5th Newsletter, January 2020

LIFE-Respire

Radon r**E**al time monitoring **S**ystem and **P**roactive **I**ndoor **Re**mediation - LIFE16 ENV/IT/000553

Website: www.liferespire.eu, www.liferespire.it

The LIFE-RESPIRE (**R**adon r**E**al time monitoring **S**ystem and **P**roactive **I**ndoor **Re**mediation) project, which started in September 2017, is approaching at month 30 (2.5 years). The project is realized with the financial contribution of the European Union LIFE programme (LIFE16 ENV/IT/000553).
The main objective of the project is **to demonstrate in 4 areas** (Caprarola, Celleno, and Ciampino in Italy and Jalhay in Belgium) characterised by different Geogenic Radon Potential (GRP), a cost-effective and eco-friendly solution for Rn real-time measurement and remediation **to keep indoor Rn levels below 300 Bq/m³** (as indicated in European Directive 2013/59/EURATOM). The RESPIRE project will implement an intelligent, adaptable and versatile hybrid Rn remediation system composed of sensors, an Air Quality Balancer (SNAP) and an external additional fan-system (eolian and/or electric). A control model based on a IoT protocol will be also implemented.

The LIFE-RESPIRE geodatabase, consisting of collected continuous and discrete Rn measurements coupled with other geological, geochemical and building characteristics data, has been linked to a WebGIS for easy data management, analysis and visualization by the consortium, and available to the local authorities for land use planning and health risk assessment, helping to prepare relevant national action plans (see Articles 54, 74 and 103 in 2013/59/EURATOM).

This newsletter highlights the main actions conducted in the 5th semester of the project and lists some of the dissemination activities at conferences. Some of the mentioned material is available to the public on the Document section of the LIFE-Respire website.

Any interest and collaboration with the LIFE-Respire Group is appreciated, please contact us!

More information about the purposes of the project can be found on the LIFE-RESPIRE website (www.liferespire.it)

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LIFE-Respire Consortium

CERI-Sapienza: Centre for Research of the Sapienza University of Rome, Italy

CNR-IGAG: Institute of Environmental Geology and Geoengineering of the National Research Council, Rome, Italy

INGV: National Institute of Geophysics and Volcanology, Rome, Italy

FANC: Federal Agency for Nuclear Control, Brussels, Belgium

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IN THIS ISSUE

1. Long-term monitoring of indoor radon (Action B2)

The action includes the long-term monitoring of indoor radon concentrations and the building selection for the installation of remediation systems. The long-term monitoring covering the summer period (July-September 2019) has been completed.

Indoor radon concentrations in the three Italian municipalities of Ciampino, Caprarola and Celleno are quite different; during winter, in Caprarola were measured the highest values, in Ciampino. As expected, the median values of indoor radon concentrations were lower during the summer period than those measured during the winter period, in all municipalities.

Building selection was based on results from long-term monitoring of indoor radon concentrations during winter period and additional criteria which included building characteristics (geometry, building materials, etc.) and geographical distribution of buildings, in relation with the constructed GRP maps of the three sites. The final list of selected buildings was also affected by the essential approval of availability of individual citizen for private houses, and of local administrative staff for public buildings.

2. Installation of remediation systems (Action B2)

A large number of prototype RESPIRE radon remediation systems were installed, in both private homes and public buildings (like schools and municipal offices), from July to November 2019 (Figure 1). Units were placed in each of the three studied Italian municipalities of Ciampino, Caprarola and Celleno, which are quite different in terms of their population size, administrative operation, and (most important for the goals of the RESPIRE project) their average indoor radon concentrations due to the underlying geology and building materials used.

