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Sesssion BG1.3

Do geochemical background values still exist?

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Environmental Geochemistry Working Group

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Extending the concept of background to soil gas: natural radon concentrations in soils of Campania region

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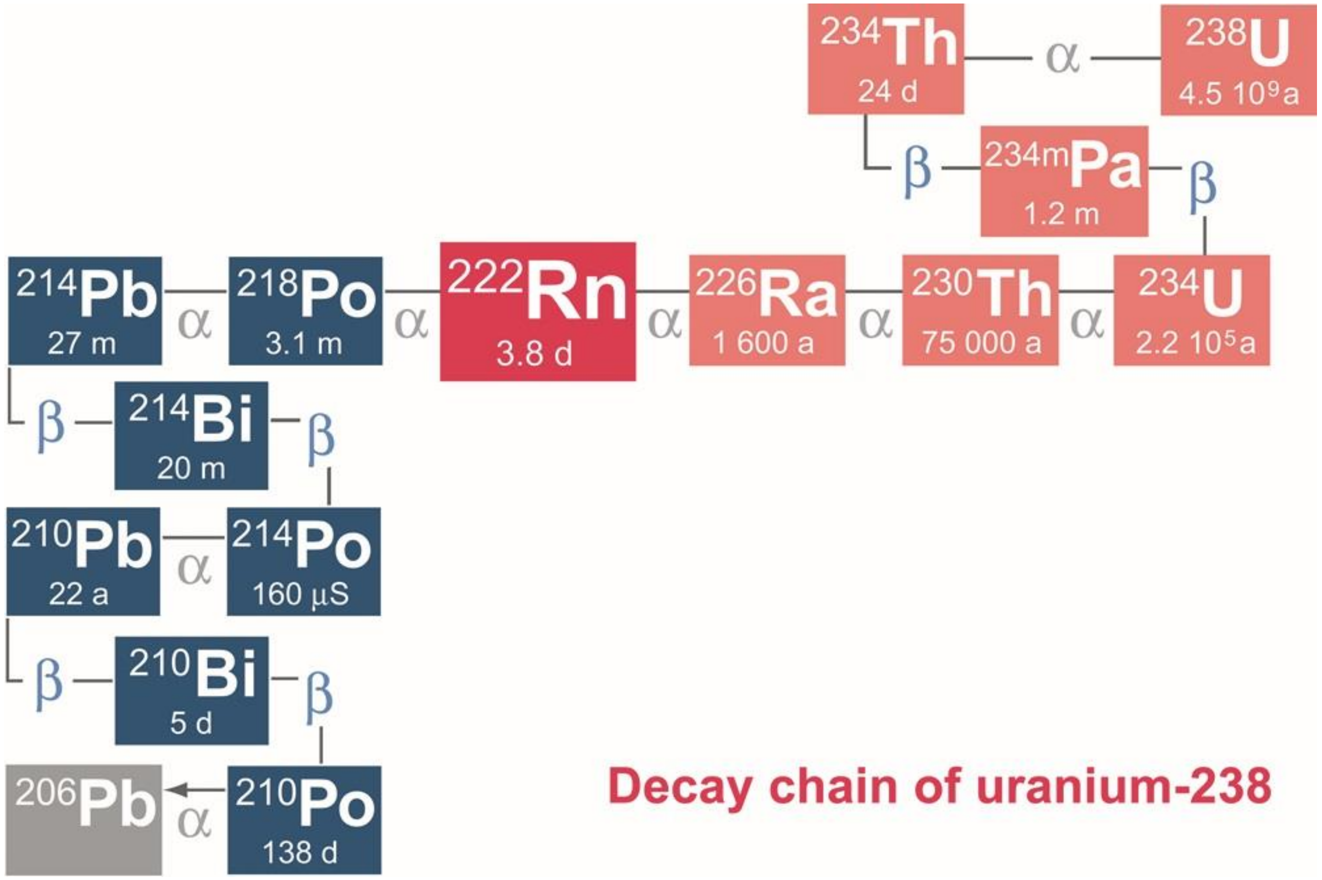
Source: https://mapio.net/pic/p-47445138/

