



## L'esperienza INGV nello studio sul Radon: tecniche di misurazione e monitoraggio.

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### The INGV experience in the Radon study: measurements and monitoring techniques

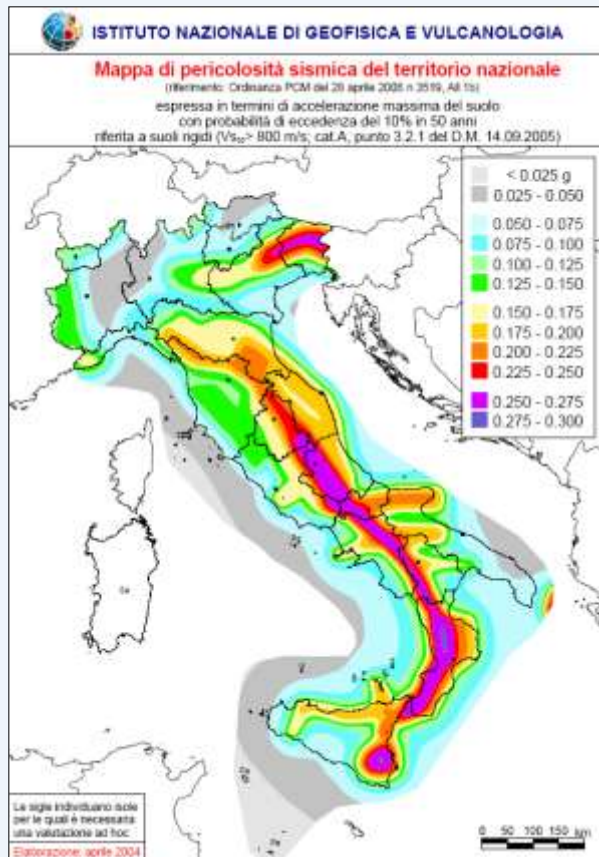
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Tullio Ricci, Rosella Nave, Giuliana D'Addezio

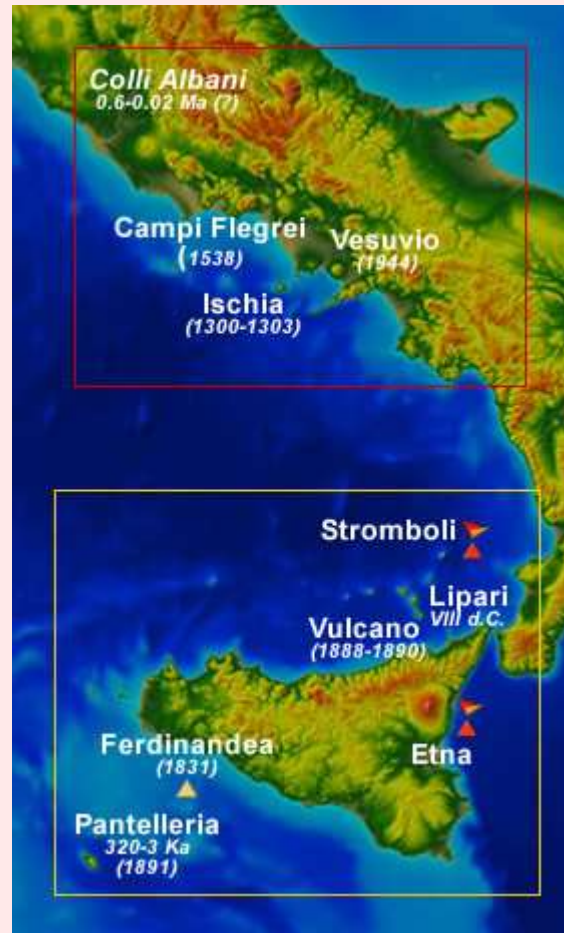


## • Earthquakes



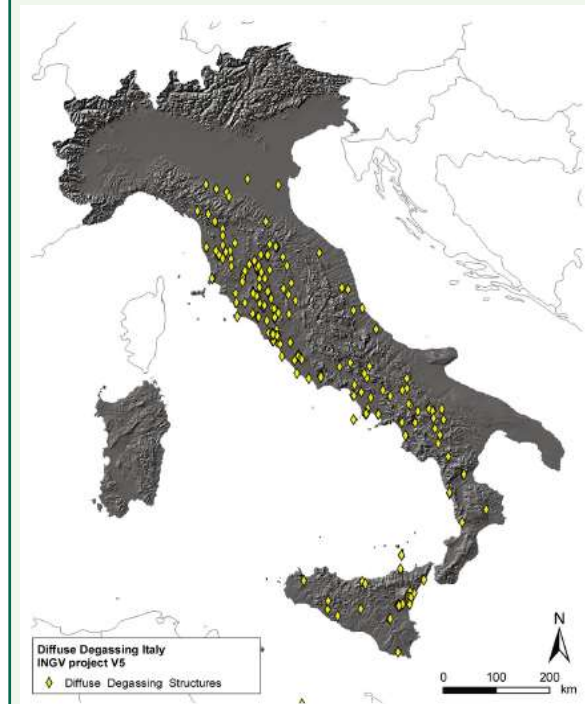
Seismic hazard map

## • Volcanoes



Map of active volcanoes, with the date of last eruption

## • Environments



Diffuse Degassing Structure map

# Contents

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- ✓ Soil gas Radon activity
- ✓ Dissolved Radon in groundwater
- ✓ Radon indoor

