VARIABILITY OF INDOOR RADON RISK BETWEEN AND WITHIN GEOLOGICAL UNITS

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Summary

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- The Walloon region and its Rn database
- Defining Rn-homogeneous geological units
- Analysis of Variance (ANOVA)
- Statistics of the percentage > 400 Bq/m^3

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Materials

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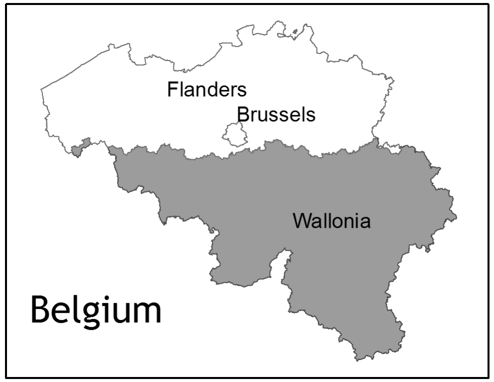
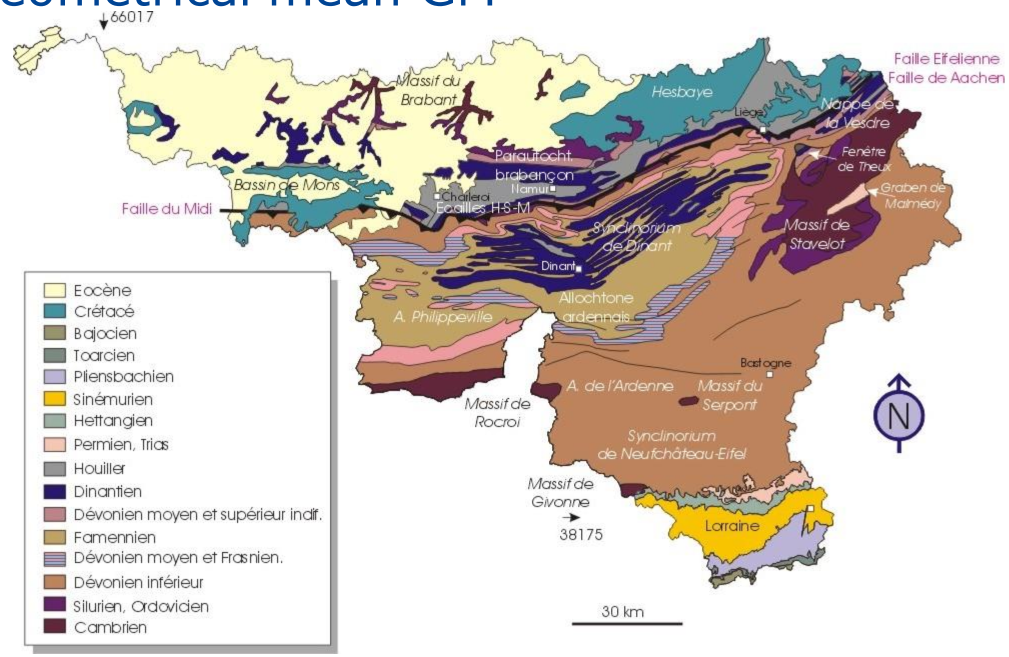
Indoor radon database:

- 13680 track-etch 3-month measurements (long term LT)
- 5090 charcoal ≈3-day measurements (short term ST)
- LT and ST equivalent for the geometrical mean GM



Geological map:

- 1/40000 map
- Limited information for lithology
- All periods from Cambrian to Quaternary
- Sedimentary rocks



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Rn-homogeneous geological units

