



UK Health
Security
Agency

Updated radon map of Great Britain – the UKHSA input

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UK approach to radon mapping

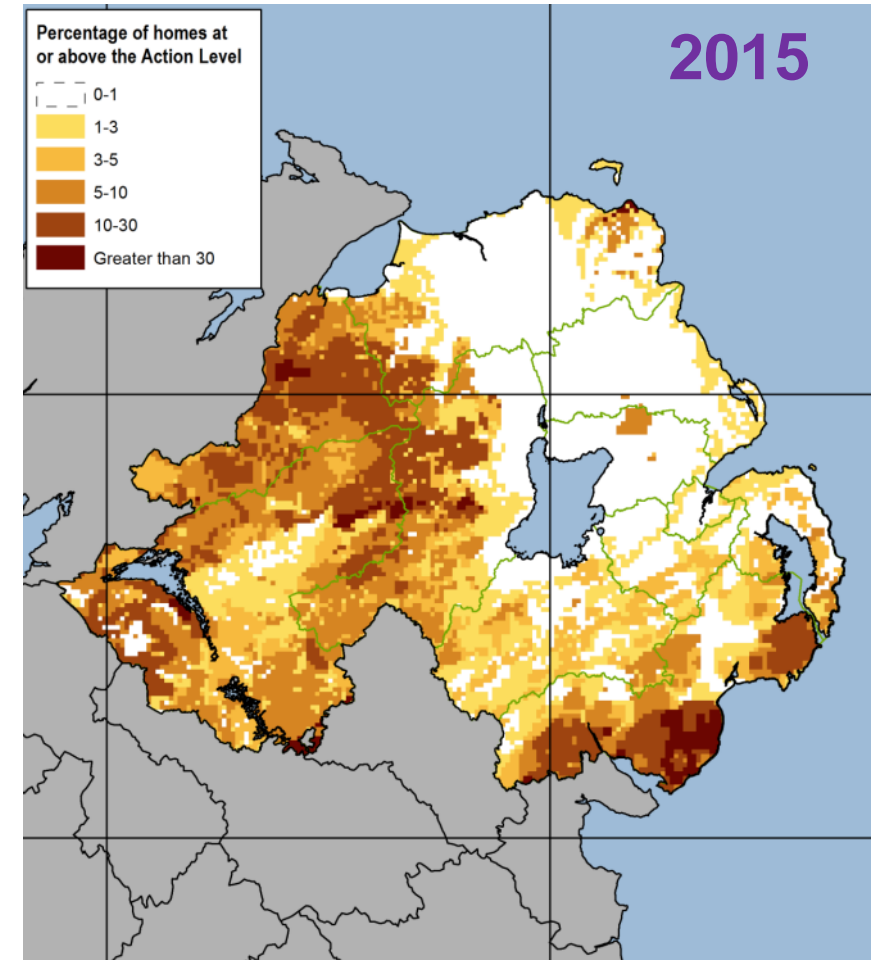
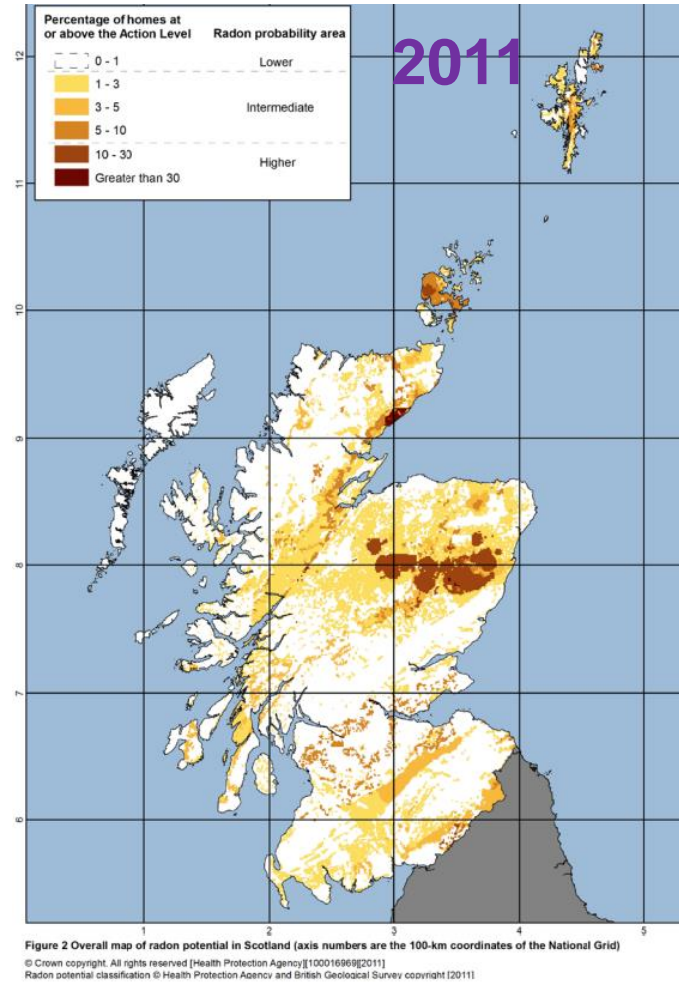
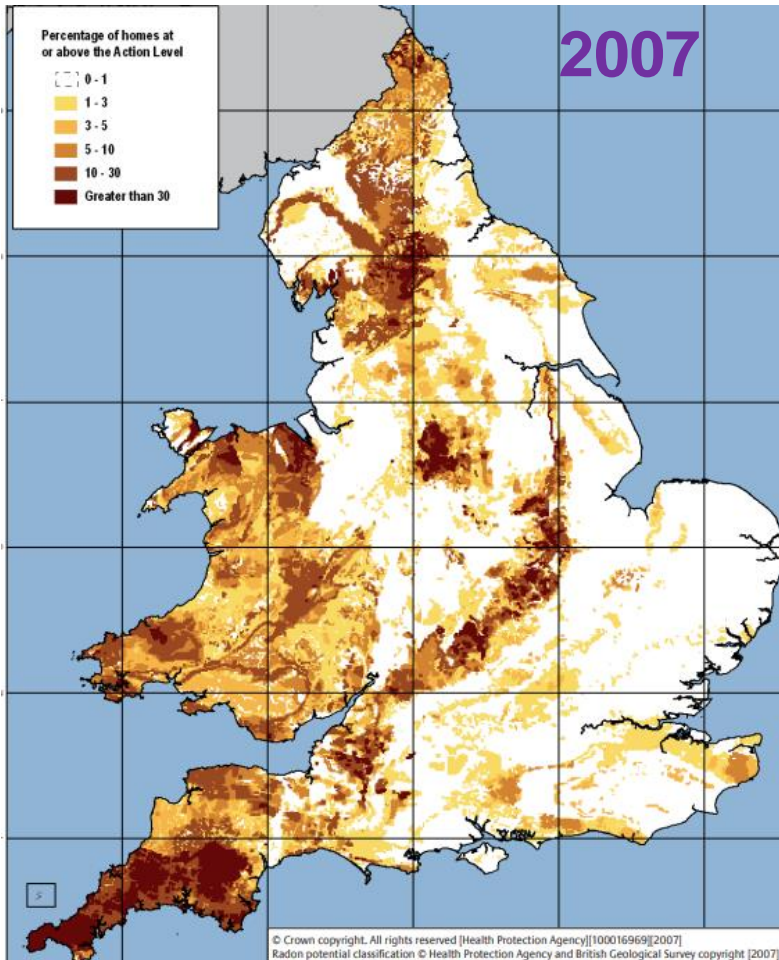
The original Joint Dataset (JDS) mapping method was developed by HPA (UKHSA's predecessor) and British Geological Survey (BGS) in 2005

