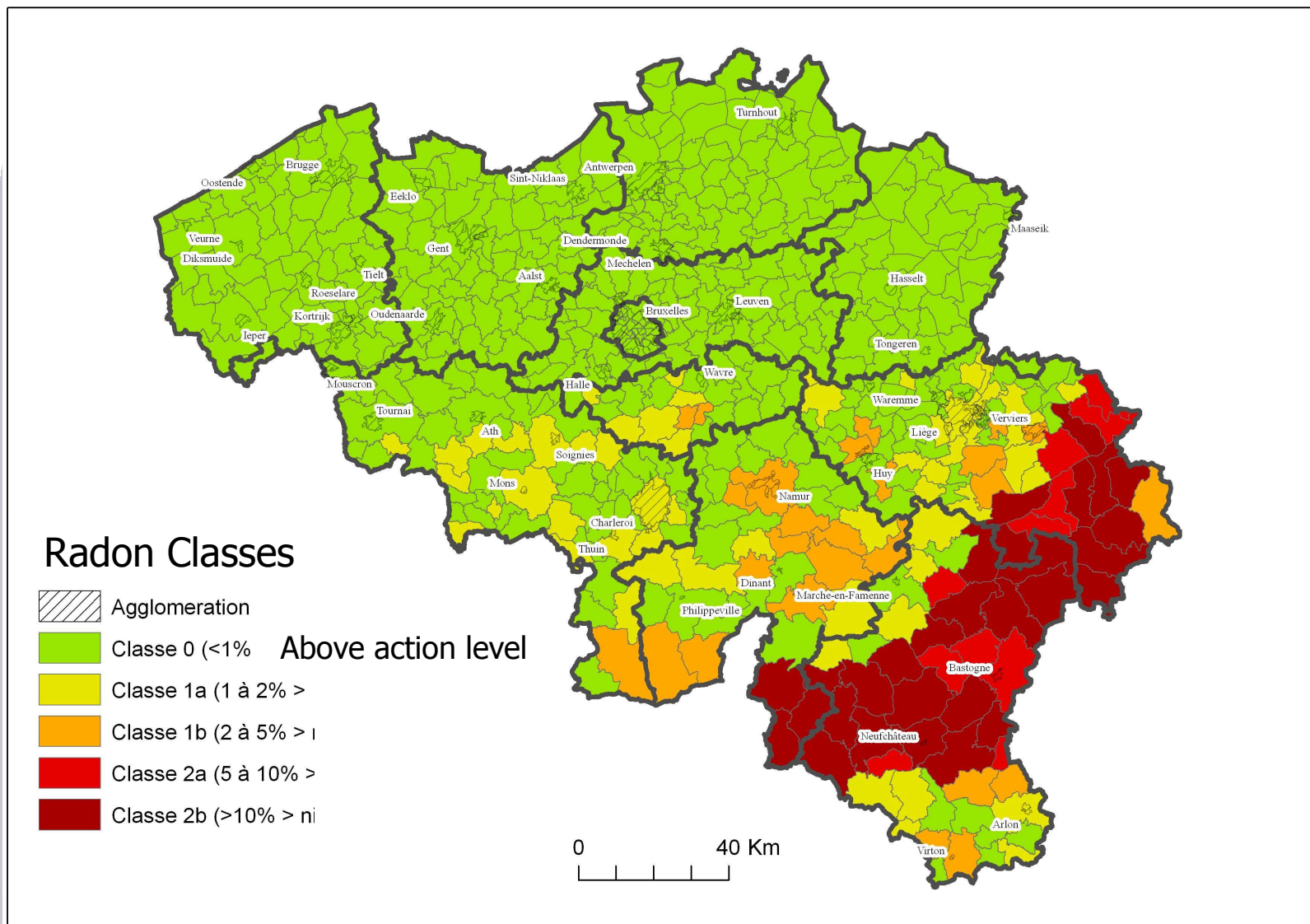# DETAILED-SCALE RADON HAZARD MAPPING COMBINING INDOOR, SOILGAS AND GEOLOGICAL DATA

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Radon Classes

- ▨ Agglomeration
- 🟩 Classe 0 (<1% Above action level
- 🟨 Classe 1a (1 à 2% >
- 🟧 Classe 1b (2 à 5% > ⋯
- 🟥 Classe 2a (5 à 10% >
- 🟥 Classe 2b (>10% > ni

0   40 Km

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→Map based on indoor data only

- Highly clustered
- Lack of information in building extension zones
- Depend on building characteristics

→Extended the database with other parameters:

- Lithology
- Soilgas radon concentration
- Permeability

→ Compose detailed maps of the radon hazard

- On the scale of a municipality
- Highlighting variations for building extension zones

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Radon Hazard in the High Risk Areas

	N	AM	GM	Median	Min	Max	SD	GSD
indoor	5411	220	140	129	6	4204	294	2,5
soil gas	4448	52	39	45	1	430	37	2,2

