE (pomodoro, mozzarella, pancetta, salsiccia, grana)	€ 6,50 € 5,50
10 - BRESAOLA (pomodoro, mozzarella, bresaola)	€ 5,50 € 4,50	34 - ITALIA (pomodoro, mozzarella, cipolla, prosciutto crudo, rucola)	€ 7,50 € 6,50
11 - BUFALINA (pomodoro, fresco, mozzarella di bufala, basilico)	€ 7,00 € 6,00	35 - LUCIO (pomodoro, mozzarella, salsiccia, salame, pizza, cipolla, Zola)	€ 7,50 € 6,50
12 - CALABRESE (pomodoro, mozzarella, salame piccante)	€ 5,00 € 4,00	36 - MARE CHIARO (pomodoro, mozzarella, gamberi, polpa di granchio)	€ 6,50 € 5,50
13 - RUSTICHELLA (pomodoro, mozzarella, salame piccante)	€ 6,00 € 5,00	37 - MARGHERITA (pomodoro, mozzarella)	€ 4,00 € 3,00
14 - CAMPAGNOLA (pomodoro, mozzarella, melanzane, cipolla, peperoni)	€ 6,00 € 5,00	38 - MARGHERITA E BUFALA (pomodoro, mozzarella, mozzarella di bufala)	€ 5,00 € 4,00
15 - CAPRINO (pomodoro, mozzarella, caprino)	€ 5,00 € 4,00	39 - MARE E MONTE (pomodoro, mozzarella, funghi, salame, gamberi)	€ 6,50 € 5,50
16 - CHIODINI (pomodoro, mozzarella, cipolla)	€ 5,50 € 4,50	40 - MARINARA (pomodoro, mozzarella, aglio, grana)	€ 3,50 € 2,50
17 - CONTADINA (pomodoro, mozzarella, funghi, salsiccia, grana)	€ 5,50 € 4,50	41 - MESSICANA (pomodoro, mozzarella, pancetta, peperoni, griglia, peperoncino)	€ 6,50 € 5,50
18 - CRUDO (pomodoro, mozzarella, prosciutto crudo)	€ 5,50 € 4,50	42 - MIX (pomodoro, mozzarella, funghi, melanzane)	€ 7,00 € 6,00
19 - CASERTANA (pomodoro, mozzarella, funghi, salame fresco)	€ 6,00 € 5,00	43 - MONTANA (pomodoro, mozzarella, funghi, salame fresco)	€ 7,50 € 6,50
20 - CAPRICCIOSA (pomodoro, mozzarella, funghi, grana, peperoni)	€ 6,00 € 5,00	44 - MIRKO (pomodoro, mozzarella di bufala, salame fresco)	€ 7,00 € 6,00
21 - DELICATA (pomodoro, mozzarella, prosciutto, salsiccia, grana)	€ 6,00 € 5,00	45 - NAPOLETANA (pomodoro, mozzarella, salame piccante, grana)	€ 5,00 € 4,00
22 - DELIZIA (pomodoro, mozzarella, funghi, fresco, salame)	€ 6,50 € 5,50	46 - OCCHIO DI BUE (pomodoro, mozzarella, salame)	€ 5,00 € 4,00
23 - FRUTTI DI MARE (pomodoro, mozzarella, grana, gamberi, calamari, polpetta)	€ 8,00 € 7,00	47 - ORTOLANA (pomodoro, mozzarella, peperoni, griglia)	€ 5,00 € 4,00
24 - GAMBERUCCI (pomodoro, mozzarella, gamberi, rucola)	€ 6,50 € 5,50	48 - PATTY (pomodoro, mozzarella, salsiccia, grana, cipolla)	€ 7,50 € 6,50
		49 - PETER PAN (pomodoro, mozzarella, salame, melanzane, pancetta, salsiccia)	€ 7,00 € 6,00

To prepare a...

Pizza

- Take the ingredients
- Wash, remove non eatable part, cut and cook
- Amalgamate the ingredients
- Contemplate the final products and eat it

Radon map

- Collect radon data
- Quality check, comparability (e.g. different surveys), statistical analysis
- Run a mapping method
- Give the final product to the end user (e.g. public, policy maker)








Indoor Radon data



Comparable



Different

- Measurement Methods 
- Thoron 
- Duration  
- Building type 
- Location in dwelling 
- Correction (seasonal, building characteristic, floor level etc.) 

Difference and comparability have been analysed thanks to the results of the WP3 questionnaire, more details in the presentation given on 25 February 2020, by Carpentieri *et al.* “Results of analysis of MetroRADON questionnaire data on indoor radon surveys”

Geogenic Radon data Proxies

✓ Comparable
✗ Different

- Soil radon ✗ ✓
- Permeability ✓ ✗
- Ambient dose rate ✓
- U concentrations in soil/rock ✓ ✗
- Airborne gamma spectrometry ?
- Rn concentration in water ✓

Difference and comparability have been analysed thanks to the results of the WP3 questionnaire, more details in the presentation given on 25 February 2020 by Peter Bossew “*The MetroRADON questionnaire on geogenic radon surveys*”

Resolution

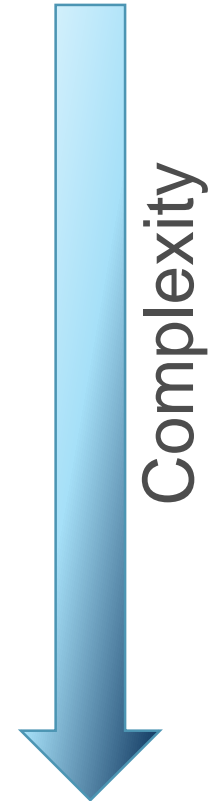
(depend on radon data and scope of the map)

Depend on radon data density and scope of the map

- Grid (1x1 km, 100x100 m, 10x10 km)
- Municipalities
- Postal code
- Geological unit, lithological or stratigraphic (at which detail?)

