A study on relation between the air gamma dose rate increase and radon in the case of rainfall

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INTRODUCTION

Reflecting the elevated national interest in radiation safety, Korea has established an Integrated Environ-mental Radiation Monitoring Network (IERNet), and has installed about high pressure ion chambers to monitor air gamma dose rates. A few researchers noticed that the gamma dose rate of these ion chambers increased temporarily during rainfall. In order to explain the increase in the gamma dose rate during rainfall in relation to natural radionuclide radon, 17 cases of rainfall in Daegu area were analyzed.

the air gamma dose rate and precipitation were obtained from each institution. A linear relationship was investigated by fitting using open source data, the gamma dose rate and precipitation. Measurements of 3" x 3" NaI(Tl) gamma spectroscopy at 1 m above ground was conducted 7 times and soil radon exhalation rates were measured using RAD7 radon detector and its surface chamber 13 times for in-depth analysis. NaI(Tl) gamma spectral analysis showed that the net counting rate of ^{214}Bi (0.609 MeV) at the time of rainfall increased to 2.9 times that before rainfall.

MEHODS

The activity radon monitoring device (RAD7) with surface chamber was used to measure the radon concentration of soil surface at rainfall. The RAD7 was set up as a closed-loop system as Fig. 1.

The RAD7 measures the daughter isotopes of ^{222}Rn (Radon) and ^{220}Rn (Thoron), and calculates a radon concentration from the daughters.

The setup of the RAD7 was a sniff mode. And to reduce the systematic uncertainty caused by leakage, all the connections, tubes and the measuring device (surface chamber, desiccant), were sealed.

The device was installed before the rain. The soil surface radon concentration before and after the rainfall was analyzed with the cumulative precipitations.

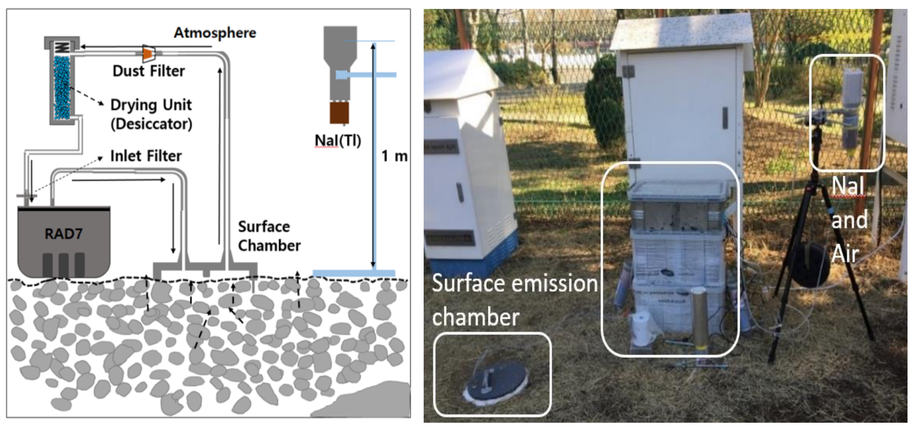

Figure 1. The experiment setup of RAD7 and NaI(Tl) detector for in-situ rain case.

RESULTS

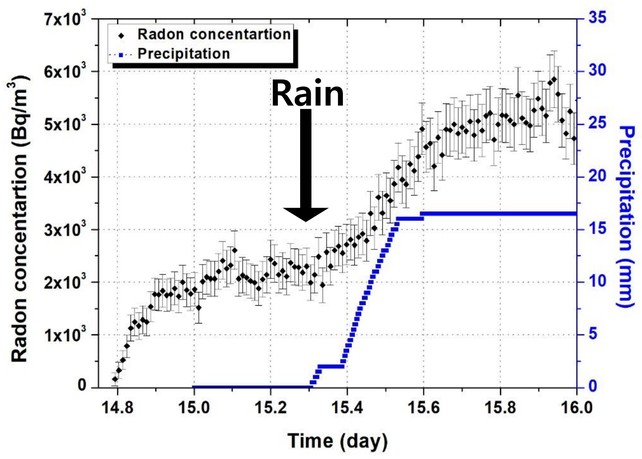

Figure 2. Radon concentration change and precipitation.

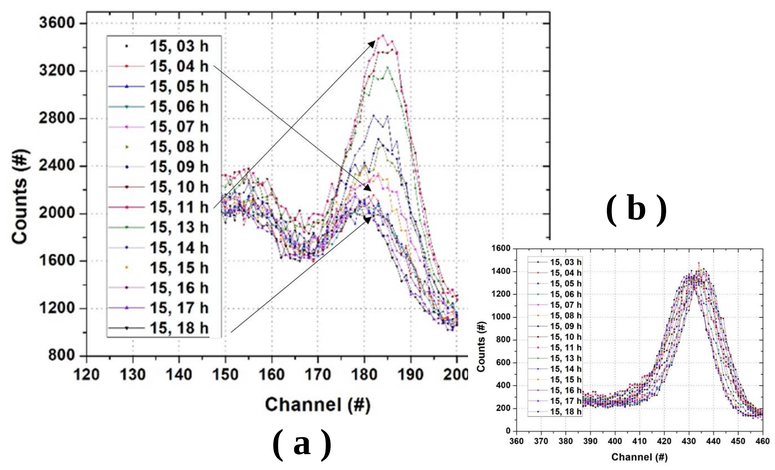

Figure 3. Energy peaks of NaI(Tl) detector at March, 14, 2018: (a) 0.609 MeV of ^{214}Bi, (b) 1.460 MeV of ^{40}K.