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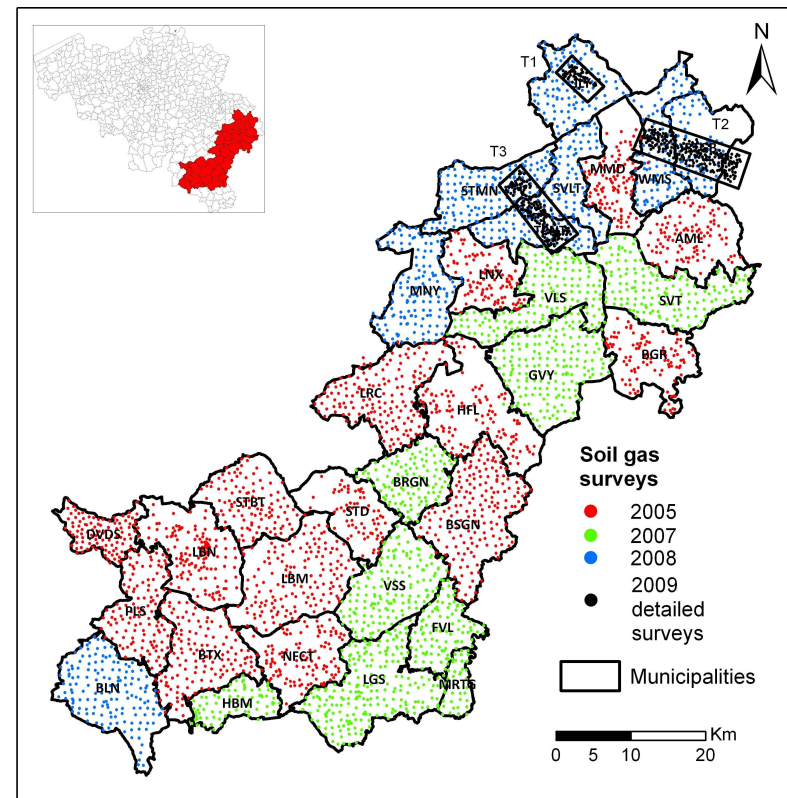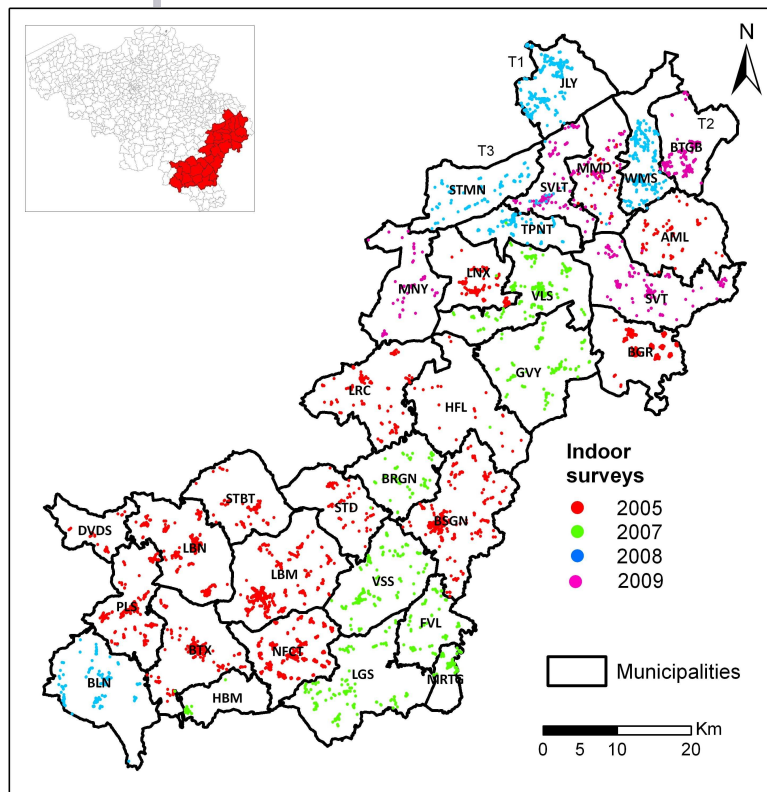
Questions?
- What is the optimal sample density?
  - → T-test between regional and local measurements: 1 km²
- What is the optimal ground resolution of the map?
  - → Kriging variance indicates accurracy ifo density: 300x300m grid
- What are the dependable parameters?
  - → ANOVA analysis
- How can they be combined?
  - → radon potential and transfer factor

