

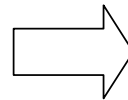
Challenges in radon mapping - Asking the right questions

P.Bossew, E.Petermann, BfS Berlin

EGU 2021, #656

Purposes of Rn maps:

- 1. Visualisation of hazard / risk:** Information of stakeholders (public, legislators, administrations, professionals)
- 2. Decision support:** e.g., identification of regions, where certain action to be taken, to comply with regulation.



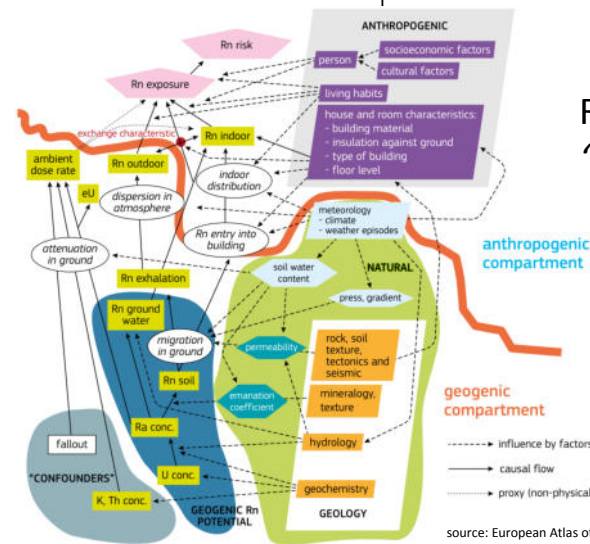
Different tasks!

- 1. Estimation of levels**
per map “point” (pixel) → isopleth map
per area unit → choropleth map
- 2. Classification**
according to options for action:
“do this” / “do that”

Challenges

Essentially traceable to

- spatio-temporal variability;
- complex physical dependence structure



Radon:
“From rock to risk”

Entails challenges to QA

- Design QA
- Measurement QA
- Evaluation QA
- Decision QA

Challenges in radon mapping - Asking the right questions

supplementary slides

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Maps have **different intentions, objectives and purposes**

This entails:

- different methodology
 - databases
 - estimation & mapping methods
- different requirements to QA

Q2: Objectives:

- Display levels of a quantity or of an indicator
- Propose regionalized decisions according criteria for action

But first of all, it means: **asking the right questions, Q1:**

- What to map
 - Hazard?
 - Exposure?
 - Vulnerability?
 - Risk?
- qualitative ? - visualizing a problem, providing guidelines
- quantitative ? - QA standards to ensure legally proof results

} see later

Q3: Which is the **target audience?**

- Fellow scientists / professionals?
 - The public?, media?
 - Administration, politicians, decision makers?
- ⇒
- Choice of quantities to be displayed
 - Mapping style
 - Degree of detail

The quality assurance chain

1. **Design QA:** Capability of an effort (experiment, survey) to enable a decision: sampling design;
2. **Data QA:**
 - a) classical metrology
 - b) protocols & actual performing an experiment;
3. **Evaluation QA:** proper methodology, adequate models, uncertainty budgeting;
4. **Decision QA:** Assessment of the chance of wrong decision, given data and methods and their uncertainties.

Decision making

DECIDE model (Guo 2008; cited after Wikipedia*)