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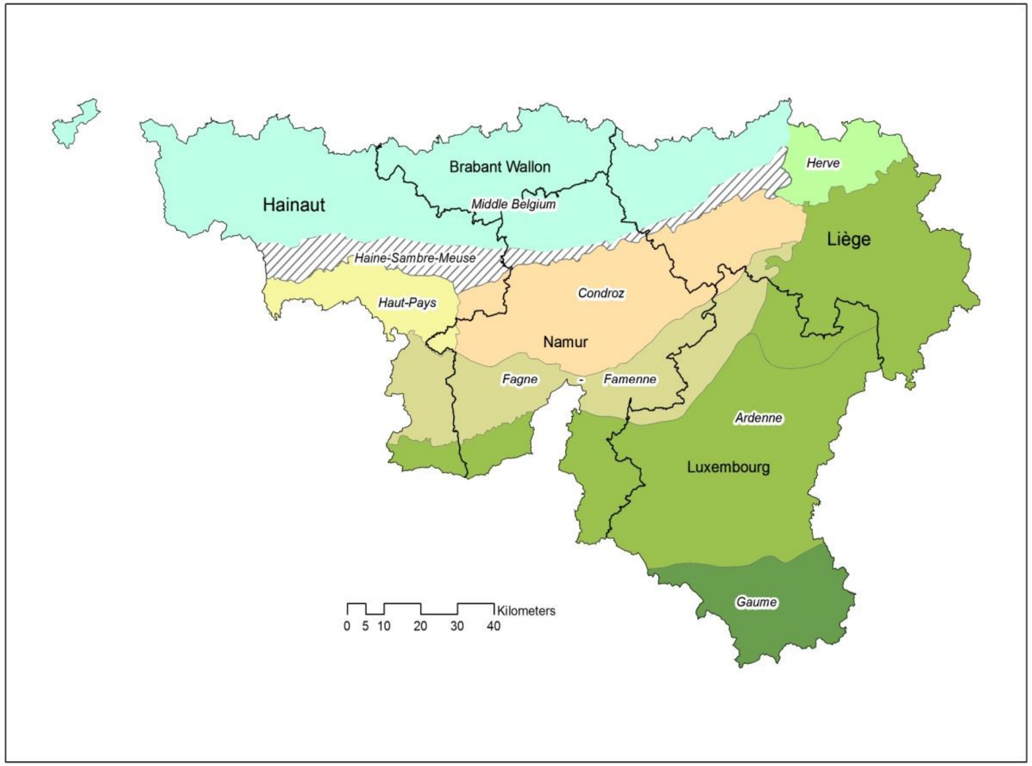
Step 1: Dividing

The region is divided according to geological age (~40),
geographical region (8)
and province (5) ...
sometimes smaller

Step 2: Grouping

Contiguous areas with
a) similar ages and
b) similar indoor radon GM
are grouped
in a geological unit (GU)



Example

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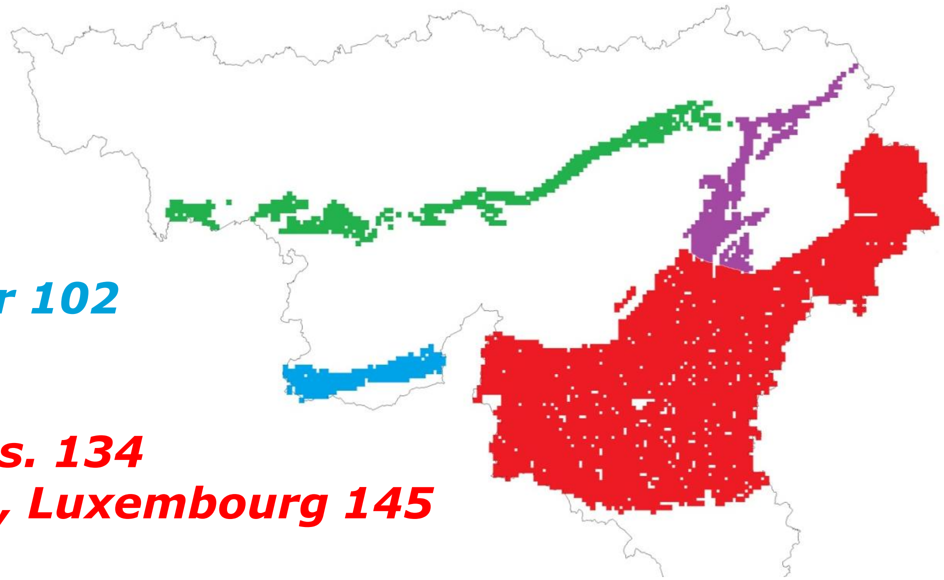
Lower Devonian: 3 ages, 4 provinces, 4 regions → 4 GUs