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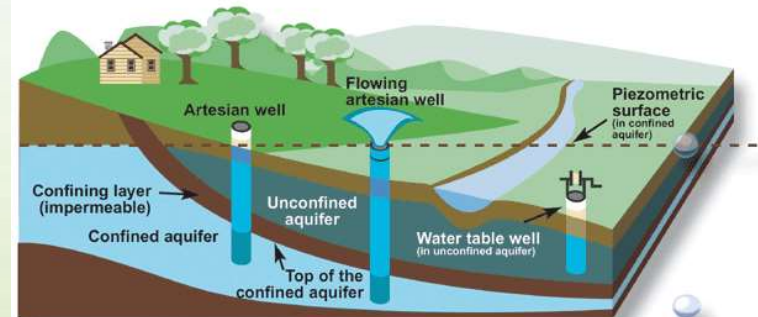


**RESPIRE**

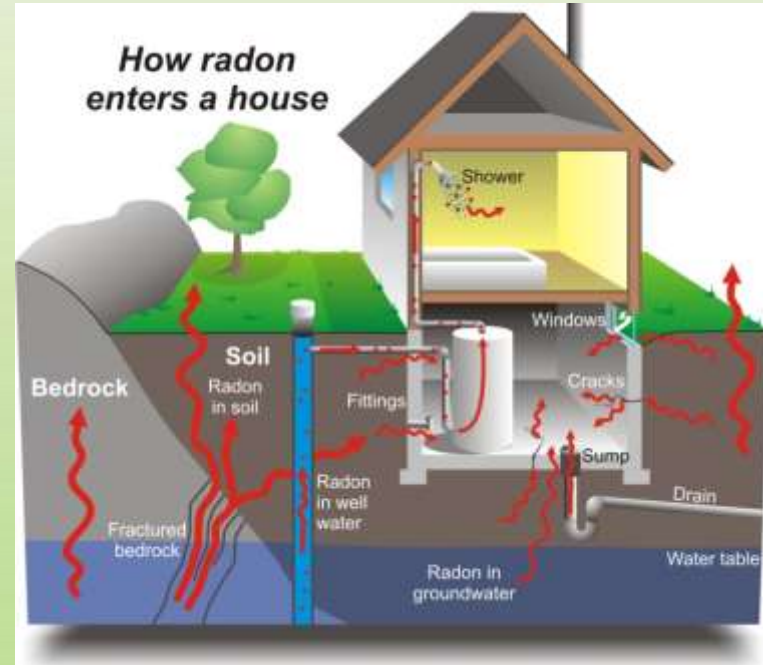
Radon real time  
monitoring system



### Aquifers and wells



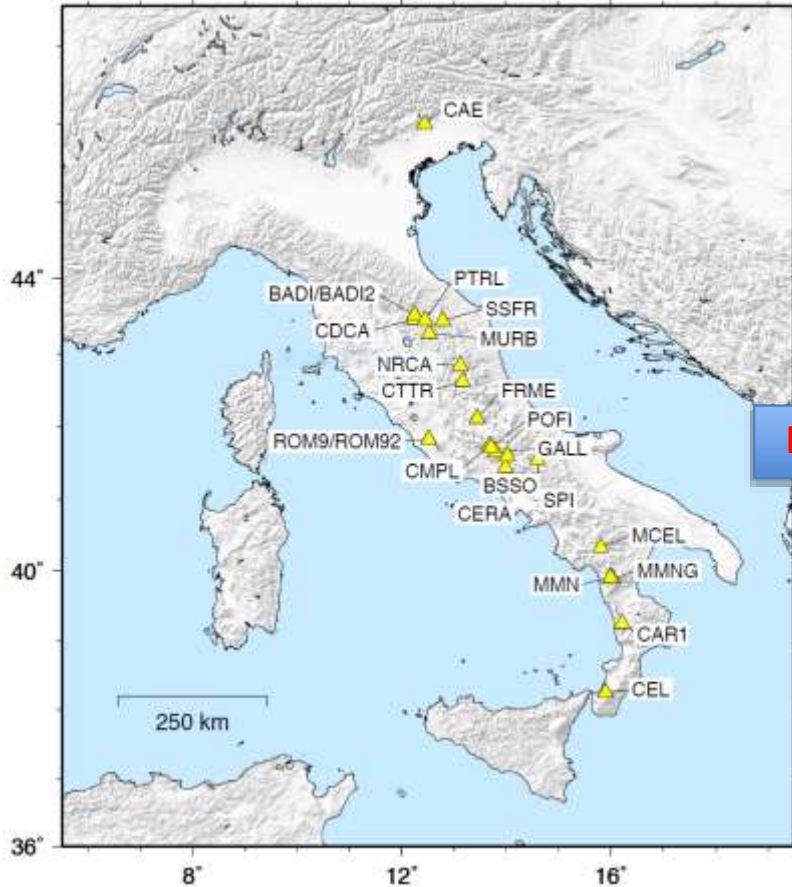
### How radon enters a house



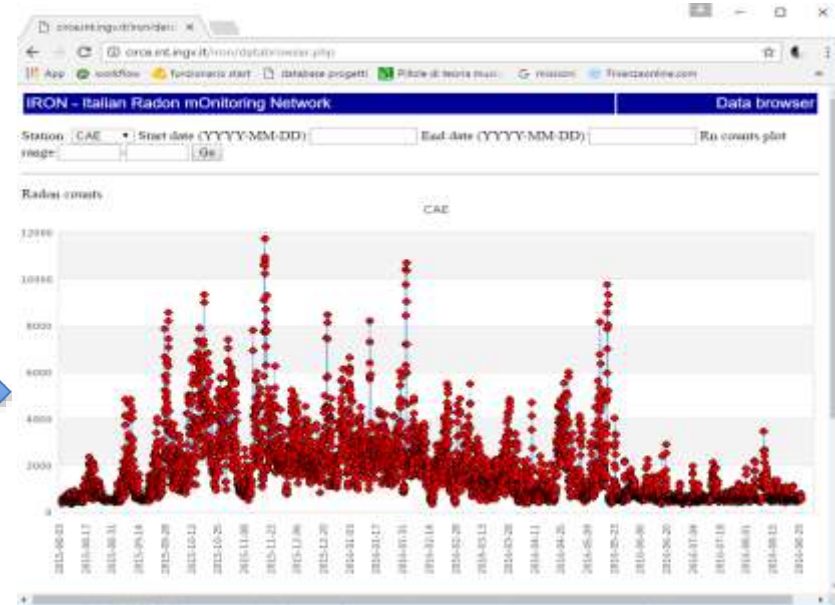


## Monitoring

# IRON: Italian Radon mOnitoring Network



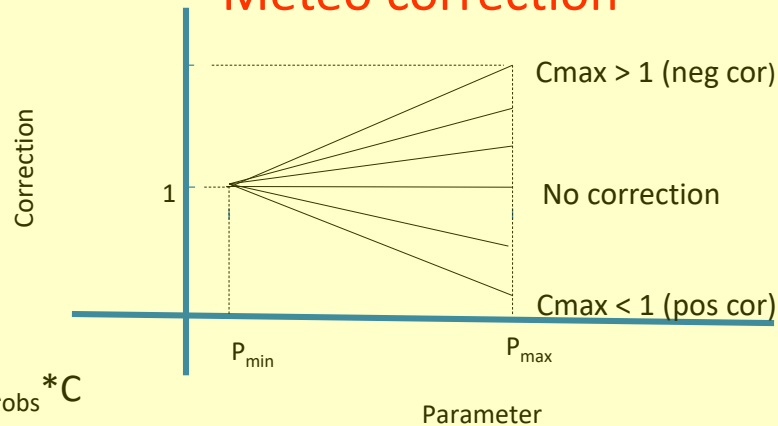
DataBase



23 Permanent stations  
Continuous measurements (real time)

## Monitoring

### Meteo correction



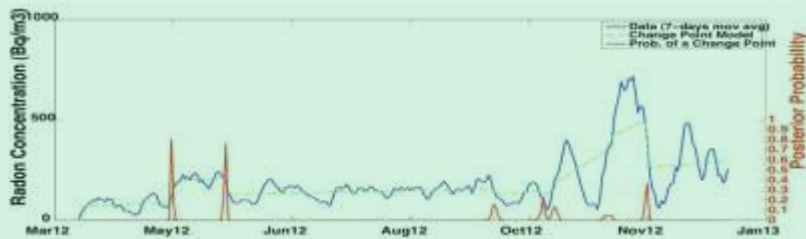
$$R_{corr} = R_{obs} * C$$

$$C(P_{min}) = 1,$$

$$C(P_{max}) = C_{max},$$

$$C(P) = (C_{max} - 1) * P_{max} / (P_{max} - P_{min}) + (P_{max} - C_{max} * P_{min}) / (P_{max} - P_{min})$$

### Change point analysis



### Detection algorithm



## Measurements

### Soil gas Radon activity



Solid-state  $\alpha$  detector that allows the measurement using the activity of relative daughters ( $^{218}\text{Po}$ ), that reaches equilibrium with parent nuclides in about 15-20 minutes