Approach
- Geostatistical analysis in a GIS environment
- ANOVA and MANOVA

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Soilgas radon (kBq/m³), indoor radon (Bq/m³)
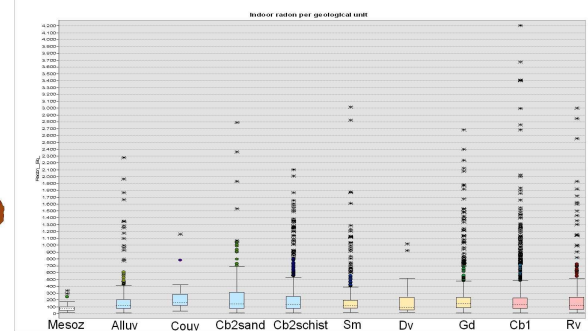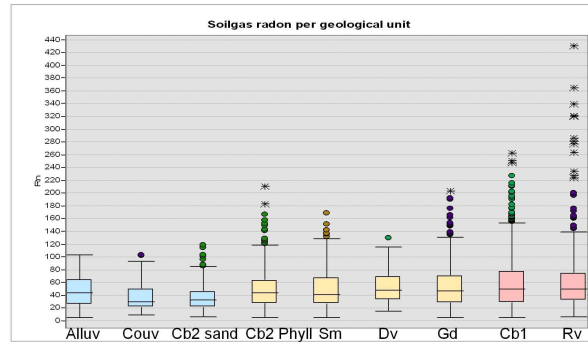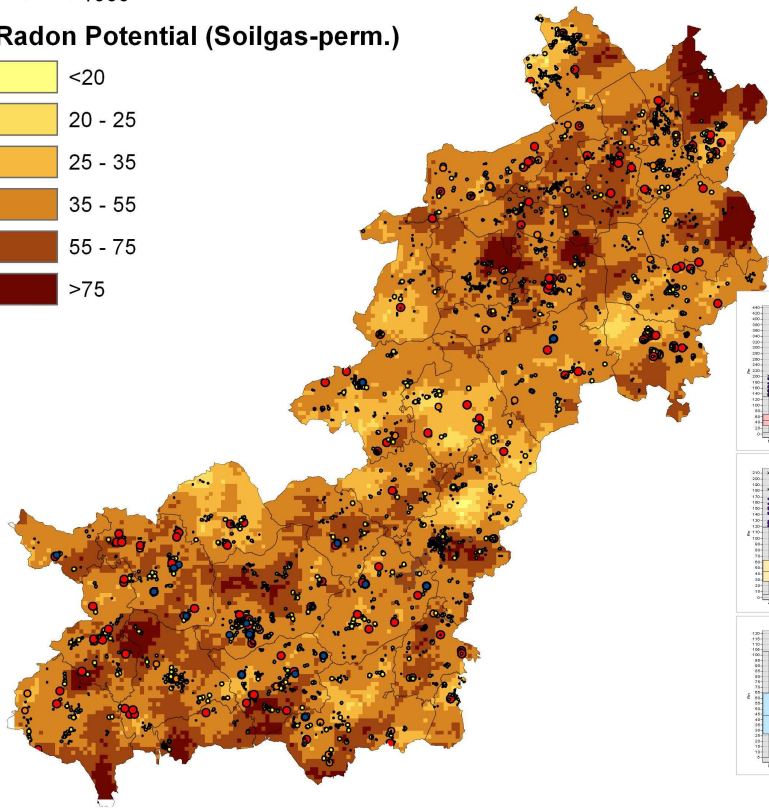and radon potential (sensu Barnet/Neznal 2004)

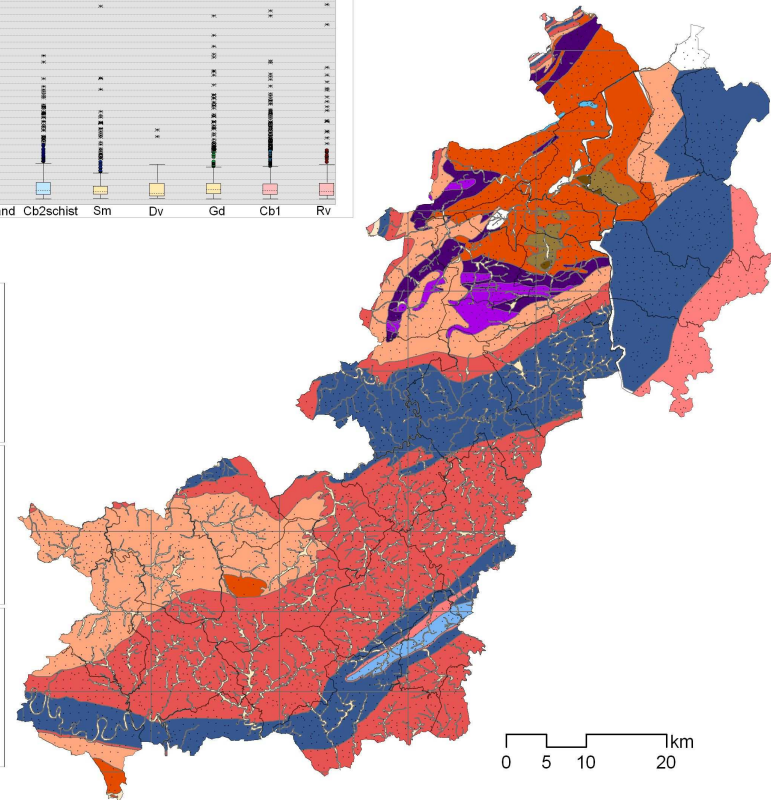- IND_RADARD_Alluvial_800

Indoor radon (Bq/m³)
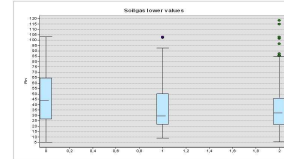
- · <200
- · 200-400
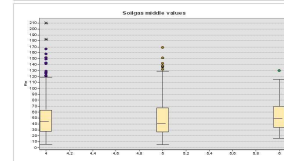- ° 400-800
- ● 800-1000
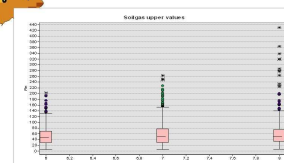- ● >1000