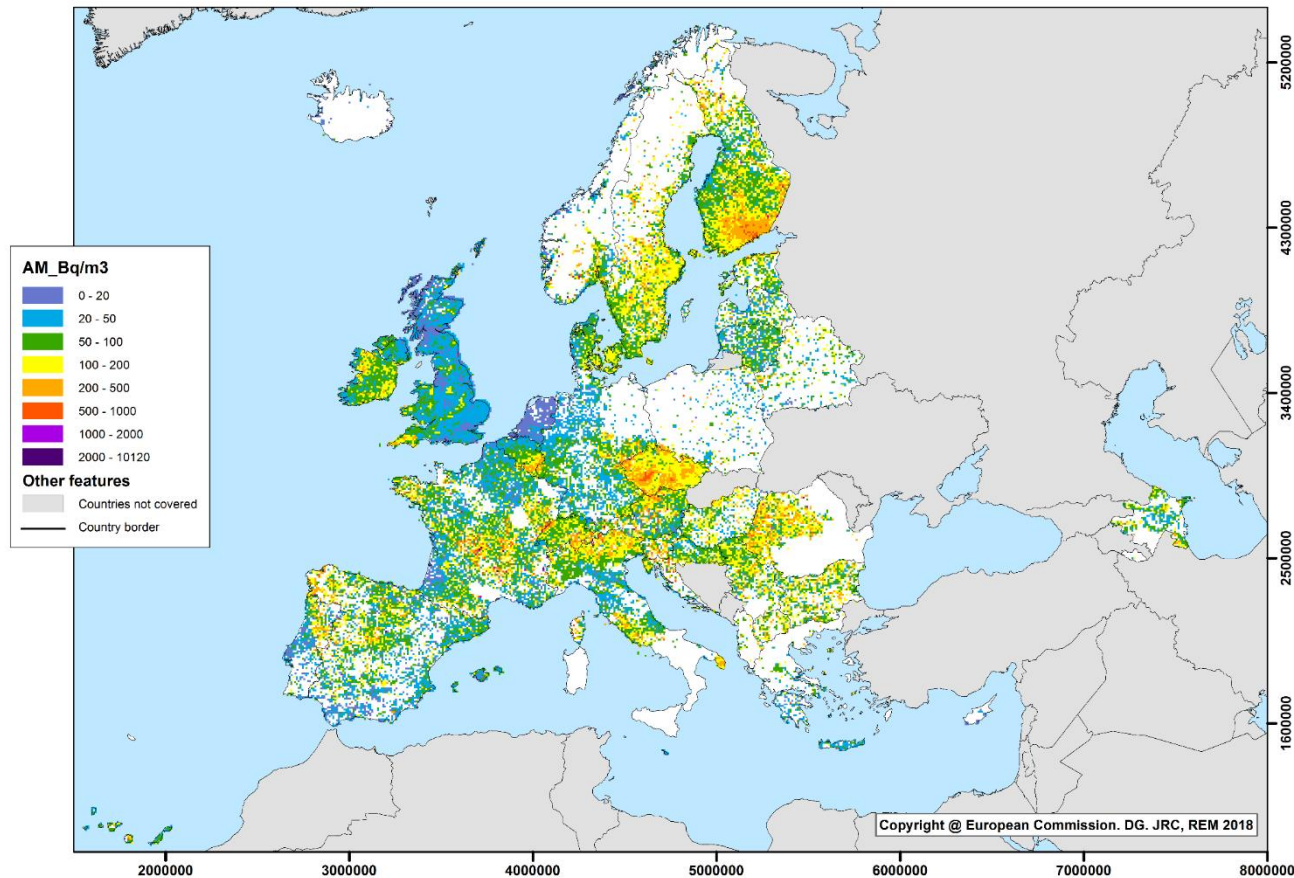
Mapping method - differences

- Display observed (raw) data
- Basic statistics (e.g. AM)
- Geostatistics: using nearby observation (and (optionally) limited number of co-variables) to predict (e.g. kriging, IDW, moving average)
- Machine Learning: Regression, using many co-variables. Not necessarily an influence of nearby observations on the predicted value



Mapping method – Examples: European Maps

European Indoor Radon Map, September 2018



Arithmetic means over 10 km x 10 km cells of long-term radon concentration in ground-floor rooms.
(The cell mean is neither an estimate of the population exposure, nor of the risk.)