### Dissolved Radon in groundwater



Degassing unit for dissolved radon transfer to activated charcoal canisters. Further laboratory analysis by  $\gamma$  spectrometry

## Measurements

### Radon indoor

#### Passive detectors

Track – etches. Suitable for prolonged exposition (months). Their employment fulfils European Directive 2013/59Euratom of 5/12/2013 that European countries must transpose before 6/2/2018



Activated charcoal canisters.  
Suitable for short exposition (48h)



#### Active detectors

Sensors for detection of  $\alpha$  decays  
(INGV, Algade, Airthings, etc.)





## Measurements

## Calibrations

Layout of calibration facility when many instruments are to be simultaneously calibrated.

Radon concentration, temperature and RH are varied to study the instrument linearity.

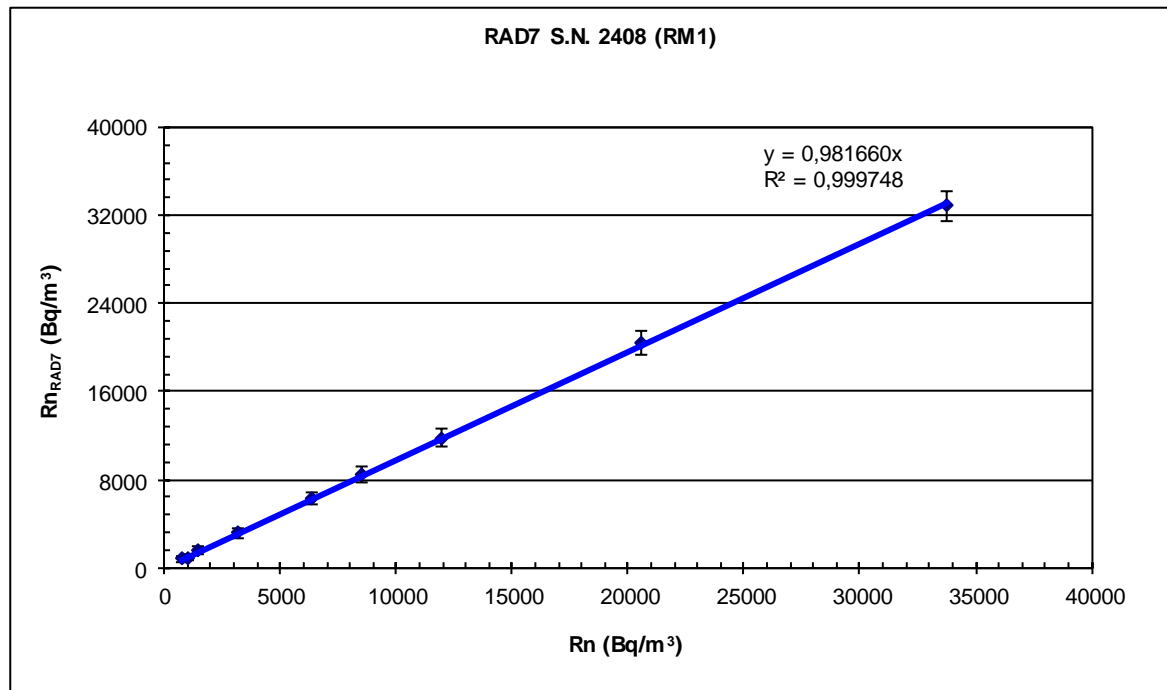
1. Radon chamber (RC);
2. Drying and humidifying devices;
3. Multichannel analyser/Multiscaler;
4. INGV sensor;
5. RAD7 (DurrIDGE) sensor;
6. Secondary RC containing many smaller sensors (Corentium, AER Plus)





