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A first version of a European Geogenic Radon Map (EGRM)

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European Atlas of Natural Radiation

Introduction

European Commission

Objectives:

- Increase **public** (and indirectly political) **awareness** and familiarize the public with its (radioactive) environment;
- Visualize the situation on a **European level**
- Provide **reference material**, contribute to methodology and scientific aspects.
- **Support and stimulate communication** within scientific community on a complex issue (e.g. radon mapping, risk definition and estimation)
- Generate **harmonized data** for the scientific community
- Potential support to EU Member States for the **radon action plan** (draft European BSS, art. 103) – "radon prone areas"

REM is not dealing directly with **health issues**!

The EC's European Atlas of Natural Radiation will not substitute for, or compete with **national activities** in the field !

Planned Maps/Topics:

- **Radon** (Indoor, Geogenic, Outdoor?)
- Others: Cosmic radiation, terrestrial gamma dose rate, water?, exposure?
- Goal: Total dose by natural radiation

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European Indoor radon Map (EIRM)

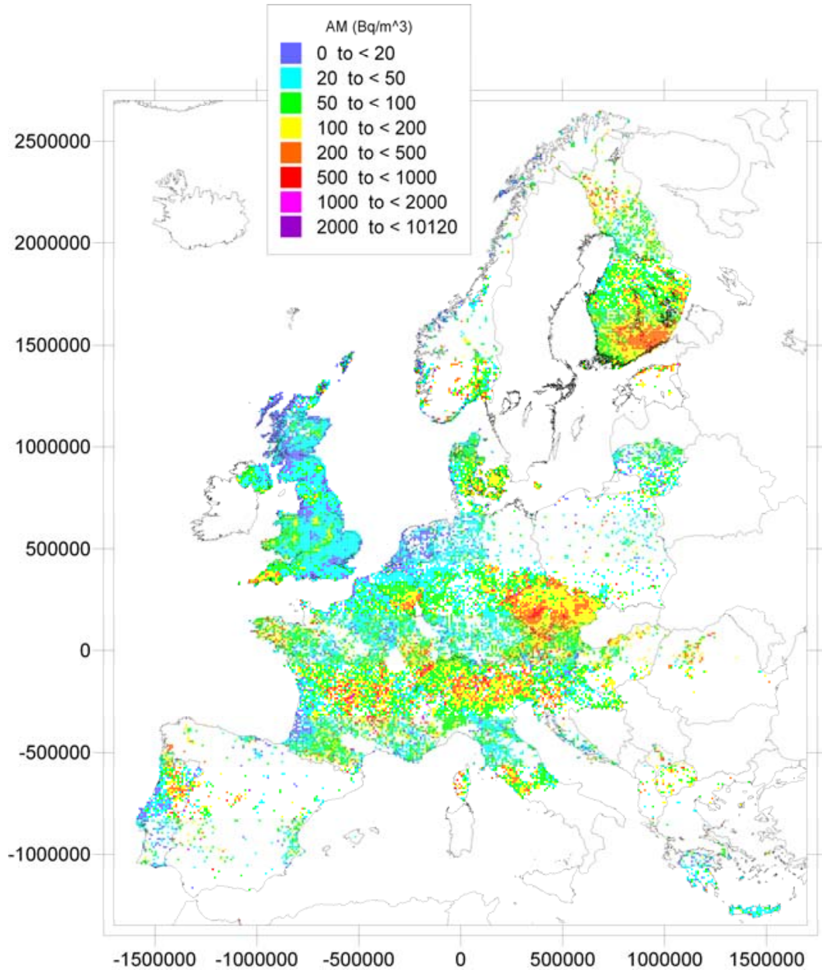
European Commission

Status, Sept. 2012

25 countries

→ 18,791 non-empty cells

→ 818,791 measurements



Indoor Rn, ground floor, 10 km x 10 km grid, AM per cell

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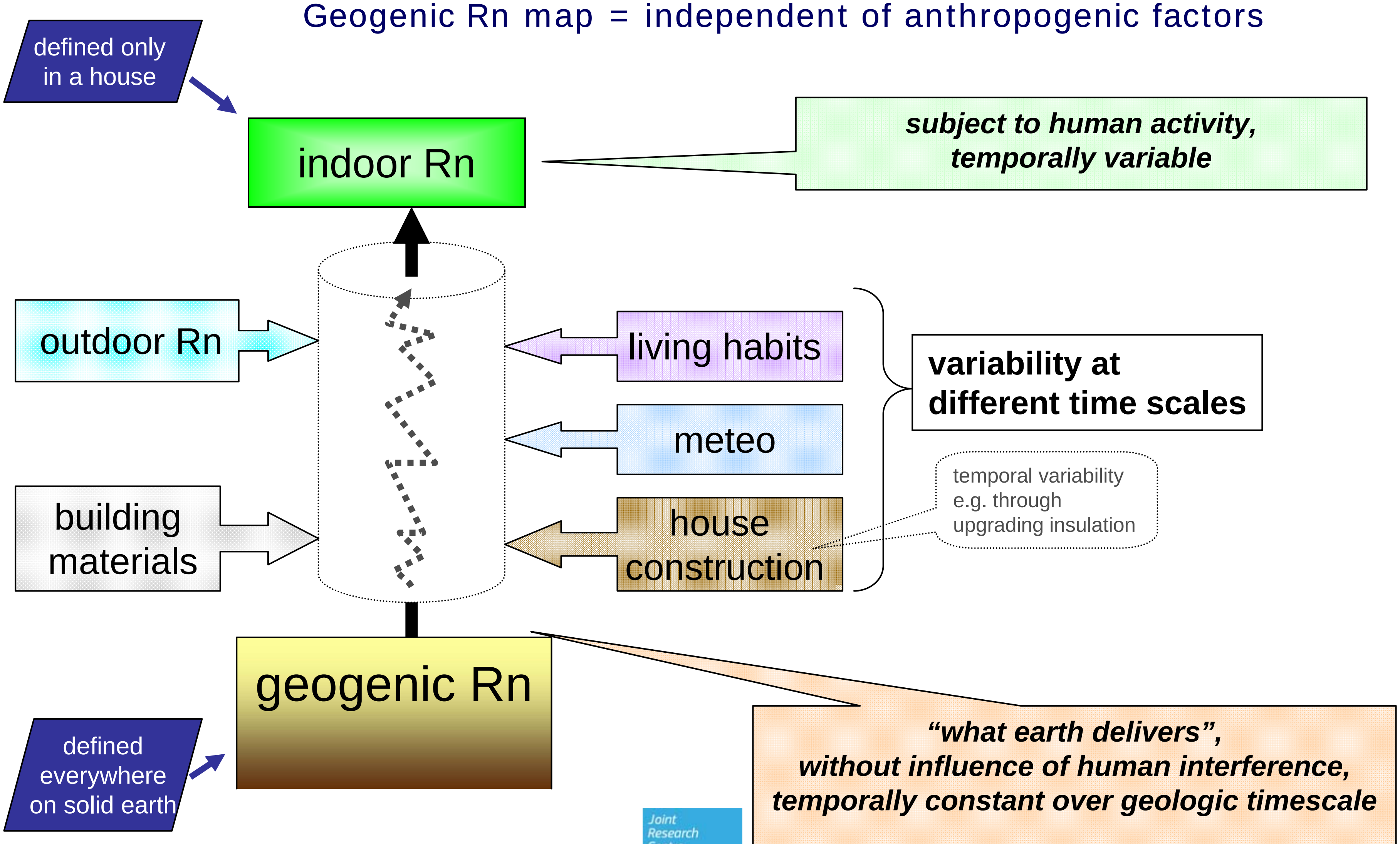
Background

