The role of karst in identifying radon priority areas in Belgium

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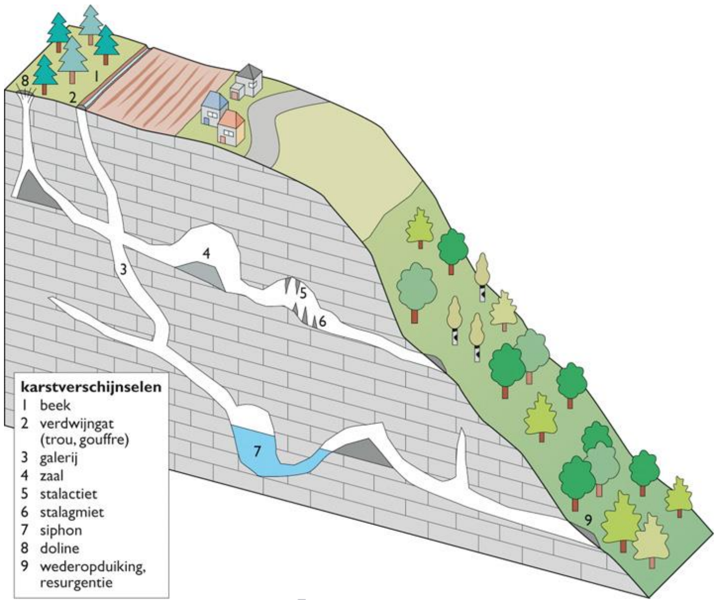
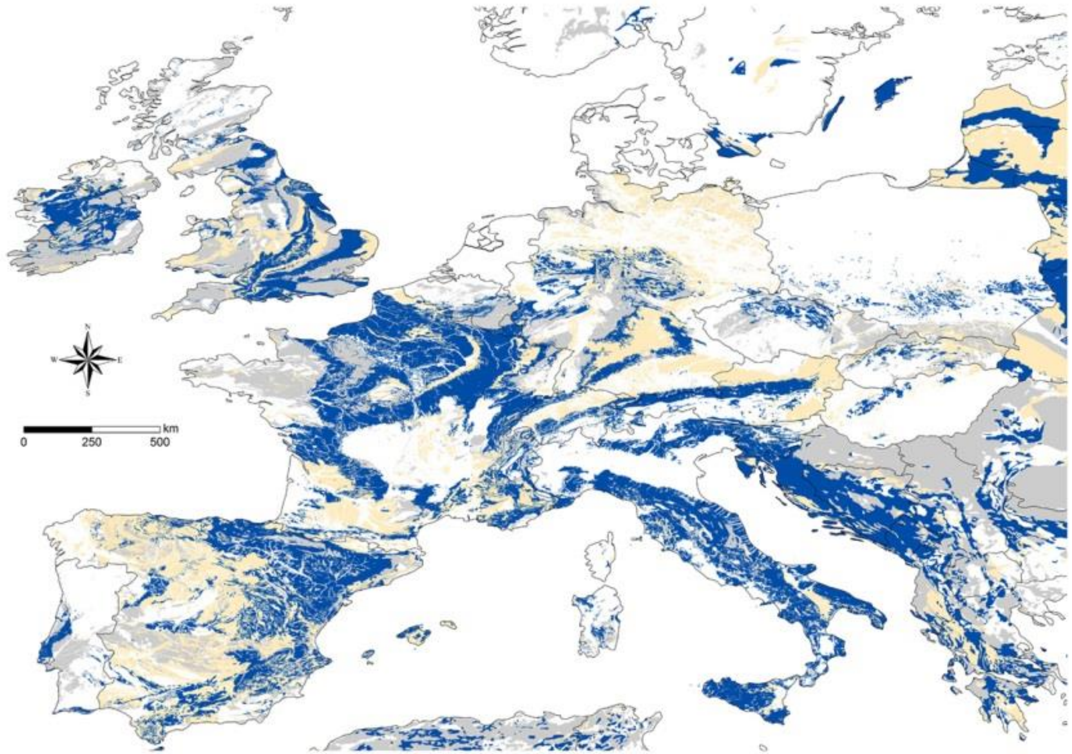
Karst:

