Radon in Austria

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Abstract

Several projects in Austria deal with the problem of enhanced radon exposure to the public. The Austrian Radon Project is the largest project within this task, with the aim of investigating the radon concentrations in Austrian homes. Another project concerns mitigation methods. According to the EU directive EURATOM 96/29 it is also necessary to check working places for possibly enhanced radon concentrations. These projects are and will be funded by the government. The federal government of Upper Austria sponsored a project to test the indoor air quality in kindergartens including radon measurements. Within an EU-research-project the radon concentrations in Austrian springs and groundwater were systematically listed and analyzed. Additional investigations will focus on methods to improve the radon potential maps from the Austrian Radon Project by including geological and other information.

1. Introduction

The exposure to high radon (progeny) concentrations means increases the risk for lung cancer. Therefore the governmental authorities in Austria are interested in the actual radon exposure of the population. Countermeasures to reduce the radon exposure can be started only when it is known where and why enhanced radon concentrations exist and who is exposed to such concentrations. The investigations started in the beginnings of the nineties cumulating in the Austrian Radon Project (ÖNRAP – Österreichisches Nationales Radon Projekt). Within this project approximately 10 000 homes were randomly selected and the radon (gas) concentration was measured in the two mostly used rooms. From the results of these measurements a map of the radon potential in Austria was made by use of a geographical information system (GIS). To improve the knowledge about radon mitigation methods the SARAH (SAnierung RAdonbelasteter Häuser) project was started. During this project several house-types were systematically investigated and different types of mitigations were tested. To improve the predictions of the radon potential from the Austrian Radon Project, a new project, called ELORA (Ermittlung des LOkalen RAdonpotentials) was created. This project is now in a stage of testing different methods using the data of the Mühlviertel area (Upper Austria). Another project deals with the exposure to naturally occurring radiation or to technically enhanced naturally occurring radiation on workplaces. This project is called NATEXA (NATürliche EXposition am Arbeitsplatz) and is a consequence of the directive EURATOM 96/29. This project will start with the end of this year and shall give an overview on affected branches and industries. Of course a great part of this project will deal with radon. The above-mentioned projects are either fully or partly funded by the Austrian government.

The federal government of Upper Austria funded (besides a substantial part of the SARAH project) the "Kindergarten Projekt". Within this project several properties of the buildings in which kindergartens are located were investigated for their influence on the health of the children and their teachers. One of these parameters was the radon concentration.

Finally a EU project (TENAWA) was the frame for a project to investigate the radon concentration in Austrian springs and ground water. The aim of this project was to estimate the probability of high radon concentrations in drinking water resources.

There are also some smaller projects concerning different special problems in relation with radon and radon progenies. These projects are mainly bond to universities and deal either with special sites or special mathematical treatment of radon data.

2. ÖNRAP

Within the Austrian Radon Project (ÖNRAP) the radon (gas) concentration in Austrian homes[1, 2, 3] was systematically investigated. In rural areas approximately one in 200 homes was examined, in larger towns the measurement density was smaller. The homes were selected from the telephone register with a fixed step width. It could be shown that this type of selection is representative for the Austrian population. The measurements were performed by track-etch dosimeters and electret dosimeters (3 months exposure time) and charcoal detectors with LSC measurement (3 days exposure). Although short-term measurements cannot give good information on the mean radon concentration in a home it could be proved that several measurements in an area give a representative mean for this area. By using a mean winter-to-summer ratio of the radon concentration (2.0 in rural areas, 1.4 in cities), an extrapolation from the measured data to the annual mean was made. The two most often used rooms were examined in every selected home and the mean of all extrapolated annual means from the measurements in a municipality was taken as the mean radon concentration for this municipality. These data are the basis for future radon mitigation measures, i.e. these data should indicate where to look for houses with extremely high indoor radon concentration.

Because of different building types and different life-style the mean radon concentration in a municipality is not in all cases a measure for the radon risk from the ground. Therefore the radon potential was introduced. In Austria we defined the radon potential as the radon concentration in a standard situation. The standard situation is a commonly used living room at the ground floor in a house without a basement or only with a partial basement, tight windows, with two adults and less than 2 children living in and some other minor important parameters. The extrapolation from the measurement data to this standard situation was made by the ratio of the medians from the different situations, using the data of the whole area. The radon potential for a municipality is the mean of the radon potentials of the investigated homes. In this way the municipalities were grouped into 3 classes (radon potential <200 Bq/m^3, 200-400 Bq/m^3 and >400 Bq/m^3). This classification should be used for radon precaution measures during the erection of new buildings in the future.