The method combines indoor radon measurements with geology

It requires a large number of measurements and very good knowledge of local geology

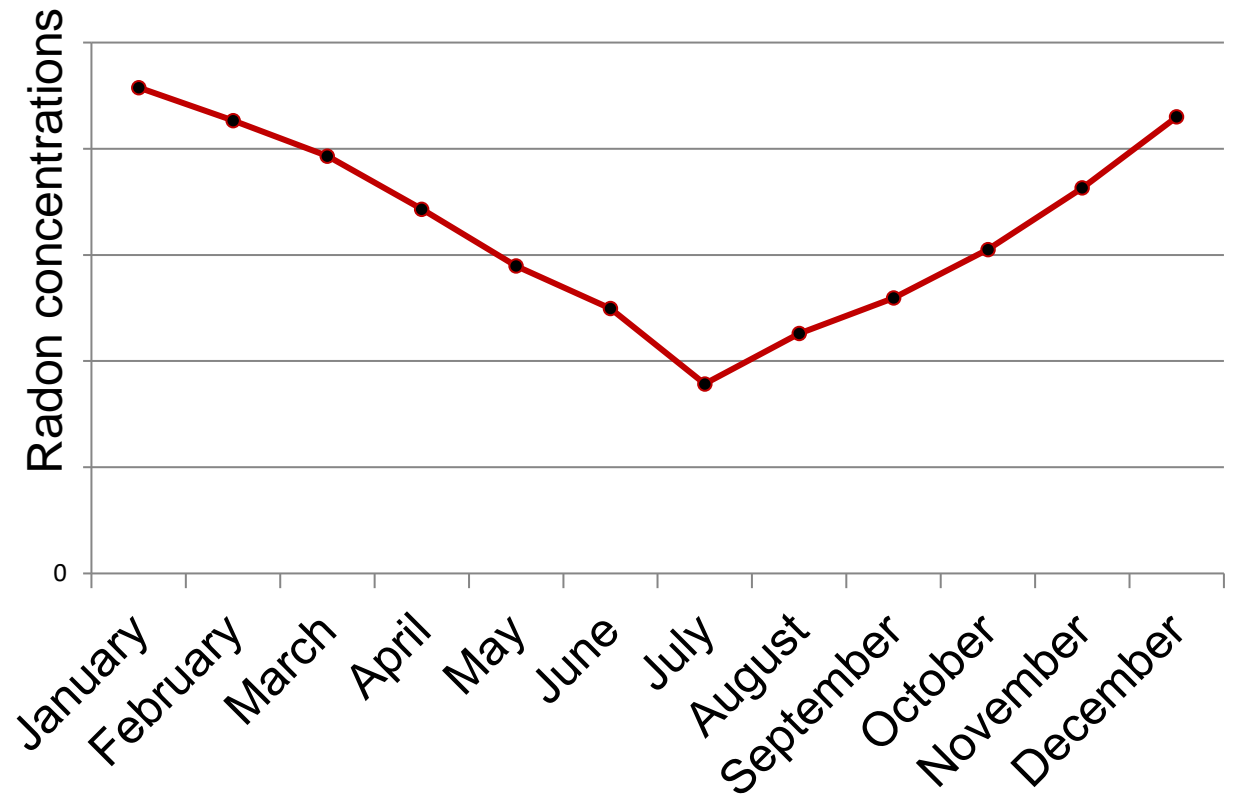
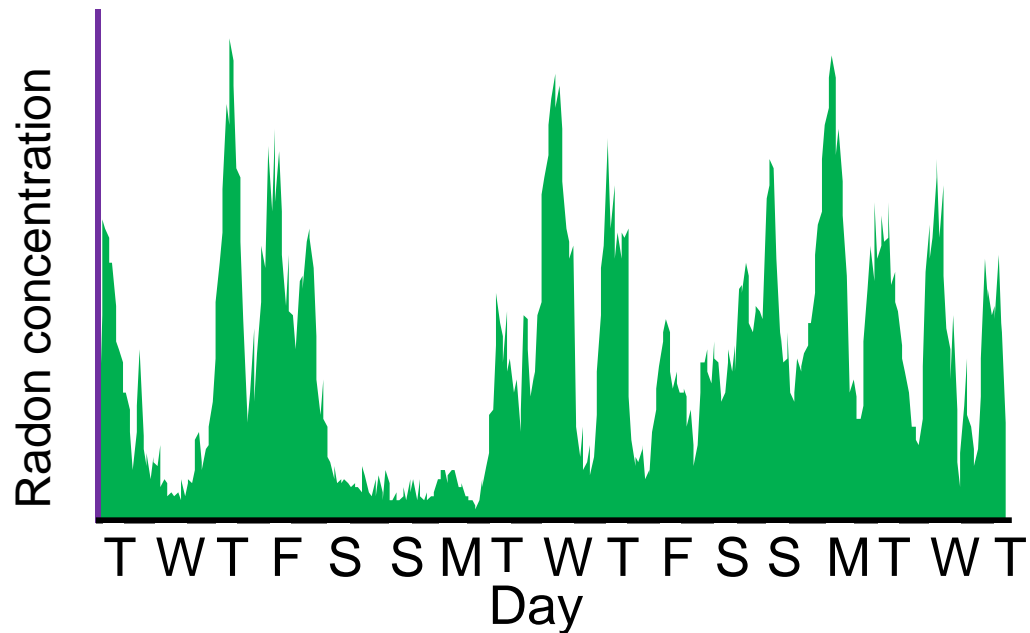
Ref: Miles JCH and Appleton, JD (2005). Mapping variation in radon potential both between and within geological units., *J Radiol Prot*, 25, 257–276, DOI: 10.1088/0952-4746/25/3/003

