4th Newsletter, August 2019

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 the end of its second year. The project is realized with the financial contribution of the European Union LIFE programme (LIFE16 ENV/IT/000553).

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) working on positive pressure method. The efficacy of the RESPIRE remediation system will be tested **in 4 demonstration areas (Caprarola, Celleno, and Ciampino in Central Italy and Jalhay in Southern Belgium)** characterised by different Geogenic Radon Potential (GRP), with the goal to check Rn indoor concentrations in real-time and **to keep indoor Rn levels below 300 Bq/m^3** (as indicated in European Directive 2013/59/EURATOM).

This newsletter highlights some hints obtained for the actions in progress. Lists of the dissemination and networking activities is also briefly reported. Details of the project actions are discussed in the Status Report that can be found on the LIFE-RESPIRE website where other dissemination material is available.

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

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

Elica: Elica S.p.A., Fabriano (AN), Italy

COMUNE DI CAPRAROLA

Comune di Celleno

CITTÀ DI CIAMPINO

CITTA' METROPOLITANA DI ROMA CAPITALE

IN THIS ISSUE

1. Prototype assembly and test (Action B1)

This action is completed. The aim of this action is to design and optimize the RESPIRE remediation system prototype for real-world use in Demonstrators. This involves: 1) design the prototype and produce early versions for tests; 2) validate the best solution and guarantee timely and effective supply chain management; and 3) first installation and test of the devices in one building. Various sensors for measuring indoor radon concentrations are available on the market.

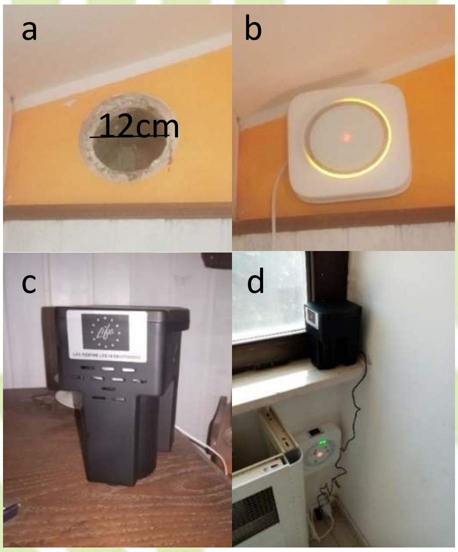


Figure 1. Respire Remediation System: a) SNAP must be installed on a wall in a 12 cm diameter hole that communicates directly with the outside; b) SNAP with working fan, the yellow light indicates that indoor radon concentration is below the reference level of 300 Bq/m^3; c) RD200M connected via Bluetooth with the SNAP; d) complete Respire Remediation System mounted in a school at Celleno municipality.

For the goals of LIFE-RESPIRE, we focused on OEM (Original Equipment Manufacturer) products which can be easily integrated into more complex, integrated systems that are being developed for an eventual commercial market.

Two Rn sensors were considered as potential candidates to be incorporated within the SNAP system:

- Radon SS Gas Sensor (1750 pCi/l Rn – 5V) produced by Euro-Gas
- RD200M sensor (100 pCi/l Rn - 12V) produced by FTLAB

Following the test period of these OEM Rn sensors, the electronic architecture and the interface for communication protocols, data transfer and control criteria, as well as power management, were developed to integrate the sensors with the SNAP air balancer. Two prototypes were assembled and tested in the Elica Lab, in a space reproducing a room in a real environment. After this period, the prototype with the RD200M sensor was preferred due to its highest sensitivity and response. This prototype was presented at the Mid Term Conference at CNR research area in Rome, on the 11th of December 2018 (Fig. 1). From March 2019, one prototype has been installed in a house in Celleno (VT), one of the selected sites of the project. Further work was also carried out including a more detailed map of the Rn distribution throughout the house and in the room hosting the RESPIRE remediation system by using three further commercial Radon-Eye sensors to determine air circulation in the room and how it can be better controlled by the SNAP. The RESPIRE remediation system was also integrated with a WebGIS system for data archiving, monitoring, and interpretation (Fig. 2).

