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RADON CONCENTRATIONS IN DWELLING OF SOUTH KALIMANTAN, INDONESIA

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Determination radon concentrations in dwelling in South of Kalimantan Province by using a passive method had been conducted. South Kalimantan is a province in Indonesia and also known as a coal mining area which has the potential for internal exposure of Naturally Occurring Radioactive Materials (NORM) to the human. The research area divided into several sections called grid. Each grid represents a 60 km × 60 km area that installed passive radon monitoring 10 population. Passive radon monitors installed in the dwelling with exposures time approximately 3–4 months and then radon monitors were collected and brought to the laboratory for processing and then read the track to calculate the radon concentrations. The data concentrations of radon in the dwelling and GPS location as an input to the make a map of radon concentration by using MapInfo Software v.10.5. The results of the analysis of the concentration of radon in the dwelling of South Kalimantan in the ranged 3.1 ± 0.2 Bq m^{-3} up to 94.0 ± 6.7 Bq m^{-3}. The result was lower than the reference level radon set by UNSCEAR was 300 Bq m^{-3}. These data are useful in the development plans and regional development, as well as the basis for health policy analysis due to radon in Indonesia. Furthermore, these data will be the contribution of Indonesia in the international world through UNSCEAR, IAEA and WHO. The data obtained as an input in making a map of the concentration of radon in houses of Kalimantan Selatan as part of the map of the concentration of radon in Indonesia.

INTRODUCTION

Radiation and environmental radioactivity described in Indonesian natural radioactivity maps include the dose rate of exposure to environmental gamma radiation and ^{226}Ra, ^{232}Th and ^{40}K concentrations on surface soil, excluding radon and thoron. The radon radiation exposure in homes is the largest contributor to natural radiation exposure that reaches 53%(1), according to the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) Report. While exposure to natural radiation is the largest contributor (reaches 85%) of all radiation exposure received by the world's population. The radon is the second leading cause of lung cancer after smoking even for those people who never smoked(2) and for the people living in the high background radon area. Therefore, it is essential to study the indoor radon–thoron levels in dwellings. Radon is a short-lived radionuclide that releases alpha particles and can attach to fine particles in the air and will inhale and irradiate lung tissue to raise the risk of lung cancer. Another radon isotope that is thoron also has the same properties, but with the degree of exposure to radiation in the lungs is smaller. Radon–thoron will raise the risk of lung cancer due to exposure to radon is caused by inhalation of short-lived radon daughters particulate matter such as ^{218}Po, ^{214}Pb, ^{214}Bi or ^{214}Po. These aerosols are inhaled, get deposited on the respiratory tracts and impart alpha energy to the lung.(3)

The presence of radon gas in the dwellings may occur through the isotopes of short half-life, the floor of the house, cracks of walls, windows and ceilings of houses with materials having a high enough radium concentration. Figure 1 is a simple house mounted by a passive radon monitor and a positioning of passive radon monitors in the dwellings. South Kalimantan is also known as a coal mining area which has the potential for internal exposure of Naturally Occurring Radioactive Materials (NORM) to the human. The potential danger of radon exposure, it is necessary to map the level of concentration of radon in South Kalimantan province that is part of the territory of Indonesia. Research on radon concentrations in the dwelling needs to be done because radon can cause a radiological effect. Measurement of radon–thoron in dwellings of Indonesia has been carried out by using CR-39 detectors as passive detectors. The ball has two separate parts, the upper part is used to trap radon and thoron gas, while the lower part is to detect radon gas. The upper part of the sphere has a hole that allows radon and thoron gas.

On the other hand, the lower part of the detector is coated with a thin layer which allows only radon

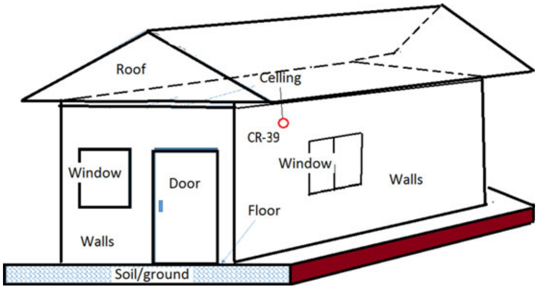

Figure 1. Installation of a passive radon monitor.

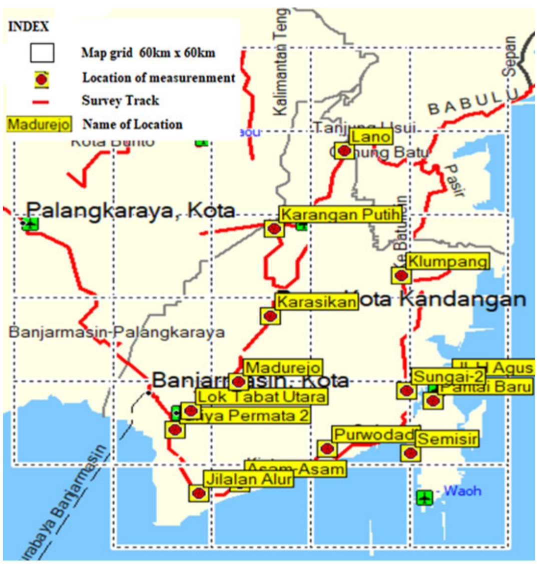

Figure 2. Map of South Kalimantan with a grid 60 km^2.