## Measurements

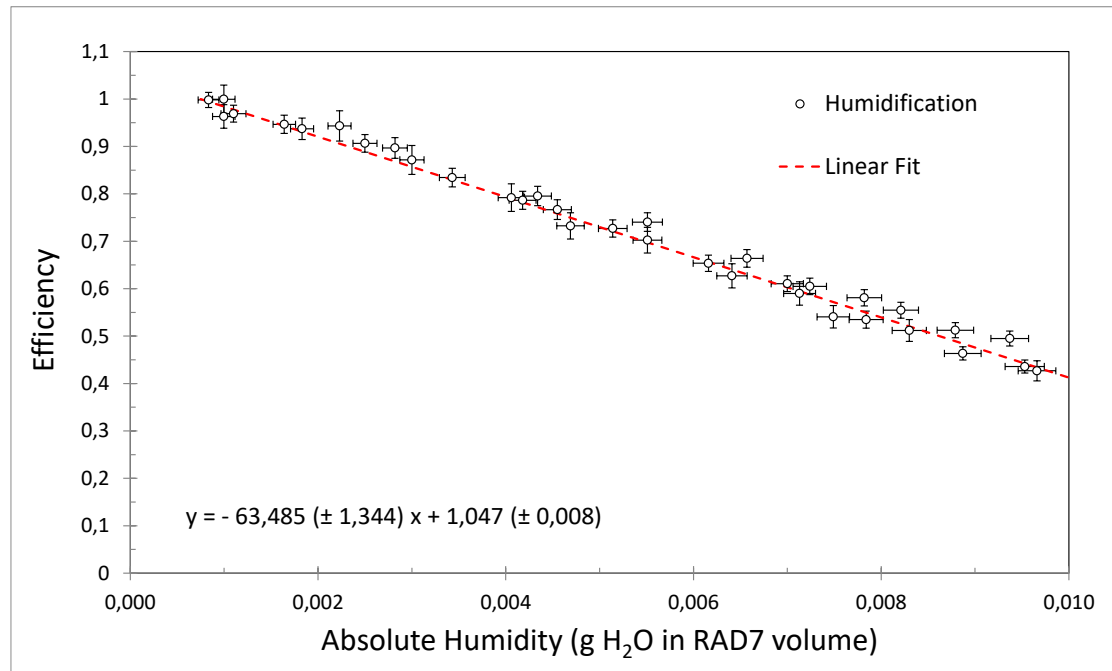
## Calibrations



RAD7 linearity (at low AH) and correction (1/0.982) to the internal calibration coefficient

## Measurements

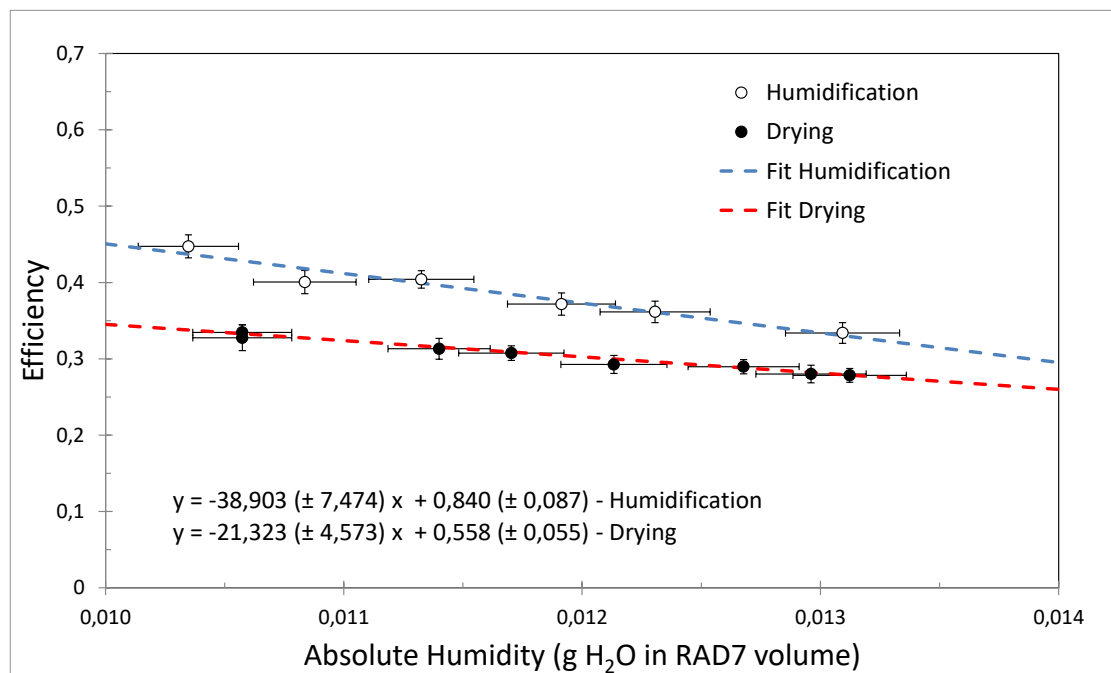
## Calibrations



RAD7 behaviour as a function of AH (less than 0.010 gH<sub>2</sub>O in RAD7) and correction (1/E) to the internal calibration coefficient (De Simone et al. 2016. INGV – Roma Tre collaboration)

