Radon affected areas : England, Wales / National Radiological Protection Board.

NRPB

DOCUMENTS OF THE NRPB

Radon Affected Areas: England Wales

VOLUME 7 NO 2 1996

National Radiological Protection Board
Chilton, Didcot, Oxon OX11 0RQ

The National Radiological Protection Board was created by the Radiological Protection Act 1970. The functions of the Board are to give advice, to conduct research, and to provide technical services in the field of protection against both ionising and non-ionising radiations.

In 1977 the Board received Directions under the Radiological Protection Act which require it to give advice on the acceptability to and the application in the UK, of standards recommended by international or intergovernmental bodies, and to specify emergency reference levels (ERLs) of dose for limiting radiation doses in accident situations.

Documents of the NRPB contain both the formal advice of the Board on standards of protection as well as guidance on their application in practice.

NRPB

DOCUMENTS OF THE NRPB

Radon Affected Areas: England Wales

VOLUME 7 NO 2 1996

National Radiological Protection Board
Chilton, Didcot, Oxon OX11 0RQ

RADON AFFECTED AREAS: ENGLAND

ABSTRACT

Board advice on radon in homes issued in 1990 specifies that areas of the UK where 1% or more of homes exceed the Action Level of 200 becquerels per cubic metre of air should be regarded as Affected Areas. Results of radon measurements in about 250 000 homes in the whole of England are mapped and used to complete the delineation of Affected Areas. The Department of the Environment is advised to consider which localities should be delimited for precautions against radon in future homes.

PREPARED BY J C H MILES, B M R GREEN AND P R LOMAS

INTRODUCTION

1 In January 1990, the National Radiological Protection Board recommended that the Action Level for radon in existing homes should be 200 Bq m^{-3} averaged over a year[1]. Parts of the country with 1% probability or more of present or future homes being above the Action Level should be regarded as Affected Areas: such areas should be identified from radiological evidence and periodically reviewed[2]. The Board advised on radon Affected Areas in Cornwall and Devon in 1990[3], in Derbyshire, Northamptonshire and Somerset in 1992[4], and in Scotland and Northern Ireland in 1993[5,6].

2 This document has an assessment of Affected Areas in the whole of England. It brings up to date and completes the earlier documents on individual counties of England. The Affected Areas are identified and details are given of the proportion of homes in these areas estimated to exceed the Action Level.

DATA COLLECTION AND ANALYSIS

3 In order to map radon Affected Areas, data were analysed by 5 km squares of the Ordnance Survey National Grid. Radon measurements are required across as much of the area to be mapped as possible. The Board has carried out various surveys of radon in homes in England using passive etched-track detectors exposed for at least three months. Most of the measurements were funded by the Department of the Environment; many were performed at the request of householders. Measurements were not evenly spread across the country, and when the results were first mapped, some areas were seen to have insufficient data.

4 In order to fill the gaps, the Board wrote to householders in these areas offering a radon measurement. The initial aim was to obtain three or more results in each 5 km grid square. In all grid squares where the results indicated a possibility that there might be 1% or more of homes above the Action Level, further measurements were carried out to obtain a minimum of five results in each grid square wherever practicable. As some areas have very low population densities, however, some grid squares have few or no radon results. The number of homes surveyed in each county is given in the table.

5 Indoor radon concentrations are affected by indoor and outdoor temperatures, by winds, ventilation conditions, and other factors. The seasonal variation in average radon concentrations had been previously assessed for the country as a whole[7] and used to derive correction factors for measurements lasting less than a year[4]. These seasonal correction factors are appropriate for improving estimates of radon concentrations in an average year. By their nature, however, they are unable to take account of year to year variations. An improved methodology has therefore been developed which takes account of both month to month and year to year variations. This is based on the use of results from the UK survey[7], analysed in terms of the mean monthly air temperatures for England and Wales: more details are given elsewhere[8].

6 The UK survey of radon in homes[7] showed that householders living in detached and semi-detached houses were more likely to participate in a radon survey than those in terraced houses or flats. As radon levels are generally higher in detached and semi-detached houses, this introduces a bias in the estimates of average radon concentrations; this problem is particularly acute in metropolitan areas where the proportion of flats and terraced houses is higher. Results for metropolitan areas and for suburban and rural areas

Surveys of radon in homes in English counties

County	Number measured	County	Number measured
Greater London	420	Hampshire	810
Greater Manchester	670	Hereford and Worcester	930
Merseyside	150	Hertfordshire	330
South Yorkshire	1 200	Humberside	680
Tyne and Wear	130	Isle of Wight	110
West Midlands	260	Kent	680
West Yorkshire	530	Lancashire	540
Avon	770	Leicestershire	1 500
Bedfordshire	380	Lincolnshire	5 000
Berkshire	280	Norfolk	970
Buckinghamshire	630	Northamptonshire	63 000
Cambridgeshire	990	Northumberland	850
Cheshire	700	North Yorkshire	1 600
Cleveland	140	Nottinghamshire	550
Cornwall and the Isles of Scilly	35 000	Oxfordshire	880
Cumbria	1 500	Shropshire	980
Derbyshire	27 000	Somerset	20 000
Devon	60 000	Staffordshire	960
Dorset	660	Suffolk	670
Durham	390	Surrey	310
East Sussex	490	Warwickshire	630
Essex	640	West Sussex	470
Gloucestershire	740	Wiltshire	760
		Total (rounded)	240 000

together were, therefore, corrected to a standard mix of houses typical of the UK housing stock using data from the General Household Survey[9]: more details of the procedure are also given elsewhere[8]. These corrections result in more standardised estimates of radon levels and more refined delineation of Affected Areas than was possible previously.

7 The distribution of radon concentrations in homes is approximately log-normal whether the sample is taken from the whole housing stock or a single grid square[3,8]. Research has shown that the distribution of radon concentrations in the UK conforms much more closely to a log-normal distribution if the mean outdoor radon concentration (4 Bq m^{-3}) is subtracted from each result; this subtraction was therefore performed for all values of radon concentration before analysis. An appropriate addition was subsequently applied when estimating the fraction of homes exceeding the Action Level.