Source:
European Commission, Joint Research Centre (JRC),
Directorate G - Nuclear Safety & Security, REM project

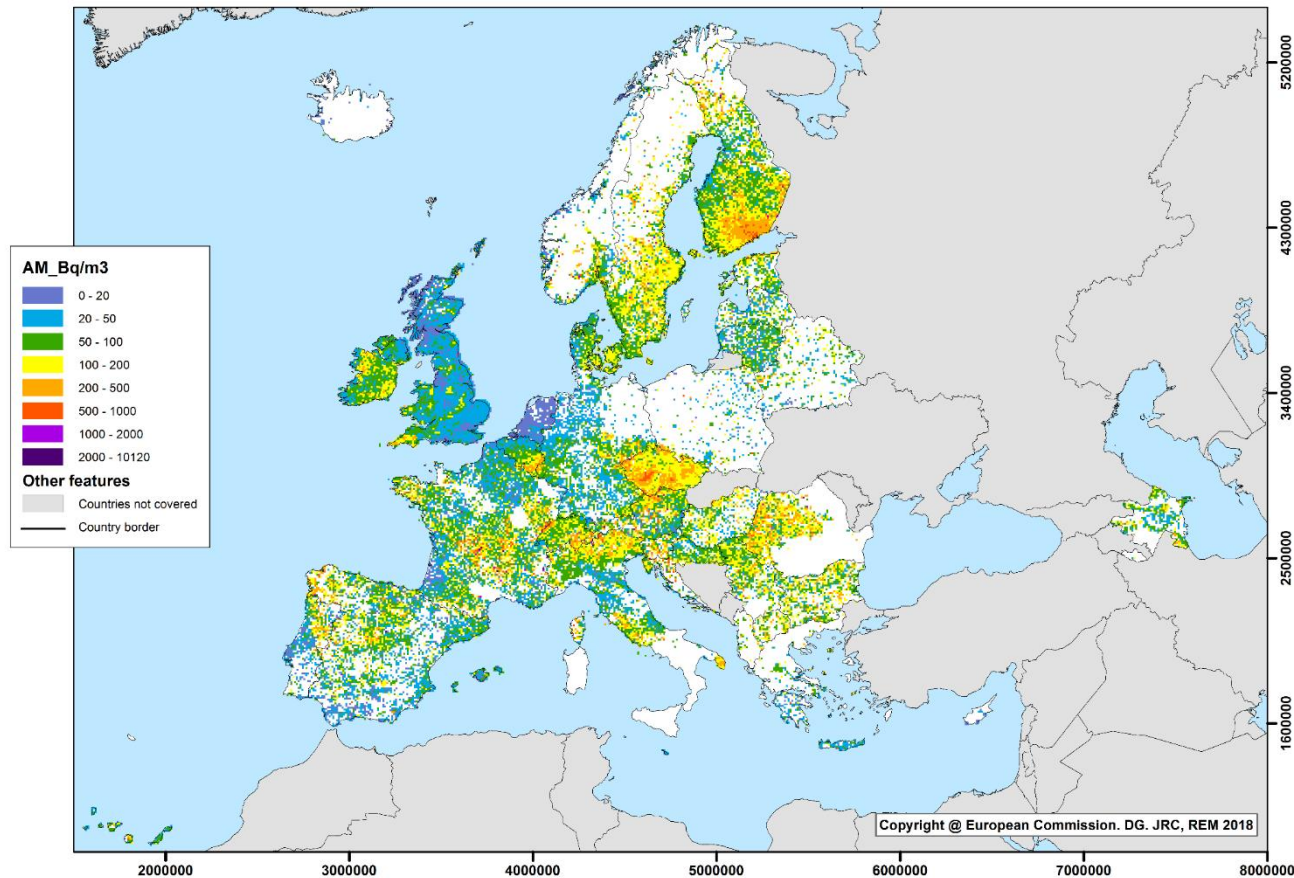
Simplest one...

Basic statistics (AM) in each cell

<https://remon.jrc.ec.europa.eu>

Mapping method – Examples: European Maps

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Simplest one...