## Measurements

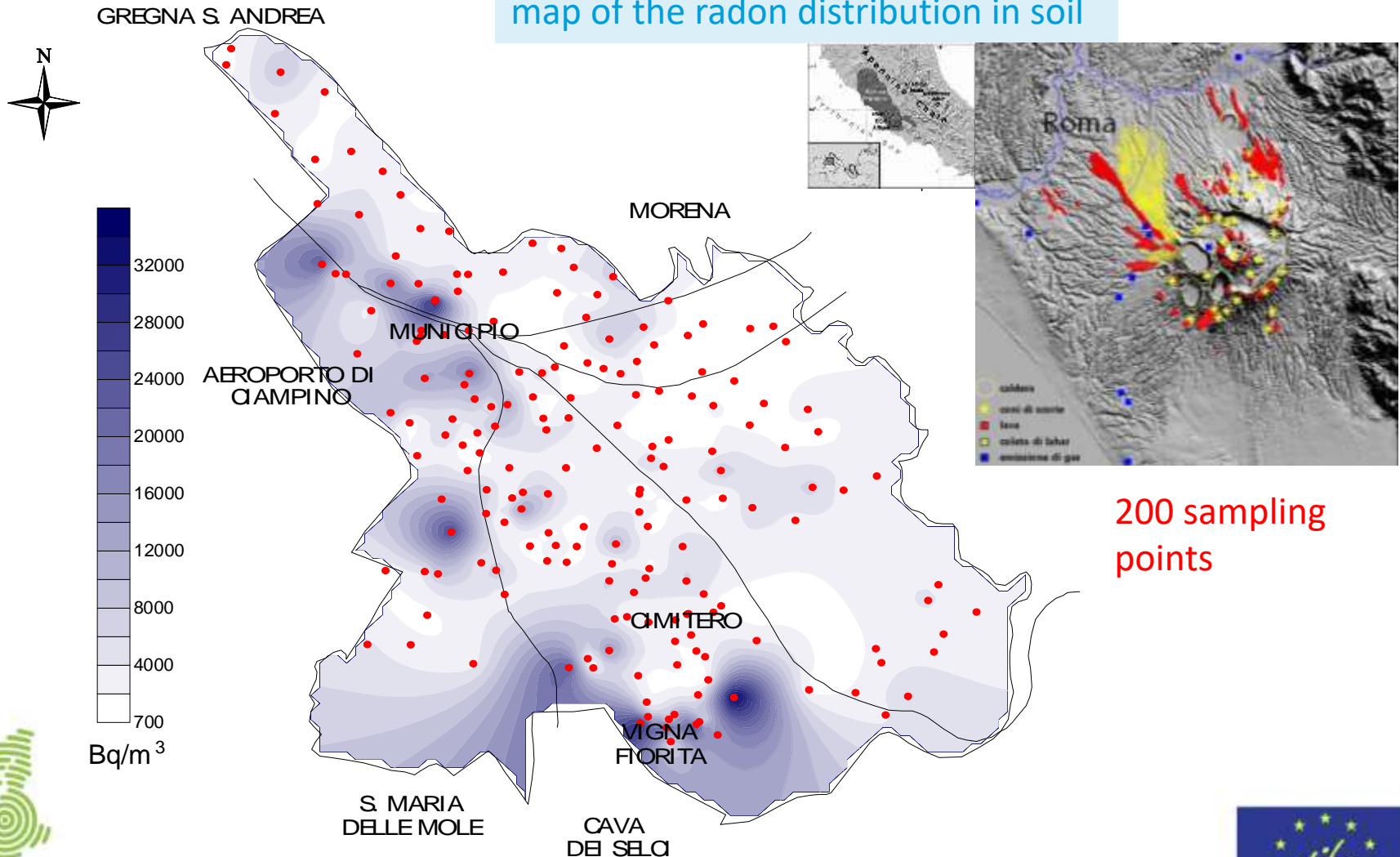
## Calibrations



RAD7 behaviour as a function of AH (greater than 0.010 gH<sub>2</sub>O in RAD7) and correction (1/E) to the internal calibration coefficient (De Simone et al. 2016. INGV – Roma Tre collaboration)