Geogenic Rn map = independent of anthropogenic factors



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Problems for a harmonised European map:

Heterogeneity of datasets

almost every country has input datasets different from the others

Heterogeneity in definition of operational quantities

- different geological classification systems,
- different sampling protocols

$\Rightarrow$ **Harmonization**!

Which RP definition is feasible ?

If a definition adopted: how to deal with missing input variables?

Estimation methods ?

European Geogenic Radon Map (EGRM)

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History and Status

***Start**: Radon mapping symposium and workshop, Oslo, IGC33, 2008*

→ *expert group*

→ 3 workshops/experts meetings (Ispra, Prague), extended expert group, discussions of national approaches and methods how to come to an harmonized European map

Workshop, Ispra, November 2011 and ongoing:

- Follow a **classification (multivariate)** and **continuous approach** in parallel
- **Target variable** for continuous scheme: "Neznal" RP:=C/(-$\log_{10}$k-10); input variables to be transformed via transfer models.
- Use **input quantities** for classification scheme: standardized indoor radon, soil gas radon, permeability, eU, dose rate, geology class, presence of special geological feature - classified [0,1] and weighted →
- Create **Geogenic Radon database -** based on a radon-relevant geological classification (use OneGeology where possible, some countries as example; include geology like quaternary) and fill with data

  see later & EGRM round table, Thursday
- Collect **sampling** and **measuring protocols** from the countries for standardisation
- Prepare **first classification maps**

  Round table, Thursday

Intermediate step – this presentation

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First Trial Map

- Insert a **first step:** Geogenic radon map based on **geology** only
- Each geological type is assigned an **index value** 1 – 4 (low, moderate, elevated, high)

  Details – Peter's presentation

  → definition of intervals: only "geological" or "radiological" (risk related – e.g. probability that C(Indoor radon)>100 Bq/m3)
- Establish list of **geological types**:
  - so far German geo-types used for **"calibration"** of the model;
  - try to translate this (as well as we can) into the **"OneGeology"** scheme

  Discussion – roundtable Thursday
- **Apply** to geological units in other countries **by analogy**
- **Iterative improvement** by feedback from experts. (In course e.g. for Belgium.)

Homework for experts!

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Steps for First Trial EGRM

OneGeology Data

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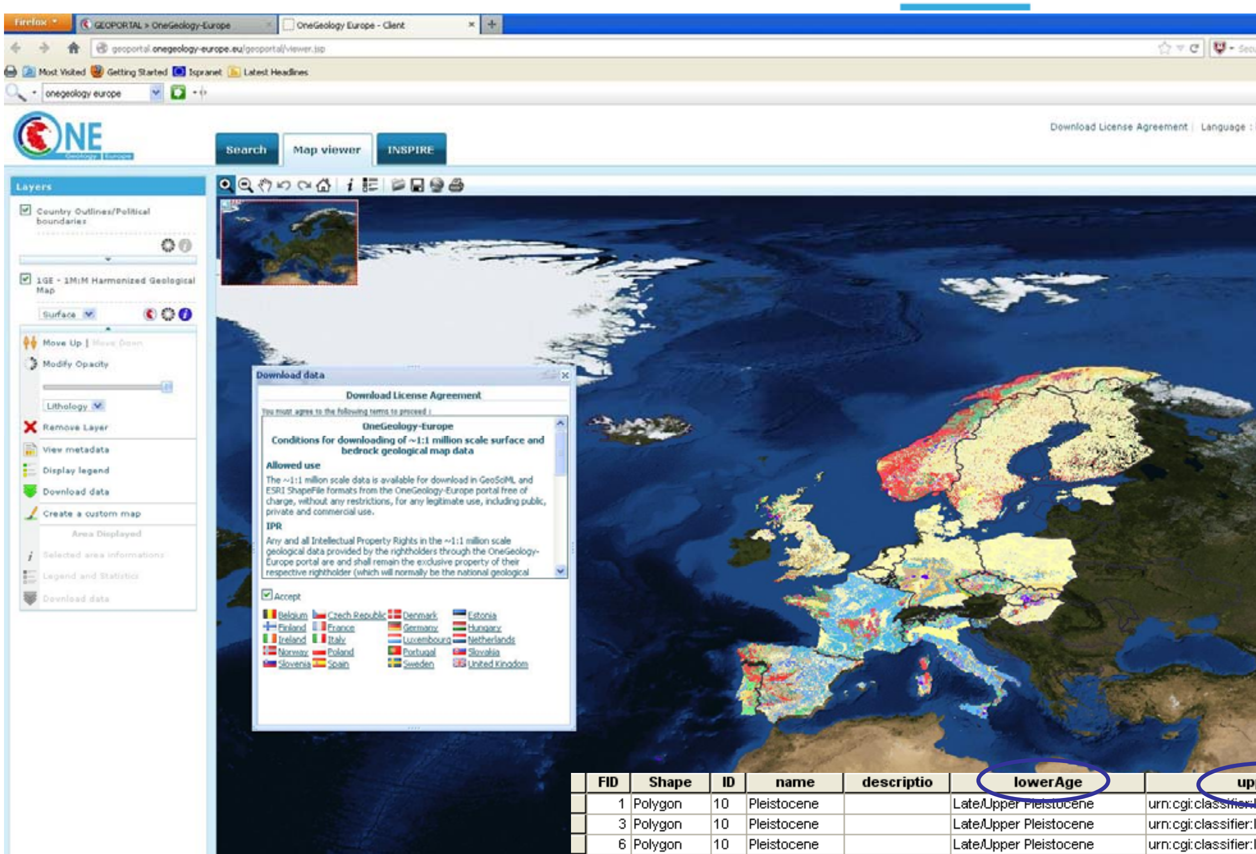