8 The techniques used to estimate the fraction of the housing stock exceeding the radon Action Level in grid squares in England were similar to those used previously[3,4] with some modifications that were found to be necessary since the survey covers the whole country[8]. If the geometric mean (GM) and geometric standard deviation (GSD) of a log-normal distribution are known, the fraction of the distribution exceeding any threshold can be calculated. This property of the distribution was used in calculating the fraction of the

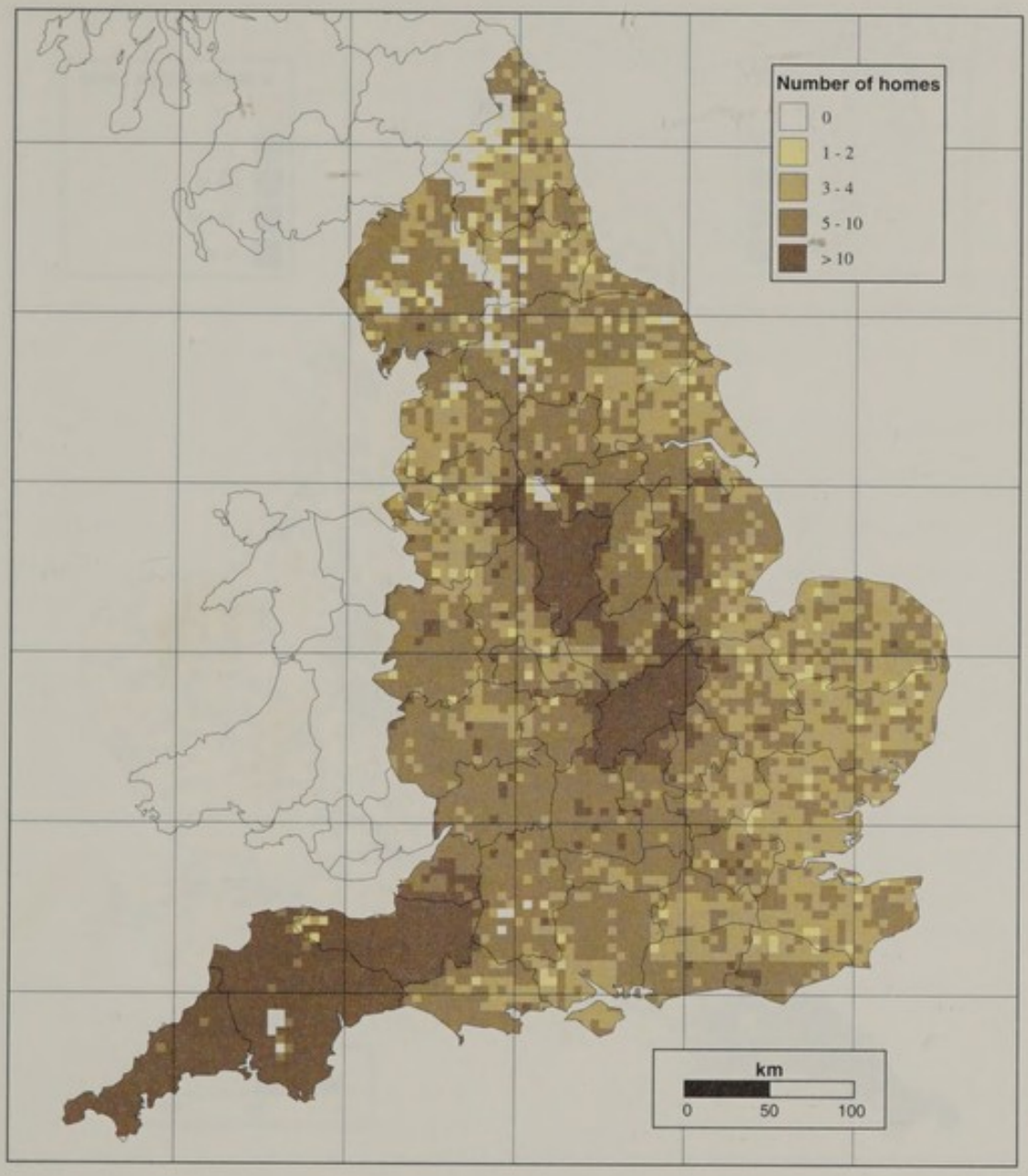

FIGURE 1 *Number of homes in which radon was measured in each 5 km grid square in England*

housing stock exceeding the Action Level in each grid square. In some squares, however, there are too few data to estimate the GM and GSD directly, so information from adjacent squares has to be used.

9 In the previous exercises, the GSDs of results within 5 km grid squares were seen not to vary significantly between nearby squares in the same county, and average values of GSDs for areas were used. The same procedure has been carried out in this case using a national average GSD of 2.5, except in squares containing enough data to estimate the GSD directly, in which circumstance the appropriate value for the grid square was used.

10 The GM values for all squares were geometrically smoothed with the GM values of adjacent squares to remove anomalies caused by the small numbers of results in some squares. The degree of smoothing was varied according to the number of results available for a grid square[8]. The established values of GM and GSD were then used to estimate the fraction of the housing stock exceeding the Action Level in each grid square.