The JDS method was used to produce 3 maps



Radon measurements in homes are used

Indoor radon is a highly variable parameter



Long-term integrated radon measurements are used for mapping



Radon is measured with passive radon detectors

The detectors contain PADC plastic material enclosed in a black plastic holder

Radon damages the surface of the PADC plastic

Damage is made visible by chemical etching

Annual average radon concentration is the input parameter

Two passive radon detectors are sent to people's homes by post

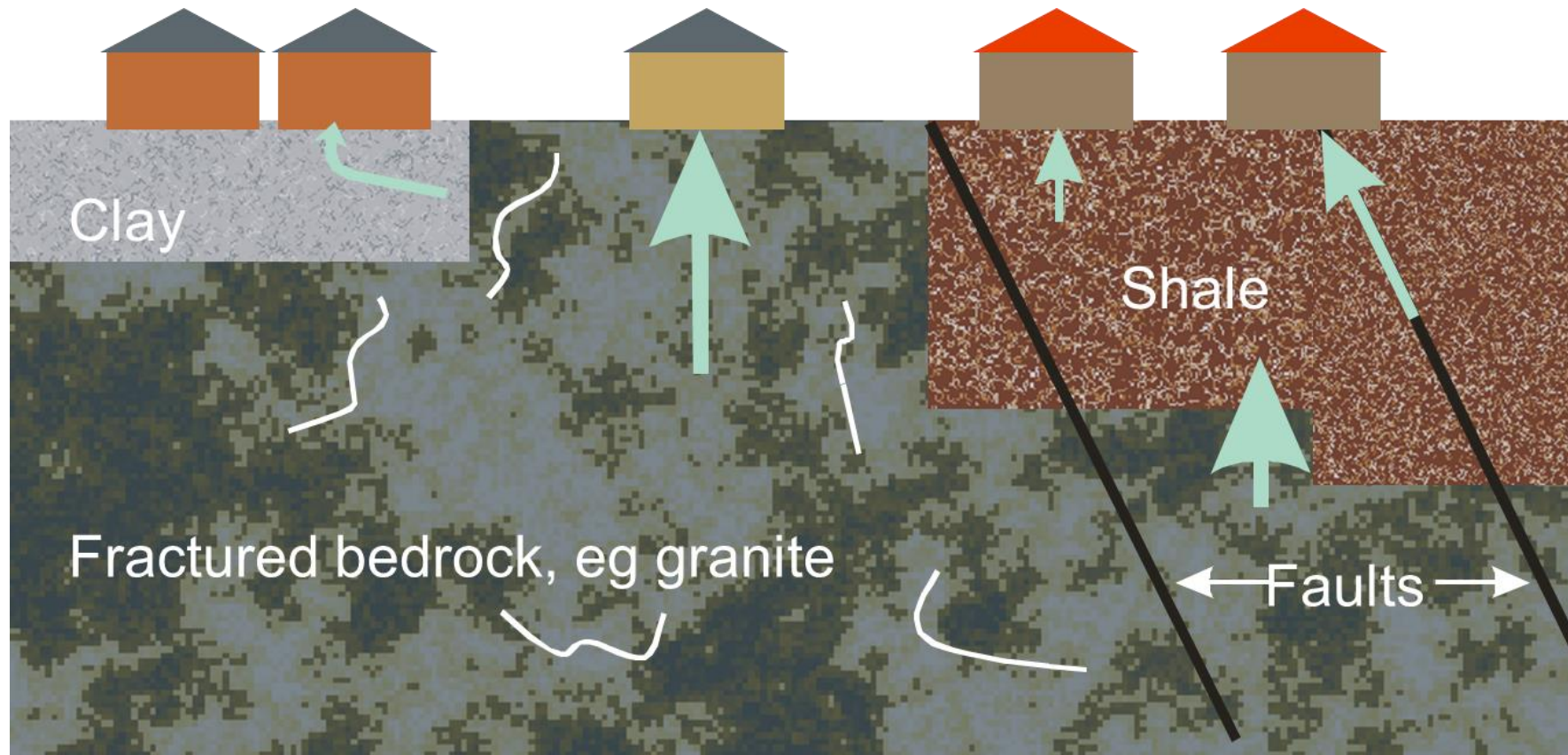
Radon levels are measured in two occupied rooms for 3 months

The annual average radon concentration is calculated from the 3-month results following the UKHSA Validation scheme

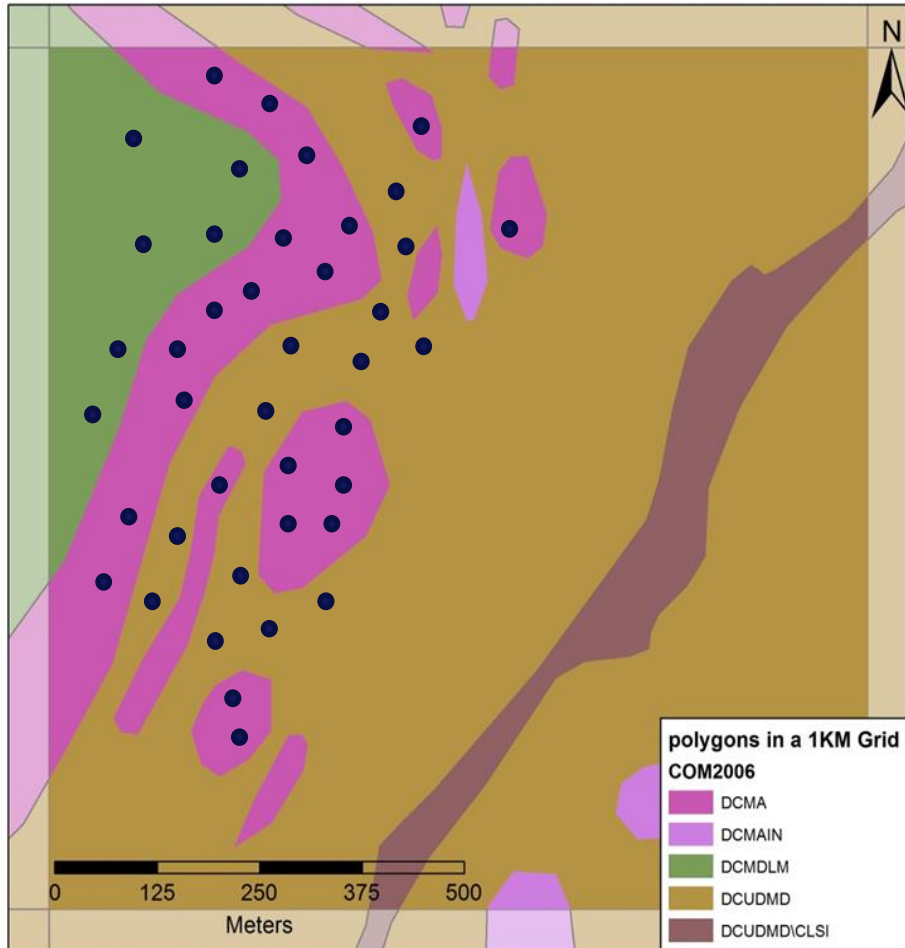
Ref: Validation scheme for organisations making measurements of radon in UK buildings: 2018 revision

<https://www.gov.uk/government/publications/radon-in-dwellings-validation-scheme-for-measurements>