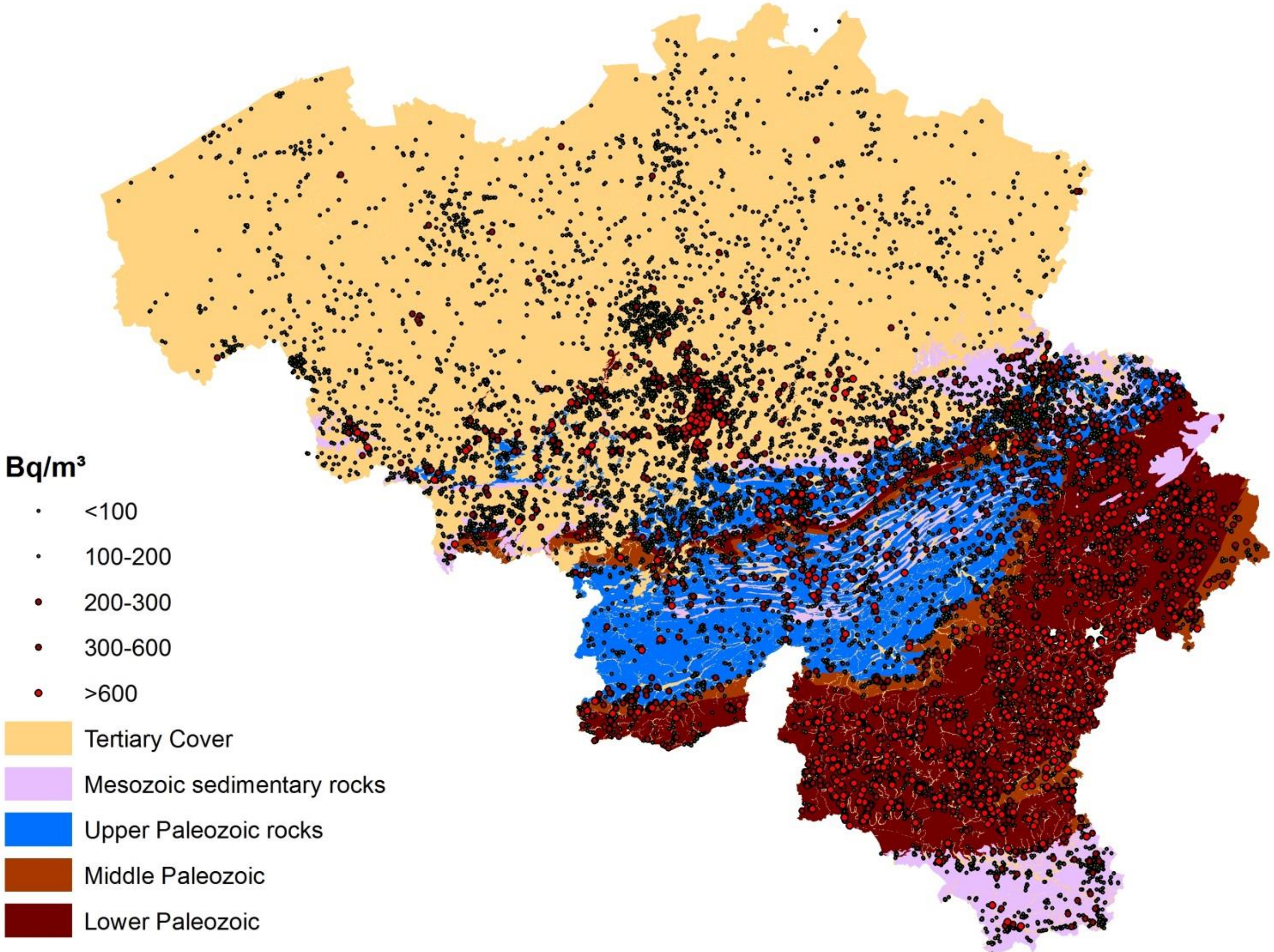
- carbonate rocks where fractures are enlarged by chemical dissolution to form a network of galleries, conduits and caves

- Forms particular landscapes when part of these galleries collapse

Of particular importance for indoor radon risk due to the potentially high permeability






Bq/m³
<100
100-200
200-300
300-600
>600
Tertiary Cover
Mesozoic sedimentary rocks
Upper Paleozoic rocks
Middle Paleozoic
Lower Paleozoic