Country	One Geology Polygons	Different Geological Classification (Units)
Belgium (BE)	153	123
Czech Republic (CZ)	8119	258
Denmark (DK)	22789	20
Estonia (EE)	2563	32
Finland (FI)	50764	classified differently
France (FR)	19696	426
Germany (DE)	15727	236
Hungary (HU)	1350	30
Ireland (IE)	4567	36
Italy (IT)	8909	103
Luxembourg (LU)	42	12
Netherlands (NL)	39	39
Norway (NO)	5000	98
Poland (PL)	7608	100
Portugal (PT)	2420	100
Slovak Republic (SK)	6489	216
Slovenia (SI)	2782	28
Spain (ES)	15572	161
Sweden (SE)	5000	55
United Kingdom (UK)	65536	247
	245125	2320

- **20 countries**
- **map 1:1mio**
- **1 shp-file per country for download**

FID	Shape	ID	name	descriptio	lowerAge	upperAge	urn_litho1	urn_litho2	urn_litho3	urn_litho4	urn_litho5
1	Polygon	10	Pleistocene		Late/Upper Pleistocene	urn:cgi:classifier:ICS:StratChart:200908:	Sand	Gravel	{}	{}	{}
3	Polygon	10	Pleistocene		Late/Upper Pleistocene	urn:cgi:classifier:ICS:StratChart:200908:	Diamicton	{}	{}	{}	{}
6	Polygon	10	Pleistocene		Late/Upper Pleistocene	urn:cgi:classifier:ICS:StratChart:200908:	Sand	Gravel	{}	{}	{}
24	Polygon	10	Pleistocene		Late/Upper Pleistocene	urn:cgi:classifier:ICS:StratChart:200908:	Sand	Gravel	{}	{}	{}
41	Polygon	10	Pleistocene		Late/Upper Pleistocene	urn:cgi:classifier:ICS:StratChart:200908:	Diamicton	{}	{}	{}	{}
46	Polygon	10	Pleistocene		Late/Upper Pleistocene	urn:cgi:classifier:ICS:StratChart:200908:	Diamicton	{}	{}	{}	{}
63	Polygon	10	Pleistocene		Late/Upper Pleistocene	urn:cgi:classifier:ICS:StratChart:200908:	Sand	Gravel	{}	{}	{}
81	Polygon	10	Pleistocene		Late/Upper Pleistocene	urn:cgi:classifier:ICS:StratChart:200908:	Sand	Gravel	{}	{}	{}
83	Polygon	10	Pleistocene		Late/Upper Pleistocene	urn:cgi:classifier:ICS:StratChart:200908:	Sand	Gravel	{}	{}	{}
87	Polygon	10	Pleistocene		Late/Upper Pleistocene	urn:cgi:classifier:ICS:StratChart:200908:	Diamicton	{}	{}	{}	{}
106	Polygon	10	Pleistocene		Late/Upper Pleistocene	urn:cgi:classifier:ICS:StratChart:200908:	Sand	Gravel	{}	{}	{}
152	Polygon	10	Pleistocene		Late/Upper Pleistocene	urn:cgi:classifier:ICS:StratChart:200908:	Sand	Gravel	{}	{}	{}
154	Polygon	10	Pleistocene		Late/Upper Pleistocene	urn:cgi:classifier:ICS:StratChart:200908:	Diamicton	{}	{}	{}	{}
156	Polygon	10	Pleistocene		Late/Upper Pleistocene	urn:cgi:classifier:ICS:StratChart:200908:	Sand	Gravel	{}	{}	{}
162	Polygon	10	Pleistocene		Late/Upper Pleistocene	urn:cgi:classifier:ICS:StratChart:200908:	Sand	Gravel	{}	{}	{}
181	Polygon	10	Pleistocene		Late/Upper Pleistocene	urn:cgi:classifier:ICS:StratChart:200908:	Sand	Gravel	{}	{}	{}