The classification was made on basis of municipalities, but it is clear, that generally the actual radon risks will not change at the borders of the municipalities. Furthermore the measurements where not distributed equally dense but concentrate in the areas with a higher population. Therefore the radon potential for a municipality represents only the radon potential of the more populated area. From the governmental point of view, however, it is now the only way to administer the radon problem. A map of the radon potential can be seen in Fig. 1.

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[1] H. Friedmann et al.: "The Austrian Radon Project". Environment International Vol. 22, Suppl. 1, pp. S677-S686, 1996

[2] H. Friedmann: "Das österreichische Radon Projekt". Mitteilungen der Österreichischen Geologischen Gesellschaft. Bd. 88 (1995), pp. 15-23, Wien Sept. 1977, ISSN 0251.7493

[3] H. Friedmann: Das österreichische nationale Radonprojekt (ÖNRAP). Mitteilungen der Sanitätsverwaltung, 100. Jahrgang, Heft 3, pp.3-8, 10.März 1999, BM f. Arbeit, Gesundheit und Soziales, Wien 1999.

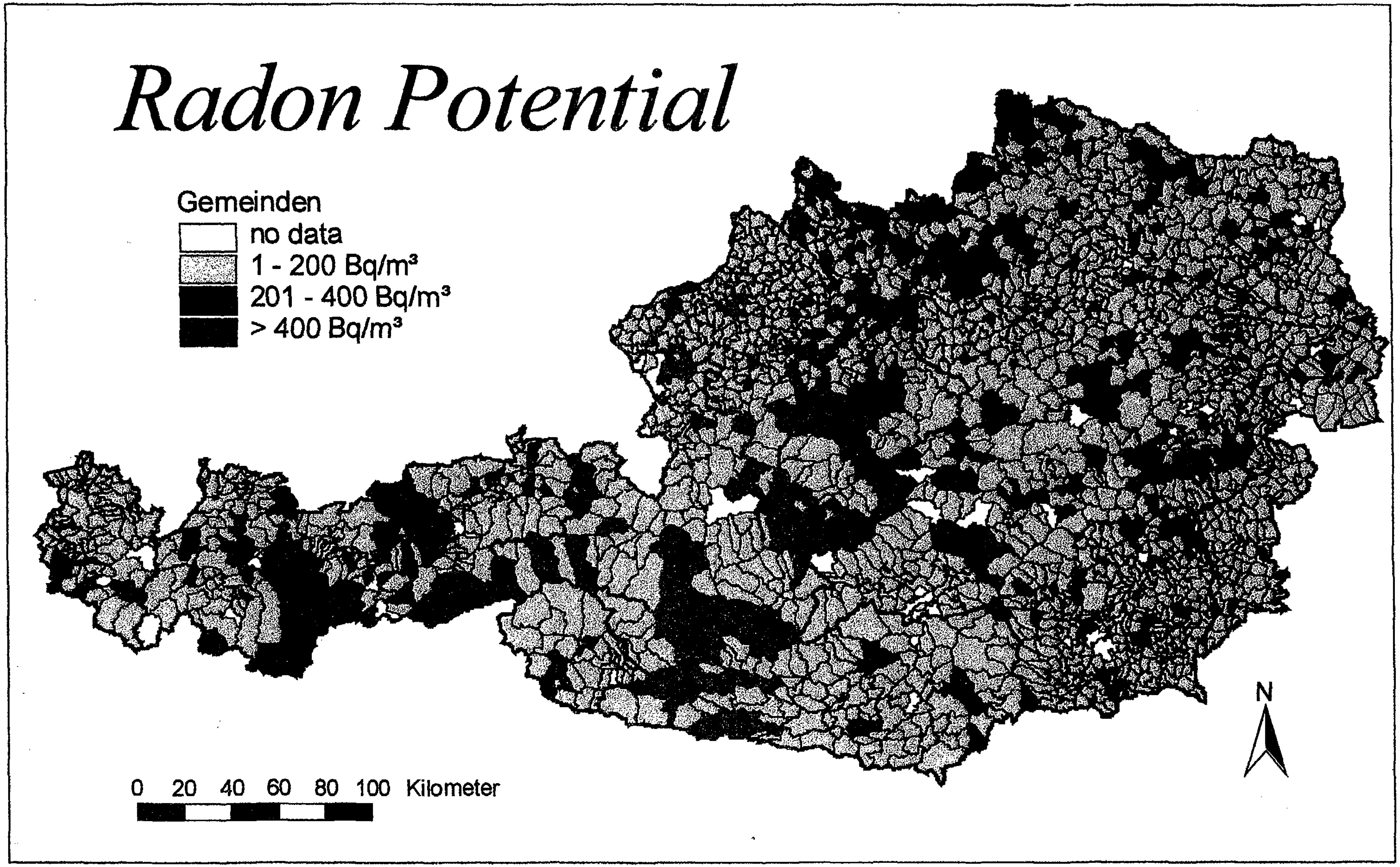

Fig. 1: The radon potential in Austria

3. ELORA

The aim of ELORA is to improve the radon potential maps by using additional information. The radon potential computed during ÖNRAP has rather large uncertainties due to the limited numbers of investigated houses and the uncertainties in the necessary extrapolations. In a first attempt, a systematic correlation analysis with different parameters is under investigation in Upper Austria. These parameters concern geology, soil, hydrology and chemistry. In a multiplicative (logarithmic additive) model the main influence parameters should be revealed and should be used to improve the results from the measurements. In a second way of data treatment these main parameters should be used as a-priori information in a Bayes approach. Finally there is also the possibility to use the measured radon data as a-priori information and modify the results of the parameter-based prediction of the radon potential. All these possibilities are now under investigation and first results will be available next year.

4. SARAH