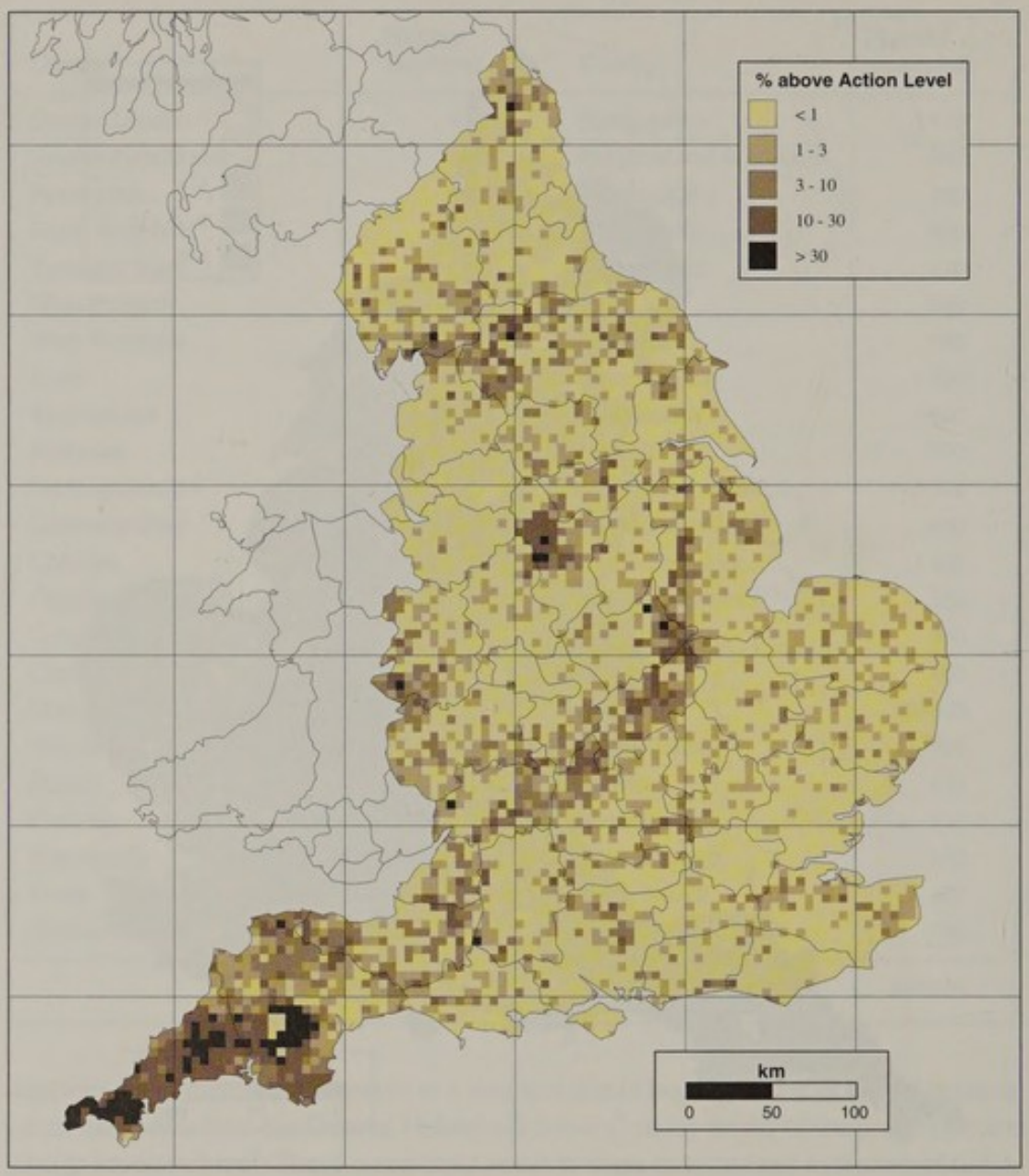

FIGURE 2 *Estimated proportion of homes exceeding the Action Level in each 5 km grid square in England. Data not smoothed*

11 Some of the grid squares had no radon results. Most of these have virtually no population, so it is not meaningful to refer to the fraction of the existing housing stock above the Action Level. It is useful, however, to estimate the percentage of the housing stock that would be above the Action Level in these squares to allow preventive measures against radon to be taken should new houses be constructed. For this reason, blank squares adjacent to squares with measurements were infilled using procedures described previously[3].

12 The results are shown in a set of maps. Figure 1 shows the number of measurements in each 5 km grid square of England: they range from 0 to over 10 000. Figure 2 shows the estimated proportion of homes per grid square with radon concentrations exceeding the Action Level of 200 Bq m^{-3}: these are based on the unsmoothed GMs. Figure 3 shows the equivalent values after smoothing. The estimates here are based on values of GM obtained from smoothing with the values in surrounding squares and infilling blank squares: the proportions range from below 1% to above 30%. Figure 4 is a more heavily smoothed

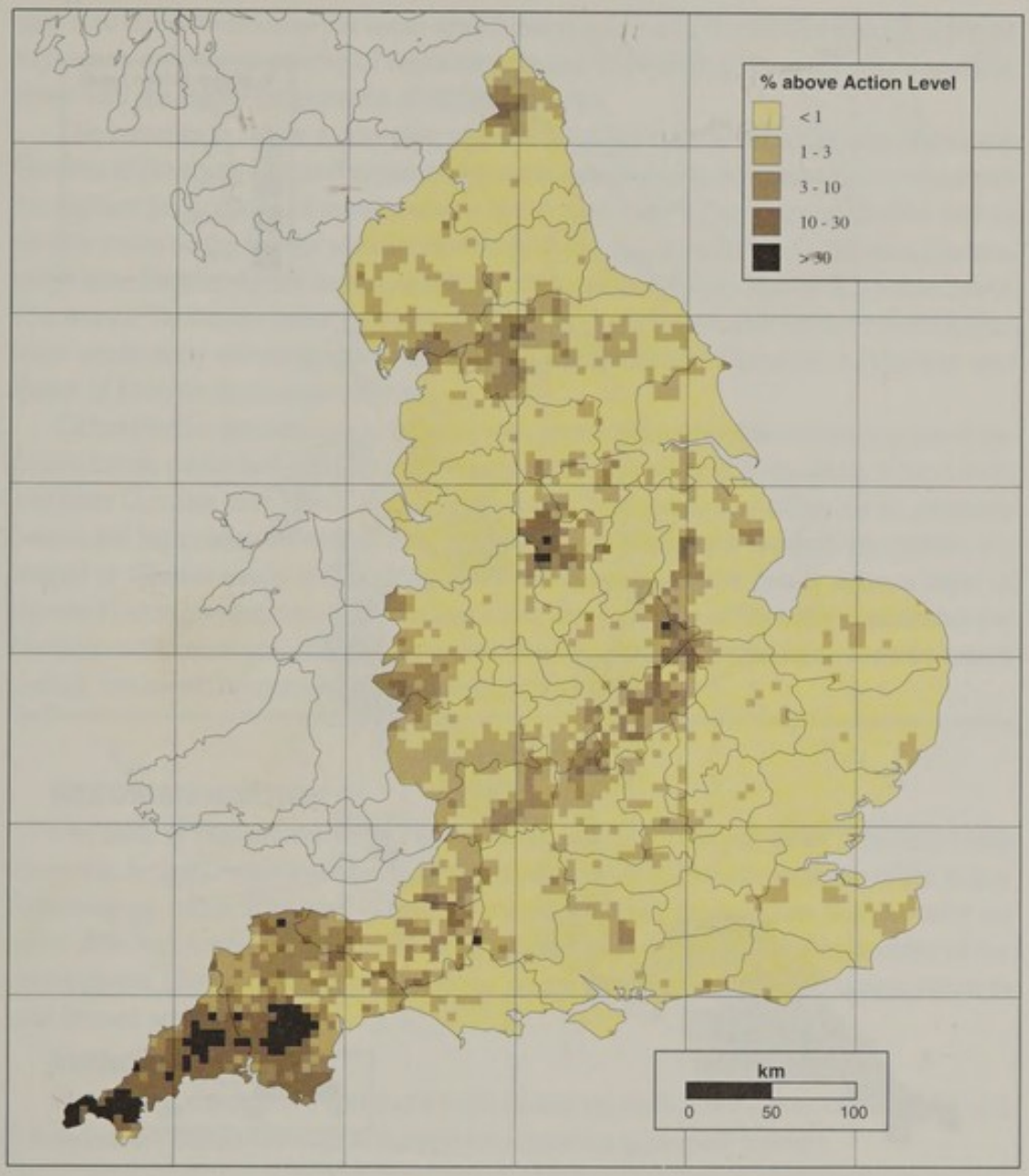

FIGURE 3 *Estimated proportion of homes exceeding the Action Level in each 5 km grid square in England. Data smoothed*

map, the purpose of which is to show the broad sweep of elevated radon levels in homes across the country.