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Steps for First Trial EGRM

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Geo-types

code	GM(RP) (Nez.)	stratigraphy 1	stratigraphy 2	genesis (last step in geol. history)	lithology	symbol DE-GK1:1M	n	Cl rad	Cl geo
Sedimentites									
210	24.3	Neoproterozoic – Cambrian		sediment, marine, partly metamorphic	slate, Bündner schist, sandstone, phyllitic schist, quartzite, greywacke	cb		2	3
221	26.5	Ordovician		sediment, marine	slate, quartzite, Geröllquarzit	o, o-sj		2	3
223	41.8	Ordovician		sediment, marine, oolithic	clayey schist, Gräfenthal group			4	4
230	46.7	Ord - Silurian – lower Dev		sediment, marine	slate, fibrous schist, greywacke, limestone, alum shale	sj		4	4
240	18.6	Devonian		sediment, marine	slate, sand stone, greywacke, quartzite, limestone	d, /*k, dz/*k, dsTA, ds, dv, dg, do, dsHU, de, dz		1	2
251	29.1	carboniferous	lower, dinantian = Viseum + Tournaisium	marine sediment	greywacke, slate, Plattenkalk, siliceo[illegible] um shale	cd, cd/*k		2	3
252	20.4	carboniferous	upper, namur = ca. Serpukhovium		quartzite, greywacke [illegible]	cn		1	3
253	36.8	carboniferous	lower	olisthostrome		cd/ol		2	4
254	16.0	carboniferous	upper, namur, westphal (= ca. Pennsylvanium) and other		[illegible] siltstone, clay stone, limestone, black coal	cn, cst, cs, cw		1	2
261	16.8	Permian	Rotliegend = ca. Cisuralium + Guadalupium	sediment, fluvatile [illegible]	[illegible] stone, conglomerate, black coal, porphyric breccia, tuff	r, ro, ru		1	2
262	29.8	Permian	Zechstein = ca. Lopingium	sedim[illegible]	[illegible] ite, clay stone with anhydrite and rock salt	z		2	4
311	11.8	Triassic	lower, Buntsandstein	[illegible]	sandstone, siltstone, clay stone, conglomerate	s, su, sm, so		1	1
312	15.0	Triassic	middle-upper, Musc[illegible] ca. Anisium[illegible]	[illegible] ent, biogenic	limestone, marl, dolomite, clay stone, etc.	m, mu, mm, mo		1	2
313	9.5	Triassic	middle [illegible] Ladini[illegible]	sediment, marine, limnic, fluvatile	clay stone, siltstone, quartzitic sand stone, quartzite, etc.	k, ku, km, kmS, kmST, kmK, ko		1	1
320	11.1	Jurassic		sediment, marine	marl, limestone, dolomite, limestone- sand stone, etc.	j, ju, jm, jo		1	1
330	15.0	cretaceous	unspecified	sediment, marine, limnic, fluvatile	marls, sand, sand stone, conglomerate	krc, krcc, kro, kru		1	2
331	4.2	cretaceous	upper, Campan	sediment, marine	clay-marl, marl-limestone, limestone, sand	krca		1	1
335	5.4	cretaceous	Cret., lower Cret., Wealden	sediment, limnic-brackish	sand stone, clay, black coal	wd		2	2
400	11.3	tertiary	(palaeogene + neogene)	sediment, limnic-fluvatile	rubble, sand, clay, marl, occasional conglomerate, etc.	kml, tml, //lm, teo, tol, /K, tUSM, tOMM, tUMM, tOSM, tpl, tml, tol, tpl		1	2
502		quaternary		crenogene	Quellkalk, tufa, travertine	//q			
511	12.7	quaternary	Pleistocene	fluvatile	sand, gravel	qpa//f, qH//f, qp//f		1	2

Details – Peter's presentation

Tried / Started to translate

Geo-types

into

OneGeology-geology units

“calibrated” on German data

Problems (Missing in trial map):

- Geology units which do not exist in Germany (e.g. Scandinavia: Fennoscandic and Baltic shield; Britain: Caldeonian; Central Alps; etc.)
- Complicated geology (in particular quaternary) – geologists needed
- OneGeology classification not detailed enough → no assignment possible to certain units
- Countries not part of OneGeology
- OneGeology shp-files incomplete or differently classified (SE, NO, FI)