Radon Potential (Soilgas-perm.)

- <20
- 20 - 25
- 25 - 35
- 35 - 55
- 55 - 75
- >75

Stratigraphy

- alluvium
- M, Conglomerate
- Co, sandy shale
- Bt, schists
- Cb1, phyllades/sandstone
- Cb2, Phyllades/sandstone
- G, Shale/sandstone
- Sm2, Quartzophyllades
- Sm1, Quartzophyllades
- Dv2, Shale
- Dv1, Quartzite
- Rv, Black shale/phyllades

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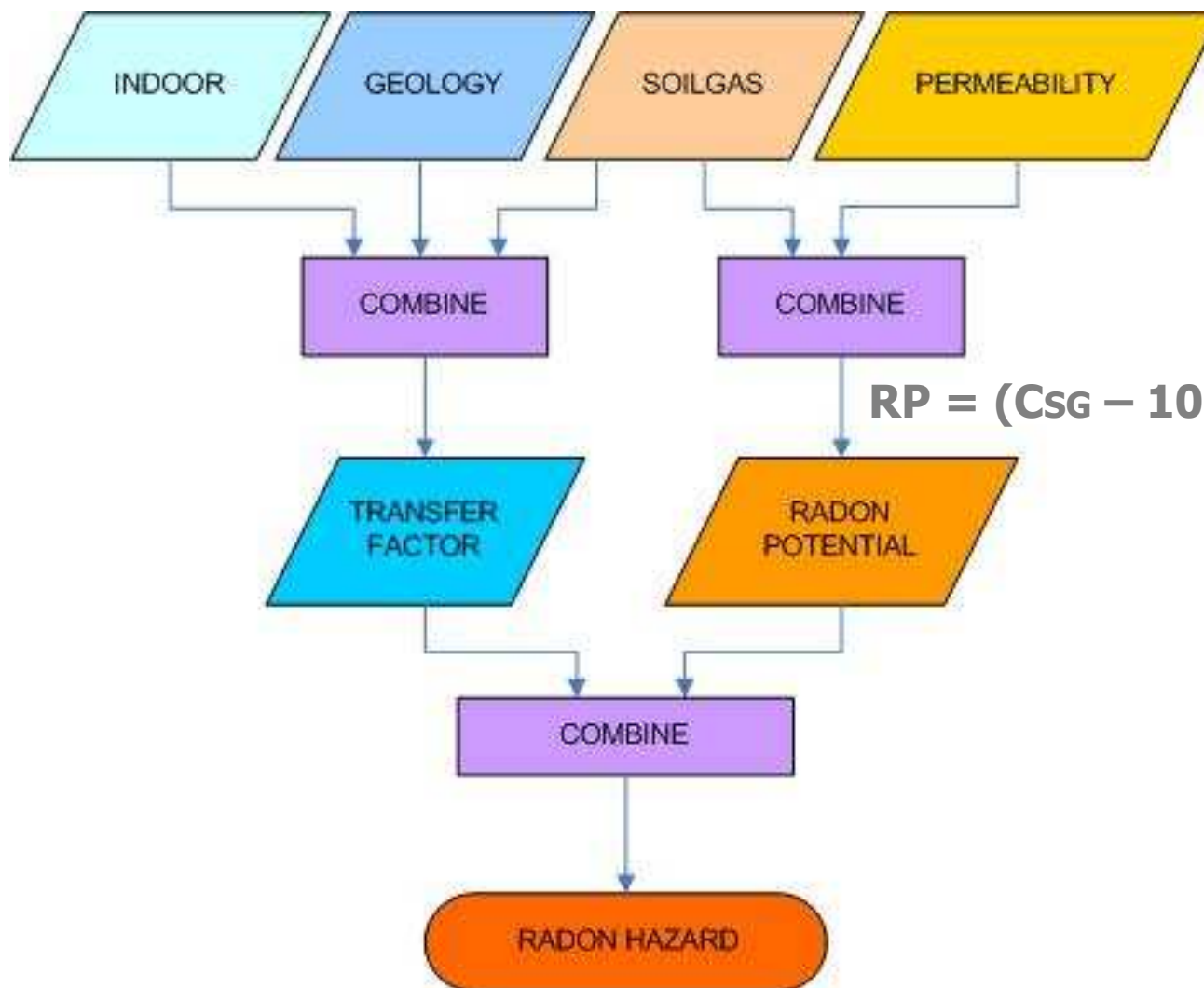
$$RP = (C_{SG} - 10) / (-\log k - 10)$$