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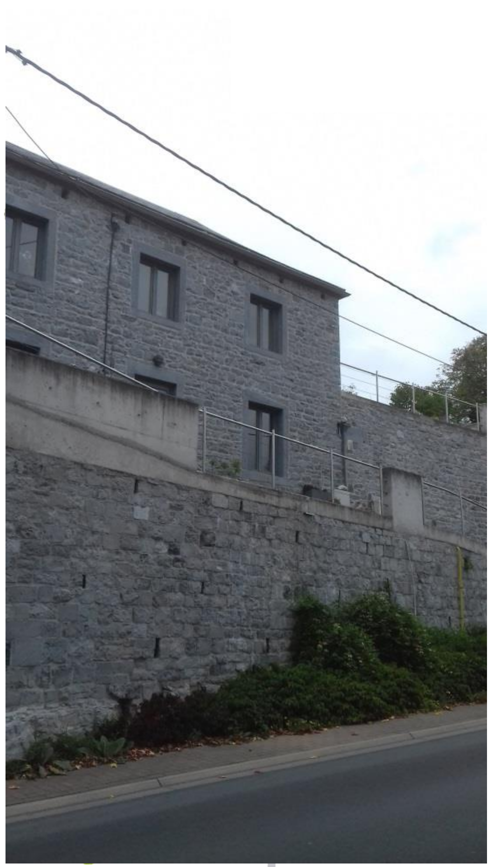
Problems related to karst

- Identify the risk (strong local variations)