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First Trial EGRM

Geo-types

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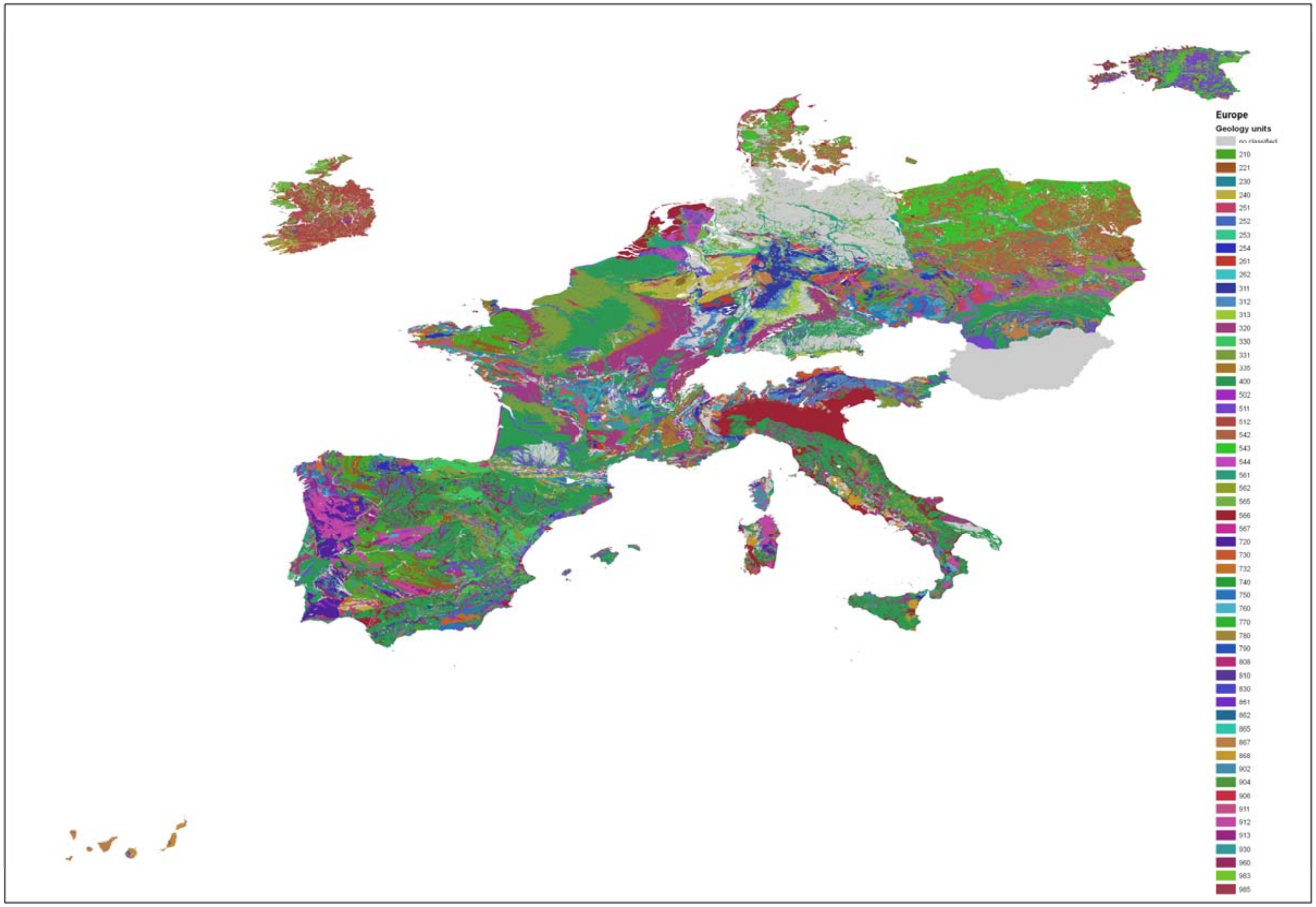
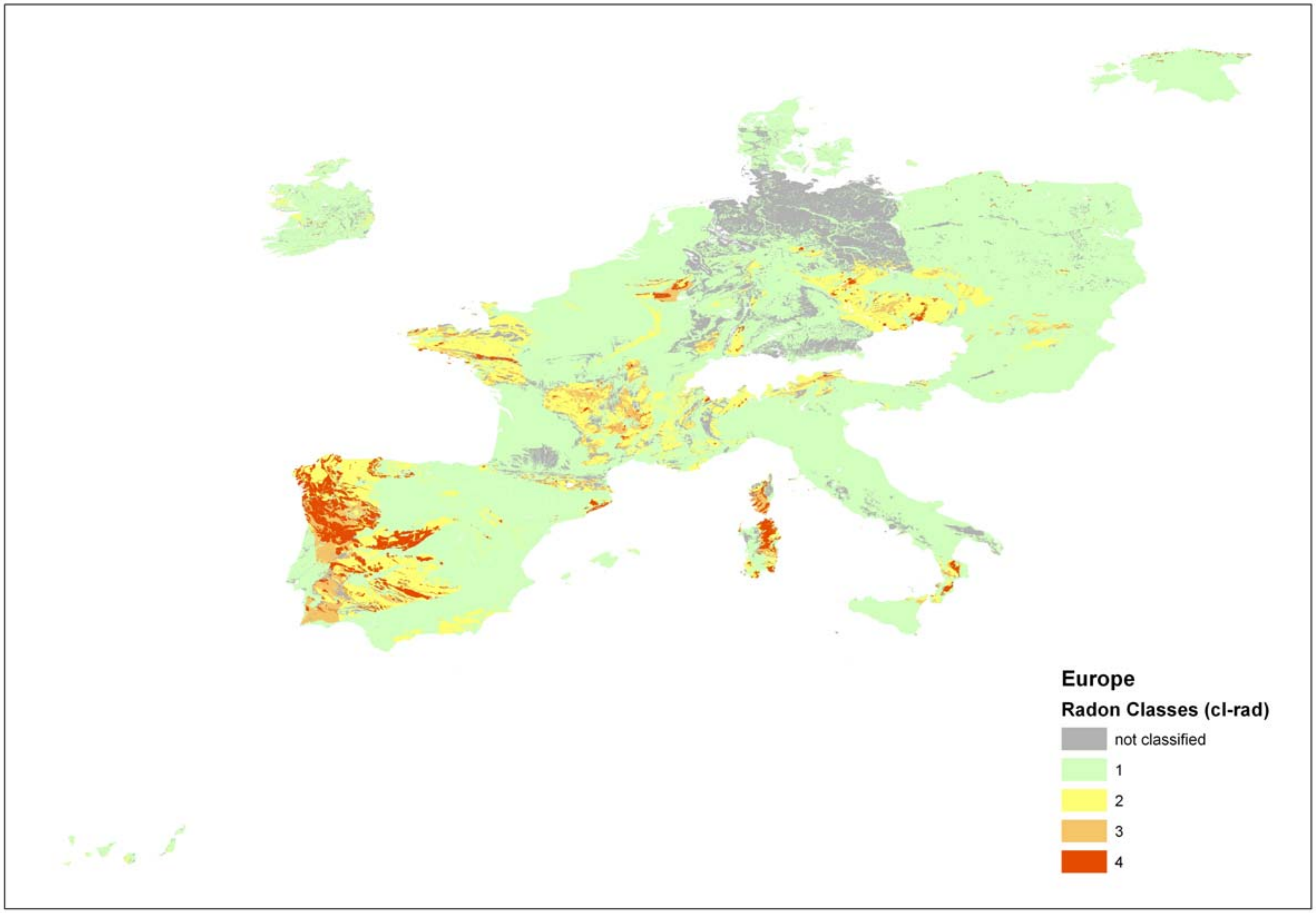


First Trial EGRM

European Commission

Radon Classes "radiological"



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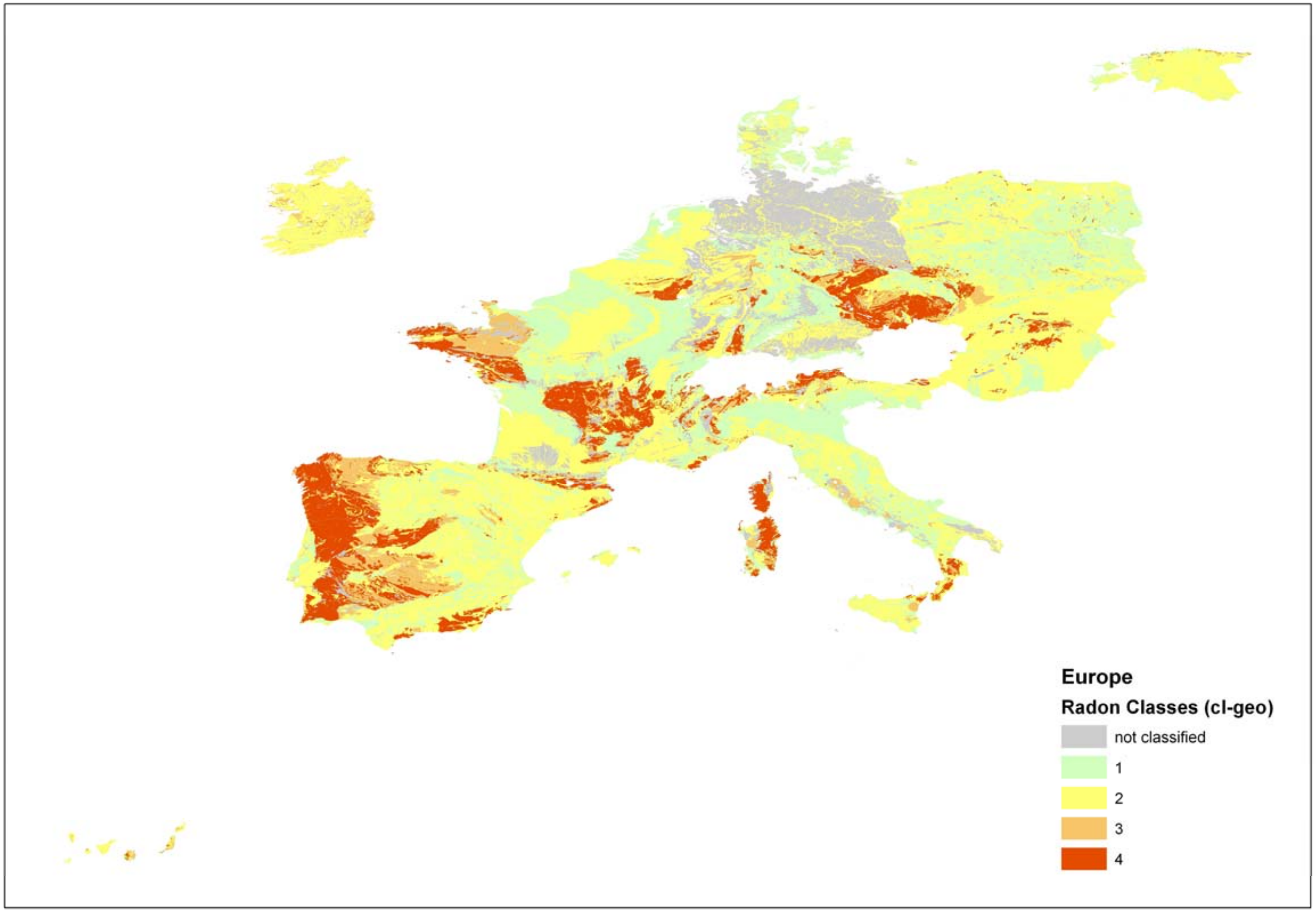
Radon Classes "geological"