## Ciampino: available geochemical data

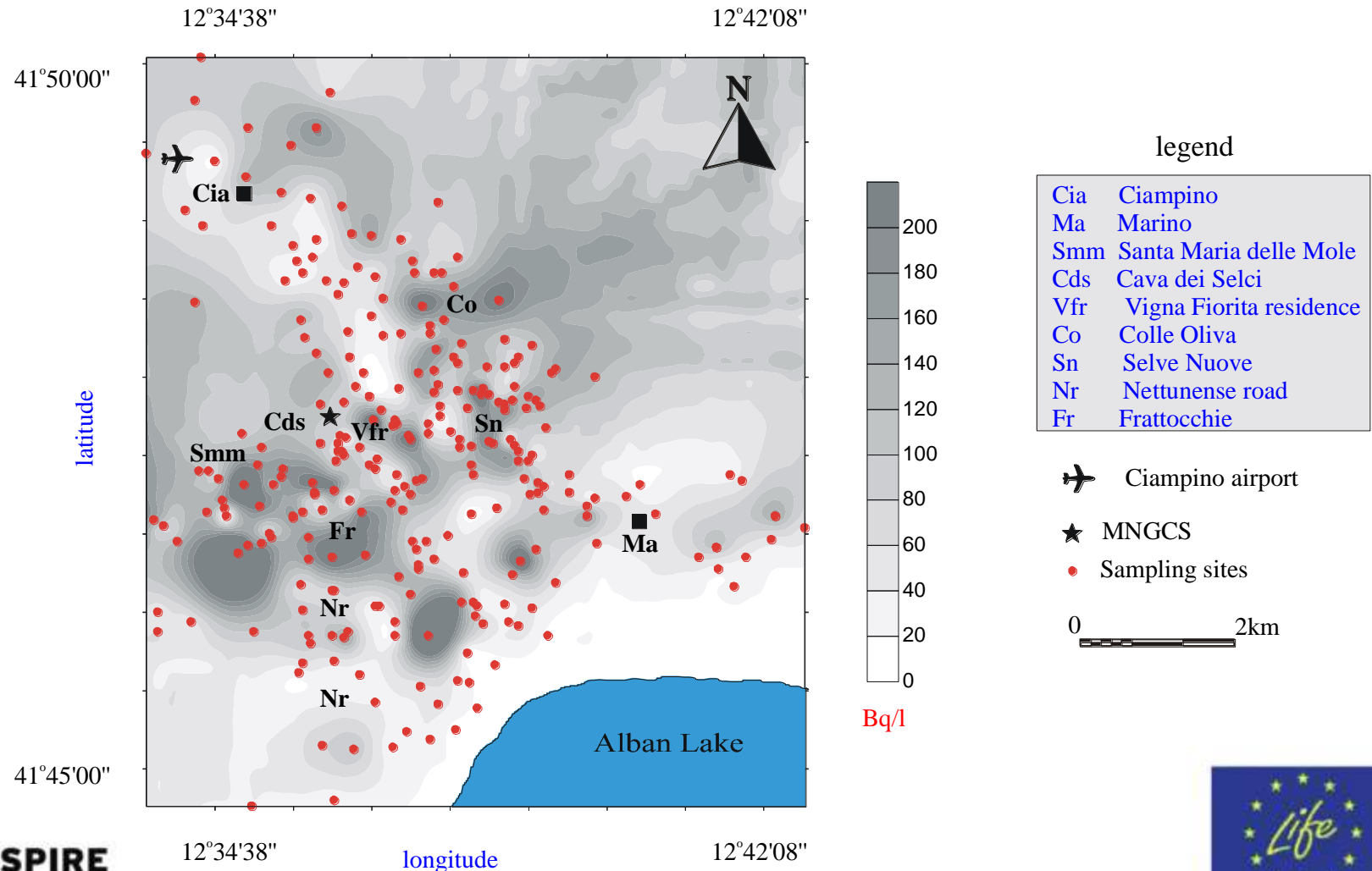
Marino and Ciampino municipalities:  
map of the radon distribution in soil