The results of RAD7 radon measurements with a surface emission chamber showed that the concentration of radon in the chamber increased again at the time of rainfall and reached a new saturation at higher concentrations. From this, it was possible to deduce the increase of the release rate of soil radon.

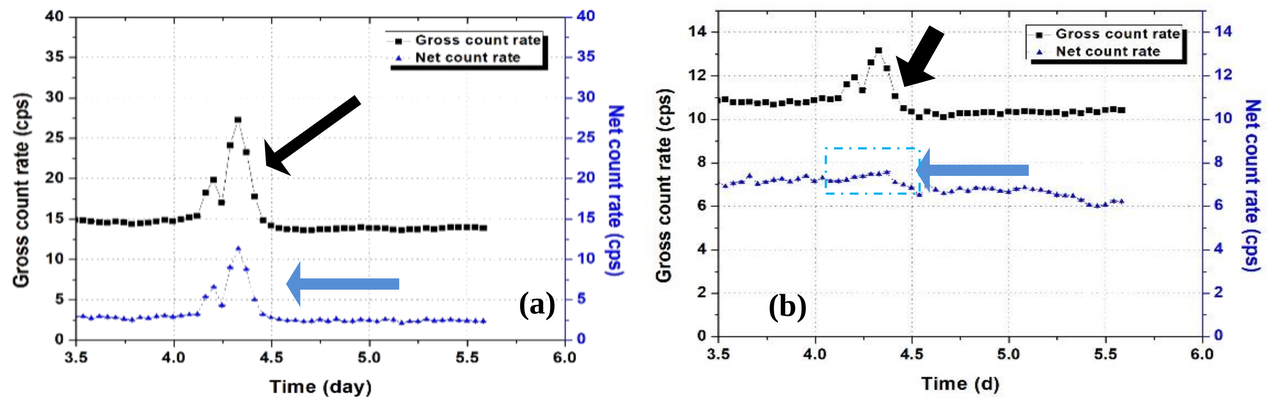

Figure 4. Count rate changes of ^{214}Bi (0.609 MeV) (a) and ^{40}K (b) at March, 14, 2018.

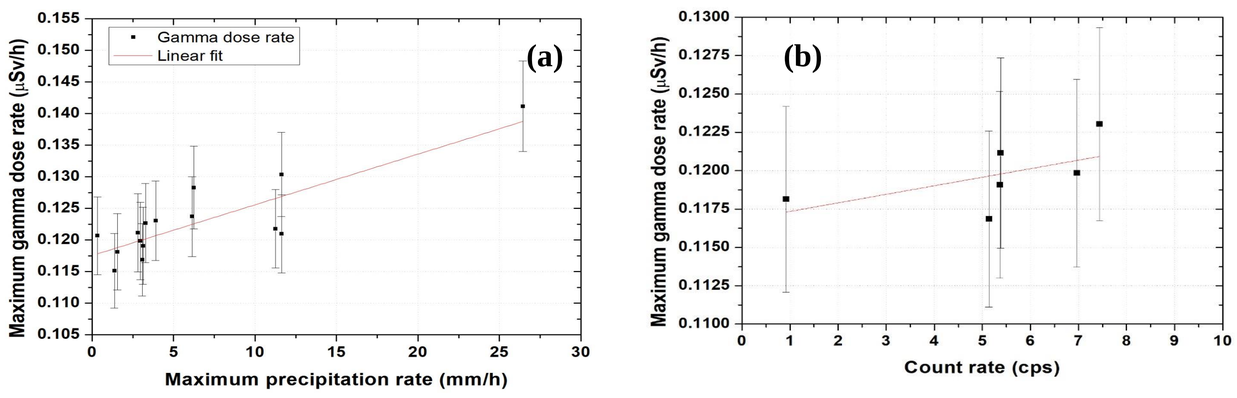

Figure 5. (a) The maximum precipitation rate and the maximum gamma dose rate at rainfall. (b) The maximum air gamma dose rate and ^{214}Bi count rates.

CONCLUSIONS

The relationship between precipitation and gamma dose rate showed a strong linear relationship between instantaneous maximum precipitation rates and gamma dose rate increases: correlation coefficient: 0.666.

In conclusion, the increase in the gamma dose rate of high pressure ion chamber during rainfall is closely related to the precipitation, and the NaI(Tl) spectrum analysis confirms an increase in the net count rate of the radon progeny (^{214}Bi). Future research on NaI spectra will be conducted to investigate the change in peak net counts of radon and its progeny radionuclides as a function of time.

ACKNOWLEDGMENTS

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