INTERPRETATION

13 When it was first introduced, the concept of an Affected Area was applied to whole counties or at least to significant parts of counties. Measurements were not available at sufficient density to permit fine detail to be resolved. Furthermore, data for adjoining squares were smoothed regardless of the precision with which they were known, and fluid contour lines were drawn to emphasise the approximate nature of the boundaries.

14 In order to allow resources to be targeted with the greatest efficiency, information about each 5 km grid square is now presented with the maximum precision that the data allow. Smoothing is not applied where there are sufficient measurements in a square to

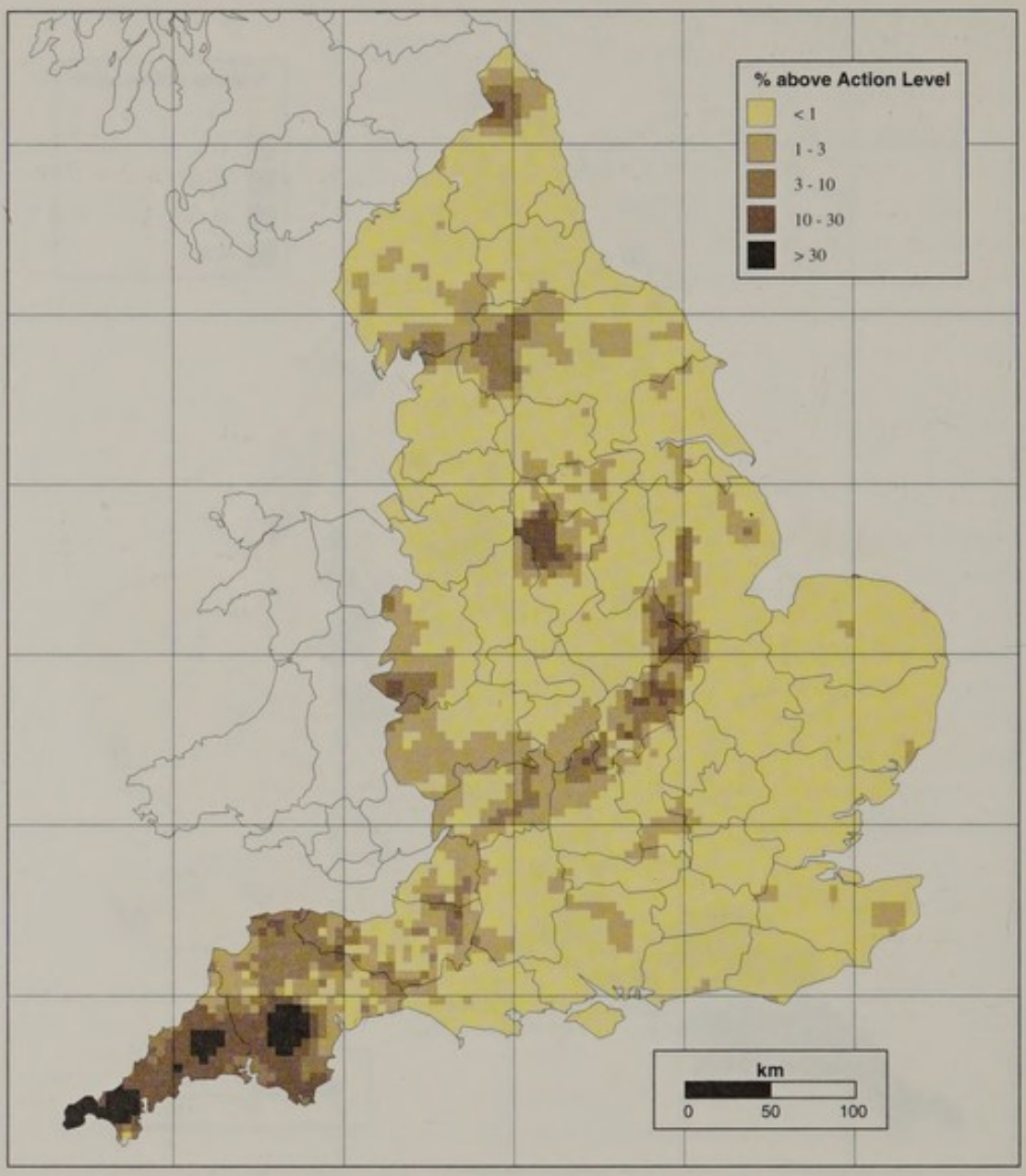

FIGURE 4 *Estimated proportion of homes exceeding the Action Level in each 5 km grid square in England. Data smoothed twice*

determine GMs directly but only when a low measurement density means that estimates will be improved by doing so. The ability to present more precise information depends, of course, on a sufficient density of measurement in each square. Where data are particularly plentiful, it is possible to resolve still finer detail, for example by using geological boundaries. Nevertheless, it must be recognised that there are only five or so measurements for many grid squares in England and this limitation does not allow boundaries to be delineated more precisely than to 5 km.

15 There are now very many measurements in the Affected Areas already defined[3,4], and this information, together with the improved methodology utilised here, has facilitated refinement in the estimates of elevated radon levels. There are some changes of detail in the distribution patterns, but the broad picture remains unchanged.

16 The parts of England shown in Figure 3 with a probability of 1% or more of homes being above the Action Level should be regarded as Affected Areas. The primary purpose of this

map is to draw attention to the areas where radon exposures should be reduced or future exposures minimised: priority of measurement and remediation should be given to those areas with the higher proportions of affected homes.

17 The patterns in Figure 3 correlate with the local geology: in particular, the Hycernian Granites of the southwest and to some extent the metamorphic aureole are associated with the highest proportions of homes above the Action Level. The Cheviot Granite and its aureole rocks on the border with Scotland also show clearly, while the Caledonian Granites in the Lake District do not have a significant proportion of homes above the Action Level. The marine Devonian rocks in Devon and Cornwall with shale and sandstone lithologies have moderately elevated radon levels, but the continental Devonian sandstones and shales of Exmoor have higher levels.