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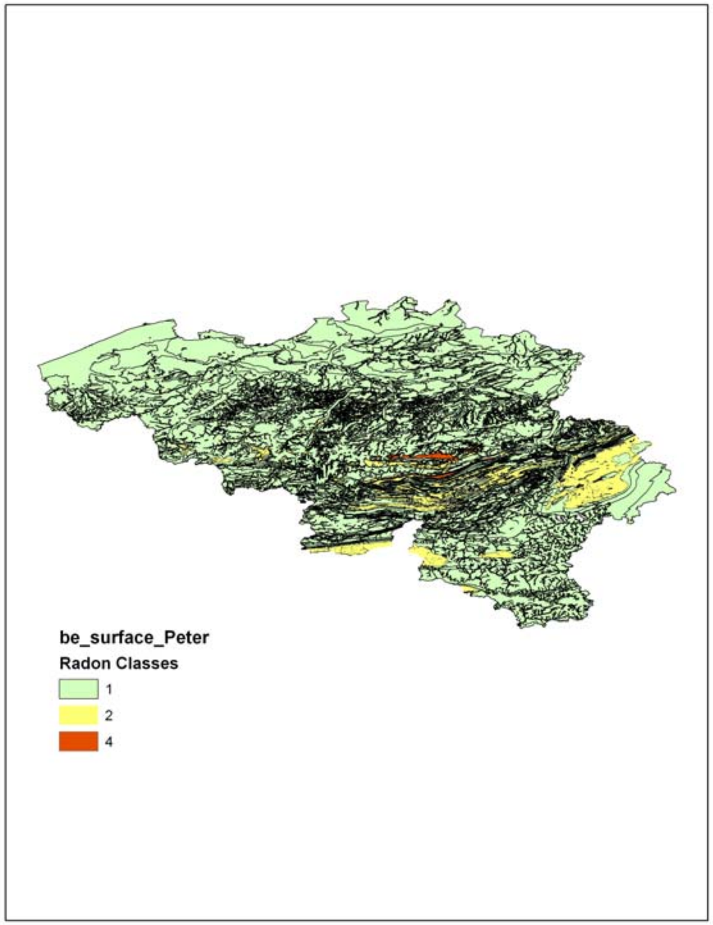
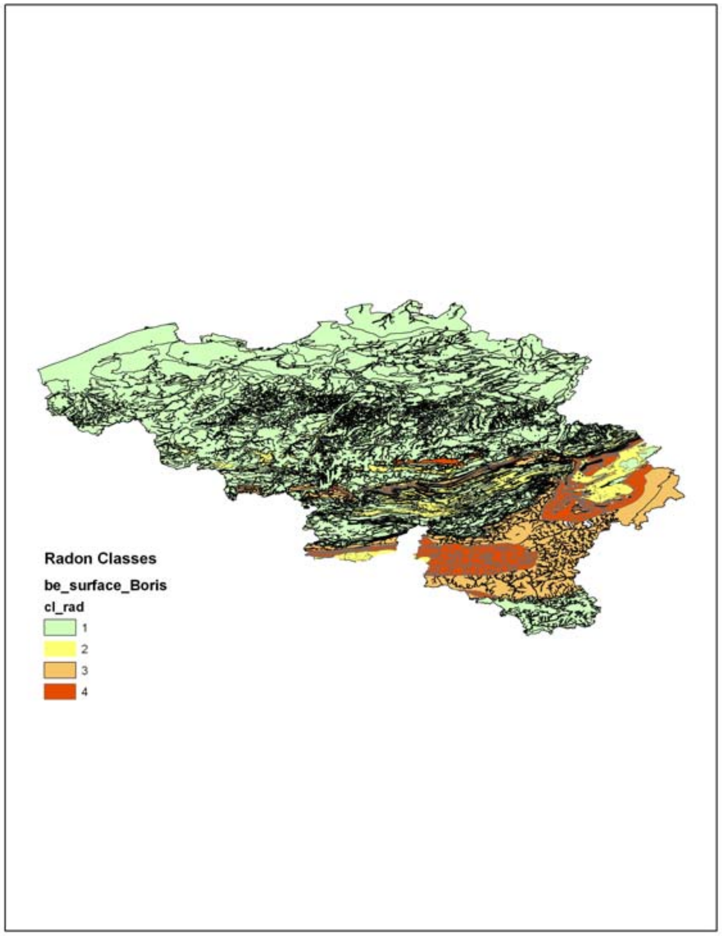
Examples and “Problems”

Example Belgium





Classification according to the described method (radiological classification) based on German “calibration”

Re-classification by Boris

First Trial EGRM

Examples and "Problems"

