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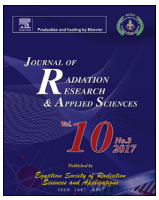

Risk assessment of radon in the South Dayi District of the Volta Region, Ghana

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ABSTRACT

Radon is a globally present and known radioactive gas with its ability to cause lung cancer as its major health implication. Ghana currently lacks national policies on radon gas and substantive radon vulnerability map largely due to lack of adequate baseline radon concentration data for the entire country. LR115 type II detectors were deployed in 30 sites/homes within the South-Dayi District. The detectors were retrieved after specified periods and analyzed for the radon concentration at the Nuclear Track Detection Laboratory of the Ghana Atomic Energy Commission. From the results, indoor radon concentration was found to range from 11.60 to 111.07 Bq/m^3 with the mean value for the district being 34.90 ± 20.18 Bq/m^3, a value lower than the mean global indoor concentration of 40 Bq/m^3. The values of 0.44 mS/yr, 8.80 mSv/yr and 1.01 mSv/yr were the mean annual; absorbed dose, equivalent dose and effective dose to lungs respectively for the populace of the district. The mean soil radon concentration for the district was 1.76 ± 0.91 kBq/m^3 with values ranging from 0.38 to 3.93 kBq/m^3. Correlation and T-test analysis was performed to establish strength of the linear relationship between indoor radon concentration and the soil radon concentration, indoor radon concentration on altitude and soil radon concentration on altitude.

1. Introduction

Radon is a naturally occurring radioactive gas which is not detectable by the human senses. There are three natural isotopes of radon namely, radon (^{222}Rn), thoron (^{220}Rn) and actinon (^{219}Rn), the most stable being ^{222}Rn with a half-life of 3.8 days. Radon is radioactive and alpha-emitting, producing daughters of polonium, bismuth, and lead. These progeny products are solid and have the tendency to attach themselves to aerosols in ambient air. When these aerosols are inhaled, they tend to cling onto inner walls and membranes of respiratory system to cause damage due to alpha emitting activities (Khan, Tariq, & Rawat, 2012; Shoeib & Thabayneh, 2014). Because radon is ubiquitous in nature, the general public maybe exposed to various naturally occurring radiation of which radon can be a major contributor. The radiological impact caused by radon have health implications. It is estimated that the global annual dose from background radiation is 2.4 mSv and out of which about 1.15 mSv may be responsible for individual effective exposure (UNSCEAR, 2008). Most of the exposure of the population to radon occurs indoors, especially in small dwellings and its concentration varies from one location to another depending on the geological elements, construction materials of buildings, indoor atmospheric conditions and ventilation (Akbari, Mahmoudi, & Ghanbari, 2013). The international agency for research on cancer categorized accumulated radon in dwellings as Group 1 carcinogens (IARC, 1988). So far available statistics have shown evidence that lung cancer cases due to inhalation of indoor radon ranged between 48,241 and 225,128 worldwide in 2008 (WHO, 2009a,b). In the United States, it has been estimated that of all lung cancer cases between 3% and 14% are attributable to radon gas inhalation (WHO, 2009a,b).

This work investigates the indoor and soil radon concentrations

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for South-Dayi district which is one of the major inland fishing ports in Ghana, thus attracting large numbers of fisher folks and traders and for which no baseline radon data exists. Monitoring and measurement of radon radiation activity concentration is important as most individuals spend about 80% of their time indoors (Lust and Realo, 2012). Therefore, it is essential to know the natural risk and the dose limits associate to radon within this fishing port and tourism potential area.

2. Site description and geology

The South- Dayi District has Kpeve as its district capital and administrative center. The District is bounded by: the Lake Volta to the west and south, Ho Municipality and Adaklu-Anyagbe District to the East, Kpando Municipality and Hohoe Municipality to the north. The South-Dayi District can further be divided into three major traditional areas: Peki, Tongor-Kpalime and Kpeve Traditional Areas.

The district lies between latitude 3°20′ N and 3.5°05′ N shown in Fig. 1 It is approximately on longitude 0°17′ E. The district has a total area of 1000 km^2 with the Volta Lake covering about 20% of the total area (Ghana District Assemblies, 2012).

The geological formation is that of the Voltaian and Togo rocks underlying the district with the typical rock types found being iron-rich sedimentary rocks. The soil types present are the savannah ochrosols and ground water laterites and alluvial silty loams along the Volta Lake (Ghana District Assemblies, 2012).