Rocroi: GM=99 Bq/m³

3 ages: Gedinnian103, Siegenian 88, Emsian 112
2 provinces:Hainaut 97, Namur 102

Ardenne: GM=143 Bq/m³

3 ages: Ged.150, Sieg.134, Ems. 134
3 prov.: Namur 140, Liège 142, Luxembourg 145

Condroz: GM=57 Bq/m³

3 ages: Gedinnian 52, Siegenian 53, Emsian 62
3 provinces: Hainaut 59, Namur 51, Liège 63

Stavelot: GM=98 Bq/m³

3 ages: Gedinnian 98, Siegenian 90, Emsian 120
2 provinces: Liège 101, Luxembourg 94

Full list

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30 ~ homogeneous GUs (GM in parenthesis)

Cambrian CLM(48) CRO(65) CCM(87) **CUB(118) CST(131)**

Ordovician OCO(52) OBR(59) **ODY(123)**

Silurian SBR(41) SCO (85) **SME(123)**

Lower Devonian DLC(57) DLS(98) DLR(99) **DLA(143)**

Middle Devonian DMB(48)

Upper Devonian DUB(46) DUF(57) DUC(69) DUL(93)

Carboniferous HSM(52) TNO(63) TCO(64) HCO(74)

Permian PER(67)

Triassic TRI(91)

Cretaceous CRE(49) CHO(72)

Tertiary TNO(47) TSE(65)

Quaternary not included

4 moderately inhomogeneous GUs

Ordovician OST (101-157)

Middle Devonian DMC(55-77) DMF(74-103)

Jurassic JUR(49-75)

2 strongly inhomogeneous GUs

Carboniferous VNO(56-106) VCO(73-160)

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ANOVA – step 1

Which is the percentage of the variance that is explained by the geological variations with this geological division?

Region/ Country	Scotland	England & Wales	N Ireland	Austria	Wallonia LT	Wallonia ST
Percentage	17.3 %	24.6 %	10.5 %	11.2 %	17.7 %	15.4 %

Norway 20%

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ANOVA – step 2

Which is the percentage of the variance that is related to the variability of the localisation within the geological unit?

The post code is used as a proxy for the localisation (Min. 10 data in the GU/post code)

ANOVA

GU code	approx. Surface (km²)	number of post codes	LT number of post codes with ≥ 10 data	ST number of post codes with ≥ 10 data	LT % of the variance explained by post code	ST % of the variance explained by post code
CCM	4	2	2		0.22%	
ODY	5	5	3		1.65%	
CUB	10	4	2	3	2.35%	1.12%
CLM	22	11		6		4.45%
PER	24	3	2		0.06%	
OCO	50	10	3		0.85%	
TRI	74	6	2		1.69%	
DUB	75	16	2		5.18%	
SBR	93	13		2		0.43%
CRO	117	5	2		1.21%	
VNO	187	43		6		21.19%
DMC	193	42	7		12.86%	
DLR	202	8	4		5.92%	
OST	240	12	8	3	6.64%	13.85%
DLS	391	15	6		4.13%	
DLC	458	33	4		1.96%	
DMF	474	30	12		11.74%	
CST	651	14	9		7.86%	
JUR	692	27	15		13.27%	
DUF	1182	30	9		17.24%	
TER	3544	136		24		8.73%
DLA	3741	85	59	10	6.05%	7.83%