*Figure 2. Scheme showing integration and communication between the various components of the prototype system. (a) Radon sensor module developed by CERI; (b) SnapRn developed by Elica S.p.a.; (c) domestic router; (d) WebGIS database; (1) RF communications; (2) WiFi (802.11 b/g/n); (3) MQTT protocol; * - Snap is equipped with a brushless motor.*

When the SnapRn is operating with the Rn function on, various visual aspects of the unit change to indicate status of communications and of the air quality with respect to radon concentrations. First of all, the central logo is illuminated in orange, showing that the Rn Function is on. In addition, the illuminated outer ring changes color based on the measured Rn concentration. This is shown schematically in Figure 3, where the external ring is lit by a series of LEDs capable of changing color from green (low concentration) to yellow (interval between 150 to 300 Bq/m^3) to red (greater than 300 Bq/m^3).

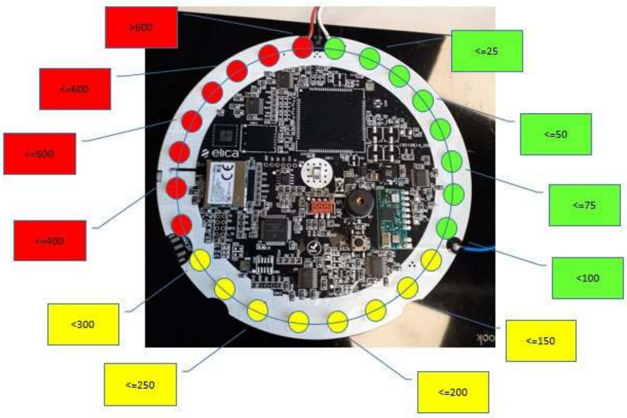


Figure 3. Photograph showing the series of LEDs that illuminate the outer ring, and the colors that change based on the measured Rn thresholds.

2. Short and Long-term monitoring of Indoor radon (Action B2)

This Action includes a series of activities including short and long-term monitoring of indoor radon concentrations and indoor gamma radiation, as well as building selection. The short term activities were already completed for the three Italian sites (Caprarola, Ciampino and Celleno), whereas two cycles of long term monitoring has been completed, covering the winter and summer periods (December-March and June-August).

The long term monitoring involves the use of passive, low-cost track-etch detectors installed in the private buildings of Caprarola, Ciampino and Celleno, in the homes of all citizens that requested them, as well as in several public buildings. Before installation a few track-etches from each lot were used for calibration checking; they were exposed in a Rn chamber at INGV Radionuclides Laboratory at a fixed Rn concentration for a few days. After an awareness and information campaign conducted in all three municipalities, citizens were offered the opportunity to participate for free in the radon monitoring survey of their homes. The total number of monitored dwelling is resumed in table 1.

Table 1. Short and long-term monitoring activities.

town	n. detectors		Public buildings	Private house
Celleno	Long term 2016	40	1	18
	Long term	56	3	27
Ciampino	Short term	66	19	-
	Long term	109	19	18
Caprarola	Short term	83	5	30
	Long term	148	6	94

Results from winter period (December 2018 to March 2019) were considered of primary importance for building selection due to the worst environmental conditions (windows closed due to cold outdoor temperatures and radon accumulation). Further criteria was also based on soil gas surveys (Action A), gamma measurements, and building characteristics (geometry, buildings materials, etc.) representative of the dwellings at these sites. Results obtained from summer long-term monitoring will be used for completing the whole year, as requested by the project, and to have an average value useful to compare and integrate the RESPIRE database with available European data. The final list contains more than the required 10 buildings suitable for remediation at each site because, although permits have been obtained for public buildings, an individual citizen can change their mind and refuse to host the RESPIRE remediation system. The definitive list of buildings was defined after the confirmation of availability for private houses. The overwhelming response to our information campaign (more than one hundred) necessitated additional working days above those originally foreseen and the purchase of a high number of these detectors (Fig. 4).

