

Environmental radioactivity mapping in Italy: insight from the ITALRAD project

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Within the national ITALRAD project, the University of Ferrara and INFN, in partnership with public and private stakeholders, developed an integrated approach combining airborne gamma spectroscopy and ground surveys to map natural and anthropogenic radionuclides and assess environmental dose.

The project employed complementary airborne platforms: a dedicated aircraft for regional-scale coverage (RadGyro) and UAV-based systems (RadHawk) for targeted surveys over critical or inaccessible areas. Equipped with high-efficiency scintillators (NaI(Tl), CeBr₃), digital multichannel analyzers, and GNSS-IMU navigation sensors, these platforms enabled real-time gamma-ray spectra acquisition, yielding spatial distributions of K, eU, eTh, and ¹³⁷Cs. Between 2010 and 2024, approximately 10000 km² of the Italian territory were surveyed. Field sampling of over 4500 rock and soil samples anchored airborne data to local geology. Advanced geostatistical methods, such as Collocated CoKriging, produced high-resolution maps of radionuclide concentrations and derived effective dose. The resulting datasets serve multiple purposes: regional geology and soil studies, mineral exploration, sustainable management of building materials, environmental protection of contaminated sites, and emergency planning for artificial fallout events. UAV-based rapid-response operations proved especially valuable for detailed assessments in industrial NORM sites and critical areas.

This presentation will outline key results and technical innovations, including examples of radiometric maps at different scales, integration with geological and geomorphological data, and case studies on emergency management and site characterization. Combining light aircraft, UAVs, advanced detectors, and multidisciplinary expertise, Italy's ITALRAD experience exemplifies a mature airborne radiological-survey framework that bridges fundamental research, environmental applications, and technology transfer to society.