## Ciampino: available geochemical data

Marino and Ciampino municipalities: map of the radon distribution in groundwater

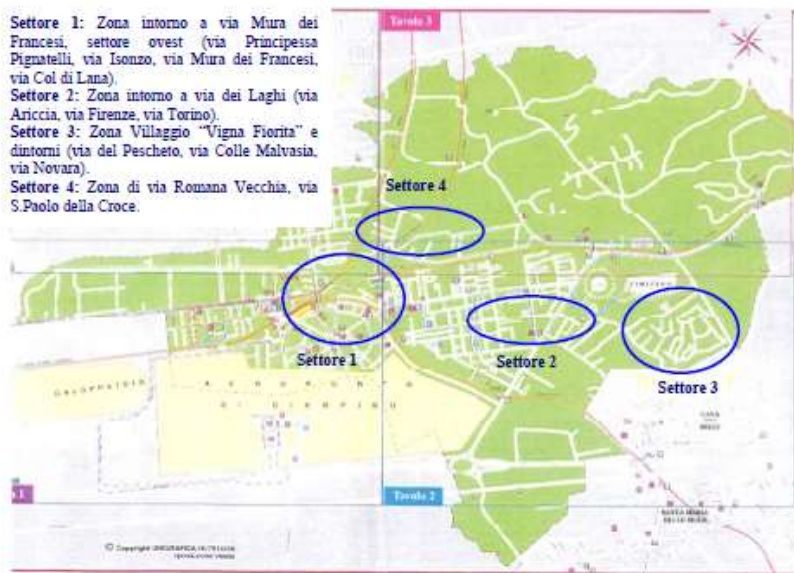


## Ciampino: available geochemical data

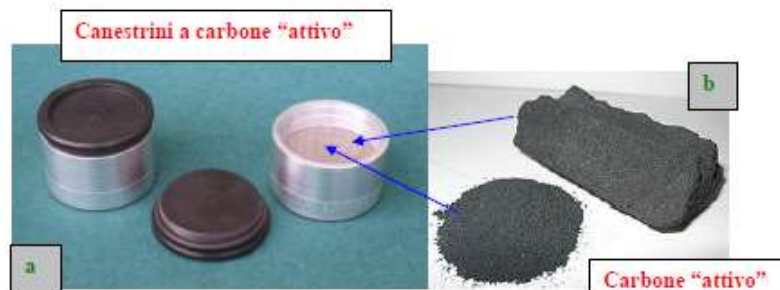
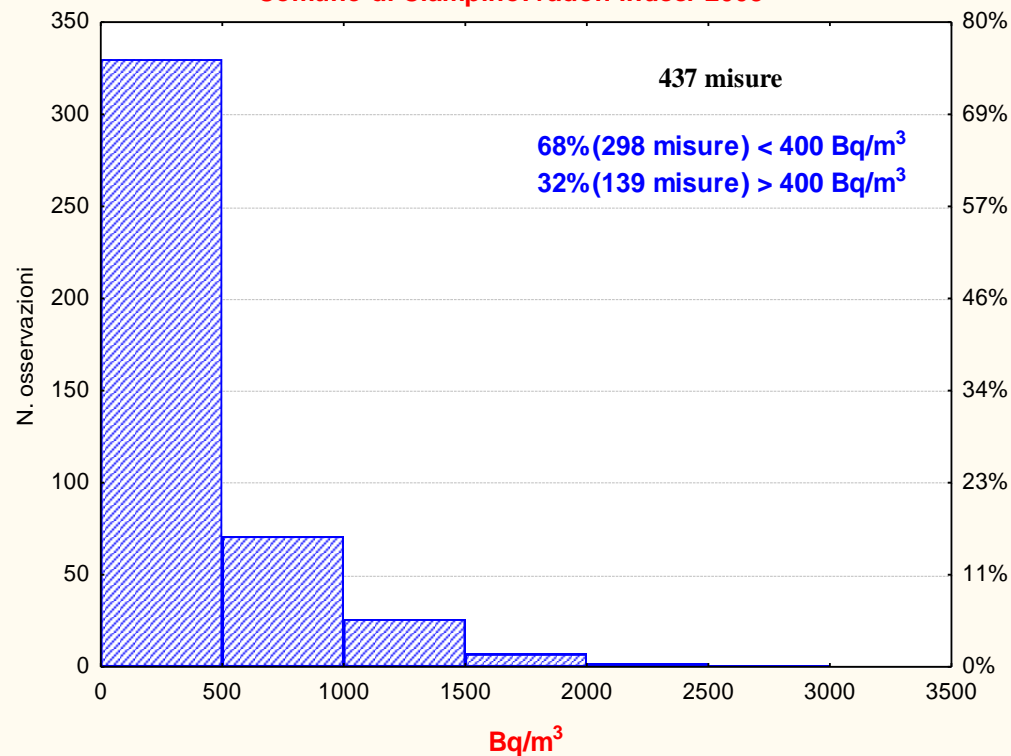
### Radon indoor

Monthly sampling in 15 sites:  
12 private buildings and 3 schools

Settore 1: Zona intorno a via Mura dei Francesi, settore ovest (via Principessa Pignatelli, via Isonzo, via Mura dei Francesi, via Col di Lana).  
Settore 2: Zona intorno a via dei Laghi (via Ariccia, via Firenze, via Torino).  
Settore 3: Zona Villaggio "Vigna Fiorita" e dintorni (via del Pescheto, via Colle Malvasia, via Novara).  
Settore 4: Zona di via Romana Vecchia, via S. Paolo della Croce.