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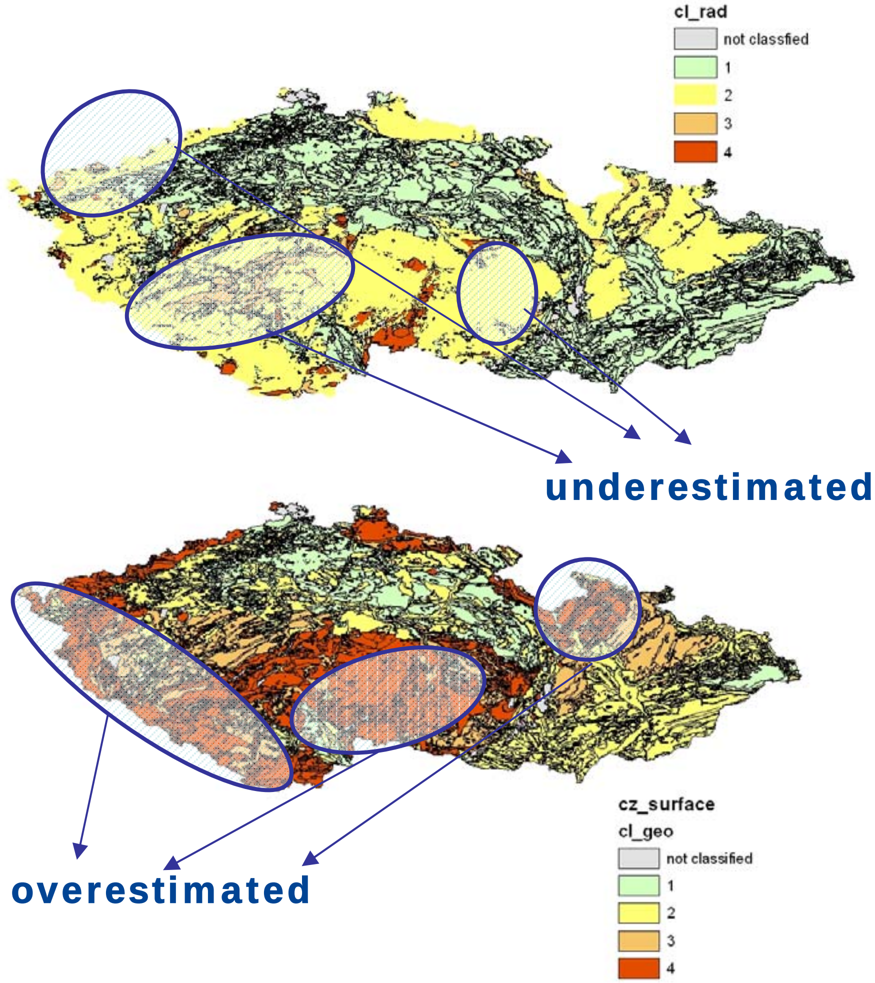
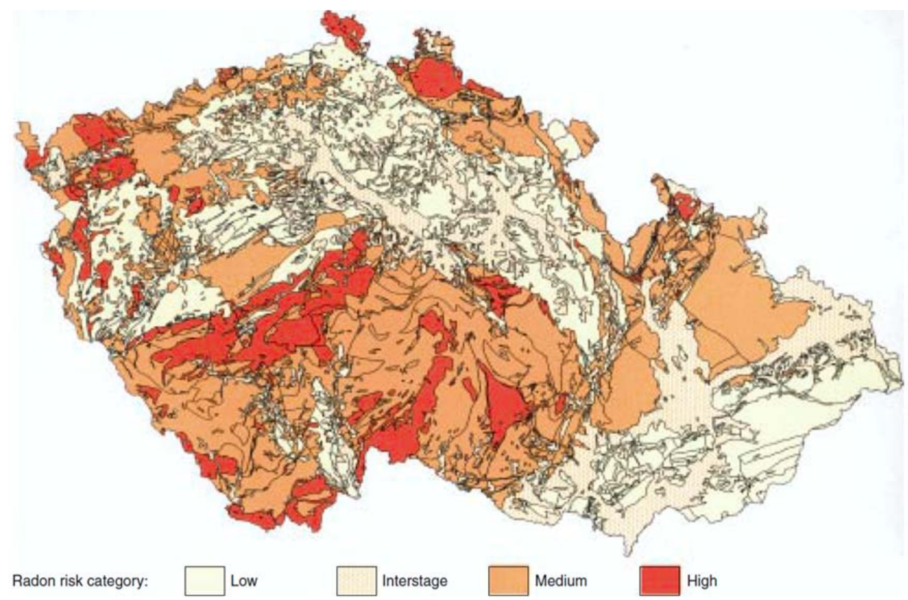
Example Czech Republic





Classification according to method based on German "calibration"

Classification by I. Barnet et al., Czech Geological Survey, Special Paper 19

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Examples and "Problems"