$$TF = \{[IND (Bq/m^{-3}) - SG (Bq/m^{-3}) / SG (Bq/m^{-3})] * 100\} + 100$$

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Soil Radon Potential

< 10
10-25
25-35
35-50
50-80
>80

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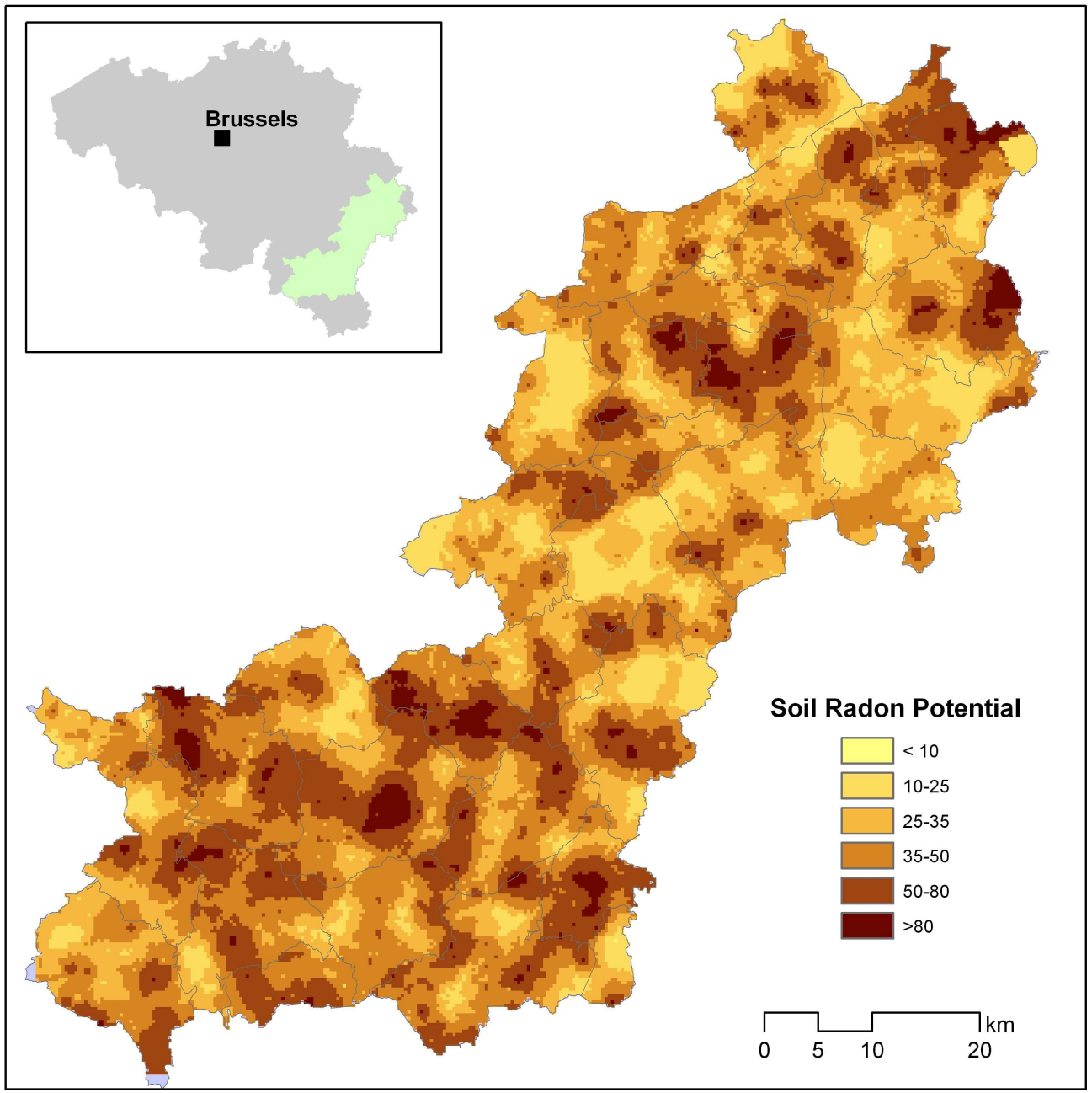
N	Mean	GM	Median	Min	Max	LQ	UQ	10%	90%	Std.Dev.	Coef.Var.
4141	0.0069	0.0035	0.0034	0.0001	0.363746	0.0017	0.0069	0.00095	0.0143	0.0146	210.92

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Transfer Factor

- < 0,5%
- 0,6% - 1%
- 1,1% - 1,5%
- 1,6% - 3%
- >3%

km
0   5   10   20

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Probability Map

	< 1%
	1,1% - 2%
	2,1% - 5%
	5,1% - 10%
	10,1% - 20%
	>20%

km
4   8

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Probability Map

Indoor radon (Bq/m)