18 Carboniferous limestone is associated with increased proportions of homes above the Action Level, particularly in Derbyshire but also in Somerset and Avon and in a band from southern Cumbria into North Yorkshire; the high permeability of these rocks probably causes the high radon levels indoors. The increased proportions in south Shropshire are related to Silurian sandy shales, flagstones, and limestones. The broad sinuous band of elevated radon levels extending from Lyme Bay through parts of Somerset and across the Midlands to Northamptonshire and beyond follows the outcrop of the Jurassic rocks, which contain radon-rich limestones, sandstones and ironstones.

RECOMMENDATION

19 The parts of England shown in Figure 3 with a 1% probability or more of homes being above the Action Level should be regarded as Affected Areas for the purposes of the Board Statement on radon in homes[1]. This advice complements the previous Board advice on radon Affected Areas in England[3,4]. Taking account of these areas, the Department of the Environment should delimit those localities where preventive measures against radon in new houses are justified.

ACKNOWLEDGEMENTS

20 We wish to thank C R Muirhead for his advice on statistical aspects of this work and T K Ball of the British Geological Survey for advice on geological matters.

REFERENCES

1 NRPB. Statement by the National Radiological Protection Board. Limitation of human exposure to radon in homes. *Doc. NRPB*, **1**, No. 1, 15–16 (1990).

2 NRPB. Human exposure to radon in homes. Recommendations for the practical application of the Board's Statement. *Doc. NRPB*, **1**, No. 1, 17–32 (1990).

3 NRPB. Radon Affected Areas: Cornwall and Devon. *Doc. NRPB*, **1**, No. 4, 37–43 (1990).

4 NRPB. Radon Affected Areas: Derbyshire, Northamptonshire and Somerset. *Doc. NRPB*, **3**, No. 4, 19–28 (1992).

5 NRPB. Radon Affected Areas: Scotland. *Doc. NRPB*, **4**, No. 6, 1–8 (1993).

6 NRPB. Radon Affected Areas: Northern Ireland. *Doc. NRPB*, **4**, No. 6, 9–15 (1993).

7 Wrixon, A D, Green, B M R, Lomas, P R, Miles, J C H, Cliff, K D, Francis, E A, Driscoll, C M H, James, A C, and O'Riordan, M C. Natural radiation exposure in UK dwellings. Chilton, NRPB-R190 (1990) (London, HMSO).

8 Miles, J C H. Mapping radon-prone areas by log–normal modelling of house radon data. (To be published.)

9 OPCS. *1993 General Household Survey*. London, HMSO, GHS 24 (1995).

RADON AFFECTED AREAS: WALES

ABSTRACT

Board advice on radon in homes issued in 1990 specifies that areas of the UK where 1% or more of homes exceed the Action Level of 200 becquerels per cubic metre of air should be regarded as Affected Areas. Results of radon measurements in homes in parts of Wales are mapped and used for the delineation of Affected Areas. The Welsh Office is advised to consider which localities should be delimited for precautions against radon in future homes.

PREPARED BY J C H MILES, B M R GREEN AND P R LOMAS

INTRODUCTION

1 In January 1990, the National Radiological Protection Board recommended that the Action Level for radon in existing homes should be 200 Bq m^{-3} averaged over a year[1]. Parts of the country with 1% probability or more of present or future homes being above the Action Level should be regarded as Affected Areas: such areas should be identified from radiological evidence and periodically reviewed[2]. The Board advised on radon Affected Areas in Cornwall and Devon in 1990[3], in Derbyshire, Northamptonshire and Somerset in 1992[4], and in Scotland and Northern Ireland in 1993[5,6].

2 This document has an assessment of Affected Areas in the areas in the previous Welsh districts of Alyn and Deeside and Delyn (now in the new Unitary Authority of Flintshire), of Glyndwr (now in Denbighshire), of Radnorshire (in Powys), of Ynys Mon (now called Anglesey), and of Preseli Pembrokeshire and South Pembrokeshire (now Pembrokeshire). The Affected Areas are identified and details are given of the proportion of homes in these areas estimated to exceed the Action Level.

DATA COLLECTION AND ANALYSIS

3 In order to map radon Affected Areas, data were analysed by 5 km squares of the Ordnance Survey National Grid. Radon measurements are required across as much of the area to be mapped as possible. The Board has carried out various surveys of radon in homes in Wales using passive etched-track detectors exposed for at least three months. Most of the measurements were funded by the Welsh Office; many were performed at the request of householders. Early results indicated that the parts of Wales identified above were likely to have the most serious radon problems, and the Welsh Office requested the Board to assess radon Affected Areas in these districts. Measurements were not evenly spread across these areas, and when the results were first mapped, some areas were seen to have insufficient data.

4 In order to fill the gaps, the Board wrote to householders in these areas offering a radon measurement. The aim was to obtain five or more results in each 5 km grid square. As some areas have very low population densities, however, some grid squares have few or no radon results. The number of homes surveyed in each district is given in the table.

5 Indoor radon concentrations are affected by indoor and outdoor temperatures, by winds, ventilation conditions, and other factors. The seasonal variation in average radon concentrations had been previously assessed for the country as a whole[7] and used to derive correction factors for measurements lasting less than a year[4]. These seasonal correction factors are appropriate for improving estimates of radon concentrations in an average year. By their nature, however, they are unable to take account of year to year variations. An improved methodology has therefore been developed which takes account of both month to month and year to year variations. This is based on the use of results from the UK survey[7], analysed in terms of the mean monthly air temperatures for England and Wales: more details are given elsewhere[8].

6 The UK survey of radon in homes[7] showed that householders living in detached and semi-detached houses were more likely to participate in a radon survey than those in terraced houses or flats. As radon levels are generally higher in detached and semi-detached houses, this introduces a bias in the estimates of average radon concentrations; this problem is particularly acute in metropolitan areas where the proportion of flats and

Surveys of radon in homes in areas of interest in Wales

Unitary Authority	Number measured
Anglesey	240
Denbighshire	200
Flintshire	220
Pembrokeshire	550
Powys	790
Wrexham	140
Total (rounded)	2150

terraced houses is higher. Results for metropolitan areas and for suburban and rural areas together were, therefore, corrected to a standard mix of houses typical of the UK housing stock using data from the General Household Survey[9]: more details of the procedure are also given elsewhere[8]. These corrections result in more standardised estimates of radon levels and more refined delineation of Affected Areas than was possible previously.