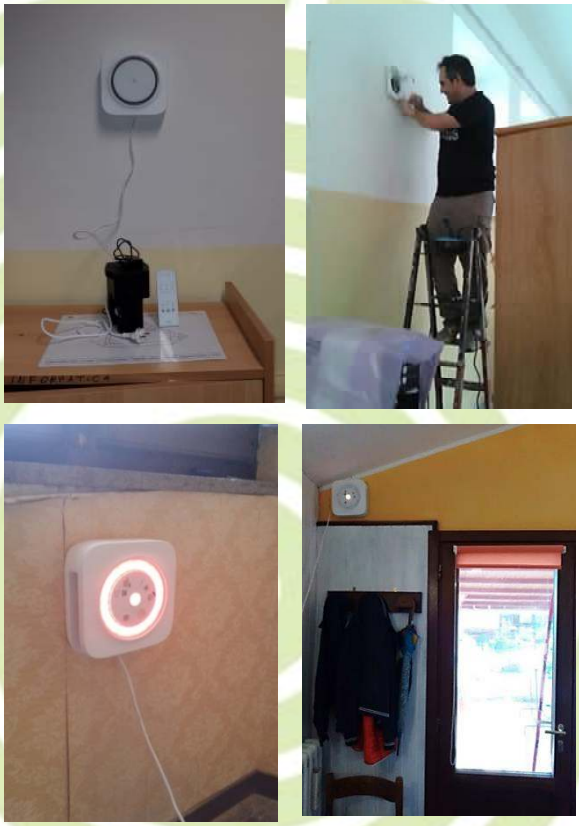


Figure 1. Photographs showing some installations of the fan and radon sensor.

The remediation system couples a stable and sensitive radon detector to the SNAP smart extraction fan of RESPIRE industrial partner ELICA. An electronic board was developed to allow the radon sensor to communicate concentrations to the SNAP using a free radio channel associated with the unit's remote control, and to actuate the fan when concentrations exceed a user-defined threshold of 200 Bq/m^3 (chosen as a function of the recent EU radon Directive).

The SNAP then transfers the radon data, together with temperature, humidity, and fan setting, via Wi-Fi to a central server where the resultant database is made accessible on the RESPIRE WebGIS. Deployment of these units thus required that a 12 cm diameter hole be drilled in an outside wall for installation of the fan, that power be provided to both the fan and the radon sensor, and that a Wi-Fi signal is available (as there is no internal datalogger).

To date a total of 11 units are operating and transmitting data, whereas another 10 units are still awaiting required interventions (e.g., drilling of the hole in the wall, supply of power, or WiFi installation) from local administrator or staff.

Figure 2. General locations of the Celleno sites chosen for installation of the RESPIRE system, and the data visualization in the WebGis interface.

3. Developing and implementing of information for WebGis (Action B3)

Several maps are available on WebGis, such as those of radon and CO_2 gases in the soil, Rn flux from soil, natural gamma radiation, and the geogenic radon potential. Also the sites selected for installation of the RESPIRE remediation systems can be visualized by the WebGis interface (Figure 2). General information about each SNAP, the current status (e.g., the SNAP mode, the fan level, the last measurement of temperature, humidity and radon level) and the long-time statistics can be visualized by the dashboard interface (Figure 3).

4. Monitoring (Action B3)

Data from the operating units that have functioned during periods from 3 to 8 months in different environments with different levels of radon concentrations, can be used to assess the radon concentration trends and the effectiveness of the developed system. Data can be visualised and downloaded by the WebGis interface (Figure 2).