Percentage above reference level

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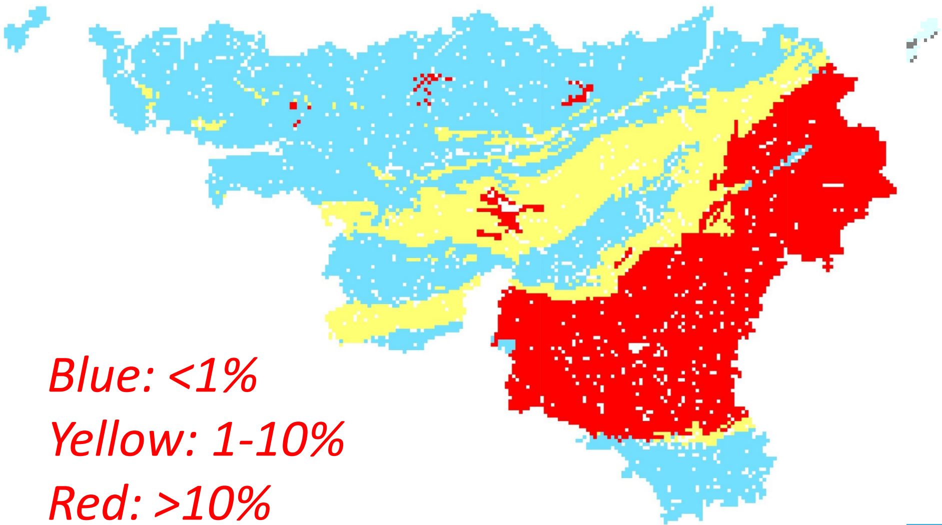
- *From a lognormal distribution fitted to the data*