7 The distribution of radon concentrations in homes is approximately log-normal whether the sample is taken from the whole housing stock or a single grid square[3,8]. Research has shown that the distribution of radon concentrations in the UK conforms much more closely to a log-normal distribution if the mean outdoor radon concentration (4 Bq m^{-3}) is subtracted from each result; this subtraction was therefore performed for all values of radon concentration before analysis. An appropriate addition was subsequently applied when estimating the fraction of homes exceeding the Action Level.

8 The techniques used to estimate the fraction of the housing stock exceeding the radon Action Level in grid squares in Wales were similar to those used previously[3,4] with some modifications[8]. If the geometric mean (GM) and geometric standard deviation (GSD) of a log-normal distribution are known, the fraction of the distribution exceeding any threshold can be calculated. This property of the distribution was used in calculating the fraction of the housing stock exceeding the Action Level in each grid square. In some squares, however, there are too few data to estimate the GM and GSD directly because there is little or no population, so information from adjacent squares has to be used.

9 In the previous exercises, the GSDs of results within 5 km grid squares were seen not to vary significantly between nearby squares in the same county, and average values of GSDs for areas were used. The same procedure has been carried out in this case using a national average GSD of 2.5, except in squares containing enough data to estimate the GSD directly, in which circumstance the appropriate value for the grid square was used.

10 The GM values for all squares were geometrically smoothed with the GM values of adjacent squares to remove anomalies caused by the small numbers of results in some squares. The degree of smoothing was varied according to the number of results available for a grid square[8]. The established values of GM and GSD were then used to estimate the fraction of the housing stock exceeding the Action Level in each grid square.

11 Some of the grid squares had no radon results. Most of these have virtually no population, so it is not meaningful to refer to the fraction of the existing housing stock above the Action Level. It is useful, however, to estimate the percentage of the housing stock that would be above the Action Level in these squares to allow preventive measures against radon to be taken should new houses be constructed. For this reason, blank squares adjacent to squares with measurements were infilled using procedures described previously[3].

12 The results are shown in a set of maps where the boundaries of the new Unitary Authorities are shown in red. Figure 1 shows the number of measurements in each 5 km grid square of the parts of Wales surveyed: they range from 0 to 55. There are also measurements outside these areas: they are not shown on the map as there are insufficient measurements to allow the designation of Affected Areas. Figure 2 shows the estimated proportion of homes per grid square with radon concentrations exceeding the Action Level of 200 Bq m^{-3}: these are based on the unsmoothed GMs. Figure 3 shows the equivalent values after smoothing. The estimates here are based on values of GM obtained from smoothing with the values in surrounding squares and infilling blank squares: the proportions range from below 1% to above 10%. Figure 4 is a more heavily smoothed map, the purpose of which is to show the broad pattern of elevated radon levels in homes across the areas of interest.

INTERPRETATION

13 When the concept of an Affected Area was first introduced measurements were not available at sufficient density to permit fine detail to be resolved. Furthermore, data for adjoining squares were smoothed regardless of the precision with which they were known, and fluid contour lines were drawn to emphasise the approximate nature of the boundaries.

14 In order to allow resources to be targeted with the greatest efficiency, information about each 5 km grid square is now presented with the maximum precision that the data allow. Smoothing is not applied where there are sufficient measurements in a square to determine GMs directly but only when a low measurement density means that estimates will be improved by doing so. The ability to present more precise information depends, of course, on a sufficient density of measurement in each square. Where data are particularly plentiful, it is possible to resolve still finer detail, for example by using geological boundaries. Nevertheless, it must be recognised that there are only five or so measurements for many grid squares in Wales and this limitation does not allow boundaries to be delineated more precisely than to 5 km.

15 The parts of Wales shown in Figure 3 with a probability of 1% or more of homes being above the Action Level should be regarded as Affected Areas. The primary purpose of this map is to draw attention to the areas where radon exposures should be reduced or future exposures minimised: priority of measurement and remediation should be given to those areas with the higher proportions of affected homes.

16 The local geology is reflected in Figure 3. The higher proportions of houses above the Action Level in Flintshire and Denbighshire are mostly underlain by Carboniferous rocks, including the Carboniferous Limestone, the Namurian and the Coal Measures. The radon levels observed are affected by overburden of glacial origin. The Carboniferous Limestone outcrops in the east and south of Anglesey also show up clearly. The complexity of the geological outcrops in Powys allow only general correlations with radon levels to be observed. Most of the area mapped is underlain by Silurian rocks, and sedimentary rocks deposited under shallow water conditions are particularly prone to higher radon levels. The geology of Pembrokeshire is also complex. The southern part of the area is underlain by Carboniferous Limestone and Devonian Old Red Sandstones. The higher proportions of houses above the Action Level in the north of the area are related to Cambrian and Precambrian acid tuffs, the volcanic equivalent of granites.

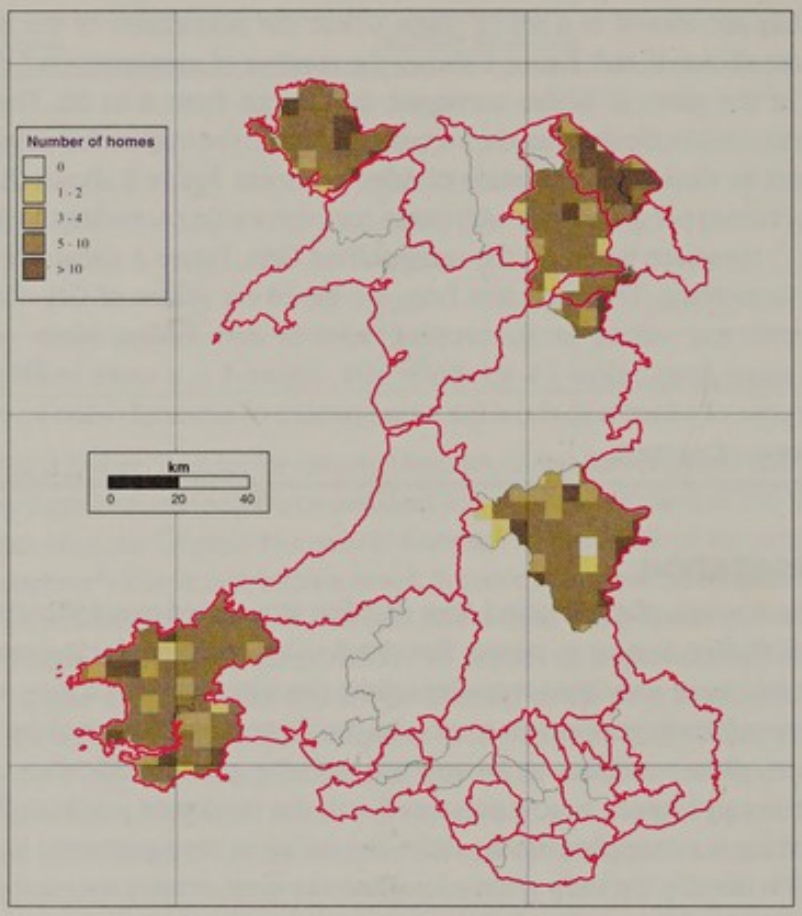

FIGURE 1 *Number of homes in which radon was measured in each 5 km grid square in Wales*