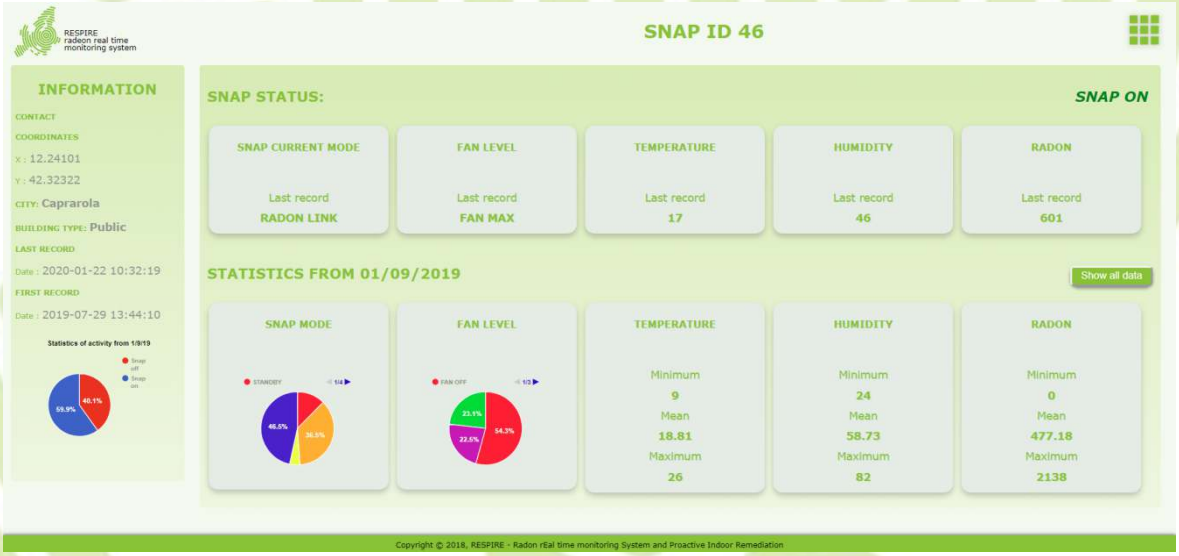


Figure 3. Dashboard of the "Caprarola SNAP-46" .

As example, the complete dataset recorded in the site "Celleno SNAP-40" is plotted in Figure 4. It shows the very high radon values (up to 1800 Bq/m^3) that occur during the late winter period of March-April 2019, the very low values (< 50 Bq/m^3) registered during the warmer summer period of August 2019 when the windows were often left open, and the steady rise in radon concentrations during the fall of 2019 (up to 1400 Bq/m^3) as temperatures begin to fall.

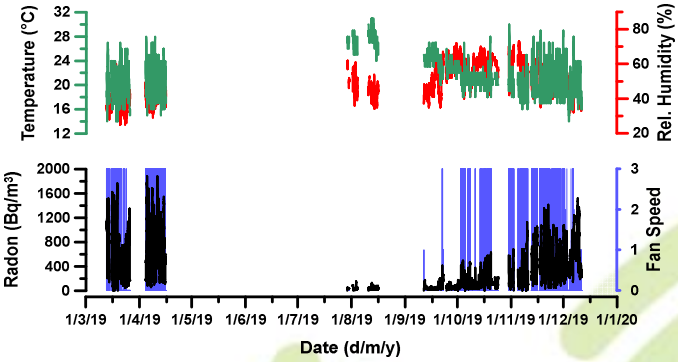


Figure 4. Monitoring data from "Celleno SNAP-40" system, showing temperature (green), humidity (red), fan operation (blue), and radon concentration (black).

5. Assessing indoor radon levels using a Scale Model Room (SMR)

A Scale Model Room (SMR)(62 cm length, 50 cm width, 35 cm height) was constructed using bricks of a lithoid ignimbrite (Tufo Rosso a Scorie Nere) and a concrete without Pozzolanic ash. This stone is one of the building material mostly used in Caprarola. The model room was placed on a wood floor, closed with a plastic roof, and connected with RAD7 monitors for experiments.

Several experiments were conducted; a first test was carried out to determine experimental ^{222}Rn equilibrium activities in the model room, not covered with plaster or other coating material. A second test was performed after sealing the external faces of the room with a transparent film commercially used to conserve food. In both tests the atmospheric conditions of the laboratory (temperature, relative humidity and atmospheric pressure) were similar. The results of these experiments are shown in figure 5.

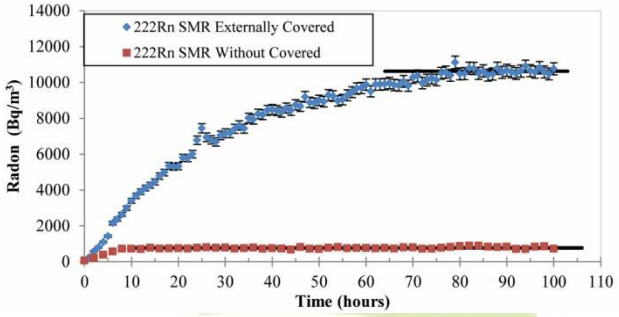


Figure 5. Results of SMR experiments. In blue: radon concentrations inside the SMR with externally walls covered by a waterproof film. In red: radon concentrations inside the SMR with the walls "free to breathe" (without externally covered)

In the first test the radon concentration reaches the equilibrium value (770 Bq/m^3) in about 10 hours. In the second test, with the walls externally covered by a waterproof film, radon concentration reaches the equilibrium (10600 Bq/m^3) in a time of about 76 hours. The second experiment (i.e., external walls covered by a waterproof film) shows how an external cover strongly limit the indoor air dilution through the very porous ignimbrite (43%), greatly increasing the accumulation of radon within the SMR.
Other tests about the correlation among indoor radon and temperature, relative humidity and pressure gradients of external environment are in progress.