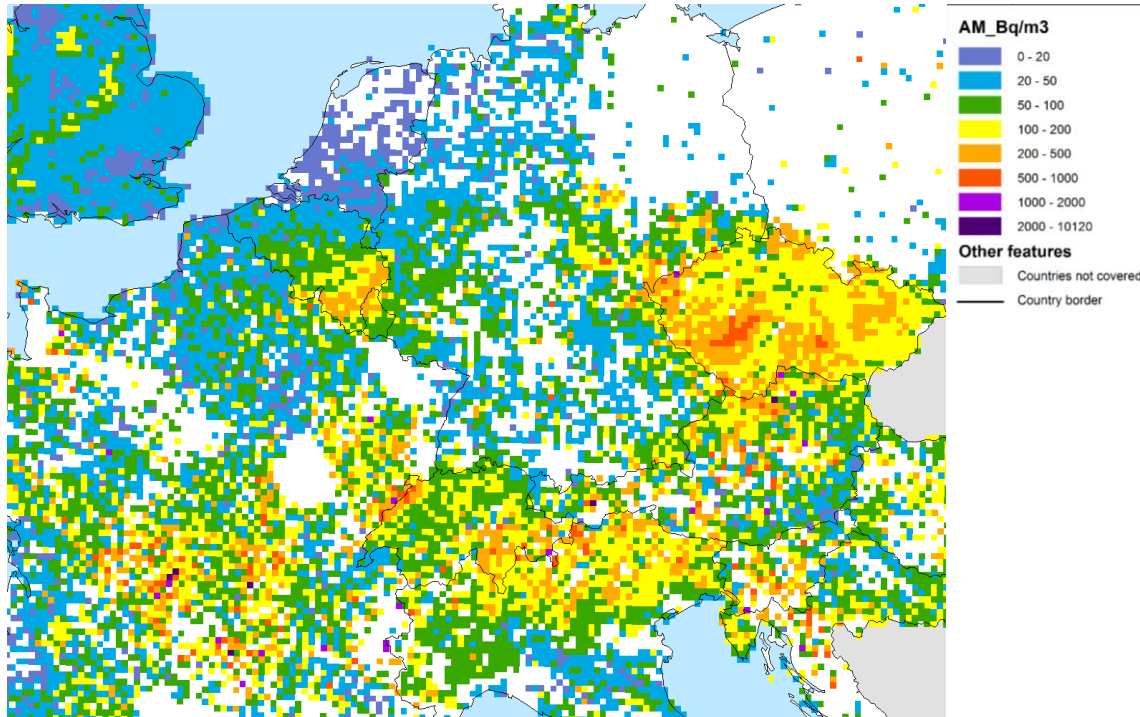
Basic statistics (AM) in each cell

<https://remon.jrc.ec.europa.eu>

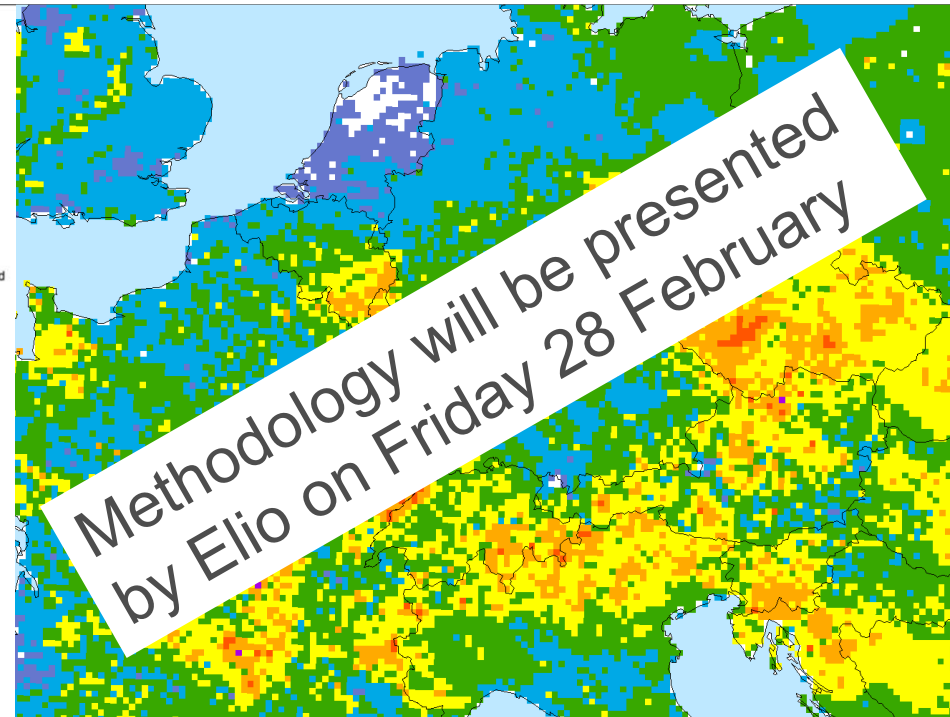
Mapping method – European Maps

- Different input data
- Different estimation methods

Basic statistic
Arithmetic mean



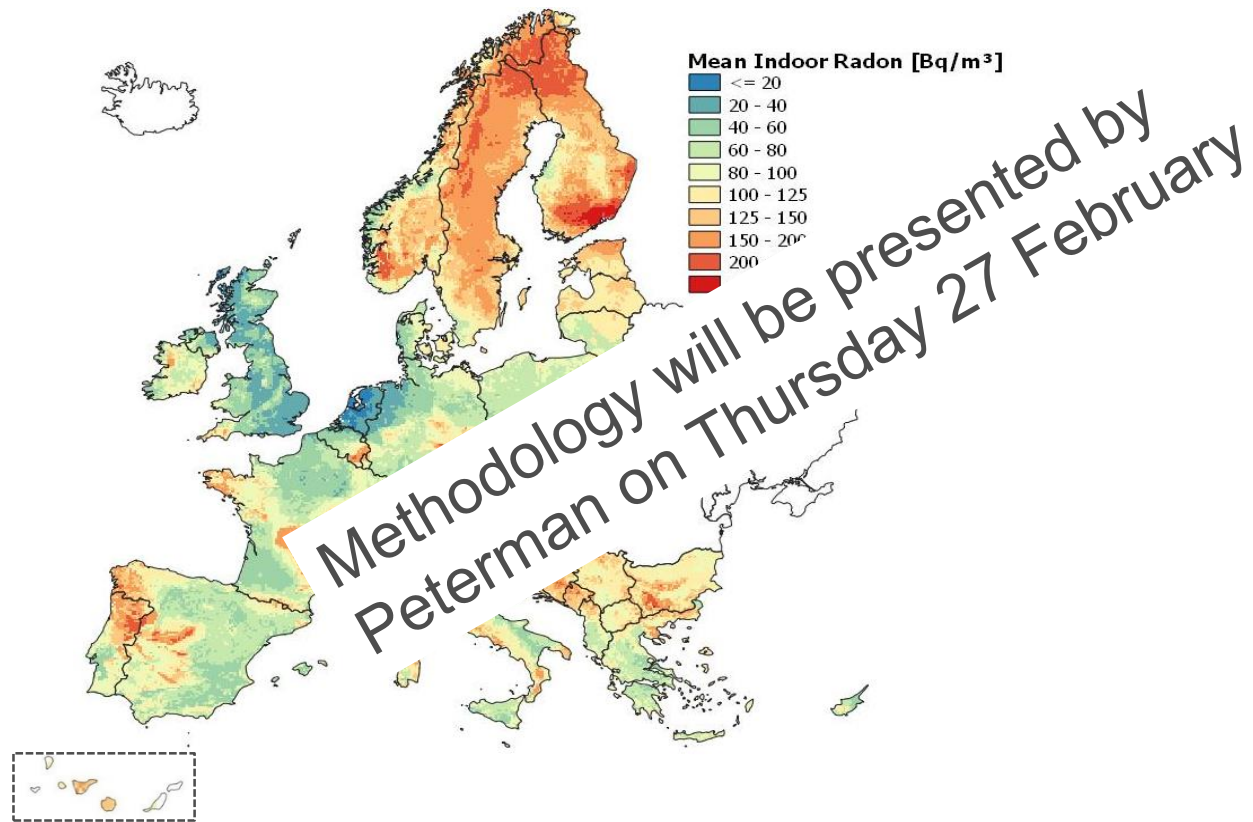
Regression Kriging
Co-variates: Geology, U and K concentration in soil