- Specific needs for remediation solutions



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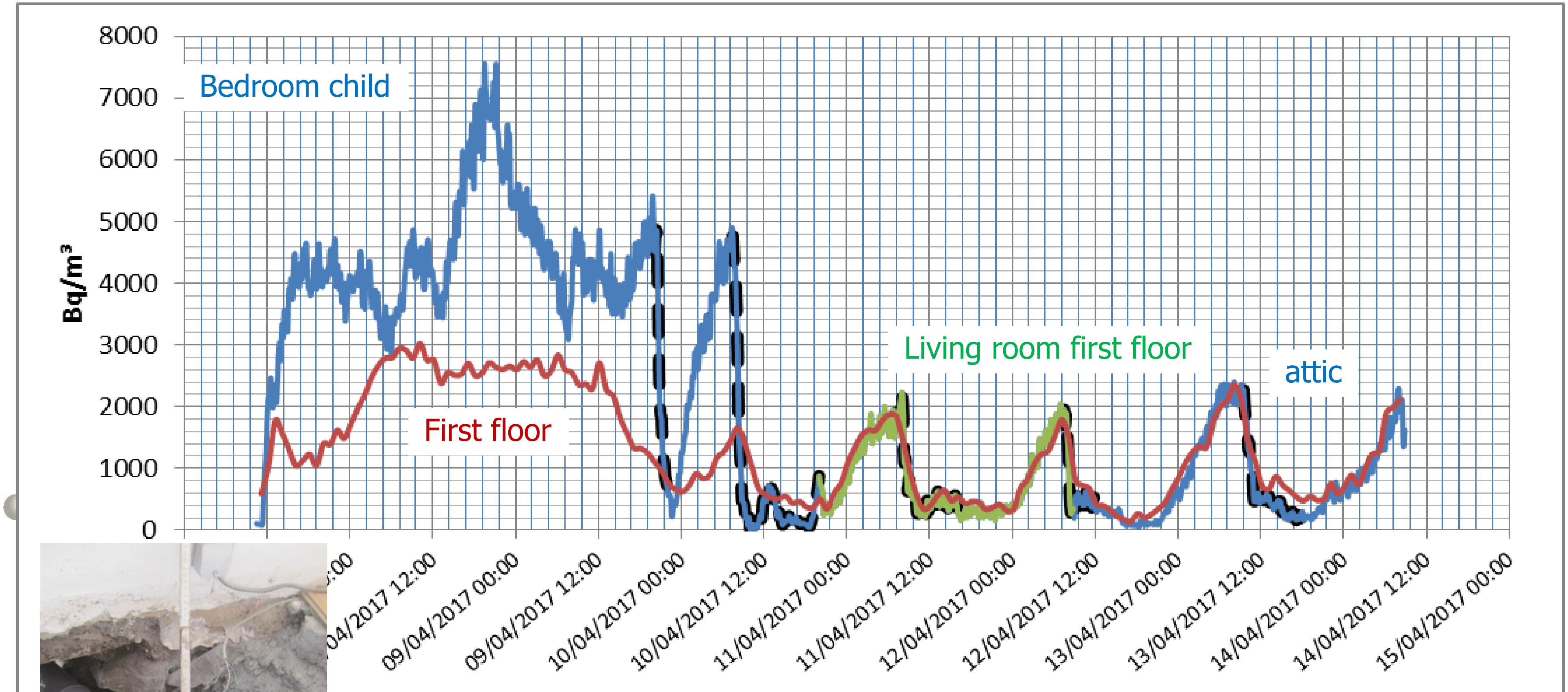
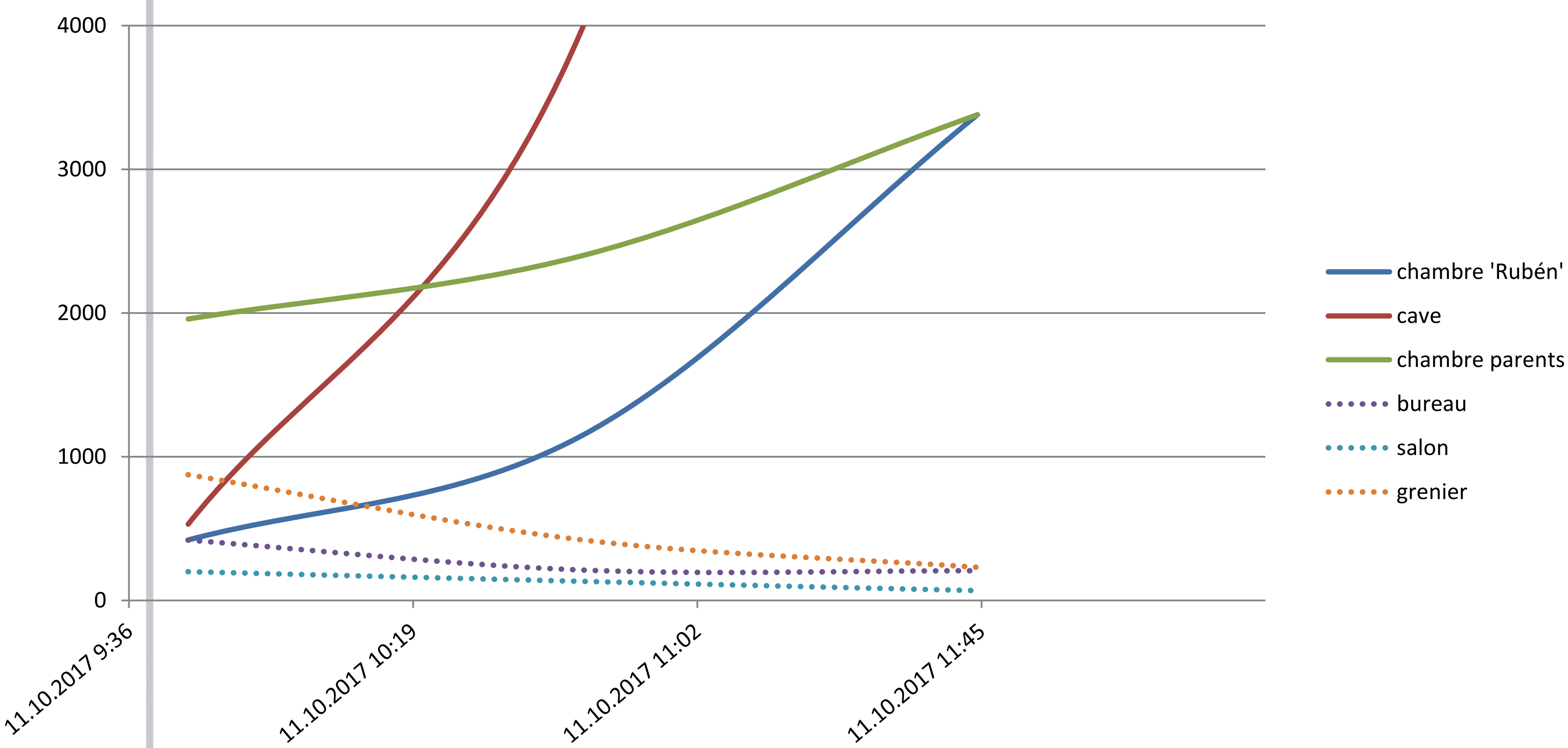