6. Replicability potential evaluation and demonstrative case in Belgium (Action B4)

Several buildings have been characterized in order to evaluate the applicability of the RESPIRE SNAP remediation system and compare them to other remediation techniques. The main idea was to select different type of buildings in different radon-potential and geological environments, since these are the main external (non-building related) factors determining the optimized and best-suited remedial action. Different types of buildings (Dwellings/schools/offices) in different radon potential zones (high/moderate/low radon potential) and in different geological settings (soft-sediments, shale, karst) have been characterised for their radon entry dynamics and remedial potential.

Very strong variations in radon concentration and entry rate of over 20000 Bq/m³ have been observed (Figure 6).

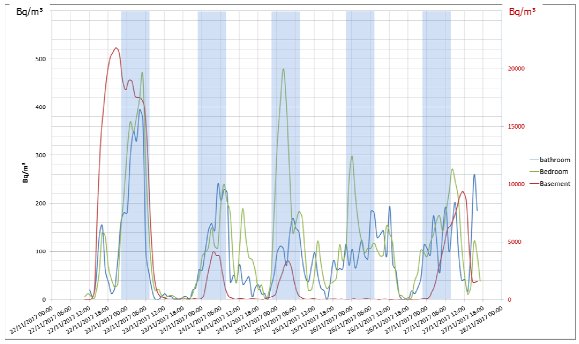


Figure 6. Radon concentration variations in the basement of a multi-storey building.

By installing a wind-driven aeolian fan on the roof that is connected to a sump in the basement, the radon concentrations have been drastically reduced to well below the reference level (Figure 7).

	Living room mean Bq/m³	Basement mean Bq/m³
before fan installation (3 months)	208	1920
after fan installation (3 months)	12	75

Figure 7. Efficiency of remediation using a wind-driven aeolian fan.

Several test with piloted ventilation have been carried out in different test houses. The results are promising as the fans are only activated when the radon concentration increase. Figure 8 illustrates the functioning and the efficiency of the system.

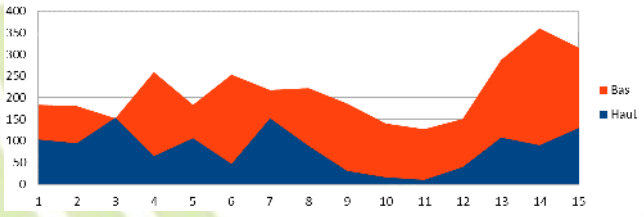


Figure 8. Controlled ventilation driven by a monitor in the basement ('bas') keeping the radon concentration in the living spaces ('haut') below the reference level.

Another example from karst area indicates the dimensioning of the sub-slab extraction depends highly on the soil permeability, which can be extremely high in karst areas. In such cases, it can be efficient to pulse fresh air into the soil instead of extracting air (Figure 9).

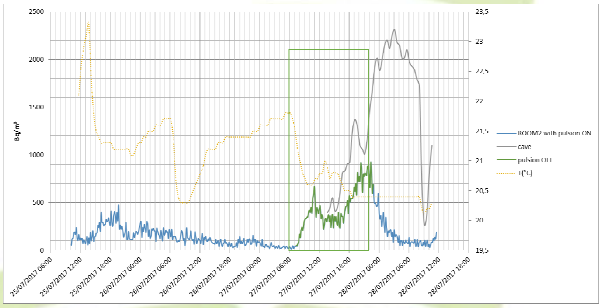


Figure 9. Air pulsion into ground in karstic areas.

A permeability test before remediation can help in dimensioning the remedial system like the extraction rate, the type of fan to use:

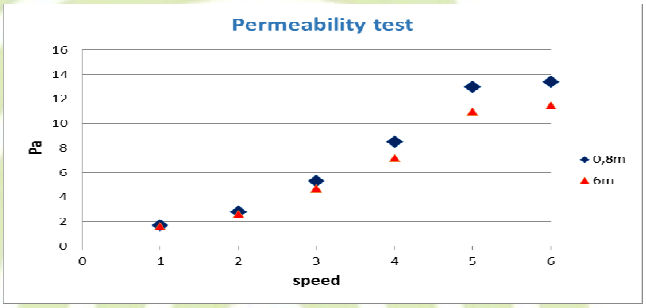


Figure 10. Permeability test for dimensioning remedial systems.