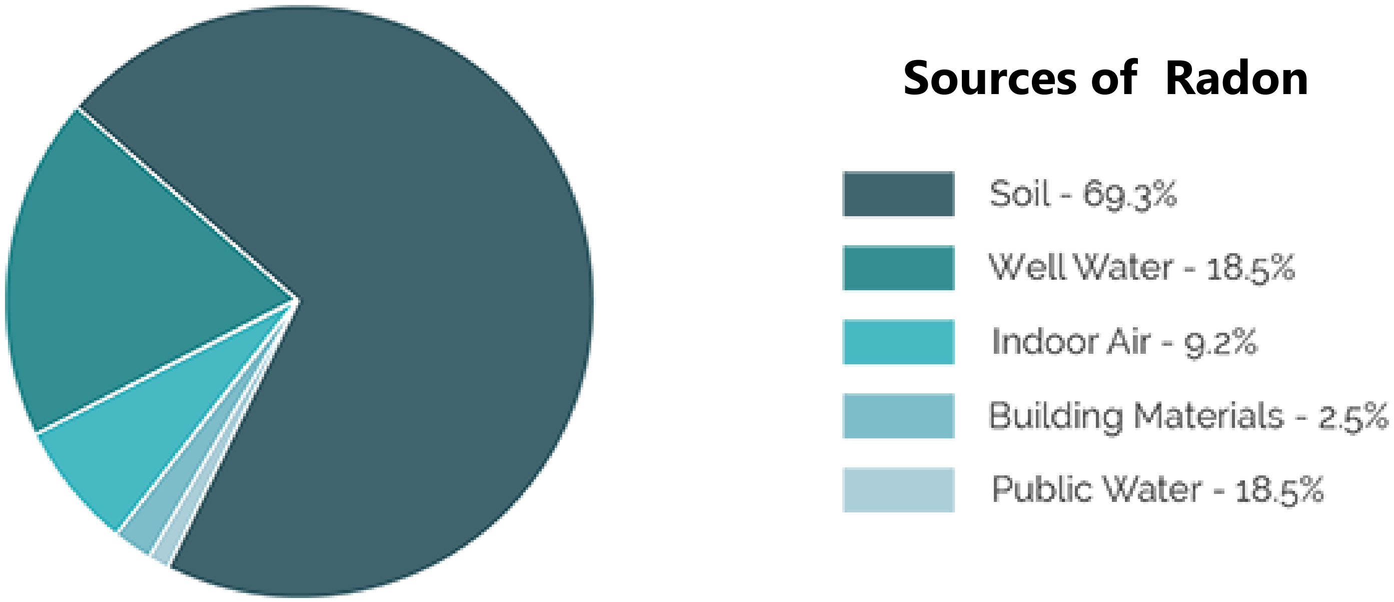
Radon

- Radon is a ubiquitous radioactive inert gas proceeding from the decay of some radionuclides, mostly abundant in igneous rock and volcanic soils.
- Radon is an element in the decay chain of uranium, which is ubiquitous in the ground. The natural decay of uranium gives rise to products including **radium** and **radon**. Radon gas atoms (Rn-222 has an halflife of 3.8 days) can in turn disintegrate, producing radioactive isotopes of **polonium (Po-218, Po-214, Po-210), bismuth (Bi-214, Bi-210) and lead (Pb-214,, Pb-210)** adhering to airborne particles. Radon decay products, which are not in gaseous state, tend to be deposited in the lungs and irradiate lung tissue, possibly leading to lung cancer.