- 6 - 100
- 101 - 200
- 201 - 400
- 401 - 800
- 801 - 4205

	< 1%
	1,1% - 2%
	2,1% - 5%
	5,1% - 10%
	10,1% - 20%
	>20%

km
0   2   4   8

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Measured indoor radon versus modelled %

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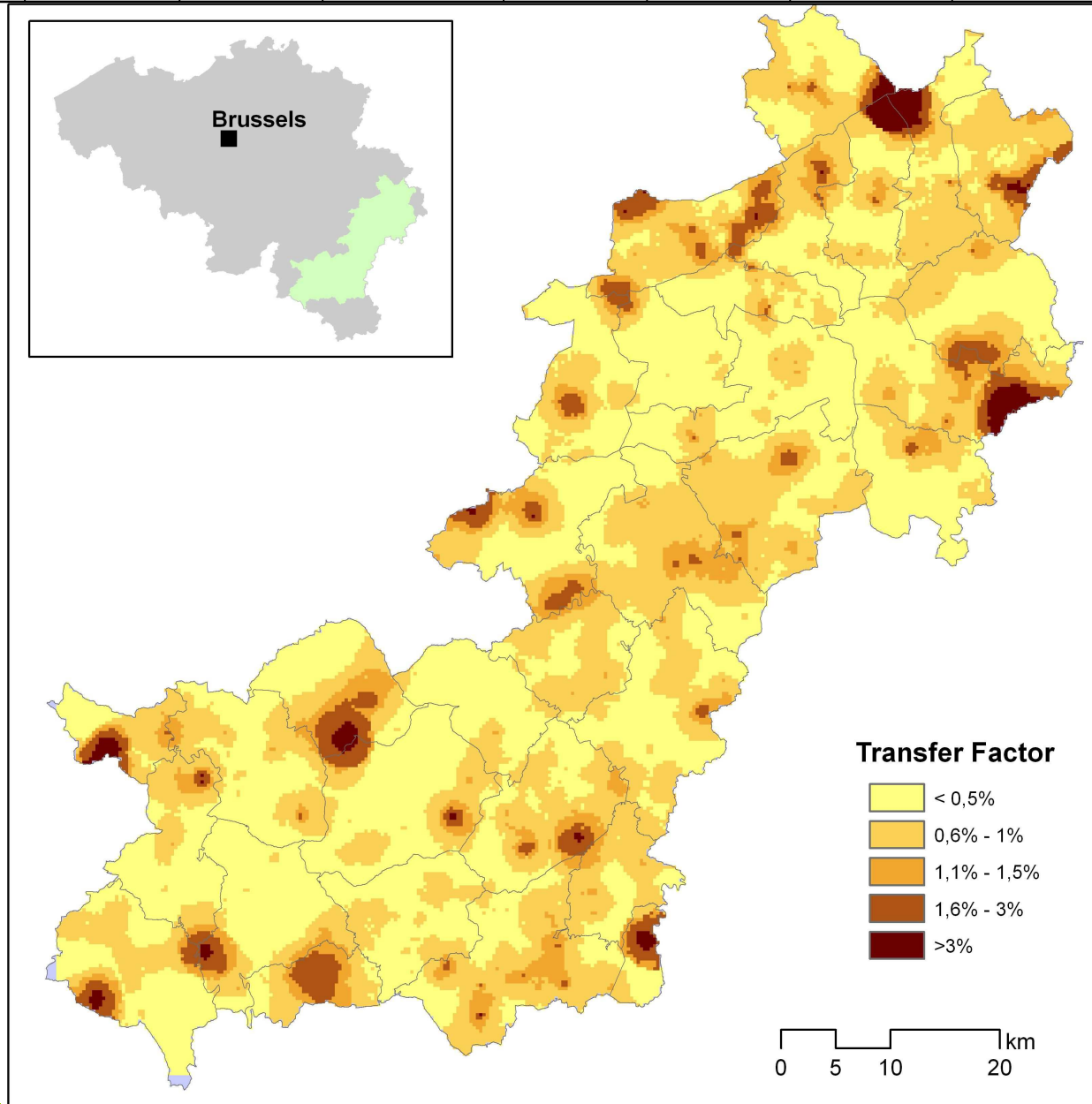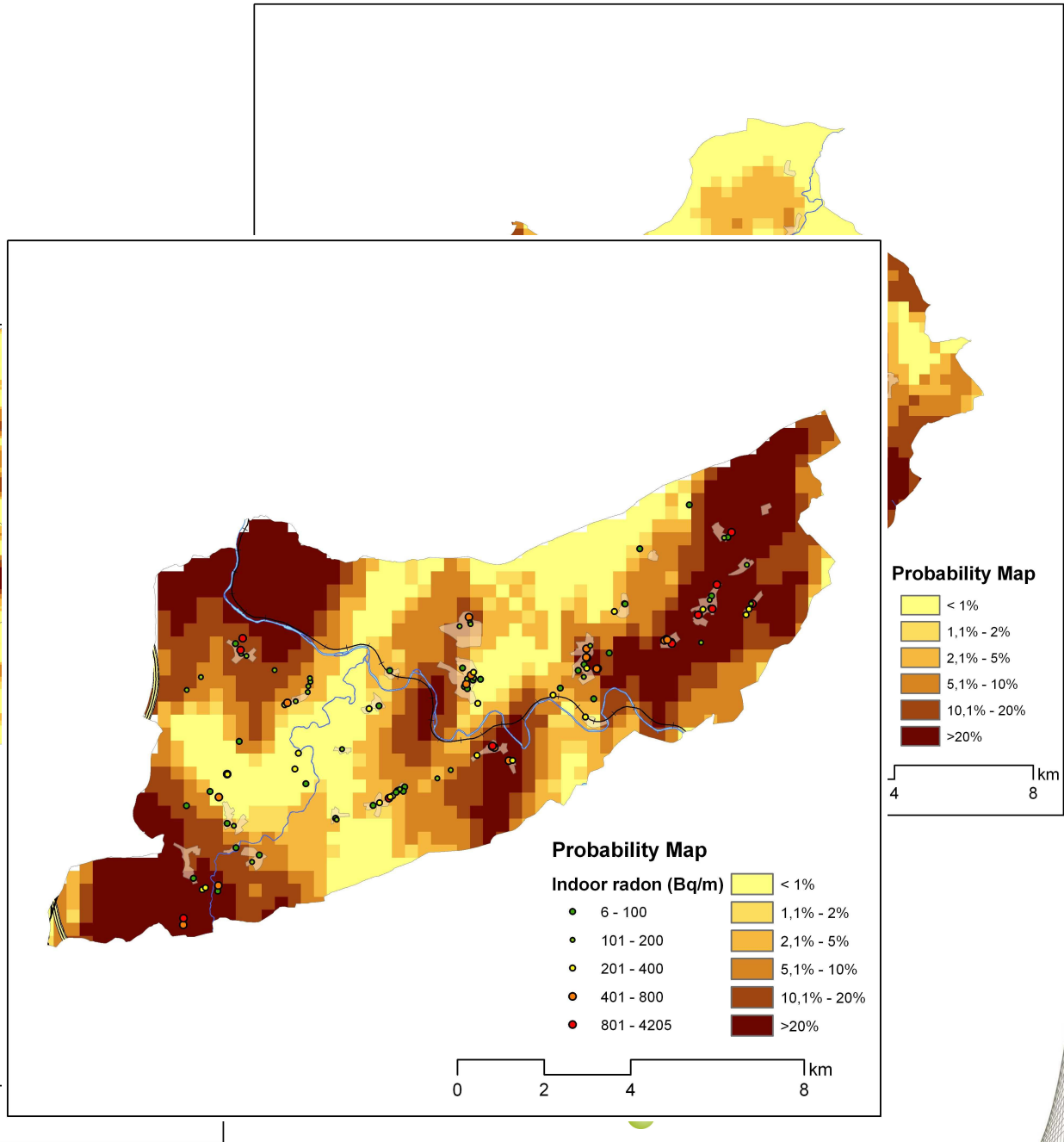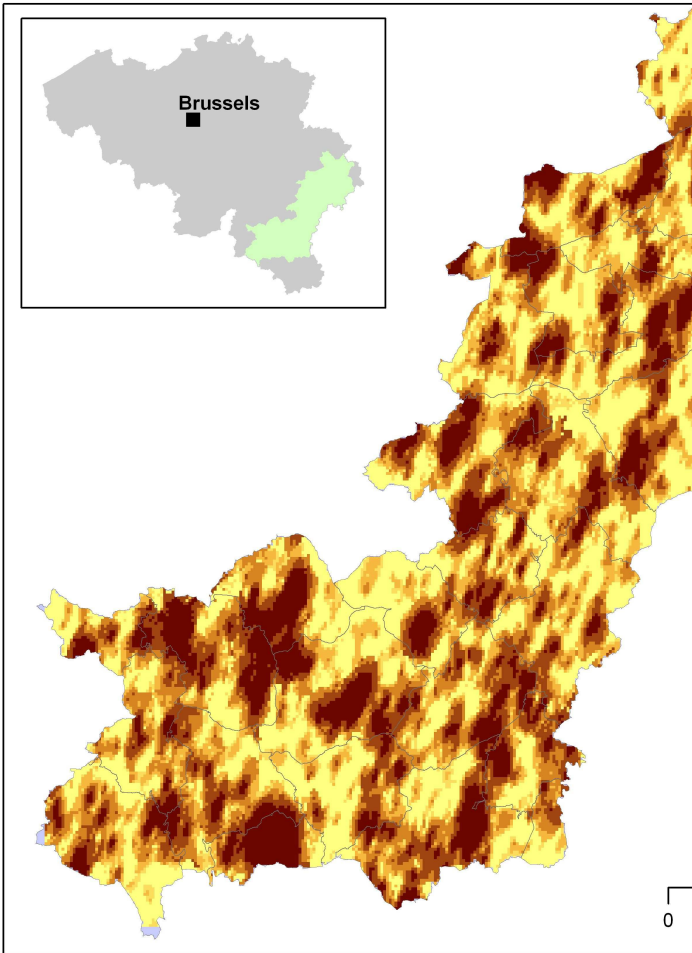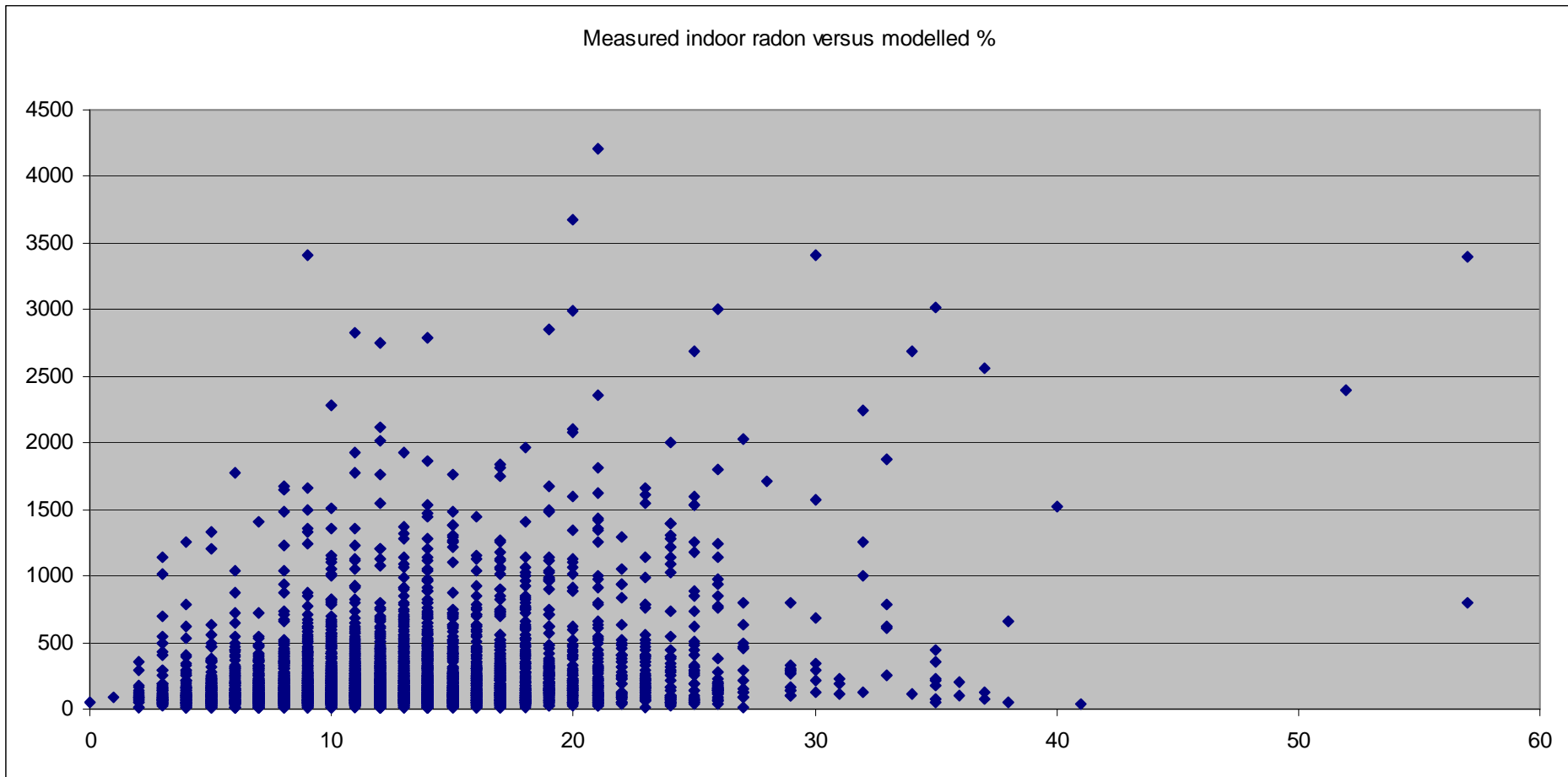
DISCUSSION

- Radon Hazard Mapping combining all available input parameters

- Leads to a 300x300 m grid of the radon hazard in terms of percentage above the action level (400 Bq/m)

- Takes into account radon proxy's outside build-on areas

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CONCLUSIONS

- There was a need for tools to efficiently organize measurement and prevention campaigns
  - Developed a methodology to combine all available relevant parameters to predict the indoor hazard
  - Mapped the radon hazard by combining all relevant and available parameters
  - Use the maps for focused measurement campaigns in houses and workplaces, and stimulate protective measures for new buildings
  - Use the maps for communication with the municipalities and public-awareness campaigns

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