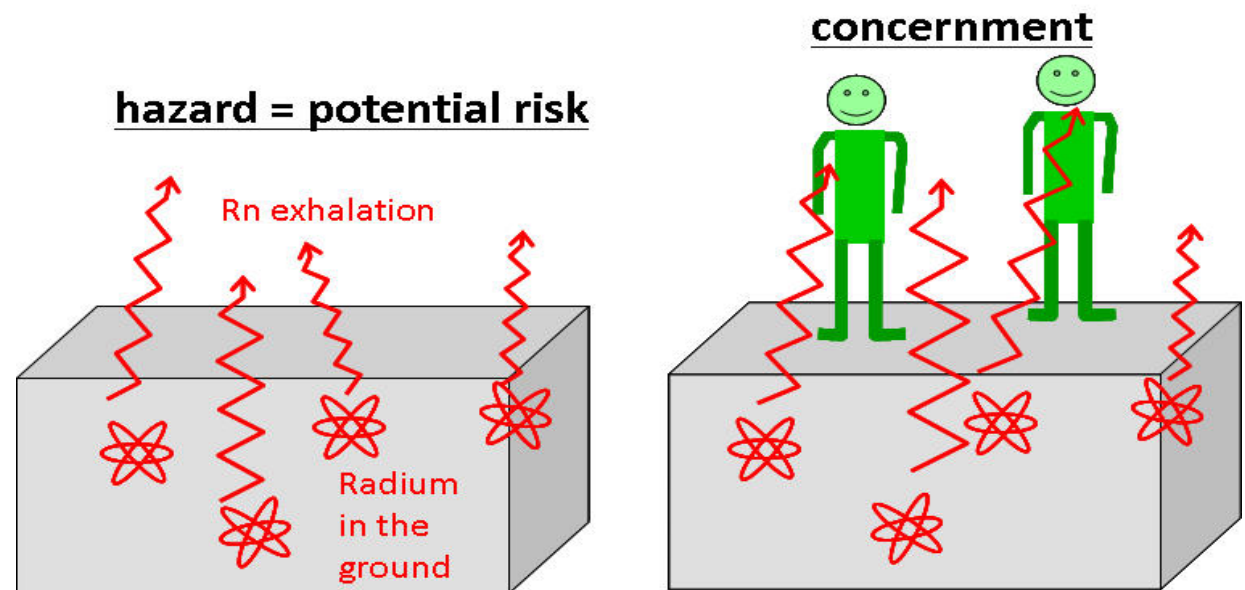
- **D**efine the problem
- **E**stablish or Enumerate all the criteria (constraints)
- **C**onsider or Collect all the alternatives
- **I**dentify the best alternative
- **D**evelop and implement a plan of action
- **E**valuate and monitor the solution and examine feedback when necessary

* Guo, K. L. (2008). DECIDE. The Health Care Manager, 27(2), 118–127. doi:10.1097/01.hcm.0000285046.27290.90 ; <https://en.wikipedia.org/wiki/Decision-making>

Hazard and risk

- **Hazard** exists also if nobody is affected, exposed or concerned;
- It becomes a **risk**, (= a certain probability of damage), if there is somebody who can be harmed. If there is nobody, evidently there is no risk, even if a physical cause exists. (Or in general, any being or thing whose damage or detriment should be avoided.)

$$\text{risk} = \text{hazard} \times \text{concernment}$$



Hazard and risk, 2

quantity	meaning	example from Rn
risk =	probability of detriment	prob. of lung cancer
hazard ×	physical cause	geogenic radon potential GRP
exposure factor ×	exposure / hazard	(Bq*h/m ³ ²²² Rn) per unit GRP
vulnerability ×	exposure circumstances exposure specific factors	e.g. floor level, building properties e.g. equilibrium factor Rn progeny per Rn conc.
risk factor	detriment / exposure incl. person specific vulnerability	(prob. lung cancer / (Bq*h/m ³ Rn progeny) e.g. age, breathing rate, smoking habits

exposure

concernment

Challenges in implementing QA

- **Uncertainty budget**, especially related to
 - Survey design; impact of lack of representativeness
 - Semantic uncertainty (correct assignment of metadata, uncertainty of geological maps)
 - Model uncertainty
- Presence of **extremes and anomalies**
Generates troubles with geostatistical methods
- Sometimes wild spatial and temporal **variability**
Variability itself not constant over space and time
- Understanding **decisions** as functions of variables of different type that predict hazard or risk
- **Multivariate** estimation can be methodically challenging
- Including **“soft” data** as decision base
- Measuring the **reliability of decisions**, validating the efficiency of action based on decisions

Definitely much space for future research! Work will not run out!