Elío J., et al. 2019. *The first version of the Pan-European Indoor Radon Map*. Nat. Hazards Earth Syst. Sci., 19, 2451–2464.

Mapping method – European maps

Machine learning



- Different input data
- Different estimation methods

output:

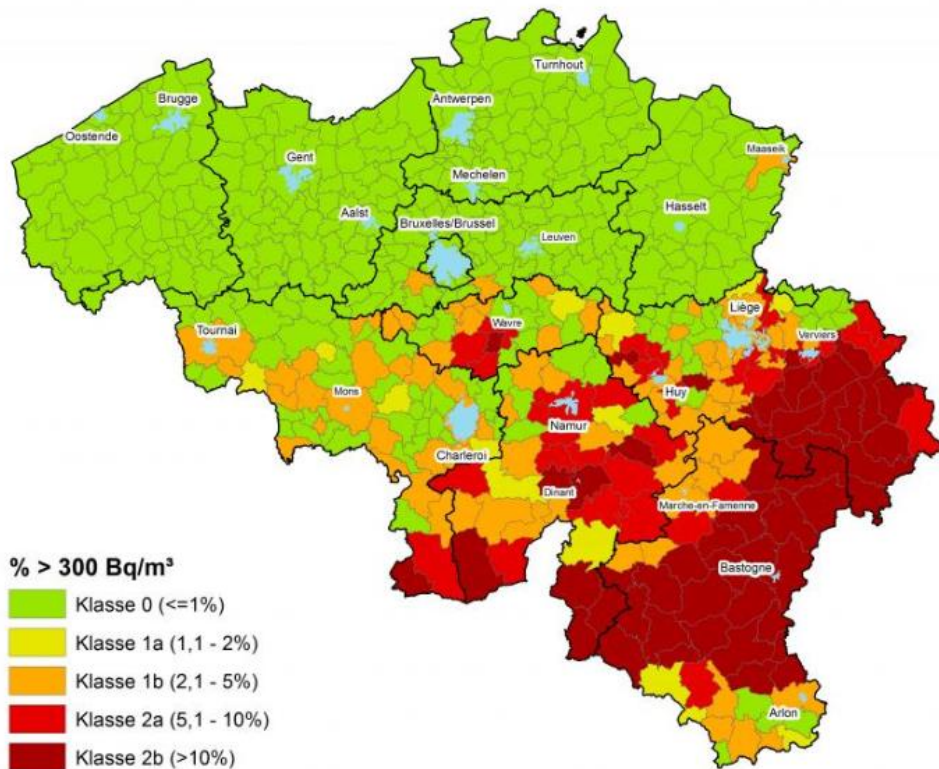
- same grid
- different colour coding

Output

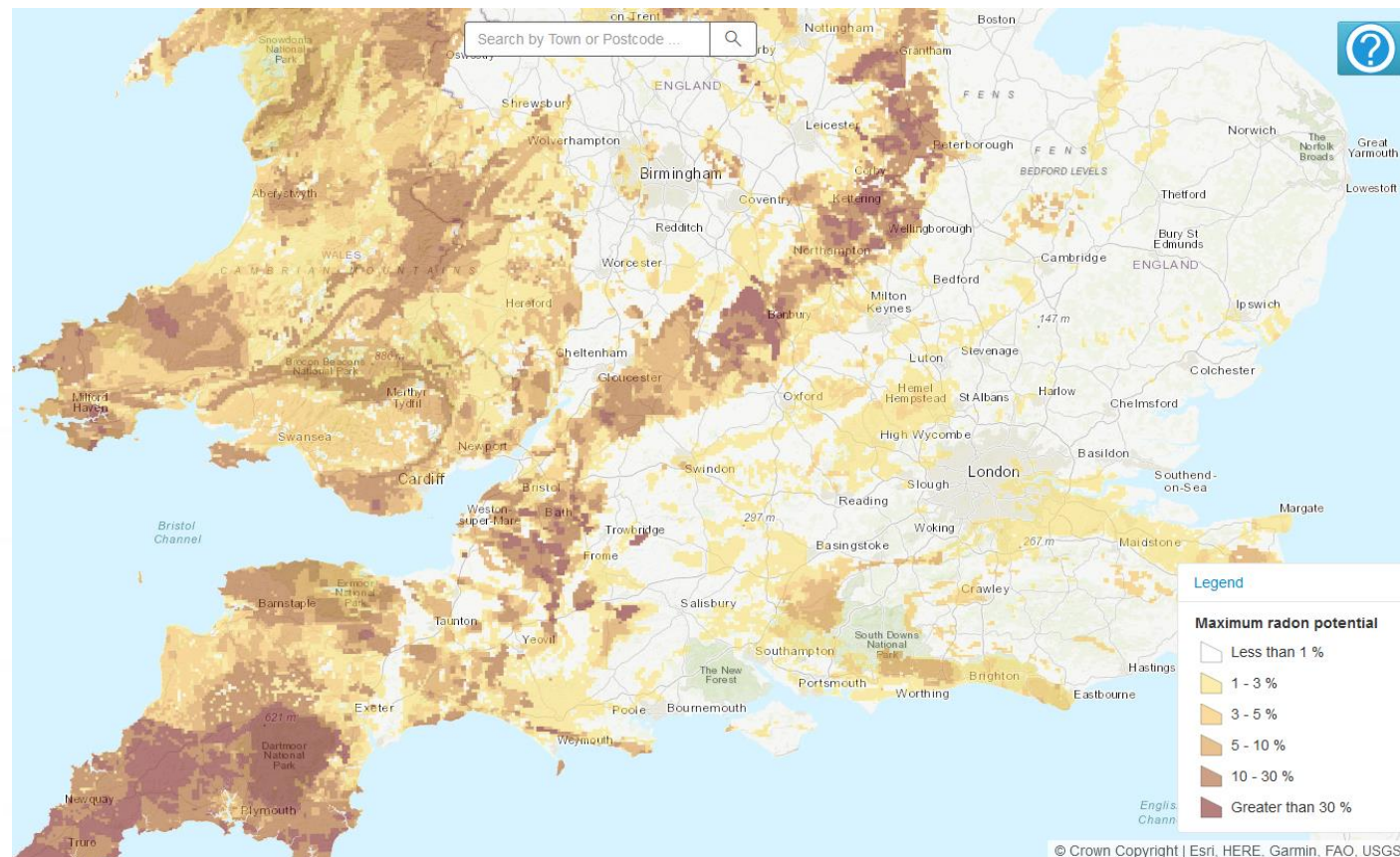
Possible output quantities

- Arithmetic mean (aggregation) or expectation (geostat, ML) in cell
- % above reference level
- Classes 4-5-6...10
- Geogenic potential
- Geogenic Radon Hazard Index -GHRI
- Status RPA yes / undecided / no