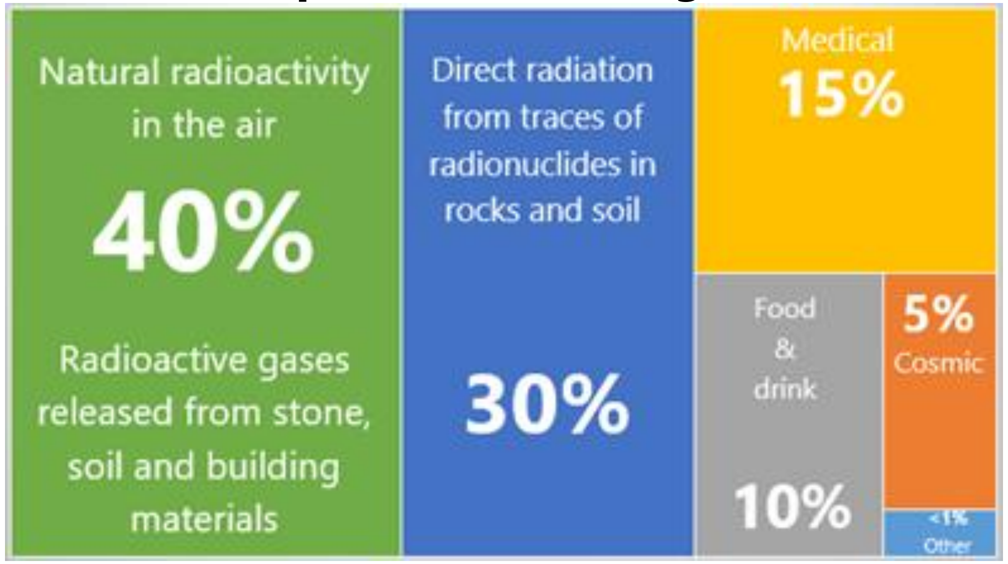


Radon

Radon is the main source of natural radiation to which human beings are exposed during their life.