8000
7000
6000
5000
4000
3000
2000
1000
0
Bq/m³
Bedroom child
First floor
Living room first floor
attic
09/04/2017 00:00
09/04/2017 12:00
10/04/2017 00:00
10/04/2017 12:00
11/04/2017 00:00
11/04/2017 12:00
12/04/2017 00:00
12/04/2017 12:00
13/04/2017 00:00
13/04/2017 12:00
14/04/2017 00:00
14/04/2017 12:00
15/04/2017 00:00

Blower door test



N50 ~7
Natural air changes per hour ~35%

date	Room1	Cellar	Room 2	office	living	attick
11/10/2017 09:45	420	530	1958	420	200	874
11/10/2017 10:45	1150	3990	2400	210	132	420
11/10/2017 11:45	3380	13403	3380	205	67	230



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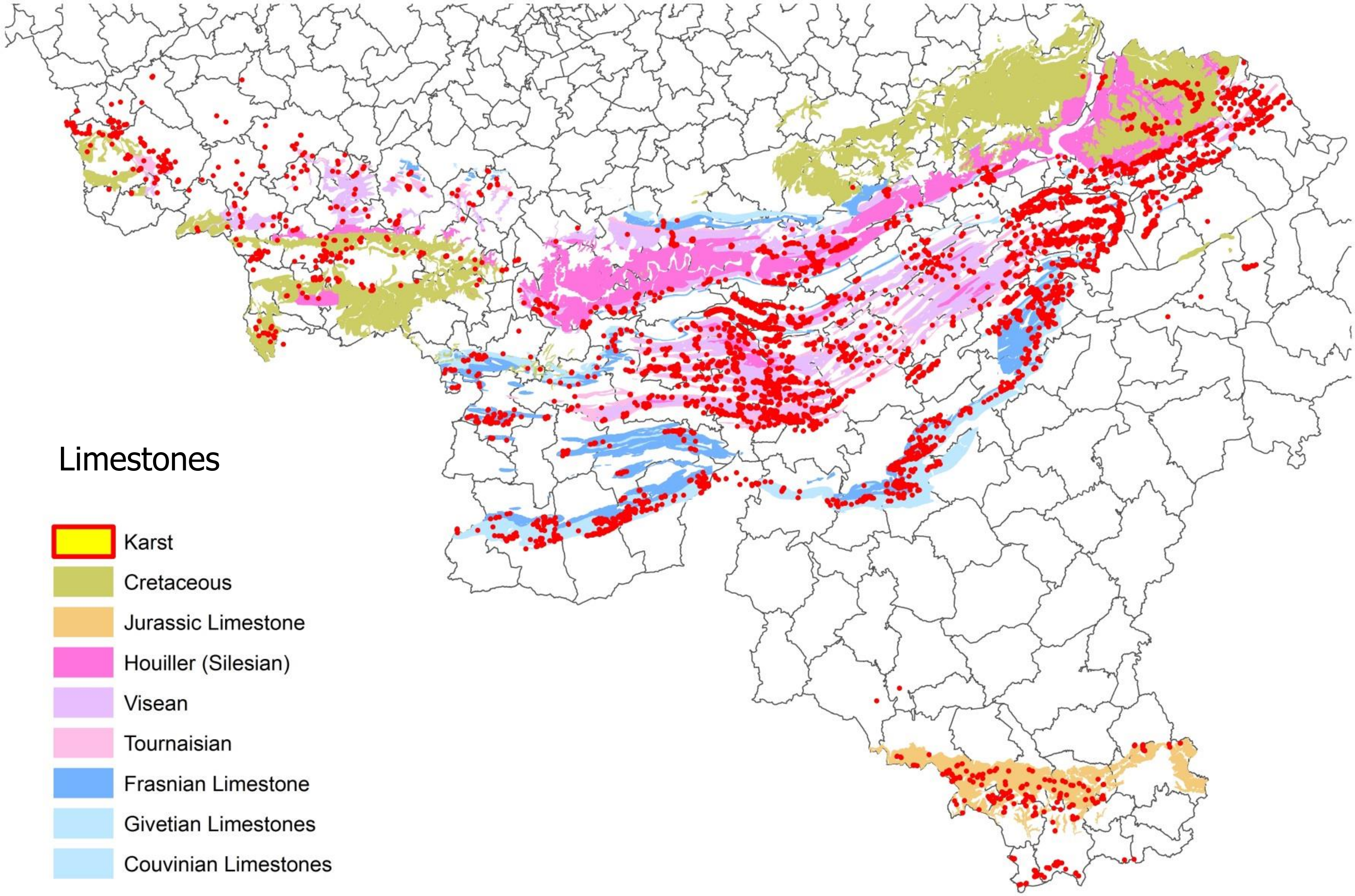
Limestones
Karst
Cretaceous
Jurassic Limestone
Houiller (Silesian)
Visean
Tournaisian
Frasnian Limestone
Givetian Limestones
Couvinian Limestones

Karst occurs in almost all levels of limestone

Age (Ma)	Period	Series		Stage	remark	GM (Bq/m³)	GSD	t-test P-value	Karst
95	Cretaceous			Cenomanian		58	2,2	0,02	low
190	Jurassic			Sinemurian		64	1,9		low
310	Carboniferous	Upper	Houiller (Silesian)	Westphalian	(coal measures)				
				Namurian	(Chockier hot shales)	57	2,4	0,0002	low
		Lower	Dinantian	Viséan		72	2,8	0,35	high
350				Tournaisian		68	2,6		modest
	Devonian	Upper		Famennian					
				Frasnian		63	2,3	0,001	modest
		Middle		Givetian		77	2,4	0,76	high
				Eifelian	(Couvinian)	76	2,2		modest
		Lower		Emsian	(Burnotian)				
				Pragian	(Siegenian)				
410				Lochkovian	(Gedinnian)				