BGS allocates a geology to each result



Local geology can be complicated

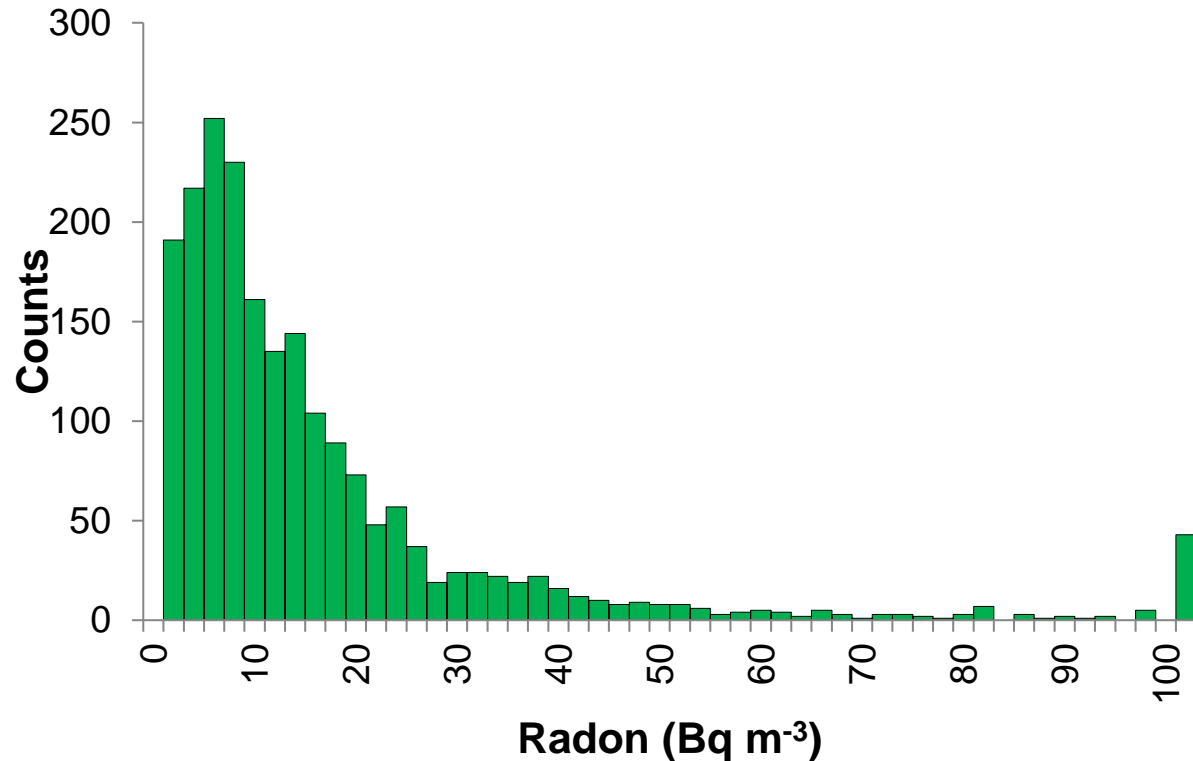


Five different geological classifications in a single 1 km Grid square

Radon results are grouped by geological classification

The grouped radon results in each geological classification are analysed

Analysis of results



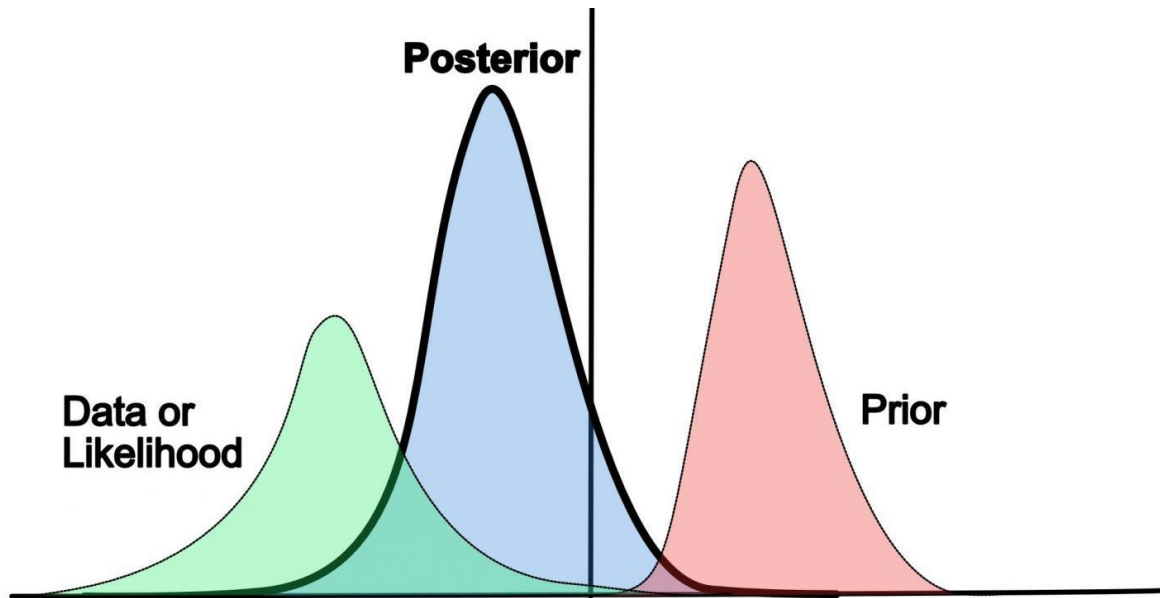
The distribution of radon levels is lognormal after subtracting outdoor radon, 4 Bq m⁻³

Radon distribution parameters - geometric mean (GM) and geometric standard deviation (GSD) were calculated

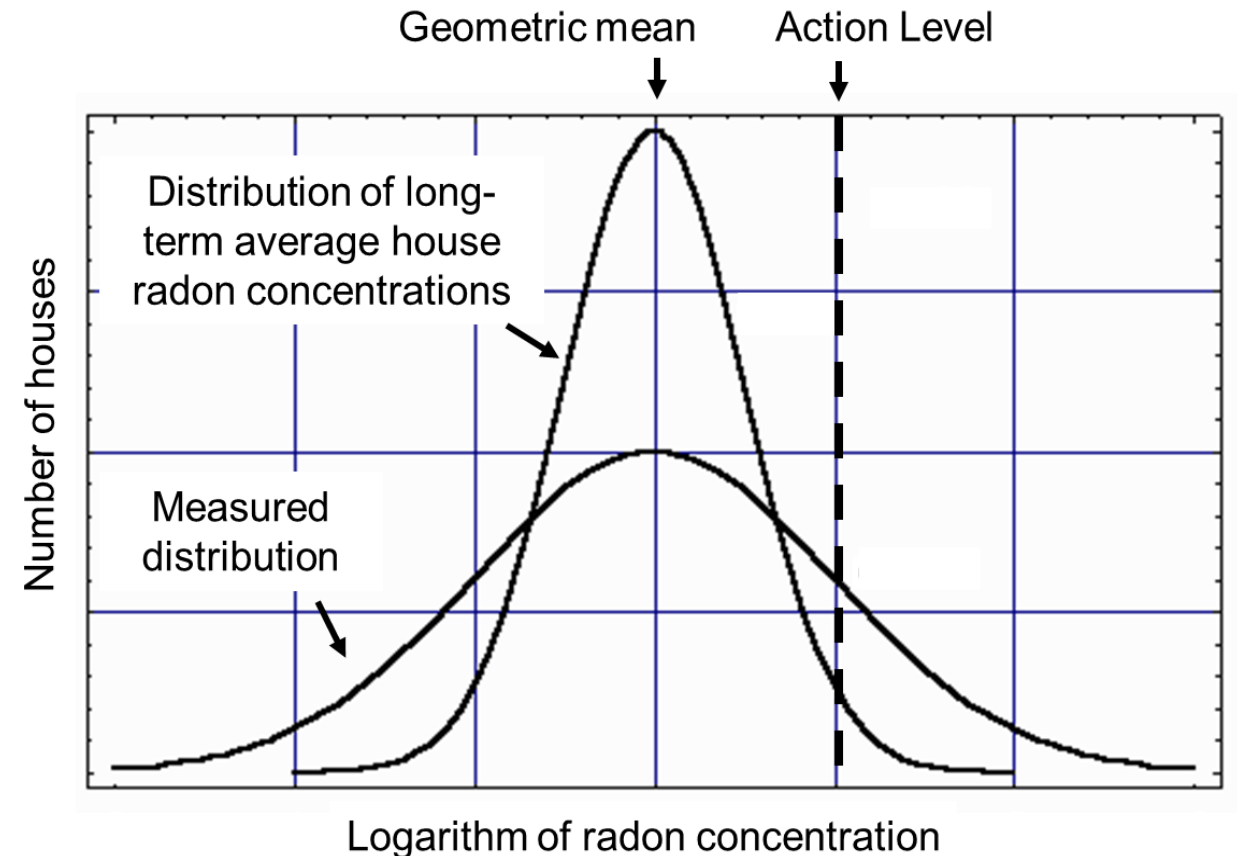
Adjustment of geometric standard deviation (GSD)