Output



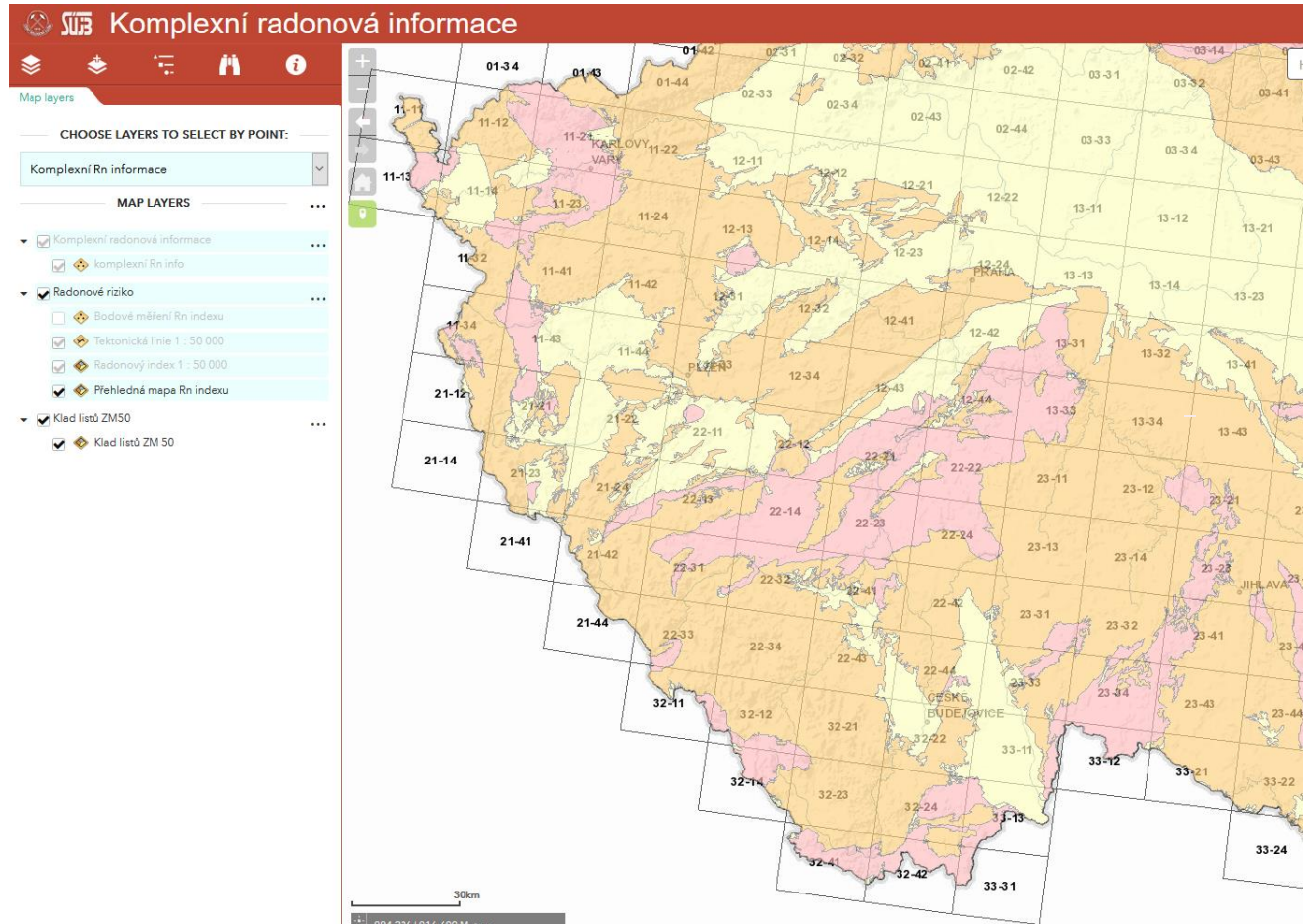
Belgium
<https://afcn.fgov.be/fr/radon>



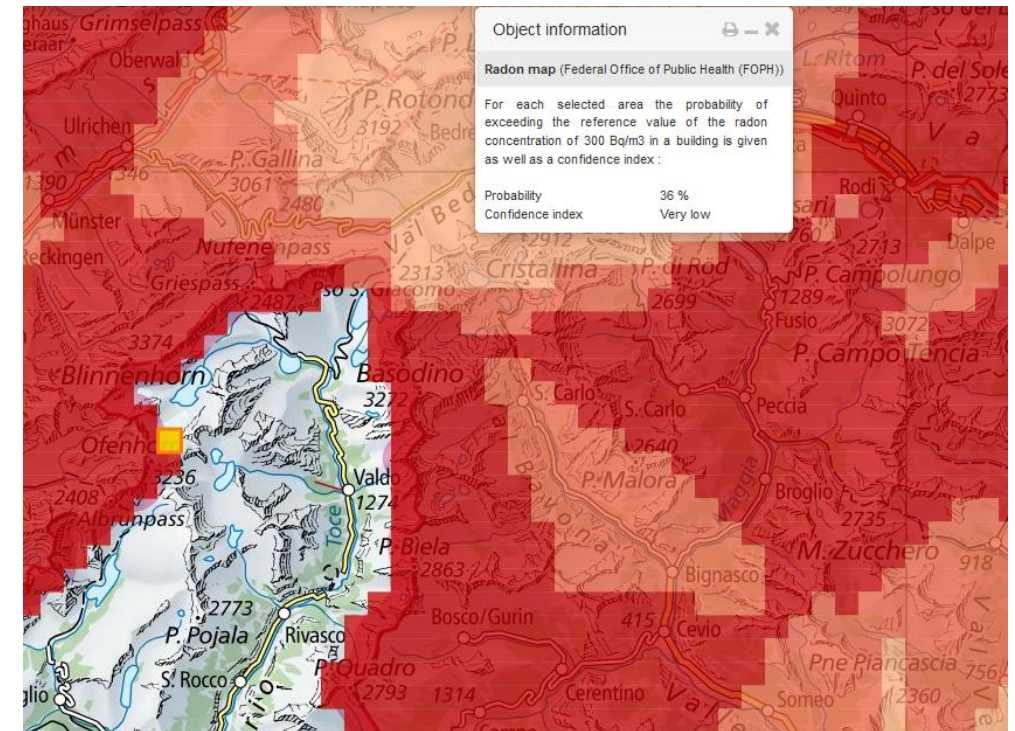
United Kindom
<https://www.ukradon.org/information/ukmaps>

Action level _ 200 Bq/m³

Output