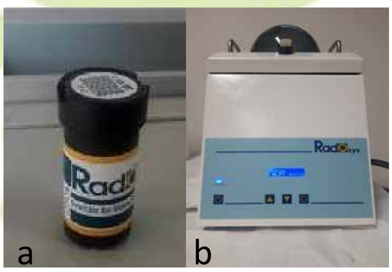


Figure 4. Radosys CR39 long-term indoor radon detector (a); automatic system for reading the alpha traces on the films of the exposed dosimeters (b).

3. Radon and thoron exhalation from building materials (Action B2)

For LIFE-RESPIRE, ^{222}Rn and ^{220}Rn exhalation rates from soils and building materials were determined in the laboratory using the accumulation chamber method under controlled and standardized experimental conditions (Figure 5). Samples (1 kg of incoherent material or 1 block of 15 x 10 x 5 cm) were oven dried for at least 24 hours because water can influence the recoil length of radon and thoron from mineral grains to soil pores, thus enhancing gas removal from the air circulating system. After drying, the sample was placed inside the accumulation chamber, located in a thermostatic bath and kept at a constant temperature of 30°C to improve measurement reproducibility, and connected in a closed circuit via vinyl tubings to a Durridge RAD7 radon detector to define the rate of radon increase in the chamber. This increase is then used, together with geometry of the chamber and the sample, to calculate the exhalation rate. The “tufo rosso a scorie nere” commonly used in the Caprarola municipality provided the highest values for ^{222}Rn and ^{220}Rn (5.9 and 6400 Bq m-2 h-1, respectively).

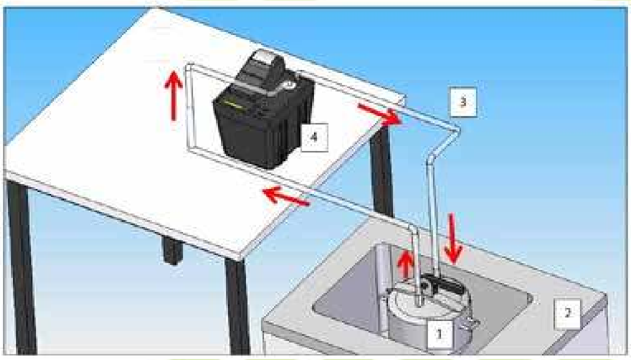


Figure 5. Experimental set up for the determination of radon and thoron exhalation rate from building materials.

4. Assessment of indoor radon levels in a scale model room (Action B2)

The contribution of building materials of volcanic origin to indoor radon concentrations was also investigated experimentally. In particular, the ignimbrite known as the “tufo rosso a scorie nere” (from the Gallese quarry) was used to construct a scale model room of 62 cm x 50 cm x 35 cm (inner length x width x height) to assess radon and thoron activity concentration under equilibrium conditions and to study the effect of climate and different coatings on radon levels (Fig. 6).

This material was chosen because of the very high exhalation rates measured in the tests described above. This experiment demonstrates that air exchange with the outdoor environment is particularly effective to decrease indoor radon levels, while inner covers (such as plasterboard and different kind of paints) only partially affect ^{222}Rn, whereas completely remove the short-lived ^{220}Rn. Finally, low temperatures further reduce radon exhalation from building material and, in turn, indoor activity concentration.

Figure 6. Construction of the model room (1,2,3) and its connection with the RAD7 detector for continuous monitoring of radon during the experiments (4).

5. Development of RESPIRE Web-GIS (Action B3)

This Action started in September 2018 with the design of the WebGis database. This is now online, but it is not yet connected to the LIFE RESPIRE website because testing is still underway and issues related to privacy are being resolved. The publication on line of the WebGis implies the management of sensitive information. More than one meeting will be planned with the Mayors of each site to define a strategy to manage data in the best possible way. Access will be from the project website, where “WebGis” has been added as an option in the main menu. The WebGis has been populated with all the data from Action A and with all the other available project data. Several layers with different attributes are visible, with all data collected in each area presented in a spatially processed form (kriging or other spatial analysis result). It is not possible to download the raw data, but just visualize the spatially interpolated results.