Correction for limited statistics

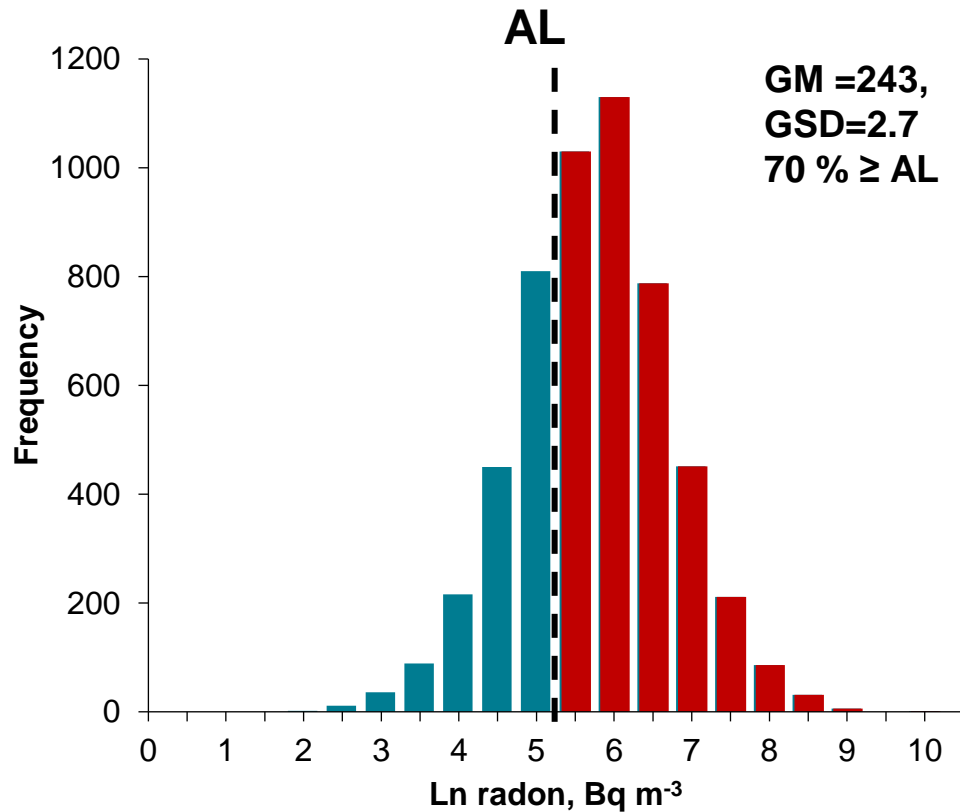
Bayesian estimation of GSD improves estimates of GSD for a particular area and avoids bias



Correction for year-to-year variation



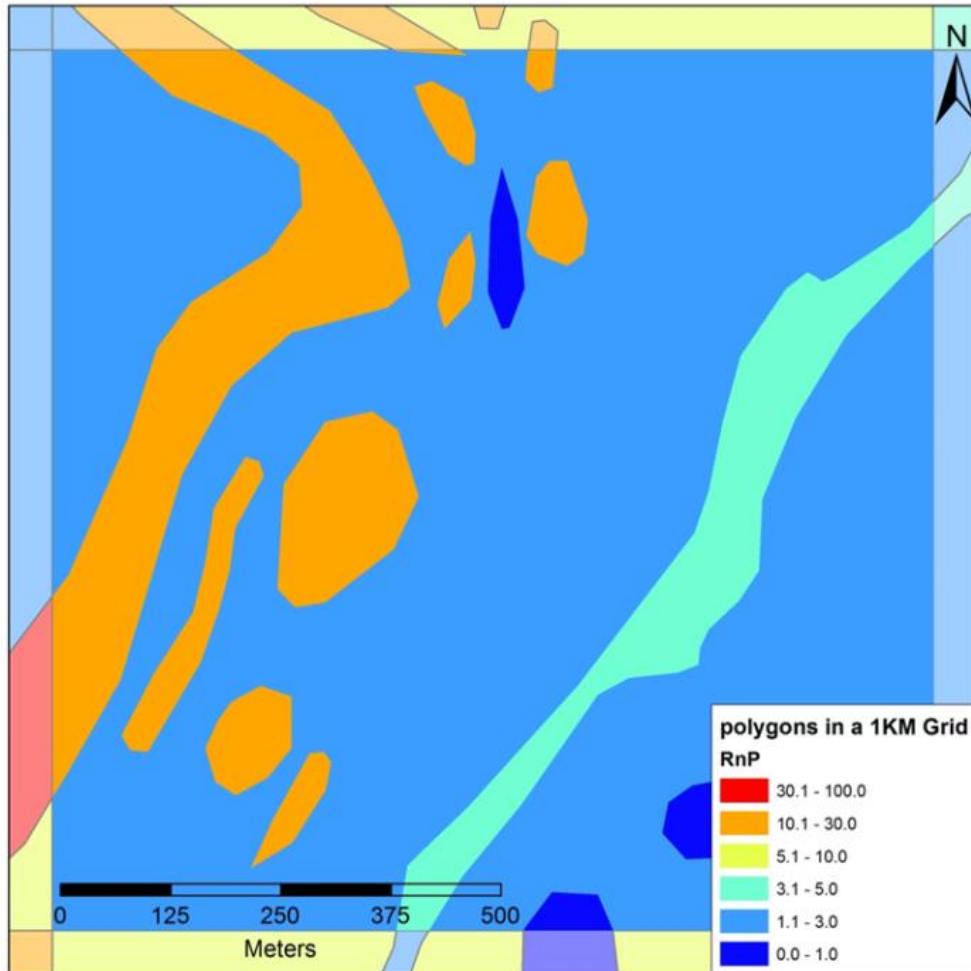
Estimation of percentage of homes at or above the UK radon Action Level



The UK radon Action Level (AL) is 200 Bq m⁻³

70 % of homes on this geological classification were at or above the Action Level

Radon potential was assigned to each geological polygon



The radon potential is equivalent to the percentage of homes expected to be at or above the Action Level

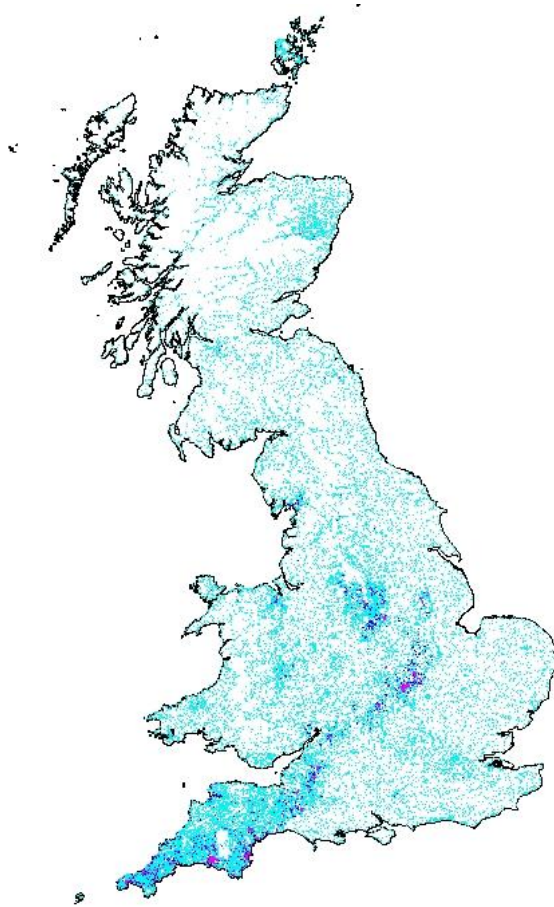
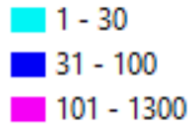
There are 6 classes of radon potential:
0-1, 1-3, 3-5, 5-10, 10-30, >30 %

What's changed in the updated Great Britain (GB) map?