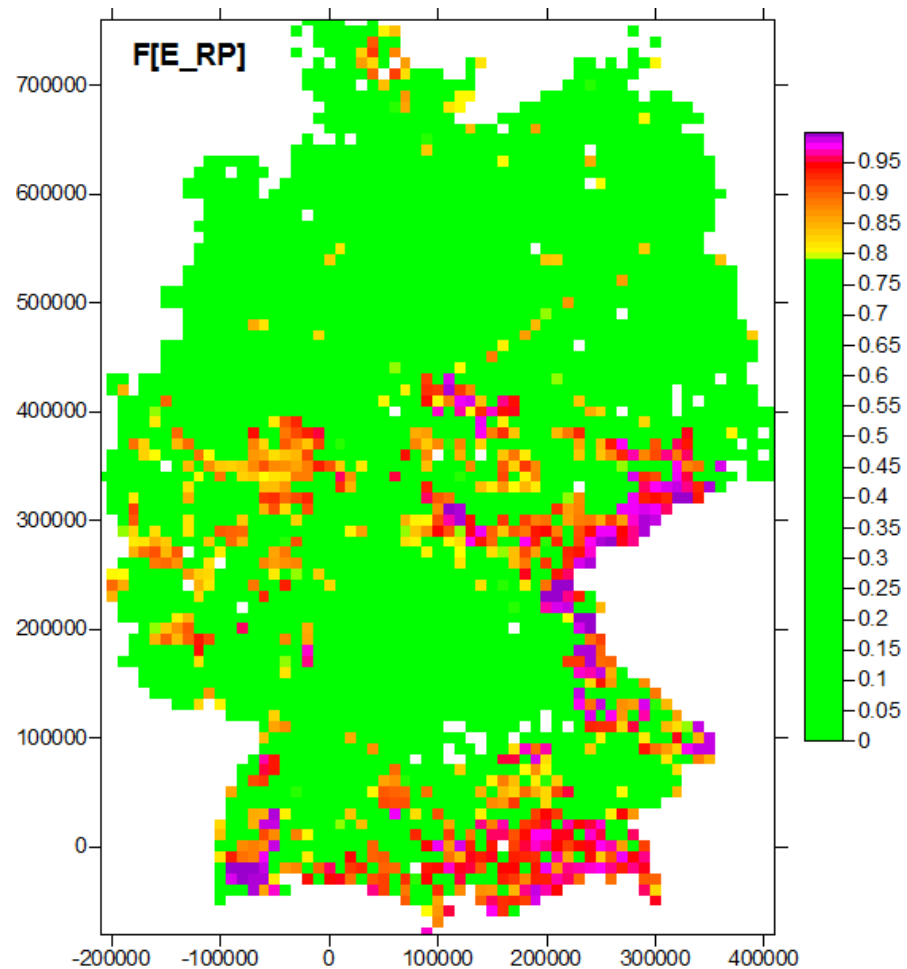


Czech Republic
<https://mapy.geology.cz/radon/>



Switzerland_ 300 Bq/m³
<https://www.bag.admin.ch/bag/en/home/gesund-leben/umwelt-und-gesundheit/strahlung-radioaktivitaet-schall/radon/radongebiete-ch.html>