Reminder:

Objectives of radiation protection

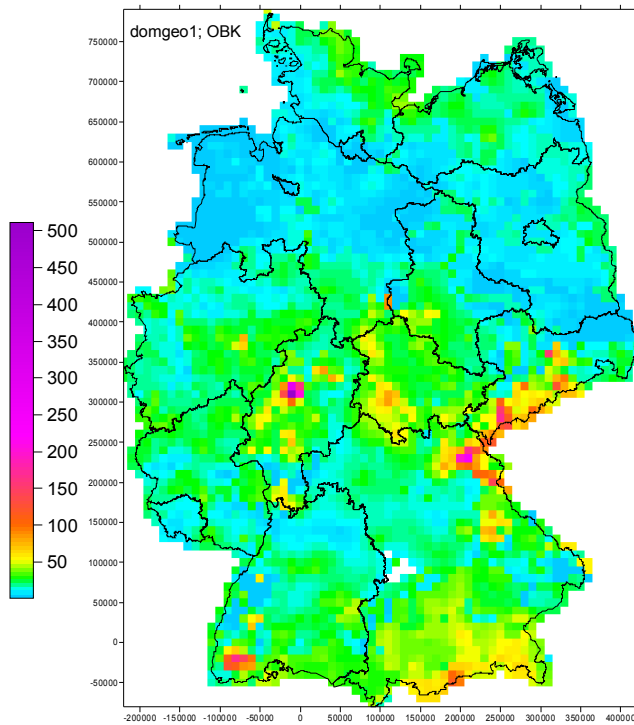
1. Protect individuals by cutting high doses, because these determine the individual risk
2. Protect the population by reducing collective exposure, because – assuming the LNT hypothesis* – the total damage is proportional to collective exposure.

* This is certainly a delicate point. For Rn, usually assumed valid; demonstrated approximately for the odds ratio (OR) from exposure above corresponding about 100 Bq/m³. But most people world-wide are subject to lower exposure.

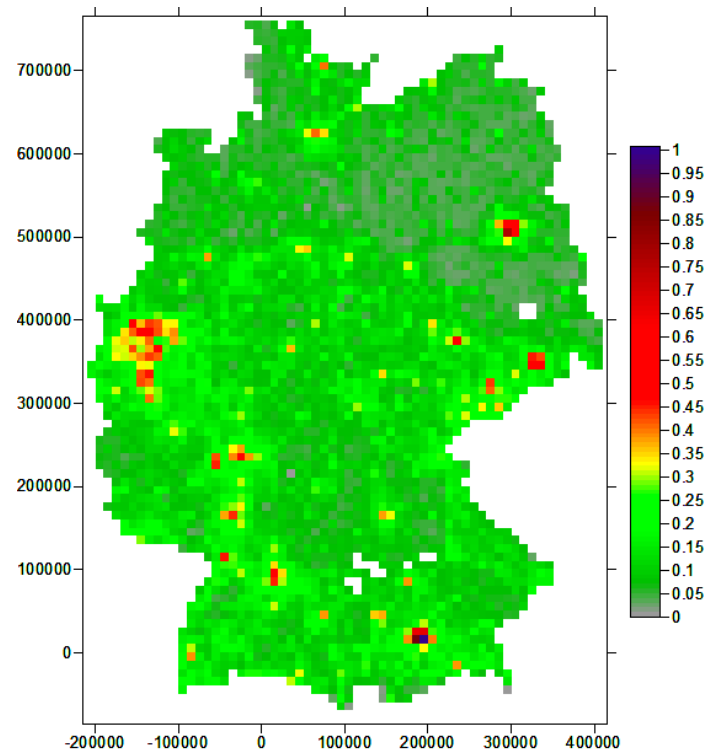


What to map ?