- 80,000 *more* radon measurements were added to the data set, to make 560,000 total (UKHSA)
- New geological codes were used (BGS)
- Minimum number of measurements needed on a single geological classification was reduced to 30
- 50 metre geological buffer was removed

UKHSA data set

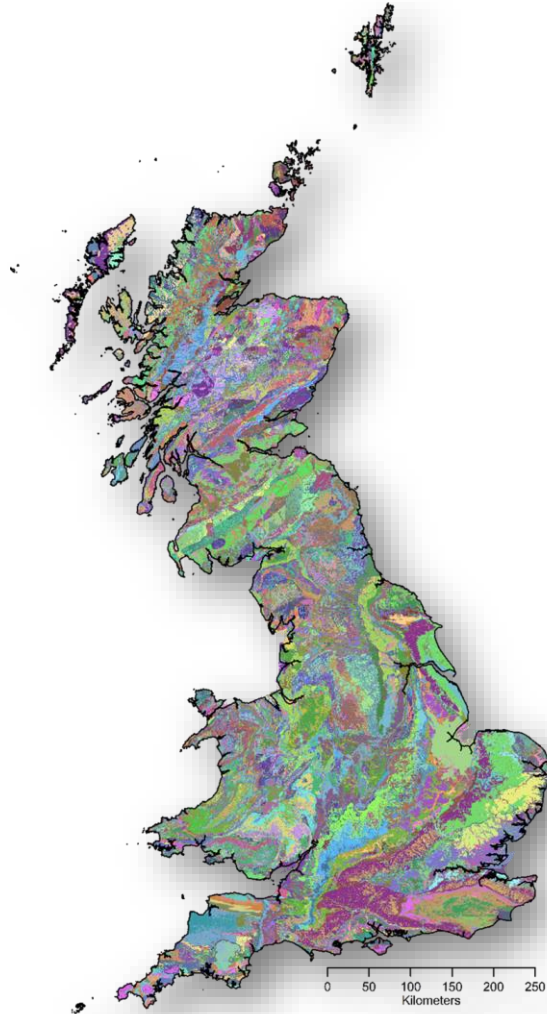
Number of
measurements



The data set included 560,000 indoor radon measurements collected by the Radon group since 1980s

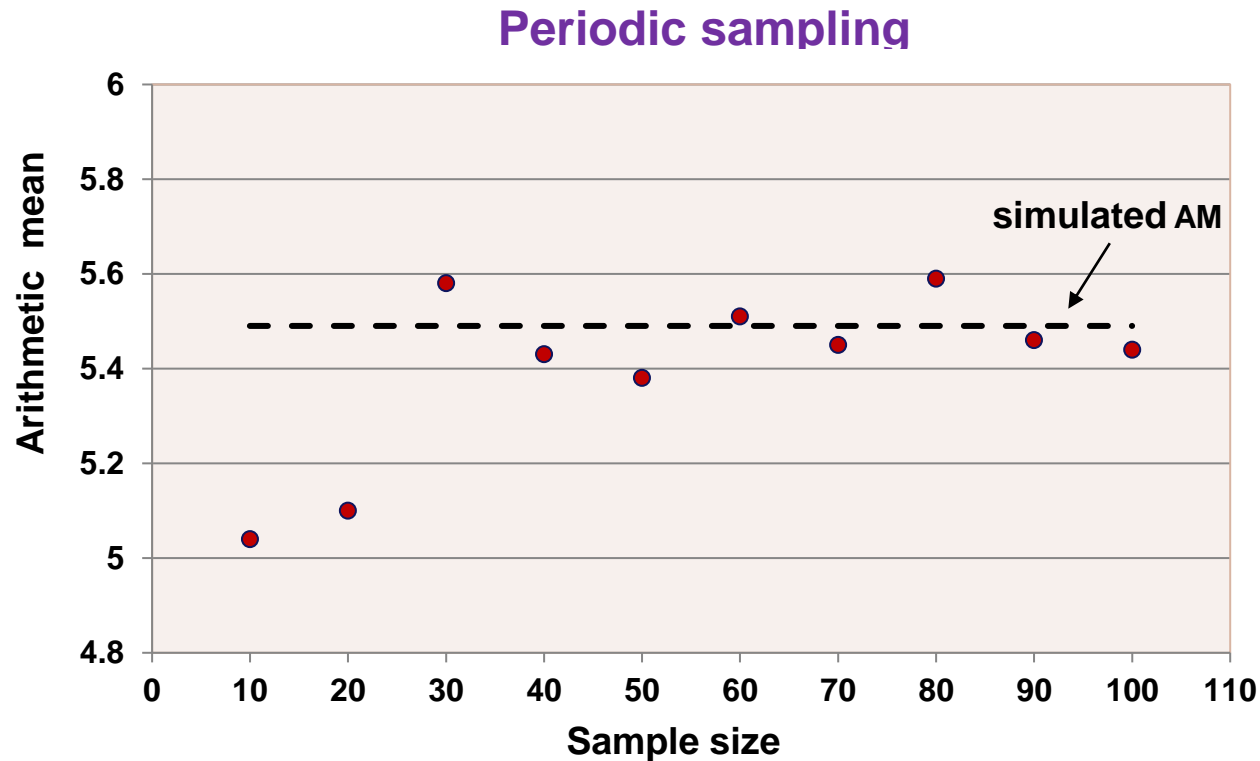
The measurements covered England, Wales and Scotland

BGS data set



BGS mapped > 10 000 rock types
at 50 m resolution

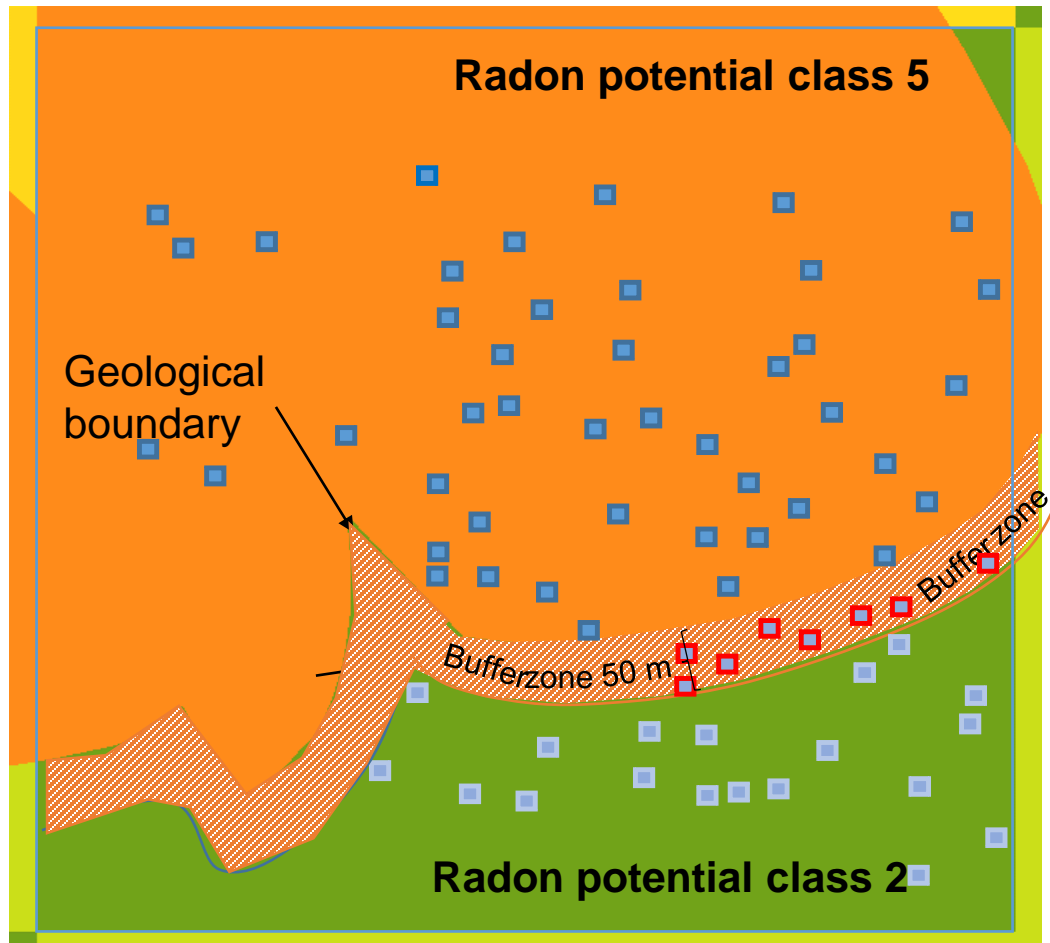
Number of measurements per geological unit