Sometimes, extraction from the air in a basement or a crawl space can be a very efficient method of remediation. The first results are promising, although the connectivity between the sensor and the fan can be a complication (transmission of a wireless signal or wired solutions).

7. Public awareness and dissemination of results (Action D1)

Some of the LIFE-RESPIRE results were presented at conferences and workshops; Several events were organized by FANC for dissemination activities on radon, for stakeholder involvement addressed to the public, local and regional authorities and building professionals:

- Journée d'étude sur le Radon, Spa, (28 June 2019): a total of 52 stakeholders participated to the Study Day on radon organised in SPA on June 28. The event was published on the FANC website (https://fanc.fgov.be/nl).

- European Research Night, Napoli, Italy (27 September 2019).

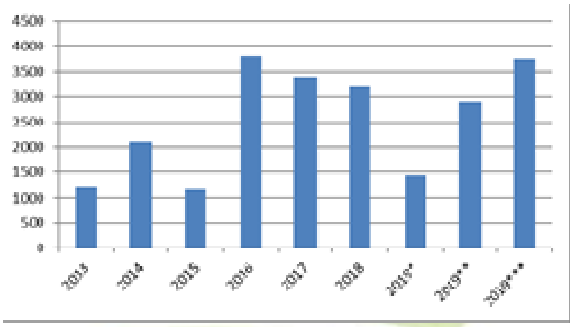
Journée d'étude sur le Radon, Spa (Belgium)

The RESPIRE booth for the European Research Night .

- Open Day at INGV, Rome (29 September 2019).

- A seminar for PhD students, organised by Università degli Studi Roma Tre (18 October 2019, Rome). C. Lucchetti gave a presentation on "The contribution of building materials of volcanic origin to indoor radon in Lazio region" .

- Radon Action 2019, (1 October – 31 December 2019): the radon Campaign 2019 did talk about RESPIRE activities and lead to, until now already more than 3000 detectors has been distributed to the public and more than 300 in workplaces.



Number of detectors distributed within the national radon campaign (between October 1 and December 31). Partial results for 2019.

- ROOMS International workshop, Berlin, 30 October 2019: FANC presented the results of the radon research activities in different environments and within the RESPIRE project research (www.liferespire.it).

- Festa della Scienza, Genova, Italy (2-3 November 2019). A RESPIRE booth was occupied all day and L. Pizzino, A. Sciarra and M.C. Tartarello gave a presentation entitled "Conoscere il Radon: un ospite indesiderato nelle nostre case. Metodi di misura e risanamento".

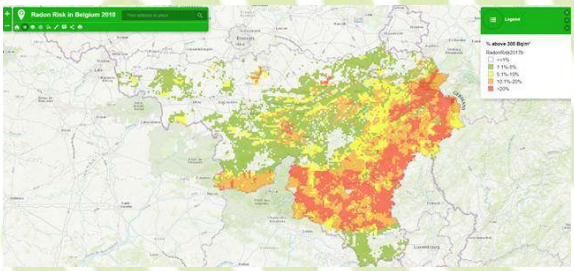
- Building fair for renovation and energy-saving, Marche-en-Famenne, (15-17 November 2019): FANC has been actively present at the building to inform the public and the building professionals about radon prevention and mitigation.

The FANC booth for the building fair in Marche-en-Famenne.

The flyer of the event.

- European Radon Day, November 7: a training for building professionals has been organised in Wavre. A press release has been published by FANC, and a publicity publication in the national newspaper 'Metro'. Following these publications, the number of visits to the different websites and online mapping application increased to > 8900. A similar increase has been noticed after the start of the campaign on October 1st :

The peak at the beginning of the campaign was above 15800 views of the mapping application:



8. Upcoming events

LIFE-RESPIRE presentations are confirmed for several conferences in the coming months, including:

- the European Radon Week 2020, from 24 to 28 February 2020, in Vienna;
- the International congress Cities on Volcanoes 11, from 23 to 27 May 2020, in Heraklion, Crete.

9. Networking

For the networking activity, a memorandum of understanding between LIFE-Respire Consortium and Municipality of Pomezia (Rome) for monitoring indoor radon concentration was signed. Two remediation systems will be installed in public buildings of Pomezia.

The signing of the agreement took place on 16 December 2019, in Pomezia (Rome). At the center, the mayor of Pomezia, on the right the municipal councillor.

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