This project served to develop and test several methods of radon mitigation[4, 5]. A major problem in radon mitigation is the verification of its success. For that purpose the ratio of the radon concentration before and after the mitigation must be measured under well-defined conditions. Within this project the "Blower Door Method" was developed[6]: The radon concentration is measured in the room or a part is of a house while reducing the pressure by a vent with defined volume flow. Also the radon concentration in the outflow can be measured. From these data a virtual maximum radon inflow from the ground can be deduced. Doing such measurements before and after mitigation gives good information about the effectiveness of mitigation measures. Different types of mitigation were tested, starting from very cheap passive methods (just drilling holes at certain points through the walls of the basements) up to relative expensive methods like active sub-floor ventilation. Generally the cheap methods give small reduction, while expensive methods can reduce the indoor radon concentration substantially. So mean reduction costs were computed per square-meter living area and

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[4] Maringer, F.J., Akis, N.G., Kaineder, H., Kindl, P., Kralik, C., Lettner, H., Lueginger, St., Ringer, W., Rolle, R., Schönhofer, F., Sperker, S., Stadtmann, H., Steger, F., Steinhäusler, F., Tschurlovits, M. & Winkler, R. "First results of the Austrian radon mitigation project." IRPA Reg. Symp. Rad. Prot. in Neighbouring Countr. of Centr. Europe 1997, Prague, Sept. 8-12. Ed. J. Sabol: Prague: Techn. Univ. Prague, 1997. pp. 145-149.

[5] Maringer, F.J., Lueginger, S., Akis, M.C., Kaineder, H., Kindl, P., Kralik, C., Lettner, H., Nadschläger, E., Ringer, W., Rolle, R., Schönhofer, F., Sperker, S., Stadtmann, H., Steger, F., Steinhäusler, F., Tschurlovits, M., Winkler, R. "Das österreichsiche Radonsanierungsprojekt ‚SARAH': Ergebnisse und Folgerungen". Tagungsband der 30. Jahrestagung des Fachverbandes f. Strahlenschutz ‚Radioaktivität und Umwelt', 28.9.-2. 10 1998, Lindau im Bodensee. Publikationsreihe Fortschritte im Strahlenschutz. ISSN 1013-4506. Köln: TÜV Verlag GmbH, 1998. pp 447-452.

[6] Maringer, F.J., Lueginger, S., Akis, M.C., Kaineder, H., Kindl, P., Kralik, C., Lettner, H., Nadschläger, E., Ringer, W., Rolle, R., Schönhofer, F., Sperker, S., Stadtmann, H., Steger, F., Steinhäusler, F., Tschurlovits, M., Winkler, R. "Das österreichsiche Radonsanierungsprojekt ‚SARAH': Ergebnisse und Folgerungen". Tagungsband der 30. Jahrestagung des Fachverbandes f. Strahlenschutz ‚Radioaktivität und Umwelt', 28.9.-2. 10 1998, Lindau im Bodensee. Publikationsreihe Fortschritte im Strahlenschutz. ISSN 1013-4506. Köln: TÜV Verlag GmbH, 1998. pp 447-452.

reduced Bq/m^3. From a first investigation by the "Blower Door Method" the most adequate method can be selected and the costs for the radon mitigation can roughly be estimated.

