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Radon Matters in Environmental Remediation

Radon is the largest contributor to radiation doses for the worldwide population. Reducing radon levels indoors is one of the initiatives of Europe's Beating Cancer Plan. While exposures vary greatly among individuals, people living in areas affected by past uranium mining and milling or other NORM related activities are particularly at risk.

NORM-contaminated legacy sites often comprise abandoned ponds of processing waste (slurry or sludge) and heaps of solid residues, both of which pose a threat to human health and the environment when not properly remediated. In cases where houses or other constructions have been built in those sites, their occupants might be inadvertently exposed to high levels of radon coming from the Ra-226 bearing waste.

To avoid this type of situations, reclamation of the sites for uses that entail building (residential or industrial) may be regarded as incompatible with any on-site confinement solutions. The practical difficulties to find viable valorization or off-site disposal options for the bulk volumes of residues may result in sites remaining unremedied for many years, thus negatively impacting the livelihoods of nearby communities.

Despite the above, there is a major upside when managing radon risk: architectural solutions are very effective at mitigating radon entry into buildings and can achieve great dose reductions at very limited cost while avoiding waste generation. Numerous building codes worldwide include provisions to achieve radon-resistant constructions. But standard solutions might not work, or even aggravate the problem, in complex settings, such as legacy sites, where buried contamination and structures and piles of residues favour advective or convective transport of radon gas. To design optimal architectural or engineering mitigation measures for buildings and/or the soil, a site-specific study is required.

The key tool for this approach is radon numerical modelling. However, the development of numerical models remains challenging due not only to the complexity of the processes governing radon generation, transport, and entry and accumulation into buildings but also to the high number of parameters that need to be accounted for. Moreover, important difficulties remain in site characterization and monitoring of radon-related variables and parameters, which would ideally be used as inputs or validation of the numerical model.

In order to contribute to the development of radon modelling in support of sustainable land remediation, an R&D project was promoted by the Spanish Nuclear Safety Council. Three different buildings and their surrounding areas have been monitored for a period of one year, and two different numerical modelling strategies have been applied to reproduce indoor radon levels:
• A dynamic multi-compartment model (RAGENA code), developed in the late 90s and adapted to incorporate the experimental data, including parameters related to the soil-building interface.
• A CFD (computational fluid dynamics) model (based on the COMSOL Multiphysics software package) capable of solving radon transport equation by finite elements and of reproducing complex geometries with the required spatial resolution.

In this presentation the main results of the modelling exercises will be summarized, including consideration of the main challenges in the experimental determination of the most critical parameters.

Primary authors: GARCÍA-TALAVERA, M. (Nuclear Safety Council); GARCÍA-RUBIANO, J. (University of Las Palmas de Gran Canaria); FONT, Ll. (Autonomous University of Barcelona); FRUTOS, B. (Eduardo Torroja

Institute for Construction Science); SAINZ, C. (University of Cantabria); SÁNCHEZ, A. (Geomnia)

Presenters: GARCÍA-TALAVERA, M. (Nuclear Safety Council); GARCÍA-RUBIANO, J. (University of Las Palmas de Gran Canaria)

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