The WebGIS interface was implemented using the open source JavaScript library "Openlayers". The application allows the users to select the site of interest, after which the system zooms into the area and opens all relative tables of contents (Fig. 7). All the layers created (geoservers services) within the table of contents are displayed, allowing users to turn off/on layers, open a panel that shows the legend, and change the opacity of a layer using a slider bar. The table of contents is sortable by clicking on and dragging a layer to a new spot within the list. In this way, the visualization of the map will change automatically and the order of the layers will follow the new list. A close-up of the table of contents (Fig. 7a) shows the various datasets available to date, with the category "Radiogenic element concentrations in soil associated with lithology" opened to show the various sub-items available for map plotting. The other categories similarly have multiple sub-items that can be selected. Instead, Figure 7b shows what happens when a user clicks on a point on the map: a pop-up window appears showing a list of intercepted layers, which when selected opens an info panel on the left side of the screen displaying the attributes of the examined feature.

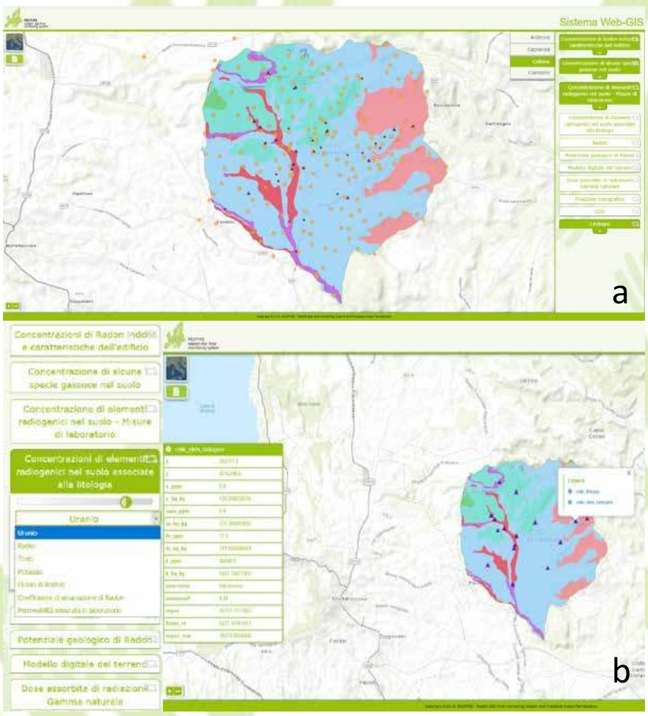


Figure 7. Example of data visualisation within the WebGIS interface (a). Enlarged view of the table of contents menu, showing how a user can choose a sub-topic under the pop-up window and associated info panel obtained by clicking on a sample point on the map (b).

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

Detailed information on the geology, soil-gas, soil permeability and soil composition of the Rn prone areas of the Ardennes Massif area in Belgium has been presented, together with all the other collected data. The Belgian Ardennes provide excellent test-cases in terms of building types (dwellings/schools/offices), geological settings and geogenic radon risk (low-intermediate-high) and remediation solution (active, passive, wind-driven, fan, sub-slab, etc.). In order to demonstrate and evaluate the effectiveness of the RESPIRE remediation solutions, several different situations have been selected for detailed follow-up in terms of measurements and remediation. Replicability of different measurement devices has been carried out at three locations, the results of which are being processed. Inter-comparison and replicability-test of different types of fans has been tested in two locations.