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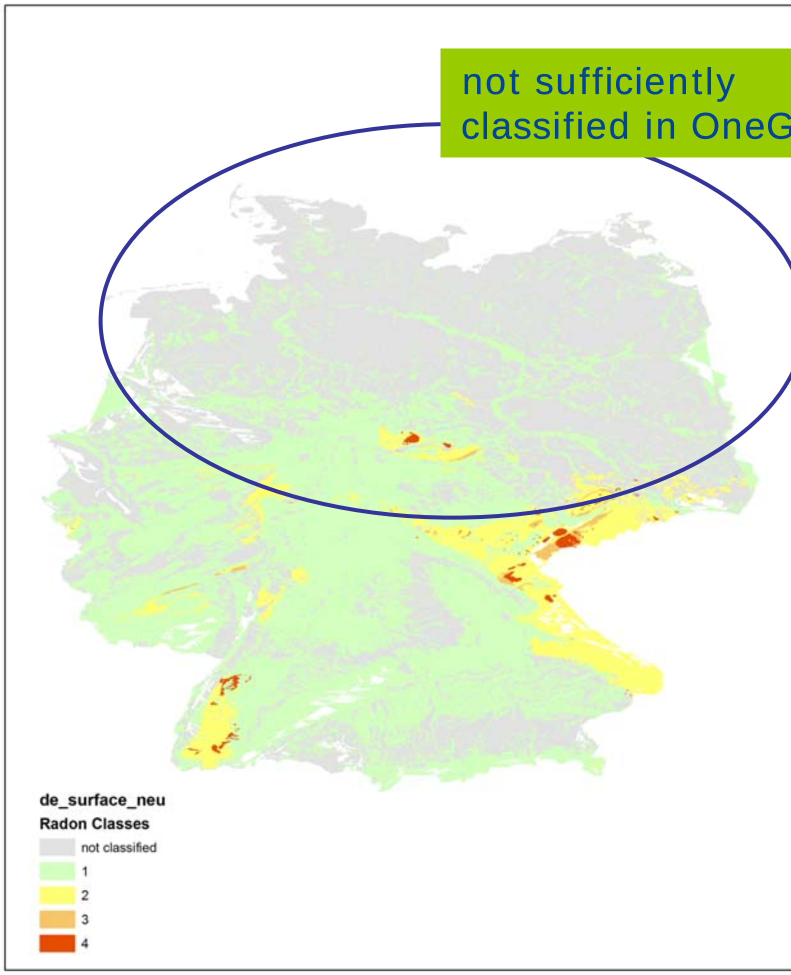
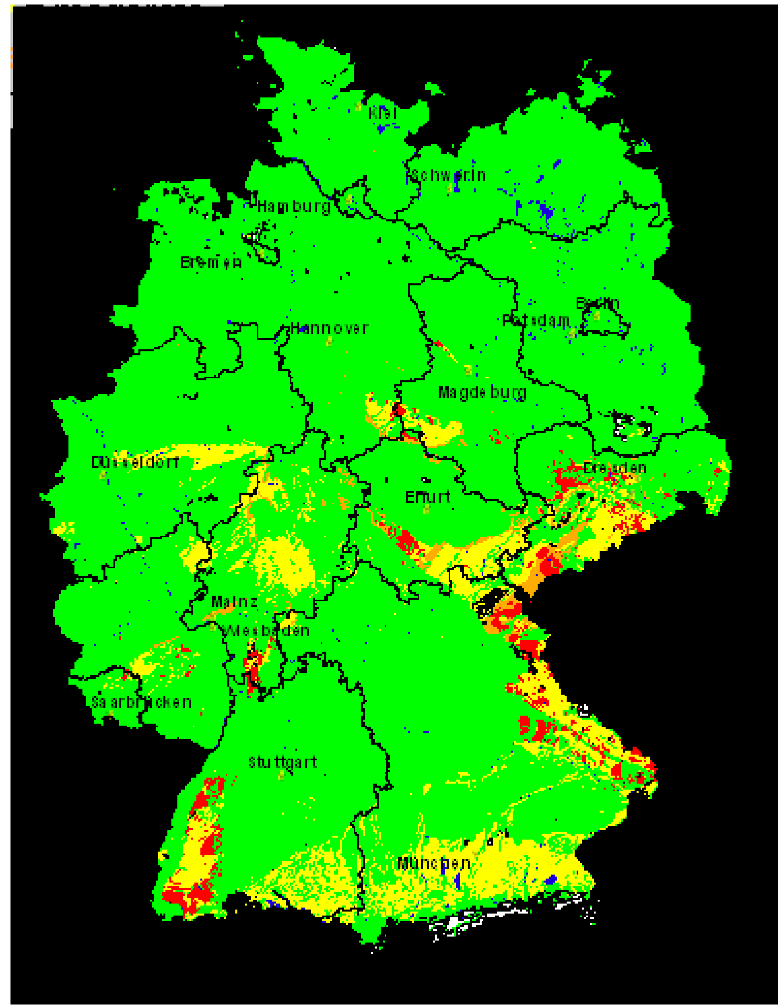
Example Germany

not sufficiently classified in OneGeology



Classification based on OneGeology



Classification based on German geology map / Geo-types

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Problems and topics for discussion

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- **OneGeology** – seems sometimes **not** be classified **detailed enough** for radon classification – Useable? How adapt it?
- Not all European countries participate in OneGeology – **how to include these countries**?
- Used method works only for **geo-types** which have been **calibrated** = the ones which exist in Germany; we need RP data for geo-types not included so far (e.g. Alpine orogeny; Baltic / Fennoscandian shield; Caledonian orogeny)
- **Geo-types** must be identified and validated in the countries with the ones which have already been classified
- **Iterative improvement** of the classification by expert‘s input
- **Workplan** (Timescale?, Who?)

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EGRM roundtable, Thursday

The database

For classification and continous approach – collect **statistics of radiometric data** for all „input variables“ for each **radon relevant geology unit** of the countries in a database

GM, GSD, AM, Med, Min, Max, Number of measurements for all „input variables“ (standardized indoor radon, soil gas radon, permeability, eU, dose rate, RP) per geology unit

Details about **geology** (Age, Lithology, Orogeny, Genesis, presence of special geological features (natural and anthropogenic))

Metadata for comparability and harmonisation of data (used methodology, data selection, data treatment, spatial distribution)

First filled by countries which have **sufficient number of measurement** data available to characterize a geological unit

Use geology information in database to identify **similar geological units** in other countries and regions where no data are available, and use existing data as default values

Needs knowledge and co-operation of **geologist experts**

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The database

>100 fields to fill per geology unit → **excel template**

→ Oracle database is waiting for data already

1–2	**Fill all the fields to enable recording data**			
5	**Geological unit**	**Geological unit's name**	text	
6		**Geological unit's size**	0 - 10^5 km^2	Name of the unit as defined by local
7		**Geological sub-unit**	text	
8		**Geological sub unit's size**	0 - 10^5 km^2	
9				
10	**Geochronological Age (ERA)**		from list	
11				
12	**Geochronological Age (PERIOD)**		from list	
13				
14	**Geochronological Age (EPOCH)**		from list	
15				
16	**Lithology**		from list	
17				
18	**Orogeny**		from list	
19				
20	**Genesis**		from list	
21				
22	**Link Code toOneGeology-Europe**		text	
23				
24	**Information about geology**		text	
25				

Country | **Geological unit** | Rn class | Soil gas | Uranium concentration | Dose rate | (-Log)permeability | Neznal RP | (szd)i… | …ayground

According to OneGeology Classification / terminology

EGRM roundtable, Thursday

Joint Research Centre

„**Summary of discussions** and „**Status of knowledge in the field**“

>40 authors > 360 pages

→ Restructuring and proofreading necessary

→ Next version postponed to autumn 2012, should be publish as JRC report

→ Contributions, ideas for restructuring, proofeading still welcome

European Commission

Thank you!

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