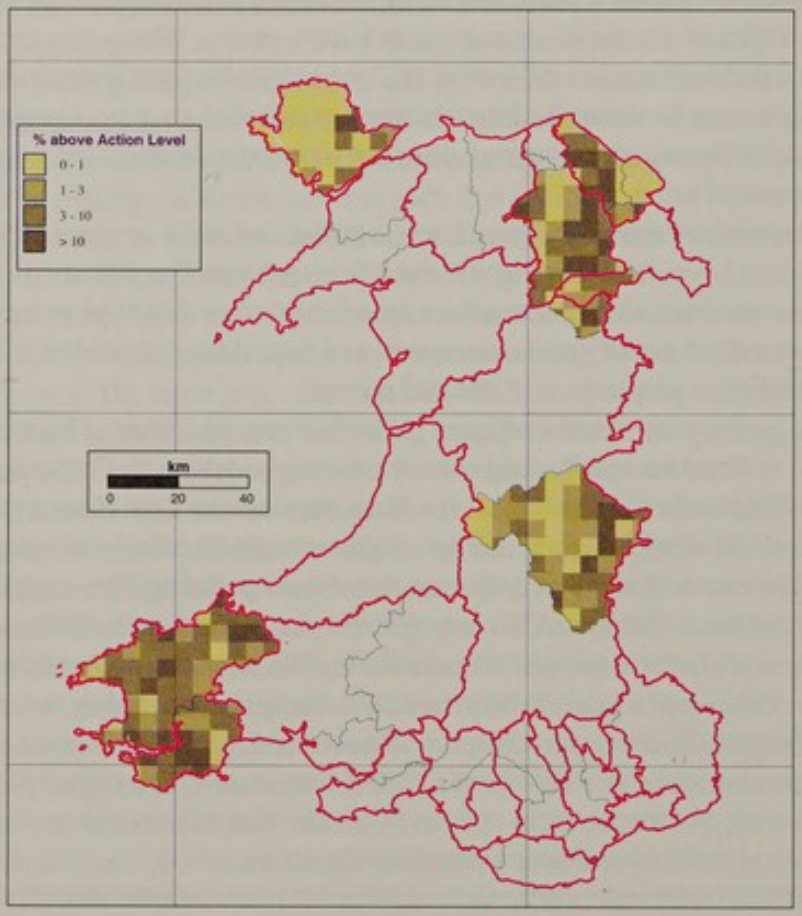

FIGURE 2 *Estimated proportion of homes exceeding the Action Level in each 5 km grid square in Wales. Data not smoothed*

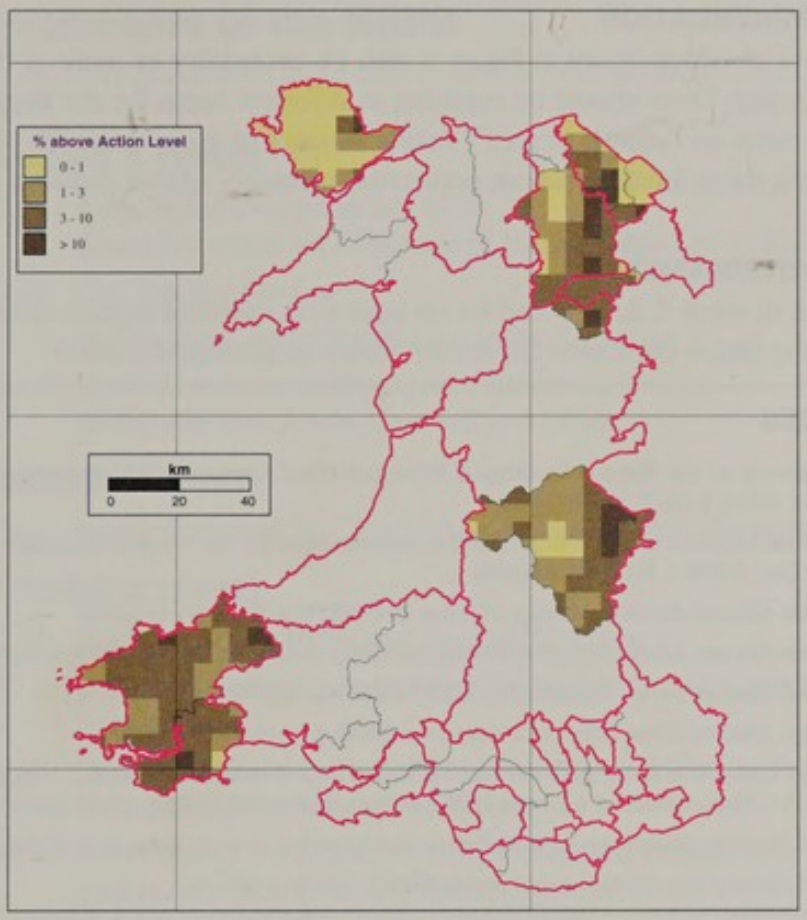

FIGURE 3 *Estimated proportion of homes exceeding the Action Level in each 5 km grid square in Wales. Data smoothed*