Monte Carlo simulation of 5,500 results
Arithmetic mean (AM) - 5.5

Samples with at least 30 results can be used to estimate, with good precision, the simulated arithmetic mean

Impact of 50m geological buffer on radon potential



A 50 metre buffer was included in previous maps to account for the uncertainty of the geological boundaries in 1:50 000 scale geological maps
1 mm in the map corresponds to 50 m on the field

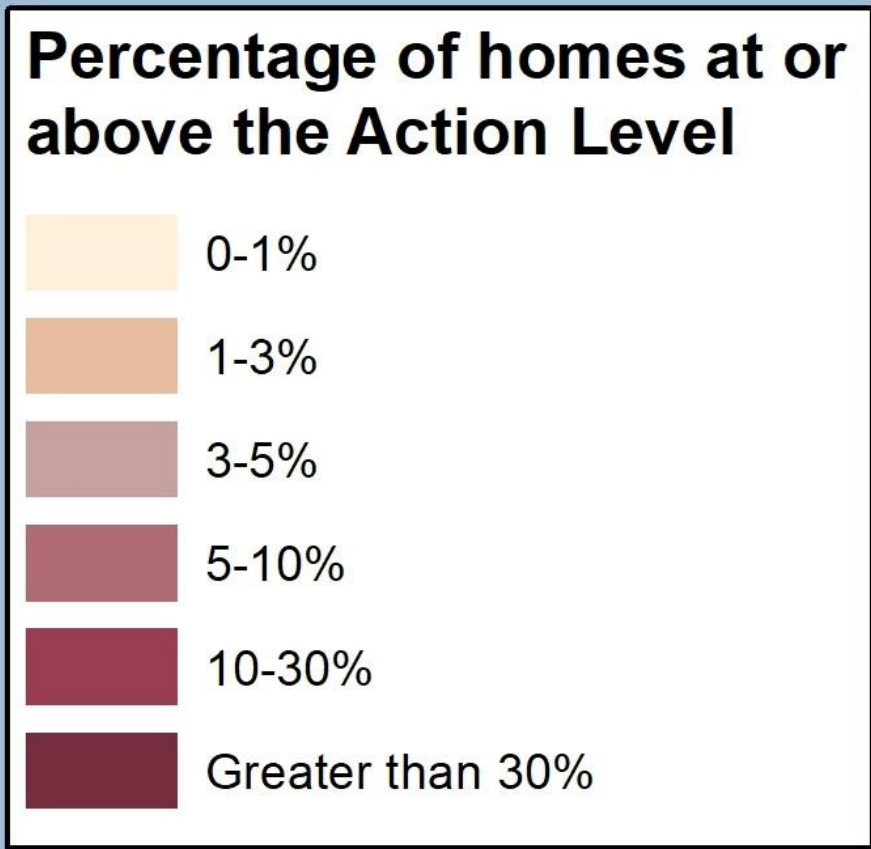
An extra radon potential class 5 zone was added due to the 50 m buffer
Houses in this zone will be classified as class 5

Updated GB map

- Covers England, Wales and Scotland
- Uses radon measurement results from 560,000 homes
- Uses an updated geology (see Antonio's presentation)
- Data were processed as a single data set

Used new colour scheme

- Increase accessibility
- Reinforce message that <1% Affected Areas are mapped
- Easy differentiation between current and next generation of maps
- Northern Ireland colours changing for consistency – data remains the same



Pre-mapping process

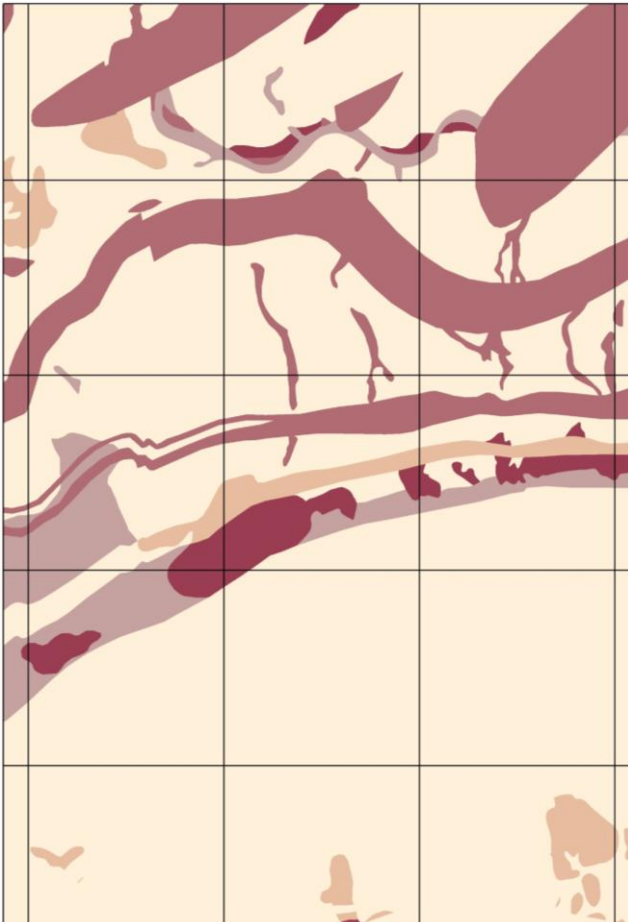
- All results were geo-located at premise level
- Only initial results were used – repeats or post remedial work tests were excluded
- BGS developed around 9,300 simplified geological classifications, allocated across 2.5M polygons
- Each result was allocated a simplified geological classification

Data processing

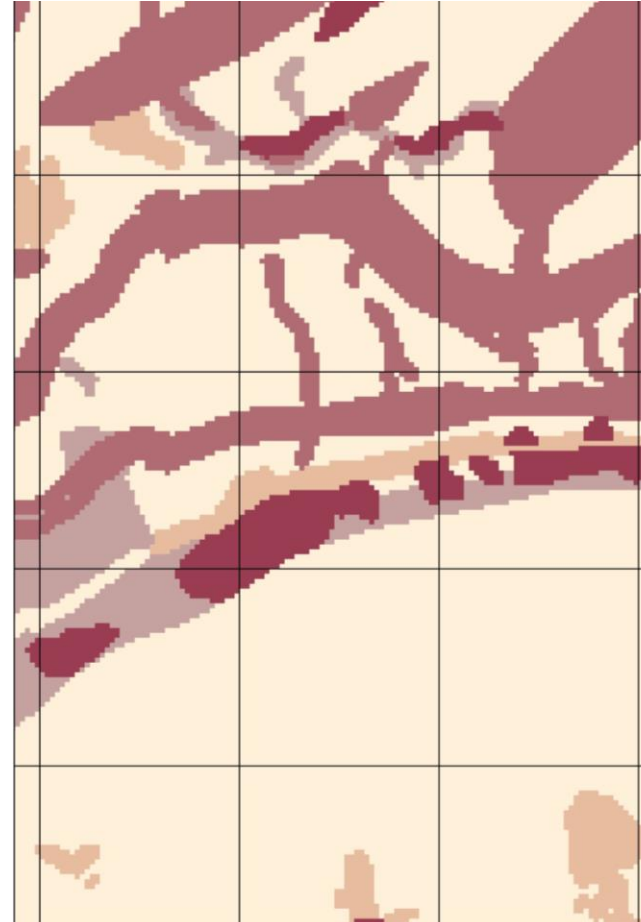
- Simplified geology was mapped :
 - ≥30 results - UKHSA evaluated radon potential (covers 75.7% of GB)
 - <30 results - BGS evaluated radon potential
- Map was processed with a 25 m buffer (to allow for building footprint)
- Geological boundary uncertainty buffer of 50 m was not added
- Map was buffered from the highest to lowest radon potential