  ST data have more variability: their LSD must be corrected

$$\sigma_{LTeq}^{2}=\sigma_{ST}^{2}-\sigma_{t}^{2}$$

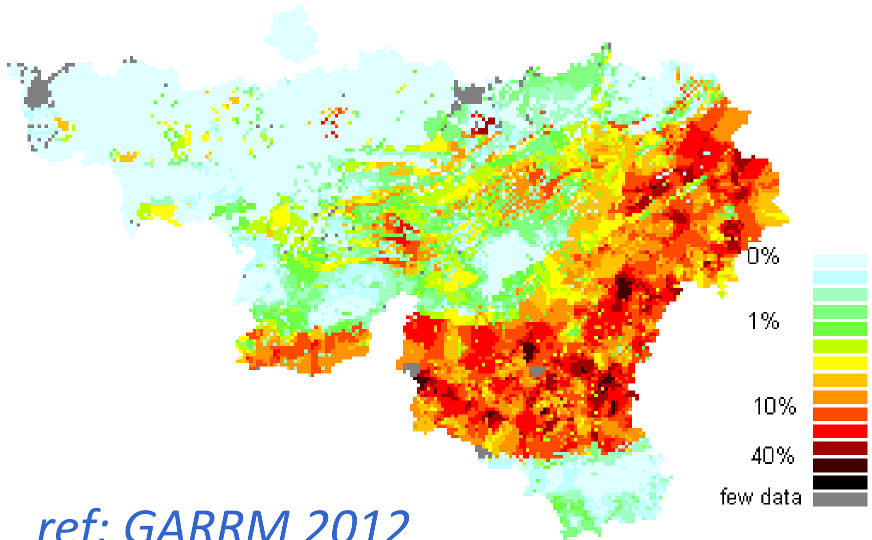
[illegible] = *constant*

Schematic map (data 2014)
No mapping within the GUs



Blue: <1%
Yellow: 1-10%
Red: >10%

Detailed map (data 2012)
Mapping within the GUs



ref: GARRM 2012

Variability between & within GUs

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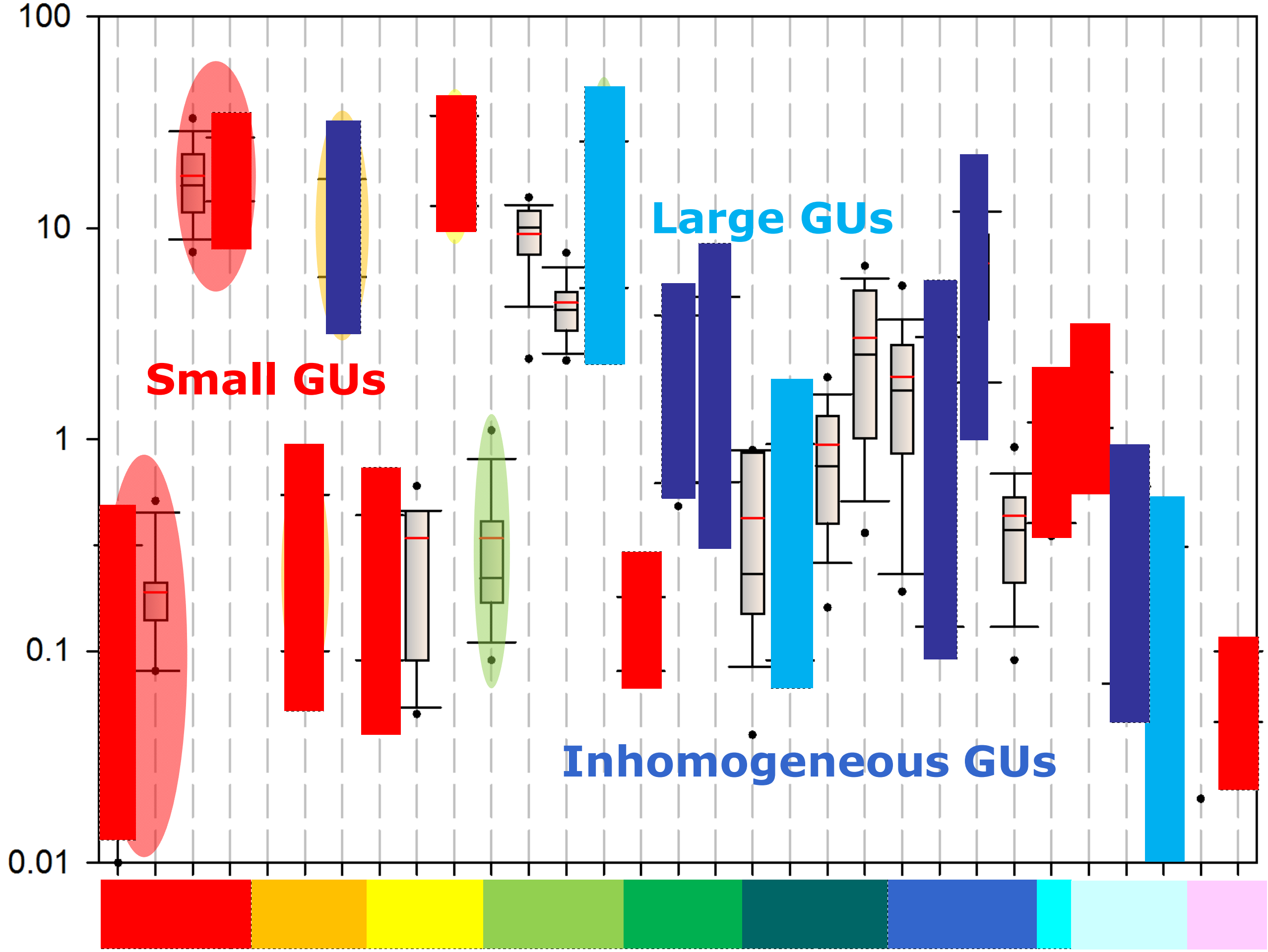
Variation of the %>400 Bq/m³ from the map



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Conclusion

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The variability of indoor radon risk in the Walloon region of Belgium between and within the newly defined “Rn-homogeneous” geological units was examined with two tools:

- the analysis of variance
- the geostatistical mapping of the risk level.

The two methods largely converge to the same conclusions:

- The influence of geology on indoor radon concentration is stronger than the influence of geographical variation within the geological units
- The geographical variation of the risk within the geological unit is not small and cannot be neglected in radon risk mapping, except in a few small units.

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Thank you very much

for the attention

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