5. NATEXA

The EURATOM 96/29 directive demands from all members of the EU a survey on the exposure to natural radioactivity on workplaces. In that connection radon may be one of the most troublesome problems. It is well known that radon can be a problem in waterworks, in underground workplaces (mining), in several types of (chemical) industries, however we do not know how many other braches may be affected and how many people are really exposed to substantially enhanced natural radioactivity. There are a lot of workplaces with possible radon problems, starting from small shops, restaurants, wine cellars in basements to warehouse workers (fertilizer), waste deposits (ashes), building material industry and the oil and gas industry. Within the first stage of NATEXA several companies (small and large) will be investigated on possible exposure problems, just to get a rough overview to which of the different types of companies we should have a closer look. A nation-wide survey on industries and companies will be started in the moment when it is clear where and in which branches enhanced exposures can be expected.

6. Kindergarten

This project was a carried out by the government of Upper Austria with the aim of testing the indoor air quality and some other facts, which may influence the health of the children. A major point of interest was the radon concentration in kindergartens. In approximately 700 kindergartens the radon concentration was measured and in about 5% of them enhanced concentrations could be found, but only in very few (1%) radon concentrations above 1000 Bq/m^3 were detected. Mitigation measures will start more or less immediately, partly funded by the government of Upper Austria.

It is planned to extend such radon measurements also to schools.

7. Radon in water

The EU-project TENAWA dealt with the removal of (natural) radioactivity from drinking water. During this project we investigated the probability for high radon concentration in Austria. There exists a lot of data on radon in water, however most of these data are not from randomly selected but from springs used for some special purpose. The data consists of a wide variety of water sources, from artesian wells to deep drillings, from surface water to highly mineralized water of spas, from cold to hot springs and often the documentation is not really informative. There are also multiple entries in the data bank[7], because of repeated measurements in time and it is very difficult to identify all such replicas because of name changes etc.

All together approximately 6500 measurement results were used, reported from P. Kindl et al.[8], M. Ditto et al.[9], F. Schönhofer et al[10] and H. Friedmann[7]. The main input to the data set

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[7] H. Friedmann: The radon and radium bank at the Institut f. Isotopenforschung und Kernphysik. Progress Report 1989.

[8] P. Kindl, K. Fink: personal communication, 1998.

[9] M. Ditto, W. Fimml, V. Karg, M. Korner, J. Weisz: Radon-222 im Grundwasser. Ein österreichweiter Überblick. Bundesanstalt für Lebensmitteluntersuchung und –forschung Wien, Jänner 1999.

[10] F. Schönhofer, C. Kralik, K. Pock: personal communication, 1998

results from a research project of the Federal Ministry of Agriculture and Forestry[9] (approx. 4300 data) within which a systematic investigation on the radon content of ground water was performed. Approx. 1600 data were measured before 1950. By comparing old data with new measurement results it could be shown for a lot of the old data that these are really reliable.

A very crude classification system was introduced which only can show its merit a posteriori. The classification into 3 classes was made according to the following criteria:

Class 1: Areas with all data below 100 Bq/l and less than 30% of all data above 50 Bq/l.

Class 2: Areas with all data below 300 Bq/l and less than 30% of all data above 150 Bq/l but not fulfilling the requirements of class 1.

Class 3: All other areas.

Combining the information of the radon in water data, the indoor radon concentration of dwellings and the geological situation, an attempt was made to extrapolate the radon classes for areas without radon in water data. It was assumed that mainly aquifers near to the surface are used for drinking water. Therefore, the availability of radon in the soil, causing high indoor radon concentrations, should be an indicator of enhanced radon concentrations in ground water. In the first step of the extrapolation, areas (clusters of municipalities) with high(er) indoor radon concentrations were marked as class 2 areas. In case of adjacent class 3 areas (from the original radon in water classification) and uniform geological background, the extrapolation was changed to class 3. Generally areas of granite and gneiss were classified as class 2 or class 3, depending on actually measured radon in water data. Generally, isolated data, i.e. municipalities with radon data quite different from the bulk of neighboring municipalities, were assumed to be less important for the estimation of the radon class as far as it was not possible to find an explanation for it. The result of this extrapolation can be found in Fig. 2.

