University of Victoria | Graduate Studies

Notice of the Final Oral Examination
for the Degree of Master of Science

of

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BSc (University of Victoria, 2013)

"Modelling and Mapping Regional Indoor Radon Risk in British Columbia, Canada"

Department of Geography

Monday, July 20, 2015
10:30AM
David Turpin Building
Room B215

Supervisory Committee:
Dr. Trisalyn Nelson, Department of Geography, University of Victoria (Co-Supervisor)
Dr. Sarah Henderson, School of Population and Public Health, University of British Columbia (Co-Supervisor)
Dr. Aleck Ostry, Department of Geography, UVic (Member)

External Examiner:
Dr. Emily Peterson, BC Centre for Disease Control

Chair of Oral Examination:
Dr. Margo Matwychuk, Department of Anthropology, UVic

Dr. David Capson, Dean, Faculty of Graduate Studies

Abstract

Monitoring and mapping the presence and/or intensity of an environmental hazard through space, is an essential part of public health surveillance. Radon, a naturally occurring radioactive carcinogenic gas, is an environmental hazard that is both the greatest source of natural radiation exposure in human populations and the second leading cause of lung cancer worldwide. Concentrations of radon can accumulate in an indoor setting, and, though there is no safe concentration, various guideline values from different countries, organizations and regions provide differing threshold concentrations that are often used to delineate geographic areas at higher risk. Radon maps demarcate geographic areas more prone to higher concentrations but can underestimate or overestimate indoor radon risk depending on the concentration threshold used. The goals of this thesis are to map indoor radon risk in the province of British Columbia, identify areas more prone to higher concentrations and their associations with different radon concentration thresholds and lung cancer mortality trends.

The first analysis was concerned with developing a data-driven method to predict and map ordinal classes of indoor radon vulnerability at aggregated spatial units. Spatially referenced indoor radon concentration data were used to define low, medium and high classes of radon vulnerability, which were then linked to regional environmental and housing data derived from existing geospatial datasets. A balanced random forests algorithm was used to model environmental predictors of indoor radon vulnerability and predict values for un-sampled locations. A model was generated and evaluated using accuracy, precision, and kappa statistics. We investigated the influence of predictor variables through variable importance and partial dependence plots. The model performed 34% better than a random classifier. Increased probabilities of high vulnerability were found to be associated with cold and dry winters, close proximity to major river systems, and fluvioglacial and colluvial soil parent materials. The Kootenays and Columbia-Shuswap regions were most at risk.

We built upon the first analysis by assessing the difference between temporal trends in lung cancer mortality associated with areas of differing predicted radon risk. We assessed multiple scenarios of risk by using eight different radon concentration thresholds, ranging from 50 to 600 Bq m-3, to define low and high radon vulnerability. We then examined how the following parameters changed with the use of a different concentration threshold: the classification accuracy of each radon vulnerability model, the geographic characterizations of high risk, the population within high risk areas and the differences in lung cancer mortality trends between high and low vulnerability stratified by sex and smoking prevalence. We found the classification accuracy of the model improved as the threshold concentrations decreased and the area classified as high vulnerability increased. The majority of the population were found to live in areas of lower vulnerability regardless of the threshold value. Thresholds as low as 50 Bq m-3 were associated with higher lung cancer mortality trends, even in areas with relatively low smoking prevalence. Lung cancer mortality trends were increasing through time for women, while decreasing for men. We suggest a reference level as low as 50 Bq m-3 is justified for the province.