Output



Germany

Priority map based on GRP:

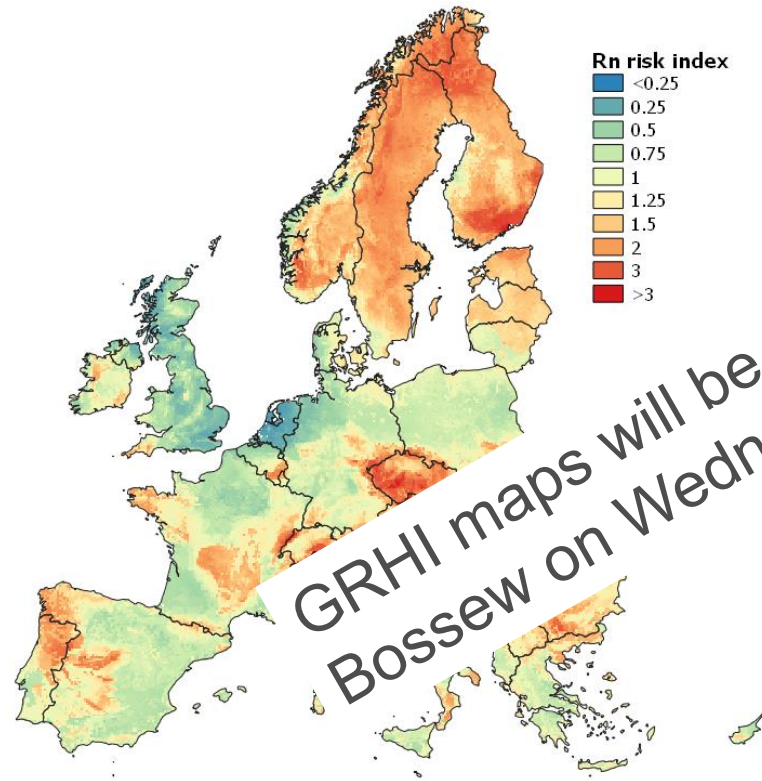
>0.95: cells with 5% highest GRP

>0.90: cells with 10% highest GRP

etc.

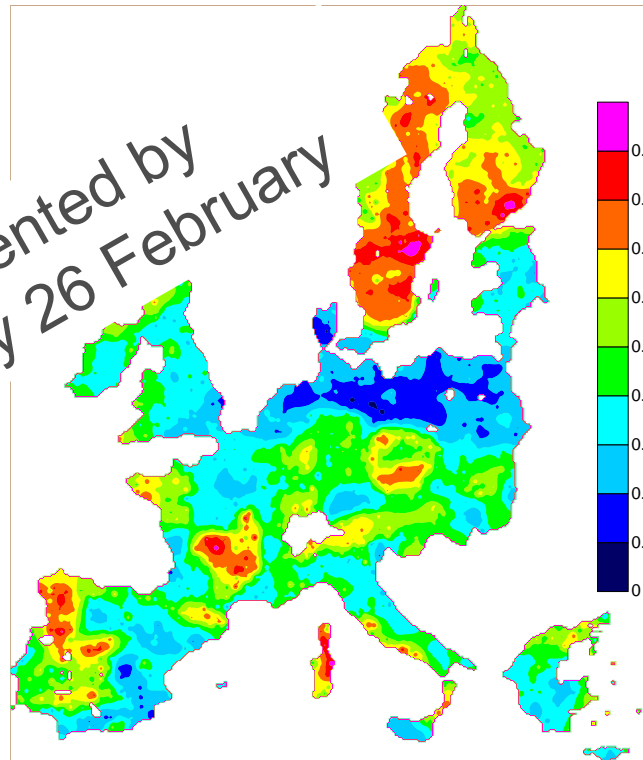
Output – European maps – trial GRHI

Machine learning



GRHI maps will be presented by
Bossew on Wednesday 26 February

Multiple regression



- Different input data
- Different estimation methods

output:

- same grid
- different colour coding

Conclusions

- **Harmonization radon data**

Possible (thanks to project as metroRADON, intercomparison etc.)

- **Harmonization mapping method**

Not necessary non reasonable because depends on the input data, resolution, output

- **Harmonization output – Many pizza types**

Hard (depend on the scope of the map, on the input data on the mapping method) or possible with GRHI

- **RPA at European Level – A European pizza**

Possible if input data are somehow harmonized (e.g. European Indoor Radon Map)

Conclusions

- **Particularly difficult: Harmonization of class maps**
 - **especially RPA maps – if**
 - definition and estimation methods are different or
 - classes are differently defined.
- ⇒ **In general inconsistent across borders!**
- **Harmonization maps possible with bottom-up approach**

Keep in touch



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Thank you



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