3. Methodology and theoretical approach

3.1. Methodology for soil radon measurement

Soil radon measurements were carried out in two sets of thirty (30) randomly monitored homes. The radon detector setup is made

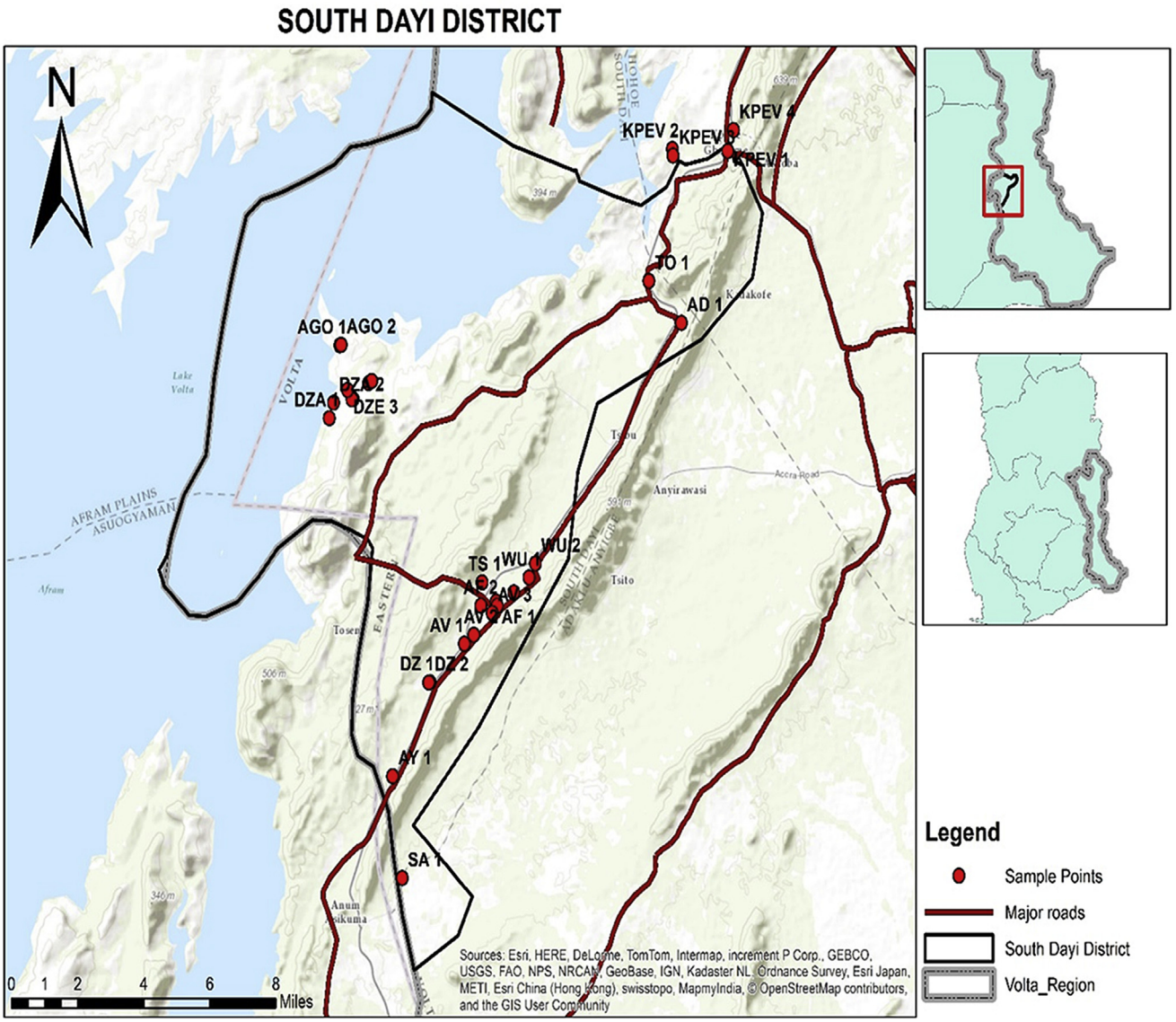

Fig. 1. Map of South-Dayi District (insert: Map of Ghana showing South-Dayi District).
The sampling locations as abbreviated on the map represent the following towns: TS1&2 = Tsame1&2; AF1&2 = Afeviofe 1&2; DJ1&2 = Djogbati 1&2; WU1 &2 = Wudome 1&2; AV1,2&3 = Avetile 1,2&3; DZ1&2 = Dzake 1&2; TO = Todome; AD = Adzorkoe; SA= Sanga; AY = Ayensu; DZEI 1,2&3 = Dzemeni 1,2,&3; TSA1 &2 = Tsanakpe 1&2; DZA 1&2 = Dzakiti 1&2; AGO 1&2 = Agordeke 1&2; KPEV 1, 2,3&4 = Kpeve 1,2.3&4 respectively.

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