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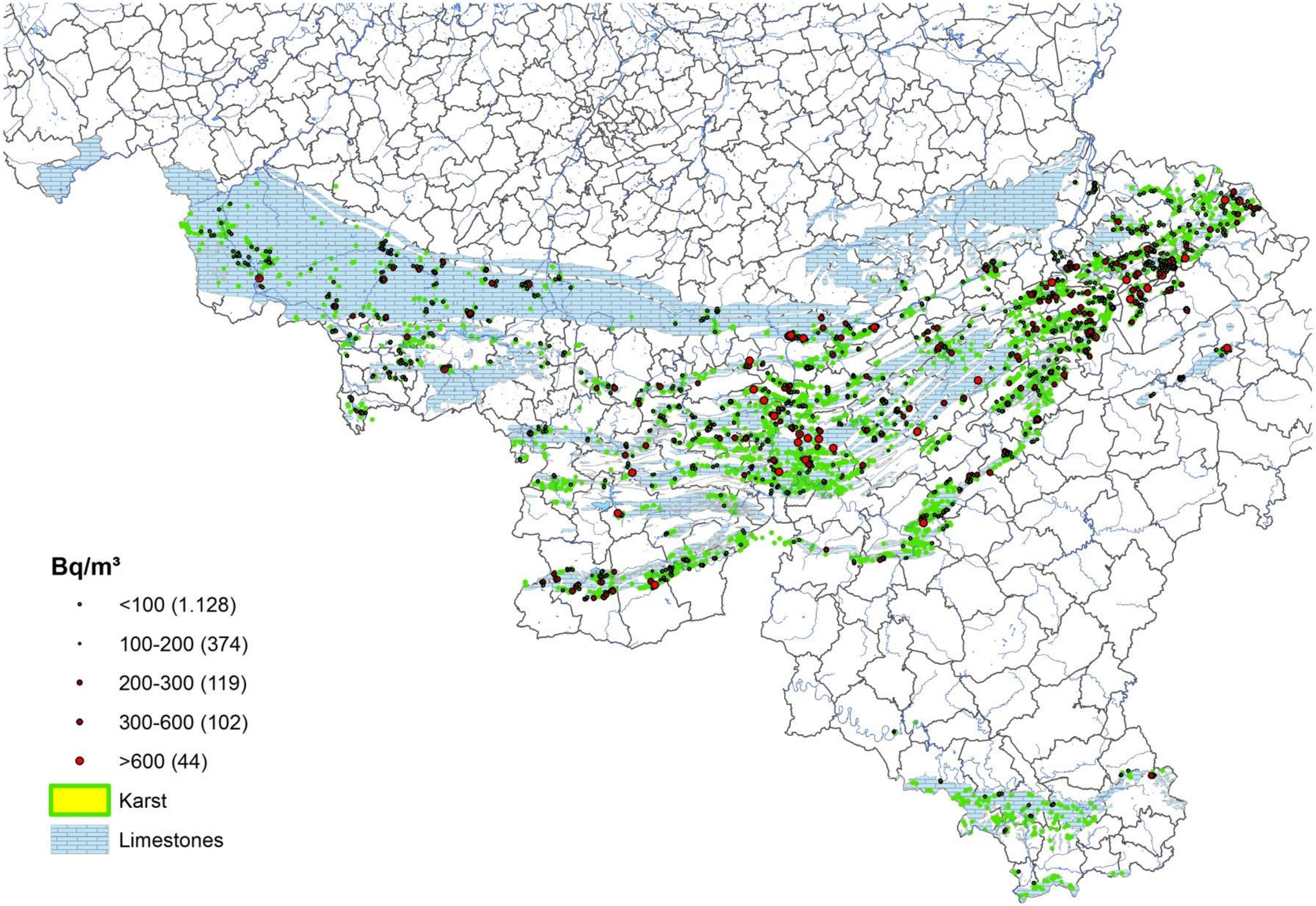
Bq/m³
<100 (1.128)
100-200 (374)
200-300 (119)
300-600 (102)
>600 (44)
Karst
Limestones