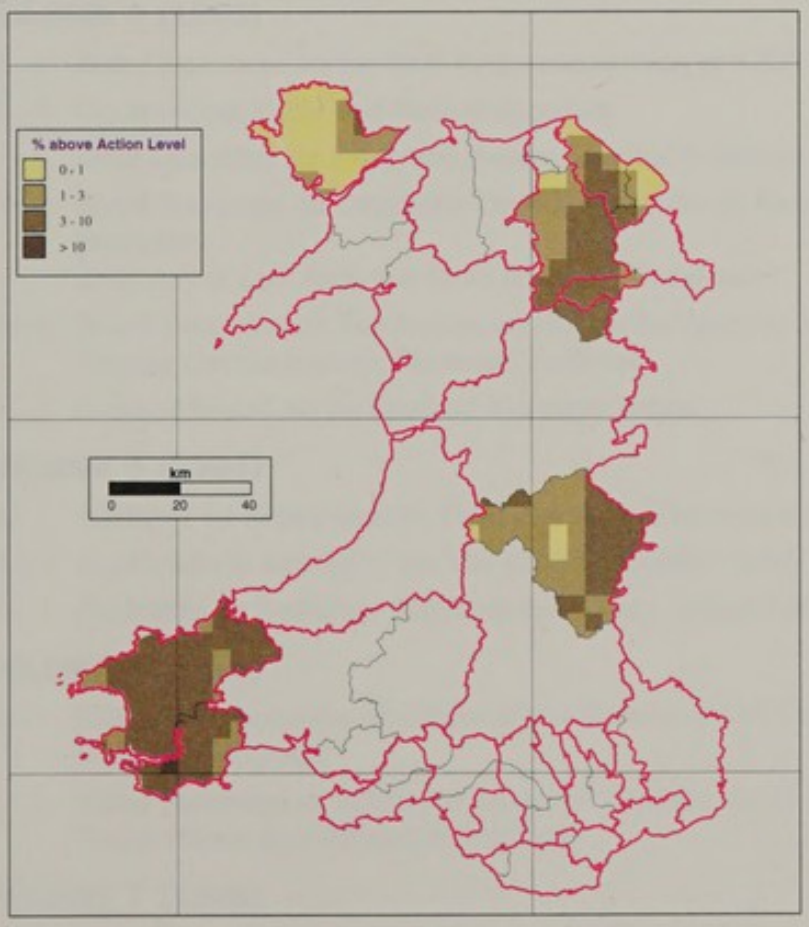

FIGURE 4 *Estimated proportion of homes exceeding the Action Level in each 5 km grid square in Wales. Data smoothed twice*

RECOMMENDATION

17 The parts of Wales shown in Figure 3 with 1% probability or more of homes being above the Action Level should be regarded as Affected Areas for the purposes of the Board Statement on radon in homes[1]. Taking account of these areas, the Welsh Office should delimit those localities where preventive measures against radon in new houses are justified.

ACKNOWLEDGEMENTS

18 We wish to thank C R Muirhead for his advice on statistical aspects of this work and T K Ball of the British Geological Survey for advice on geological matters.

REFERENCES

1 NRPB. Statement by the National Radiological Protection Board. Limitation of human exposure to radon in homes. *Doc. NRPB*, **1**, No. 1, 15–16 (1990).

2 NRPB. Human exposure to radon in homes. Recommendations for the practical application of the Board's Statement. *Doc. NRPB*, **1**, No. 1, 17–32 (1990).

3 NRPB. Radon Affected Areas: Cornwall and Devon. *Doc. NRPB*, **1**, No. 4, 37–43 (1990).

4 NRPB. Radon Affected Areas: Derbyshire, Northamptonshire and Somerset. *Doc. NRPB*, **3**, No. 4, 19–28 (1992).

5 NRPB. Radon Affected Areas: Scotland. *Doc. NRPB*, **4**, No. 6, 1–8 (1993).

6 NRPB. Radon Affected Areas: Northern Ireland. *Doc. NRPB*, **4**, No. 6, 9–15 (1993).

7 Wrixon, A D, Green, B M R, Lomas, P R, Miles, J C H, Cliff, K D, Francis, E A, Driscoll, C M H, James, A C, and O'Riordan, M C. Natural radiation exposure in UK dwellings. Chilton, NRPB-R190 (1990) (London, HMSO).

8 Miles, J C H. Mapping radon-prone areas by log–normal modelling of house radon data. (To be published.)

9 OPCS. *1993 General Household Survey*. London, HMSO, GHS 24 (1995).

Documents of the NRPB

VOLUME 1 (1990)

No. 1 Radiological Protection Act 1970
Board Statement on Limitation of Human Exposure to Radon in Homes

No. 2 Gut Transfer Factors

No. 3 Patient Dose Reduction in Diagnostic Radiology

No. 4 Board Statement on Emergency Reference Levels
Radon Affected Areas: Cornwall and Devon

VOLUME 2 (1991)

No. 1 Board Statement on Clinical Magnetic Resonance Diagnostic Procedures

VOLUME 3 (1992)

No. 1 Electromagnetic Fields and the Risk of Cancer

No. 2 Board Statement on Approval of Consumer Goods Containing Radioactive Substances

No. 3 Board Statement on Radiological Protection Objectives for the Land-based Disposal of Solid Radioactive Wastes

No. 4 Protection of the Patient in X-ray Computed Tomography
Radon Affected Areas: Derbyshire, Northamptonshire and Somerset

VOLUME 4 (1993)

No. 1 Board Statement on the 1990 Recommendations of ICRP

No. 2 Occupational, Public and Medical Exposure

No. 3 Dose Quantities for Protection Against External Radiations

No. 4 Board Statement on Diagnostic Medical Exposures to Ionising Radiation During Pregnancy
Estimates of Late Radiation Risks to the UK Population

No. 5 Board Statement on Restrictions on Human Exposure to Static and Time Varying Electromagnetic Fields and Radiation

No. 6 Radon Affected Areas: Scotland, Northern Ireland

VOLUME 5 (1994)

No. 1 Guidance on Restrictions on Food and Water Following a Radiological Accident

No. 2 Health Effects Related to the Use of Visual Display Units

No. 3 Guidelines on Radiology Standards for Primary Dental Care

VOLUME 6 (1995)

No. 1 Risk of Radiation-induced Cancer at Low Doses and Low Dose Rates for Radiation Protection Purposes

No. 2 Board Statement on Effects of Ultraviolet Radiation on Human Health
Health Effects from Ultraviolet Radiation

VOLUME 7 (1996)

No. 1 Generalised Derived Limits for Radioisotopes of Strontium, Ruthenium, Iodine, Caesium, Plutonium, Americium and Curium

CONTENTS

On sale through HMSO
Price £5.00

ISSN 0958-5648

ISBN 0-85951-396-3

HMSO bookshops
49 High Holborn, London WC1V 6HB
71 Lothian Road, Edinburgh EH3 9AZ
16 Arthur Street, Belfast BT1 4GD
HMSO Oriel Bookshop, The Friary, Cardiff CF1 4AA
9–21 Princess Street, Manchester M60 8AS
68–69 Bull Street, Birmingham B4 6AD
33 Wine Street, Bristol BS1 2BQ

Also available through booksellers.

Documents of the NRPB, Vol 7, No 2, 1996