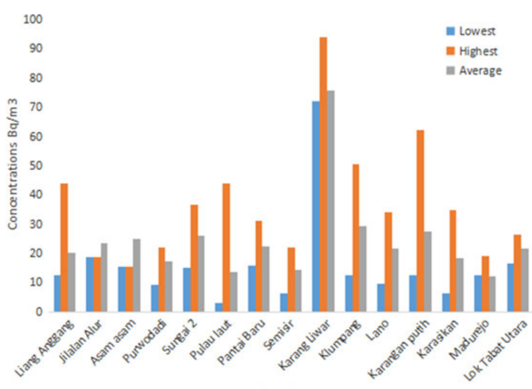

Figure 3. Radon concentrations in Dwelling of South Kalimantan Indonesia.

gas to enter. Passive radon–thoron dosimeter made from polycarbonate mixed with black carbon type FD-9054F which is an anti-static plastic material[4]. The design of passive radon–thoron dosimeters is red and white hemispherical, each 50 mm in diameter and lined with the white pipe as a buffer with a length of 15 mm and a diameter of 20 mm. The lower part of the red hemispherical had eight holes with a diameter of 10 mm and covered with a gauze filter (effective volume). The white hemispherical has two holes[5].

METHODOLOGY

The equipment used is location determination (GPS), passive radon monitor with CR-39, oven, ultrasonic vibrator, desiccator and microscope. While the materials used are 6.25 mol dm^{-3} of sodium hydroxide (NaOH) as etching material, acetone, glass object and container. While as a supporting material is a MapInfo v.10.5 software and also a map of South Kalimantan with a grid 60 km × 60 km (Figure 2). Passive radon monitors are installed in the homes of residents with each grid fitted with 10 devices on each mounted device marked longitude and latitude position with GPS with exposures time approximately 3–4 months. The etching process was carried out with 6.25 mol dm^{-3} NaOH, 70°C of temperature for 7 hours.

The counting of CR-39 track carried out by a microscope with 400× of magnification and 25 times the viewing angle. The value of radon concentration in the dwelling (C_{Rn}) depends on the exposure time (T, day) and counts of the track (N_B and N_T) as well as the calibration factor. The calibration factor depends on magnification on the microscope and the number of viewing angles. To facilitate calculating the concentration of radon in a resident's house use the following equation:

$$C_{\mathrm{Rn}} = \frac{N_{\mathrm{B}} - N_{\mathrm{T}}}{E \times T} \tag{1}$$

where total trace counts and background footprint (trace/5.0625 mm^2), E is the efficiency of the detector [(trace/5.0625 mm^2)/(Bq/m^3/day^1)] or radon calibration factor (0.00241) and T is the exposure time (day)[6].

Contour map of radon concentrations is made based on radon concentrations data and GPS data using MapInfo software.

RESULT AND DISCUSSION

The result of radon concentrations analysis in the dwellings of South Kalimantan ranged from 3.1 ± 0.2 Bq m^{-3} to 94.0 ± 6.7 Bq m^{-3} with the average radon concentrations of 24.5 ± 16.1 Bq m^{-3} (Figure 3). Radon concentrations in dwellings are generally influenced by geological conditions in the area of

Figure 4. Map of radon concentration in South Kalimantan.

measurement, type of house, house air exchange system and building materials. In simple homes generally made of wood with no ceiling, this type of house has the best air exchange system. The relationship between geological conditions and radon-related to the type of unconsolidated basic and sedimentary relationships; for example, granite (but not all), limestone, phosphate have contained radium. For many houses made of brick, the radon concentration is relatively higher than that made of boards or wood because of bricks containing radium, the sources of radon gas. Besides that good air circulation allows reducing radon concentration in the house. In Figure 4, it is seen that radon concentrations are generally low in the south and west, but rather high in the eastern region of Liwar Reef, Kalumpang district Hulu. Kota Baru city. At these locations, the geology of the area consists of limestone mountains known as kars Karang Liwar. Its caused the concentration of radon in the home population is relatively higher than in other places.

The condition of the house that is measured in general is the cement floor, wall and plywood ceiling. From these data collected in general radon concentrations in South Kalimantan are still below the radon reference levels established by the International Commission on Radiological Protection (ICRP)[7] and the International Atomic Energy Agency (IAEA)[8] of 300 Bq m^{-3}.

This research is the first study in South Kalimantan Province and a part of the mapping of radon concentration levels in Indonesia so that the radon concentration data will give the contribution to the international communities through UNSCEAR, IAEA and World Health Organization (WHO). For local government, these data can be used as a consideration in the regional development planning.

CONCLUSION

The amount of radon concentration in the house is influenced by the air exchange system, the quality of the building and the geological structure of the area. The analysis showed radon concentration in South Kalimantan in the range from 3.1 $\pm$ 0.2 Bq m^{-3} to 94.0 $\pm$ 6.7 Bq m^{-3} with a mean concentration are 24 $\pm$ 16.1 Bq m^{-3}. These data are still below the recommended radon concentration by UNSCEAR of 300 Bq m^{-3}. Data obtained as data in the manufacture of radon maps in South Kalimantan Province are as part of the map of the concentration of radon in Indonesia.

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