With the definitions of the different classes and an assumed log-normal distribution of the radon in water data we can expect the following probabilities: Class 1 means for usual ground water (no deeply drilled wells) a probability of 70% having a radon concentration of less than 50 Bq/l and approximately 15% for a radon concentration above 100 Bq/l. Class 2 means a probability of 70% for usual ground water having a radon concentration of less than 150 Bq/l. With an estimated median of 80 Bq/l the probability for finding water with a radon concentration above 300 Bq/l is roughly 15%. Finally in class 3 at least more than 15% of all water sources will have radon concentrations above 300 Bq/l.

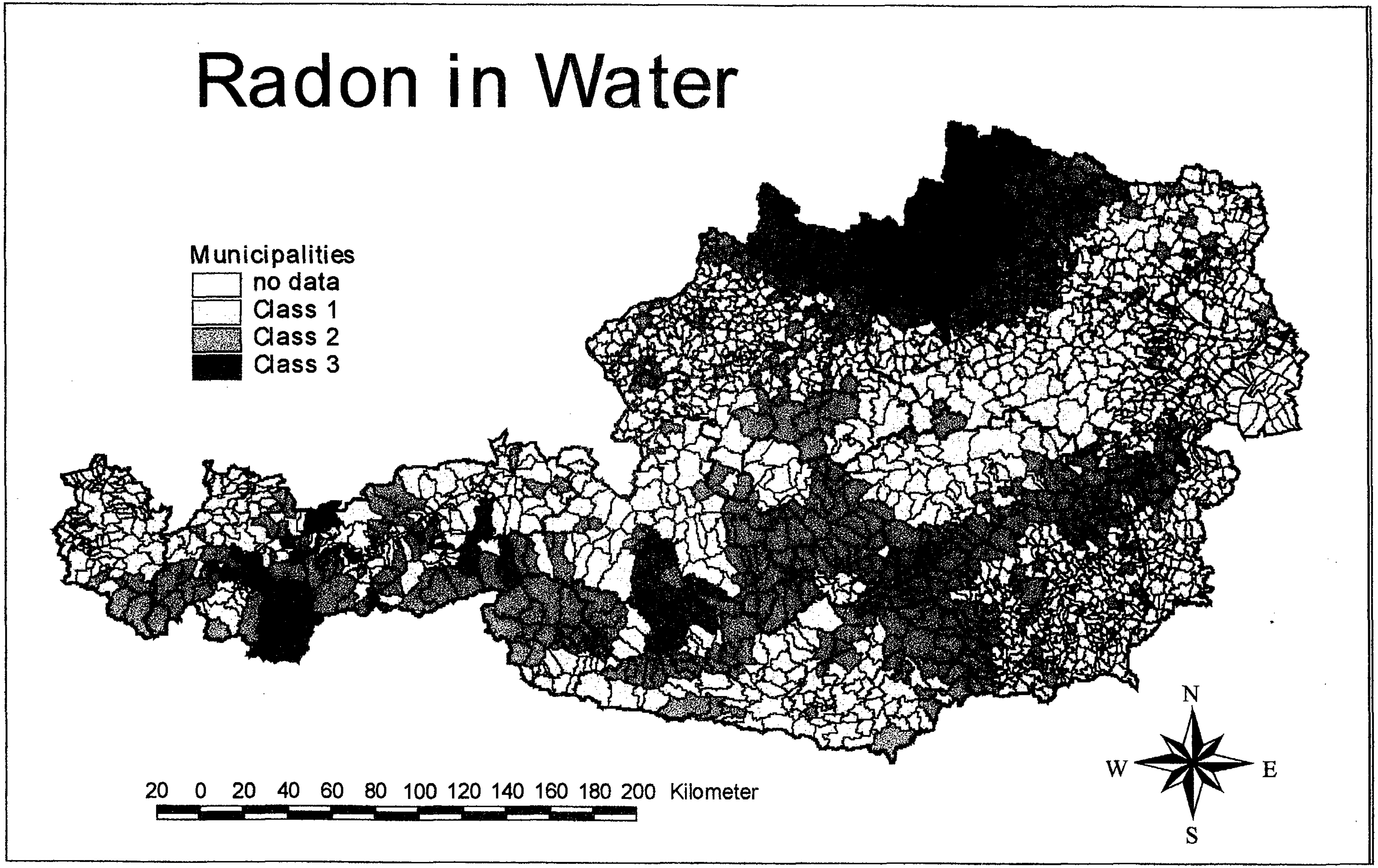

Fig. 2: The extrapolated classification of municipalities according to radon in water.