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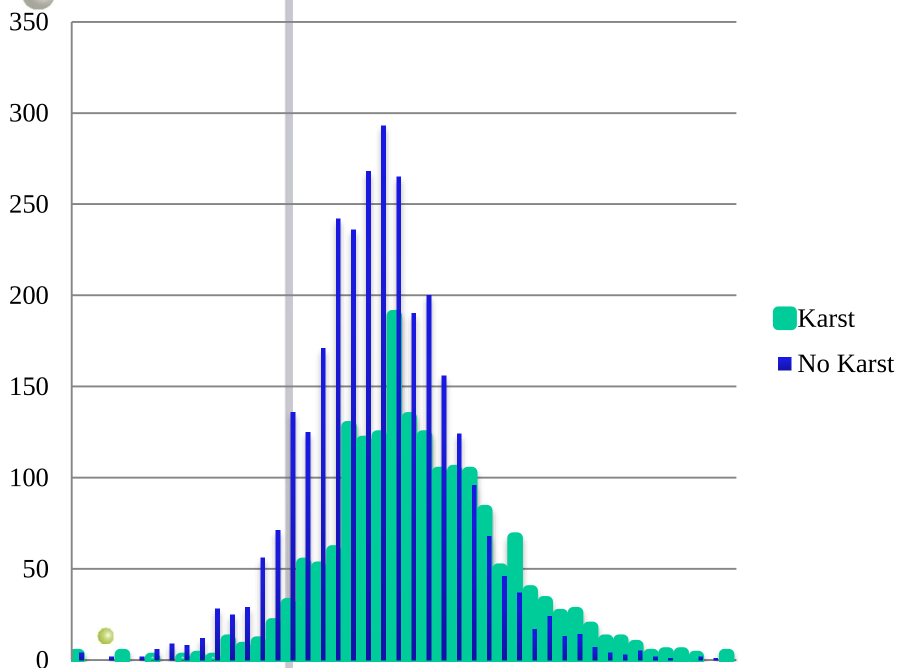
Bq/m³	Proven karst	No proven karst
count	1767	3008
GM	80	59
GSD	2,54	2,31
Median	72	58
Arithmetic mean	132	86
% > 300	8,3	3,0
% > 600	2,5	0,8



t-Test: Two-Sample Assuming Unequal Variances

	Karst	*NoKarst*
Mean	4,38	4,08
Variance	0,87	0,70
Observations	1767	3008
Hypothesized Mean Difference	0	
df	3388	
t Stat	11,209	
P(T<=t) one-tail	5,83E-29	
t Critical one-tail	1,645	
P(T<=t) two-tail	1,17E-28	
t Critical two-tail	1,961	

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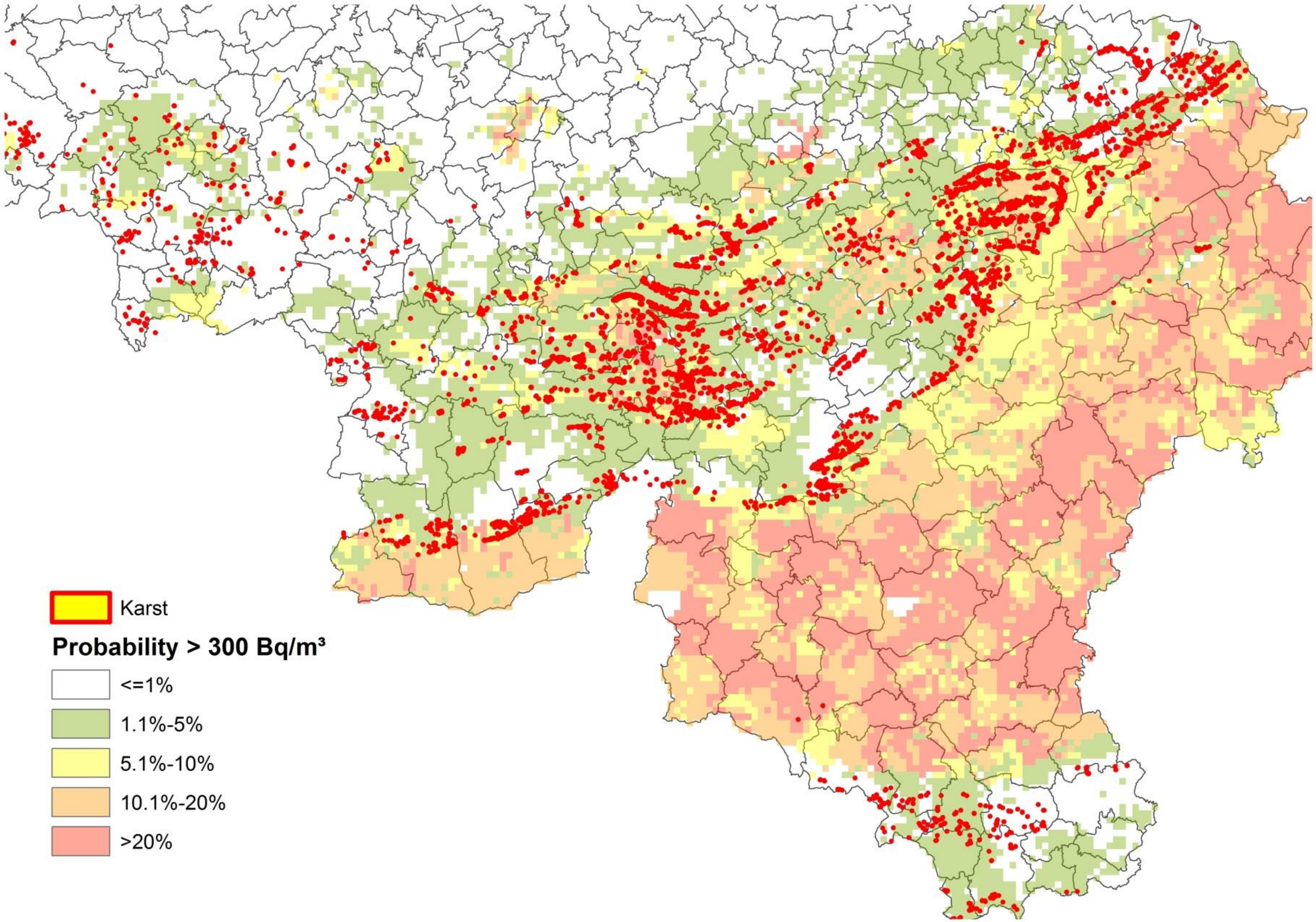