Buffer effect

Raw data

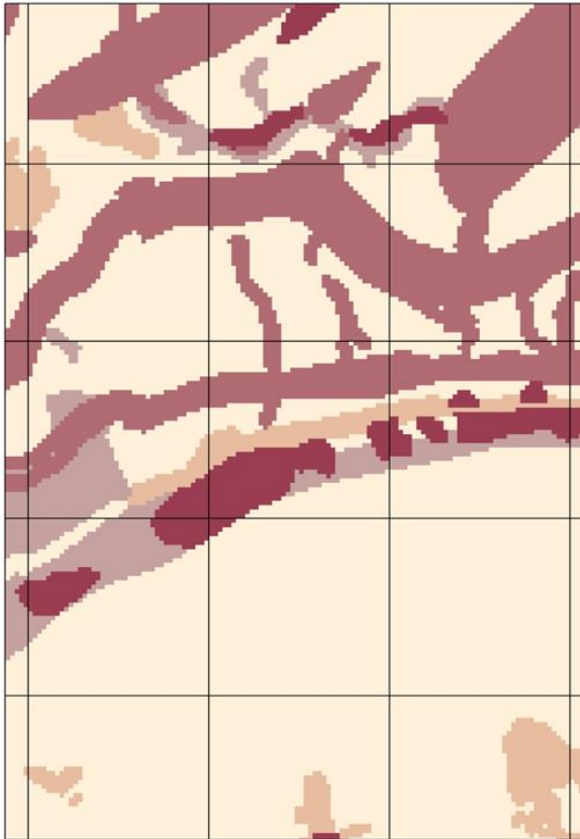


Buffered highest to lowest



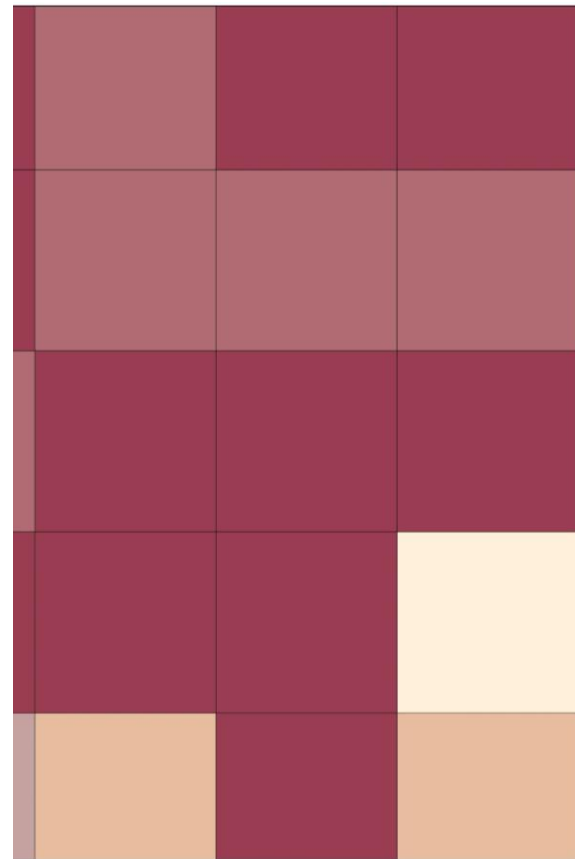
Two data sets are produced

Definitive data



Shows the detail inside 1 km grid square

Indicative data



Shows the highest radon class reported in 1 km grid square

Comparison between the updated GB map and previous maps

Map	Number of measurements	Number of geological classifications	Number of measurements per geological classification
England and Wales (2007)	460,000	1,434	≥ 100 (UKHSA) <100 (BGS)
Scotland (2011)	19,000	798	≥ 100 (UKHSA) <100 (BGS)
Updated GB (2022)	560,000	9,323	≥ 30 (UKHSA) <30 (BGS)

Quantitative changes in Great Britain*

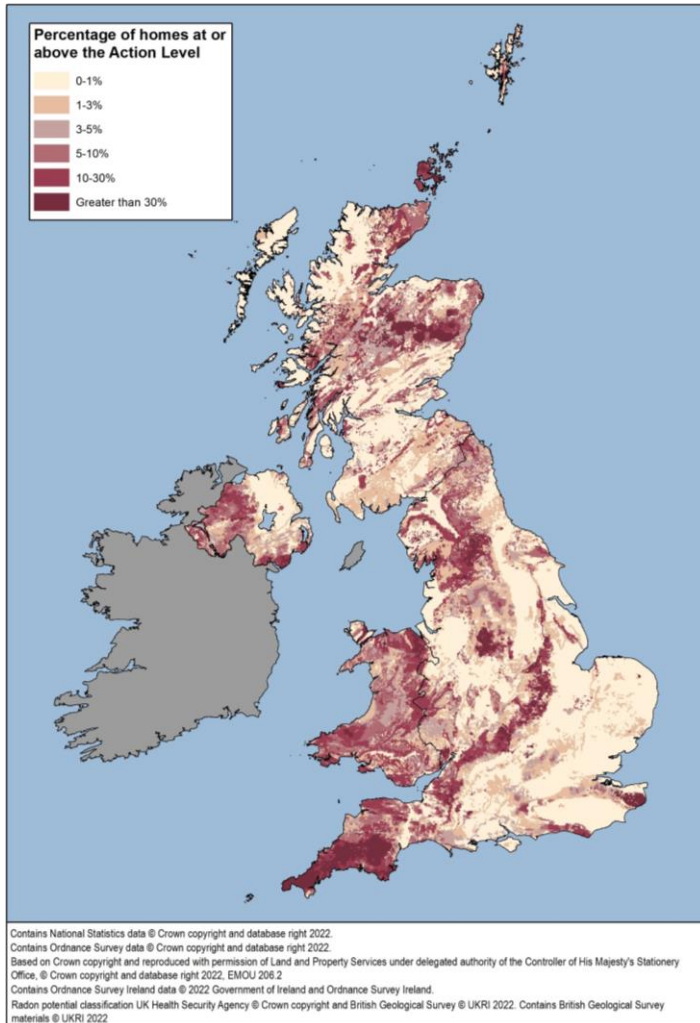
- **England**
 - 3% increase in homes in AA's
 - 2% increase in 3-10% bandings – basic protection range
 - Slight increase in >10% bandings – full protection range
- **Wales**
 - 4% drop in homes in AA's
 - 6% drop in 3-10% bandings – basic protection range
 - Slight increase in >10% bandings – full protection range
- **Scotland**
 - 2% increase in homes in AA's
 - 1% increase in 1-10% bandings – basic protection range
 - 1% increase in 10-30% bandings – full protection range

* Statistics derived from the address list for GB (November 2022)

Updated GB map

You can access the interactive map on the UKradon website:

<https://www.ukradon.org/information/ukmaps>



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