Human exposure to ionising radiations



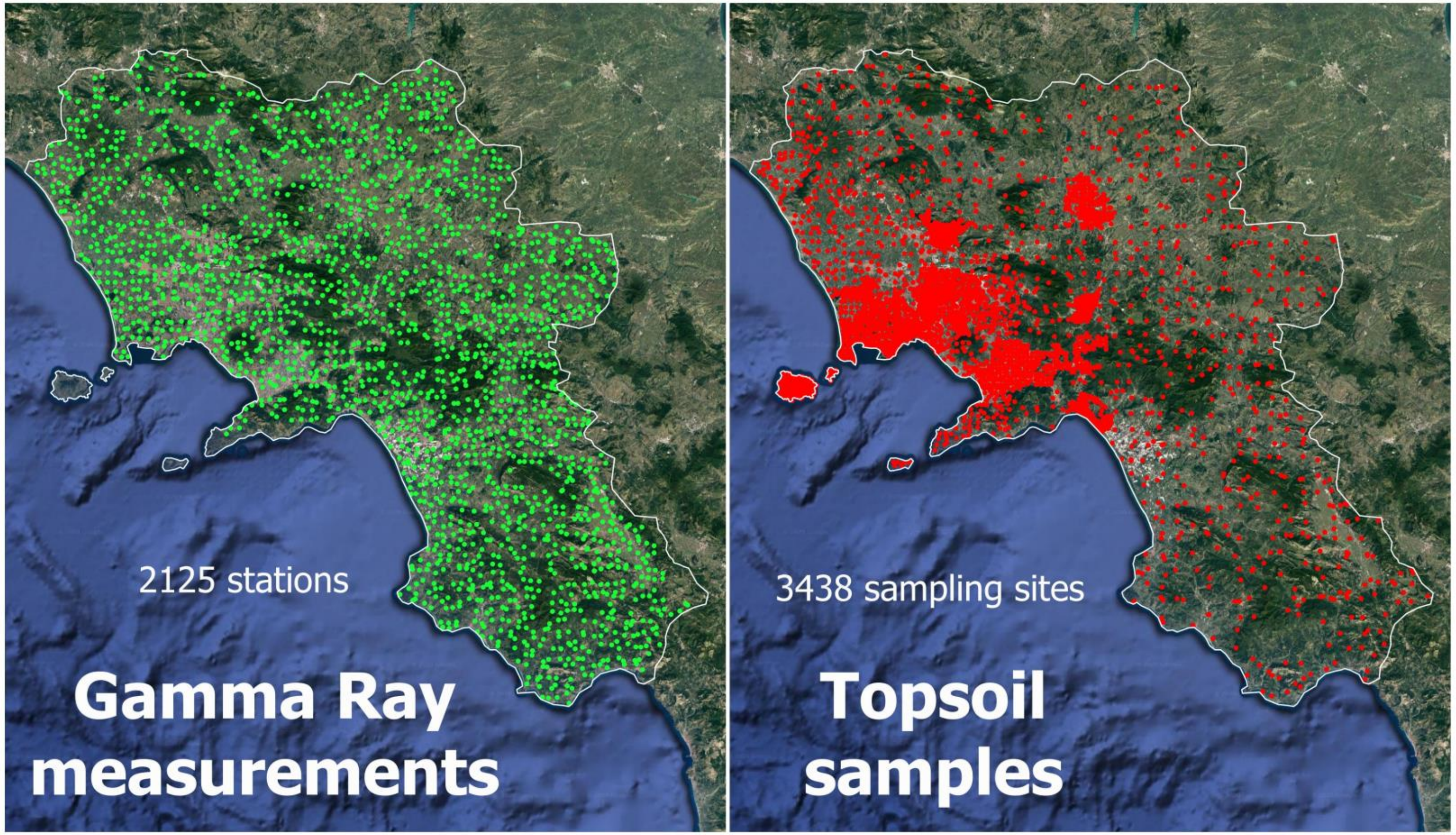
Study area

Campania, a region located on the south-western sector of the Italian peninsula, has a territory mostly characterized by the presence of volcanic lithotypes and sediments.

Materials

An empirical method was applied to determine the flux of Rn-222 from the surface using gamma ray measurements and compositional data for U, Th and K recorded in two extensive different environmental prospecting campaigns completed in 2003 and 2015, respectively.

Radiometric surveys were carried out with a nominal density of 1 station per 5 sqkm with a GRS-500 portable scintillometer produced by Scintrex Ltd (Ontario, Canada); topsoil samples were collected at 3438 sites with a nominal density of 1 sample per sqkm. Samples were analysed by ICP-MS after an Aqua Regia digestion at the ACME Analytical Laboratories Ltd (now Bureau Veritas) in Vancouver, Canada.



Methods

Specifically, the concentrations of U, Th and K in topsoil samples and the activity (gamma radiation) generated by the decay of U-238, Th-232 and K-40 (expressed as Bq) at each measurement station were used as proxies in order to determine the variation of Rn-222 flux from the ground and to estimate the distribution pattern of geogenic radon potential (GPR) across the region.

To estimate the Rn-222 flux, the first step consisted in the conversion of all the data available (i.e. the K, Th and U soil concentrations and K-40, U-238 and Th-232 activity) in Bq/kg to led the calculation of the Terrestrial Gamma Dose Rate (TGDR in nSv h-1), which is the gamma-radiation emitted by the naturally occurring radionuclides belonging to the principal decay series, U-238 and Th-232, and the radioactive K-40.

The elemental concentration of uranium, thorium and potassium in soil, together with the equivalent values calculated as above explained (i.e. eTh, eU and eK), were thus used to calculate the specific activity in Bq kg^{-1} by mean of the subsequent experimental formula, as suggested by Rasha et al. 2018

Once calculated the TGDR, which can be considered as a good proxy to determine the Rn-222 flux, the flux was evaluated by mean of an empirical regression equation (Szegvary et al. 2009):

