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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Prediction of indoor radon concentrations in dwellings in the Oslo region – a model based on geographical information systems" *by* R. Kollerud et al.

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General comments

Interesting study that aims to improve the prediction of indoor radon in unmeasured dwellings based on information from gamma-spectrometric data, geology and distance from homes where radon have been measured. A model based on GIS technology is developed, and the aim is to use this data in a future study to link radon exposure with childhood cancer.

The stated purpose of the study seems at first very ambitious, as indoor radon concen-

tration depends on a long list of factors (this is correctly mentioned in the introduction bottom page 3047). The distribution of indoor radon data from a representative sampling is typically lognormally distributed. A reasonable prediction of radon in individual dwellings is very difficult, perhaps impossible, due to lack of very detailed information on the individual buildings and of the exact data about the radon source, the ground beneath the building. However, it should also be recognized that such detailed data about the buildings are usually not available.

This probably leads to a considerable uncertainty in the modeled indoor radon concentrations for individual dwellings, although correlations between the distributions/mean values are found to be significant. It is suggested that the formulation of the purpose should be slightly modified to account for this uncertainty. Still, I think it was well worth the effort to try to develop methods to improve estimates of radon exposure based on available geological and radon survey data.

The title is informative and reflects the content of the study sufficiently well. The presentation is generally clear and easy to follow.

Specific comments

I miss some basic and important information about the health issues related to radon: the only well-established risk is that of lung-cancer, so this risk should at least be mentioned.

In the reference Kendall et al, 2012, a significant correlation between background gamma radiation and childhood leukemia was found, but no significant link between radon and childhood cancer. Although this could be due to the statistical power in the radon part of the study, it indicates that exposure to external gamma radiation could be more important than radon when it comes to leukemia and other childhood cancers. I would therefore recommend that the radiation exposure from external gamma radiation and perhaps also ingestion of food and drinking water was mentioned as important factors contributing to (background) radiation dose.

Page 3047 Line 4: Correct first sentence. Only the radon isotope Rn-222 (called radon) can be considered one of the main sources for background radiation as correctly stated further down. Radon data in this study reflect only this nuclide. Rn-220 (often called thoron) may contribute to radiation dose, but is thought to be less significant. Indoor thoron data from Norway is lacking. The nuclide Rn-219 with halflife of a few seconds is not a relevant contributor to radiation dose.

Furthermore, the other important sources to ionizing radiation should be mentioned (external gamma background radiation, perhaps also ingestion of radioactivity in food and drink, medical diagnostic exposures etc.)

Page 3049 Line 11-12 : Stated purpose a little ambitious as mentioned above. Substitute “estimate” with “assign” ? (The usefulness of the model data in a future cancer study must depend on the risk of severely “wrong” assignment of radon concentration to a building, a problem that is likely to be serious if the number of cancer cases are low.)

Page 3050 Strength: large data set on radon measurements, densely populated area, complete coverage of airborne gamma measurements. Weakness: No building properties included in the analysis.

The relevance of including maps of K-40 and thorium concentrations in the analysis are not explained. These nuclides do not have a direct causal relationship to radon concentration, as opposed to uranium-238. Ref. Scheib notes that K-40 is a good indicator for clay content and permeability, but the relevance of thorium is not explained.

Page 3052 The steps included in assigning radon levels to dwellings without measurements seem reasonable.

Page 3053 Line 3: Explain very briefly how the fraction of radon measurements above 200 Bq/m3 was calculated. Was this calculated for each buffer based on the few actual radon measurement data available? This could be quite unreliable, as in most cases

less than around 10 % of dwellings would be expected to be above this threshold. If a buffer only contains 5-10 measurements, there is a very high risk that the fraction calculated is “wrong”, since one single measurement could influence the result very strongly.

Line 5-6: bedrock and eU is probably correlated, and perhaps not fully independent, does this influence analysis results?

Page 3058

Line 1-2: A correlation between indoor radon and uranium concentrations from airborne gamma measurements in this area was established in an earlier publication by Smethurst et al 2008. I suggest the reference to this is included here. I assume this sentence refers to analysis in the present study, this should be clarified/explained clearly.

Page 3059

Line 14-18 I suggest that radon in household water is also included on the list of factors that might affect indoor radon levels.

Technical corrections

Page 3046 Line 26: "In accordance with international recommendations " Suggest to include reference to WHO radon handbook.

page 3047: Line 2 : "..maximum limit in a residence"– correct to "maximum limit in new build homes"

Page 3054 Line 27 correct “indoor radon measures” to “indoor radon measurements”

Page 3060 Acknowledgements. Include reference to radon data supplied from NRPA radon database.

Reference list line 22: typing error in first reference, should be corrected to “Smethurst,

M.A....”

Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., 1, 3045, 2013.