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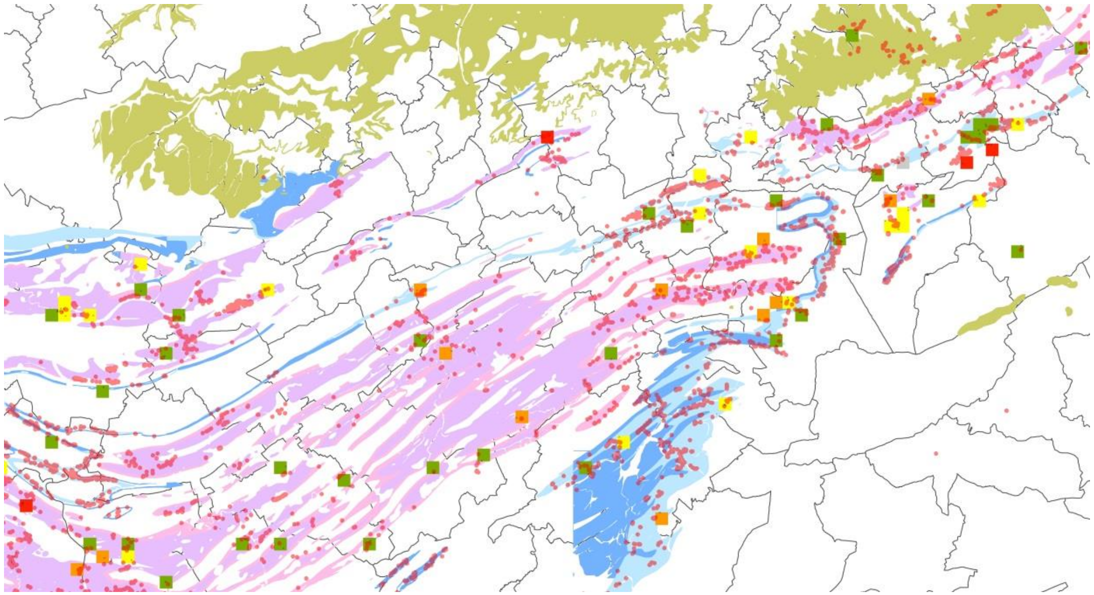
- Select high indoor values near karst (most probably due to karst)
- Isolate the high indoor values on low risk grid squares (based on general geology)



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- 49% of the high indoor values on limestone are found in low risk classes 1 and 2

- For the whole dataset, only 14% of high indoor values are located in low risk classes 1 and 2

- For the high indoor values located on limestones, 71% of the high indoor values are located within 700m distance of proven karst.

- So, the presence of karst could be used to ‘upgrade’ the local risk in a low risk grid square

Conclusions

- Presence of karst increases indoor radon risk, whereas limestone itself represents low to medium risk
- Indoor radon variations are higher in karst regions than outside karst regions
- They can vary greatly in time and space
- The presence of karst can be used to locally 'upgrade' the local risk in an overall low risk region
- Problem: not all karst is proven and mapped

Thank you for your attention!