

# The radon mapping exercise





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V. Gruber, S. Baumann & data providers & exercise participants

AGES – Austrian Agency for Health and Food Safety, Radon & Radioecology

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## Thanks to all for your contribution!



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# MetroRADON – WP4

## Task: Harmonisation of radon priority areas across borders

The exercise:

"Test existing mapping methods used in various countries with different datasets and evaluate their usability for other countries"

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Find usable datasets and prepare them for the exercise



Find participants/volunteers



Participants apply their mapping method and definition of radon priority areas



Analyse, compare, **evaluate** results





## Data set Austria

### **Extensive survey in 6 municipalities**









- Indoor radon concentration (1638 households), soil gas & permeability (~ 150 locations), soil samples, ADR (~ 100 locations)
- Additional data from literature (geology, soil map etc.)
- All data available in shp-files and tables; georeferenced

## Data set Cantabria



#### **Measurement data from different surveys**



# Data Sets – Data extend / quality



### Data sets are different - interesting for the exercise!

Variable	Cantabria	Austria			
Indoor radon conc.	measured, location approx., low sample density	measured, exact location, high sample density			
Soil gas radon conc.	<i>measured</i> , similar	<b>measured</b> ; similar			
Act. conc. in soil	European K, Th, U in soil maps (JRC) 10x10 km grid AM/GM (FOREGS, GEMAS)	<sup>40</sup> K, <sup>210</sup> Pb, <sup>226</sup> Ra, <sup>228</sup> Ra, <sup>228</sup> Th, <sup>238</sup> U <b>measured</b>			
ADR	<b>measured</b> ; similar	<b>measured</b> ; similar			
Faults	map; similar	map; similar			
Geology	map; similar	map; similar			
Permeability	estimates derived from lithological units	Soil permeability <i>measured</i> + estimates derived from soil units			
Karst	Binary, derived from lithological units	-			
Building characteristics	_	Questionnaire; at location of IRC			
Soil map	-	Soil unit, water conditions, soil depth,			
Airborne radiometry	-	eU; <b>measured</b> only North region			

# Mapping methods

## **Different methods were applied to (selected) data!**

- Basic statistics for IRC (AGES)
- Belgian Radon mapping software: Map variation of radon risk within geological units with moving average method (F. Tondeur)
- Generalised Additive Mixed Model (GAMM) for prediction of IRC for location/grid cell/municipality – define relevant variables with 5-fold cross validation (AGES)
- Ordinary kriging (OK), Indicator kriging (IK) with ANOVA for target variables (E. Petermann, P. Bossew)
- Empirical Bayesian Kriging Regression (EBKR) combines krigind with regression analysis, raster layers for the proxies (G. Ciotoli)



# Mapping methods

## **Comparison of key-features**



Method	IRC	Building characteristics	Soil Gas	Radionuclide contents	Geogenic factors	Interpolation
IRC mean over threshold	yes	possible subset data	no	no	no	no
Probability of IRC over threshold	yes	possible subset data	no	no	no	no
GAMM	yes	yes	yes	yes	yes	yes
EBK regression	no	no	yes	yes	yes	yes
Kriging IRC (AUT)	yes	subset data	no	no	no	yes
Kriging GRP (SP)	no	no	yes	yes	yes	yes
BE Rn Risk Software	yes	subset data	no	no	yes	yes

## Mapping methods Examples of correlations - Cantabria

Cantabria, Geogenic Radon Potential





AGE

## Mapping methods Examples of correlations - AUT North

AUT North, % over 300





AGE





## Mapping methods Examples of correlations

- Examples show compareable results on predicted cells
- Indicates that this methods could be used interchangeable for harmonisation
- In general: Possible methods for a certain area will highly depend on the available data.









## **Experiment: AUT North**

- Final goal is the identification of radon priority areas (RPA)
- Method: Use the aggregated results of the different methods with alternating thresholds to define
   RPA
- Austria: RPA are defined for each municipality (smallest administrative entity)

## Austria North: 3 municipalities





## **Experiment: AUT North**

- Final goal is the identification of radon priority areas (RPA)
- Method: Use the aggregated results of the different methods with alternating thresholds to define RPA
- Austria: RPA are defined for each municipality (smallest administrative entity)
- IF AM(results) in municipality > threshold -> RPA
- From left to right the applied threshold increases



Threshold IRC [Bq/m<sup>3</sup>]

## Classification of RPA Classification experiment: AUT North







**Increasing IRC Bq/m<sup>3</sup> Threshold** 



Threshold IRC [Bq/m3]





## **Classification experiments: AUT North**

- Final goal is the identification of radon priority areas (RPA)
- Method: Use the aggregated results of the different methods with alternating **thresholds to define RPA**
- Austria: RPA are defined for each municipality (smallest administrative entity)
- IF AM(results) in municipality > threshold -> RPA
  From left to right the applied threshold increases
  - For large intervals of classification thresholds independent of applied method – same RPA classification is predicted.



Threshold IRC [Bq/m<sup>3</sup>]



## **Summary RPA definitions for different classification schemes**

	AM	GM	Med	% > 300	Med (BE)	% > 300 (BE)	GM GAMM (AT)	OK (DE)	IK % > 300 (DE)
Cant.	97	54	54	3	-	-	54	-	-
Mun. 1	289	196	197	31	231	40	243	352	86
Mun. 2	313	207	213	36	240	41	201	360	39
Mun. 3	429	273	266	45	230	39	208	367	39
Mun. 4	289	165	168	28	209	38	153	305	26
Mun. 5	251	157	144	22	183	32	241	300	26
Mun. 6	234	146	130	21	173	31	310	304	26

**RPA:** Prob (IRC>300) >10 %

**RPA:** AM/GM/Med > 300 **RPA:** AM/GM/Med > 100

# Summary & Conclusions

## Harmonisition of radon priority areas



- Different methods applied; exercise data are challenging
- Not all methods are suitable for all data/areas (depends on data quality, sample density, heterogeneity of the area, etc.)
- In some cases different methods show comparable results on predicted cells
- Possible methods for a certain area will highly depend on the available data. For harmonisation the model using less parameters might be preferable.
- Classification Experiment: Independent of the applied method for large intervals of classification threshold same RPA classification is predicted!

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Radon-characterisation of areas: different methods deliver similar results, depending on definition of RPA!

Y

Definition of classification thresholds might be as relevant as harmonising methods!

# If you are interested....

## ...stay tuned!

- Report & MetroRADON Deliverable
  - www.metroradon.eu

## Peer reviewed Paper



journal of the European Radon Association

#### MetroRADON



#### Documents

This is the document section of the MetroRADON website where project outputs are shared.



Metrology for radon monitoring

AGE

#### Newsletters & Status Reports

February 2020 newsletter

- Status Report February 2020
- July 2019 newsletter
- Status Report July 2019
- January 2019 newsletter
- Status Report January 2019



European Radon Week February 24 - February 28

5th International Conference on Radioecology & Environmental Radioactivity April 19 - April 24

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## Thank you for your attention!

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