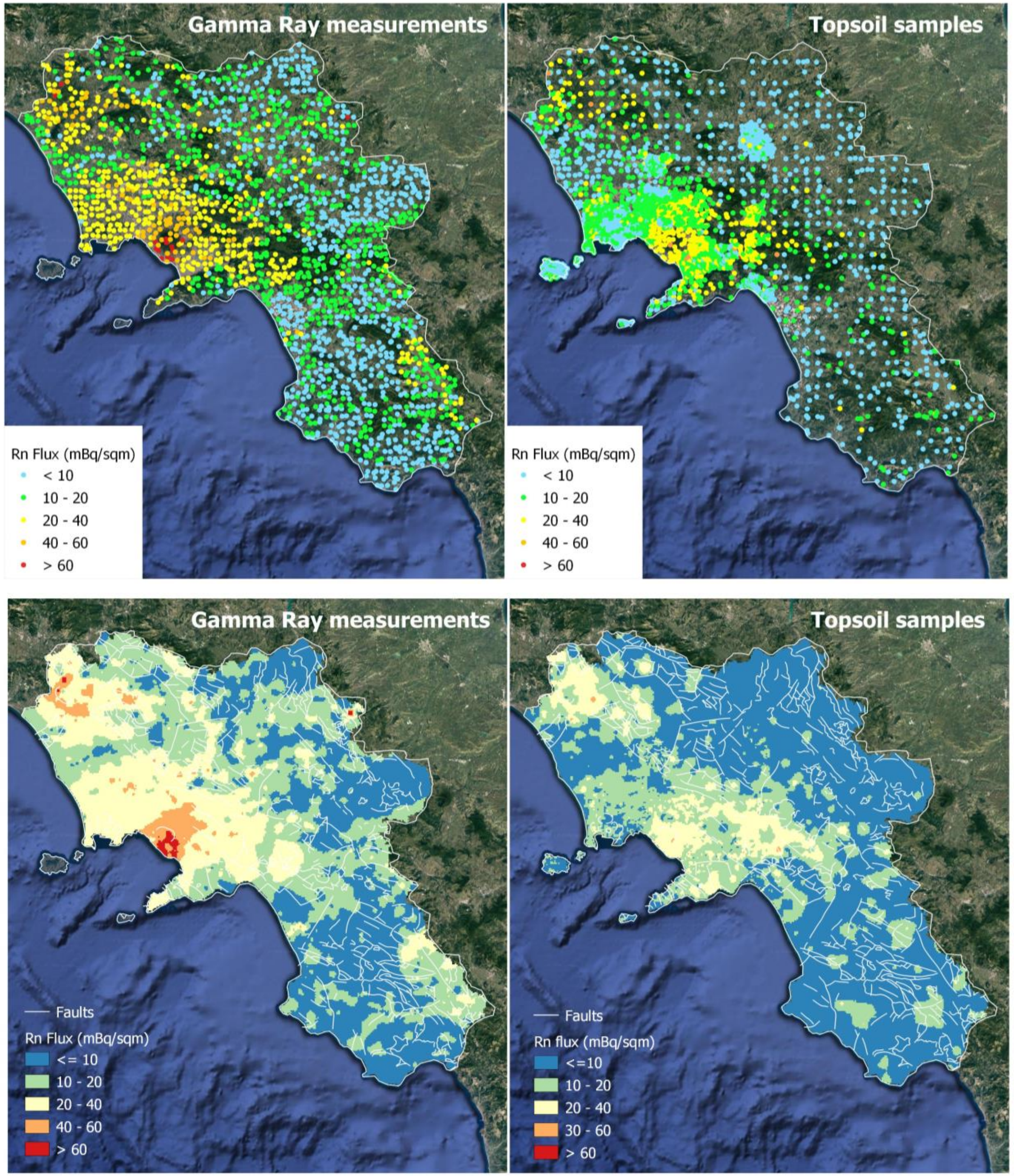
^{222}Rn flux [atoms cm^{-2} s^{-1}] = ɑ γ - ɓ

where γ is the gamma-dose rate in µSv h^{-1}, ɑ = 11.75 (± 1.27) and ɓ = 0.15 (± 0.11) dimensionless factors.

Methods

Multiplying the obtained values by the Rn-222 decay constant (λ = 2.1 10-6 s-1), and making the necessary dimensional corrections, we obtain the flux as mBq m-2 s-1.

Obtained results were then mmaped through the use of QGIS and a geochemistry dedicated GIS software (ArcFractal) to perform Multifractal IDW Interpolation.



Results

A regression analysis was performed to quantitatively evaluate the discrepancies between the results obtained using both data sources. Due to the lack of direct measurements of the Rn-222 concentration in soil and its flux, we tried to explain the obtained residuals by superimposing them to a map with known structural lineaments.

For the inner part of the region, the high values of residuals could be explained by the presence of a number of quaternary active faults favoring the upwelling of Rn from the deepest geological layers.

For the outer part of the region, where volcanic complexes are located (Mt. Somma Vesuvius, Mt. Roccamonfina, Phlegrean Fields) high residuals could be explained by the presence of thick layers of volcanic rocks below the alluvial sandy soils. This condition, of course, should be responsible of the the production of a strong natural flux of radon toward the surface. The additional amount of Rn, non dependent on topsoil chemistry, should represent the residuals.