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Determining the outdoor and indoor ambient dose equivalent rates in Celleno municipality (central Italy)

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People are continuously exposed to radiations from terrestrial, anthropogenic and cosmogenic sources. Terrestrial ionizing radiation essentially derives from primordial radionuclides such as ^{238}U, ^{226}Ra, ^{232}Th and ^{40}K, which are present in almost all geological materials. Exposure to ionizing radiation in the outdoor and indoor environment poses adverse impact on human health, and is considered a cause of increasing risk of cancer.

In this work we presented data of outdoor and indoor Ambient Dose Equivalent Rates (ADER) due to gamma radiation collected in the municipality of Celleno, located in central Italy at the eastern border of the Quaternary Vulsini volcanic district, whose activity produced pyroclastics and lava flows particularly enriched in natural radionuclides. These rocks (tuff in particular) were traditionally used in the past as building materials in the old center of the Celleno village.

Terrestrial gamma dose rate measurements were carried out in 77 locations (1 m above the ground level), whereas indoor measurements were carried out in 23 dwellings (center of the room and 1 m above the floor). Measurements were performed by means of a portable gamma spectrometer, the "Exploranium GR-135 Plus -The identifier", equipped with a NaI crystal. In dose rate mode, the detector measures directly the ambient dose equivalent rate at 10 mm depth of human tissue, H*(10), in μSv/h at a pre-selected time.

The outdoor ADER values range from 0.13 to 0.42 μSv/h (average 0.22 μSv/h). A dose map was constructed by using ordinary kriging algorithm in order to evaluate the spatial distribution and relationship with the bedrock types. The outdoor Annual Effective Dose Equivalent ($AEDE_{out}$) was calculated by using the measured ADER. Results showed that average $AEDE_{out}$ value is equal to 0.399 mSv/a, a value about 4 times higher than the population-weighted world's average of 0.106 mSv/a. To assess the radiological risk, the Excess Lifetime Cancer Risk (ELCR) was also calculated from the $AEDE_{out}$ values. This parameter quantifies the probability that an individual will develop cancer over his lifetime of exposure to outdoor gamma radiation; the mean of ELCR is $1.87 \cdot 10^{-3}$ which is about six times higher than the world average ($0.29 \cdot 10^{-3}$). The indoor ADER values range from 0.13 to 0.57 μSv/h (average 0.30 μSv/h) and $AEDE_{ind}$ equal to 2.067 mSv/a. The indoor values are generally higher than outdoor ones, suggesting an additional and much more relevant contribution to the total gamma ambient dose rate due to building materials.

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