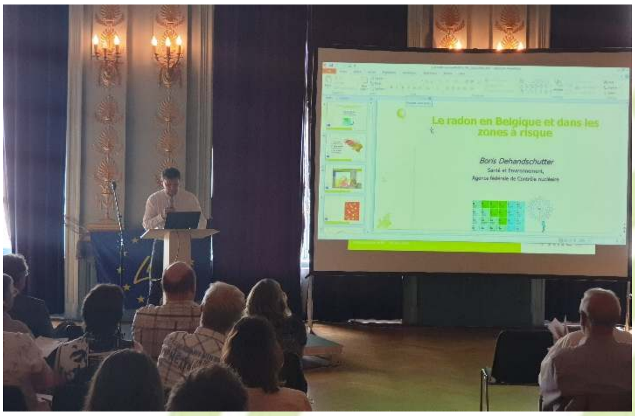
A detailed overview of the measurements and of the remediation solutions has been presented at the RESPIRE public event in SPA (Belgium) on June 27-28, 2019, organised by FANC.

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

LIFE-RESPIRE results were presented at several conferences and events.
Public events organized by the RESPIRE Team:

1. The second monitoring visit was held in Rome and in the city of Caprarola, the 15th and 16th of April 2019.
2. Three webinars planned for the first year were conducted during April-May 2019, as substantial mailing lists had been compiled by that time which were needed to build a sufficient potential audience. A dedicated announcement was prepared for the web and for the social network sites of Facebook and LinkedIn). The first three webinars, given in Italian, were:
   - 05/04/2019 at 12:00 – The presence of radon in buildings: identifying the areas at risk – Salvatore Lombardi, Sapienza Università di Roma
   - 09/04/2019 at 12:00 – The problem of radon in volcanic areas – Alessandra Sciarra - Tullio Ricci, INGV
   - 14/05/2019 at 12:00 Radon mapping in Europe and Italy – Giancarlo Ciotoli, CNR

3. Cherry Festival held in Celleno municipality the 8th and 9th of June 2019.
4. The third RESPIRE public event in SPA (Belgium) on June 27-28, 2019, organised by FANC. This conference served to present the data acquired at the half-way point of the project in Belgium and in Italy. The experiences of stakeholders from Suisse, France and Luxemburg, as well as from the European project ENGAGE, were also presented. The meeting constitute and occasion to make contacts with other projects (international) and potential European stakeholders.



Third RESPIRE Conference (Spa, Belgium, 27-28 June 2019)

Other public events not organized by the RESPIRE Team

1. The INGV Open Day event "Earthquakes – from memory to prevention" was held in Rome on 20/1/19. L. Pizzino presented on Gas Hazards and the LIFE RESPIRE Project.

2. Fiera di Grottaferrata (Rome), from 23 to 30 March 2019. A RESPIRE booth was occupied all day on 29/3/19 and Luca Pizzino gave a presentation on "Volcanic gasses risk hazard". The booth hosted two practical demonstrations on radon measurement procedures and indoor radon monitoring.

3. The European Geosciences Union was held in Vienna, the 7-12 April, 2019. Livio Ruggiero, Francesca Giustini and Giancarlo Ciotoli gave oral presentations on RESPIRE results.

8. Networking

LIFE RESPIRE signed a collaboration agreement in February 2019 with the MetroRADON project (http://metroradon.eu) within the framework of the actions regarding Geogenic Radon Map construction within the European Radon Atlas Project (EARN) led by the Joint Research Center of the European Commission(https://remon.jrc.ec.europa.eu/About/Atlas-of-Natural-Radiation).

Other networking agreements are in progress: one with the University of Roma Tre and one with INAIL Research Sector – DiMEILA. Further collaboration, to be implemented mainly in the After-LIFE period, consists of collaborations and agreements with representatives of other Italian municipalities, like Pomezia (Roma), Montecompatri (Roma) and Raviscanina (CE).

9. Upcoming events

LIFE-RESPIRE Team will present project results and demonstation activities, inlcuding RESPIRE remediation system at the European Night of Researchers at Neaples on 27/9/2019,
More details can be found in the News & Events Section on the LIFE-RESPIRE website.

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