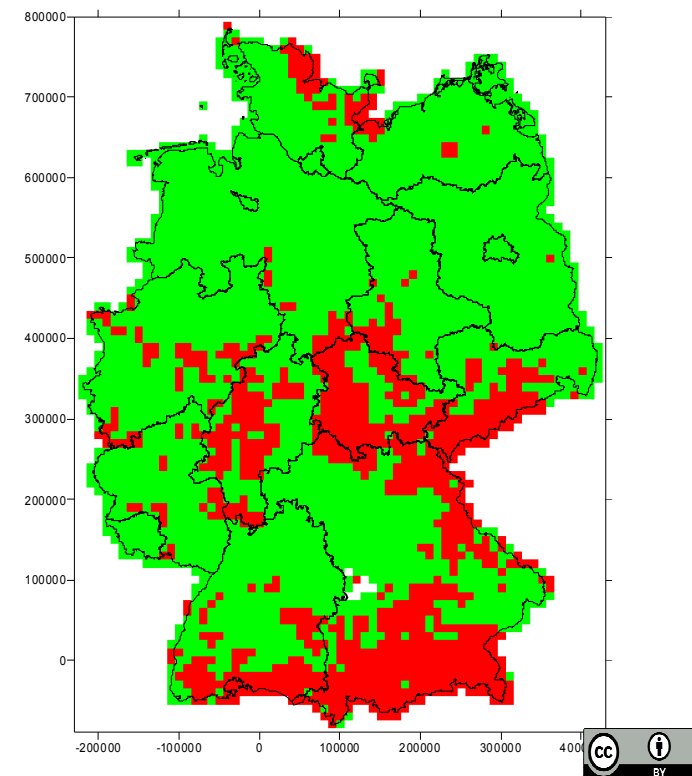
Ex. Germany:
Geogenic radon hazard



collective exposure per
unit area



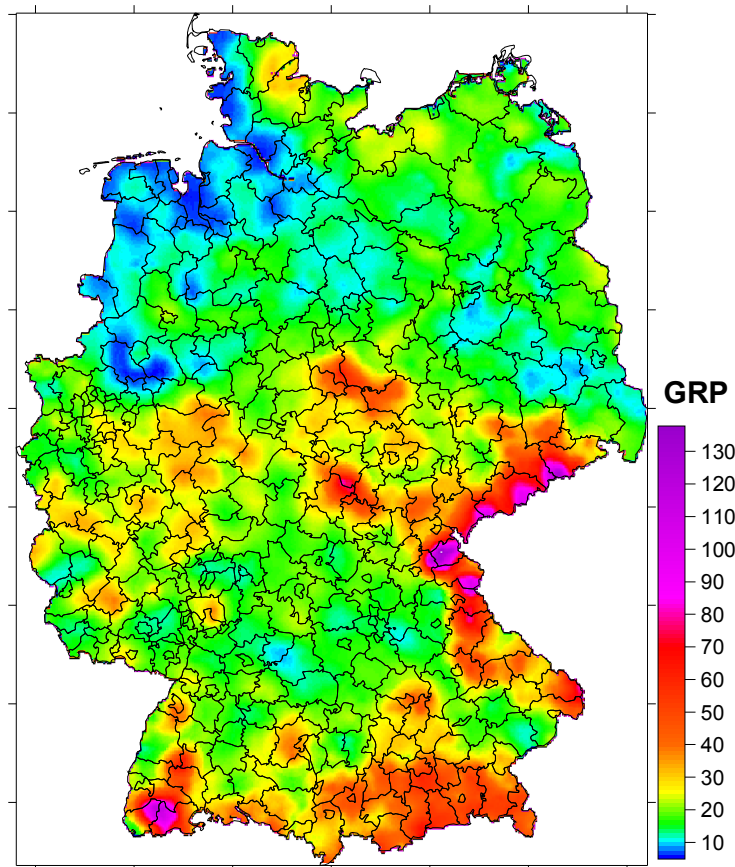
suggestion for action
Rn priority area



How to map? – Display types

- Isopleth map: points (pixels) with same value of the mapped quantity have same colour;
- Choropleth map: relevant units, e.g. municipalities, with same aggregated value (e.g. mean) have same colour.

isopleth: pixel = 1km × 1 km



choropleth: areal units = districts