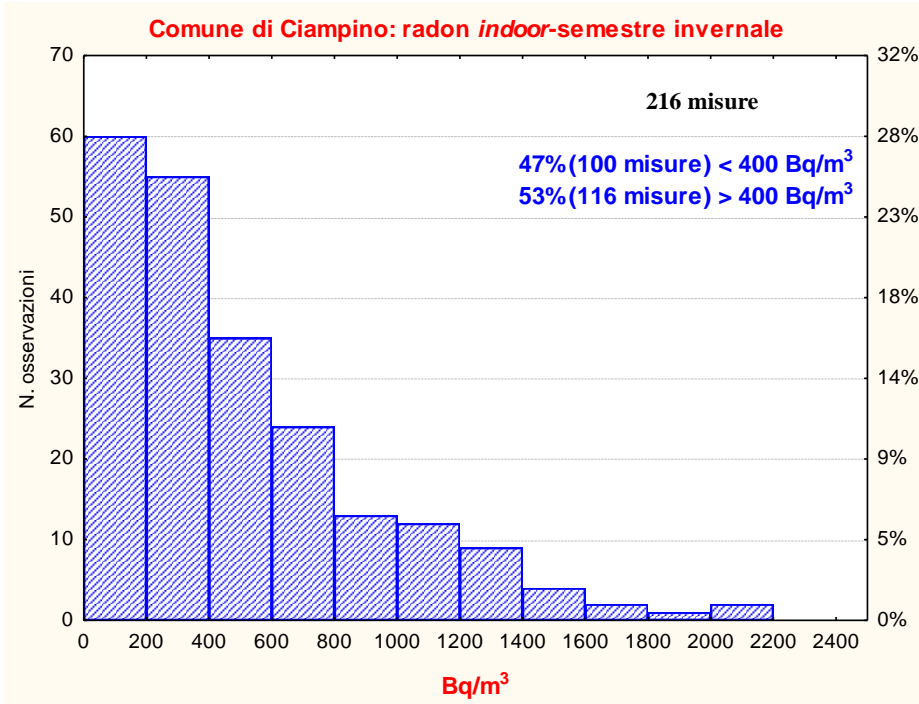


Comune di Ciampino: radon indoor 2008

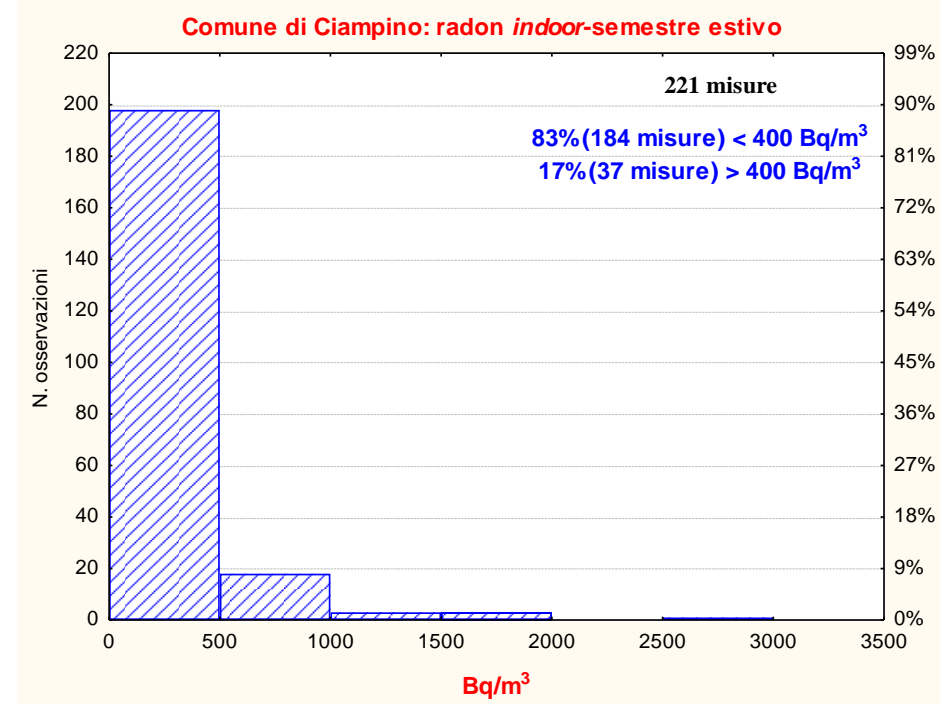


## Ciampino: available geochemical data

### Radon indoor



winter



summer

# Perception of hazard and Risk

In risk mitigation strategies, communication and information have an important role, in particular during long lasting periods of inactivity/quiescence. Several worldwide researches focused on the public's understanding and perception of natural hazards have highlighted that risk mitigation actions have to be based on the real needs and knowledge of the at-risk population.

On the bases on some studies we carried out on natural hazard and risk perception (aimed to evaluate the level of knowledge of the hazard and risk, level of information received and these factors relationship with residents' sense of community) a survey on Radon Hazard public perception, also finalized to introduce RESPIRE project, will be performed in order to evaluate both hazard perception and project interest perceived by people living in at risk areas

- The survey instrument will be a questionnaire, and it will be developed in collaboration with all Project partners. The questionnaire (OMR) will be design for general population target, represented by residents in RESPIRE investigated Municipalities (Italy and Belgium)



**RESPIRE**

Radon real time  
monitoring system

Barberi F., Davis M.S., Isaia R., Nave R., Ricci T., 2008 Volcanic risk perception in the Vesuvius population, J. Volcanol. Geotherm. Res. 172 (2008) 244–258

Ricci T., Barberi F., Davis M., Isaia R., Nave R. (2013) Volcanic risk perception in the Campi Flegrei area. J. Volcanol. Geotherm. Res 254 (2013) 118–130

Nave R., Ricci T., Davis M., Pacilli G. (2014) Rapporto sulla ricerca Percezione del hazard vulcanico alle Isole Eolie. Febbraio 2015. Dipartimento Protezione Civile, ROMA

Nave R., Ricci T., Pacilli M.G. (2016) Perception of Risk for Volcanic Hazard in Indian Ocean: La Réunion Island Case Study. In: Bachelery P., Lenat JF., Di Muro A., Michon L. (eds) Active Volcanoes of the Southwest Indian Ocean. Active Volcanoes of the World. Springer, Berlin, Heidelberg



## Radon hazard and risk perception survey: PHASES:

- **Sample Choise:** Population residents in RESPIRE investigated area.
- **Survey Methodology:** The instruments that will be developed is a Questionnaires (OMR) with a series of item, also oriented on peculiar aspects of the investigated are each.
- **Questionnare Distribution and Collection:** The survey distribution will designed to reach a representative population sample ( gender, education..)Teachers, students, volunteers of local civil protection associations and community groups will collaborate with the researchers to distribute questionnaires.
- **Data Analisis:** Results will be crucial in order to plan communication and information activities

# Communication efficacy of Hazard and Risk Maps

In the communication chain between scientists and decision makers (end users), maps represent a fundamental tool and the widespread source of information on hazards zoning, and the related at risk areas definition. Anyway the relationship between volcanic phenomena, their probability and potential impact can be complex and the geospatial information not easily decoded or understood by not expert even if decision makers. Particularly, recent studies have shown that hazard and risk maps are sometime difficult to interpret and consequently preparedness to react to activity escalation and to manage the emergency may be compromised, even when users have high levels of education.

Focusing on Radon hazard, the goal of is to improve the communication efficacy of scientific outputs, as maps, shaping them taking into account opinions and needs of the different stakeholders, on the bases on authors previous researches. An Evaluation/Validation procedure will be applied on the hazard tools developed by RESPIRE.



**RESPIRE**

Radon real time  
monitoring system

Nave, R., Isaia, R., Vilardo, G. and Barclay, J. (2010). Re-assessing volcanic hazard maps for improving volcanic risk communication: application to Stromboli Island, Italy, J. of Maps, v2010, 260-269. 10.4113/jom.2010.1061

MEDSUV REPORT [http://cordis.europa.eu/result/rcn/191839\\_it.html](http://cordis.europa.eu/result/rcn/191839_it.html) ( **WP6 : Hazard assessment, disaster preparedness and mitigation. Task 6.3** : Capacity building and interaction with decision-makers.)

## Maps Evaluation/Validation Procedure: PHASES

- **Sample Choise:** decision makers, local civil protection officials, (End users), Teachers, working in and the municipalities and Regions included in RESPIRE investigated area
- **Survey Methodology:** Semi-structured interviews, with the sample of stakeholders defined. The interviews will be provide both quantitative and qualitative data:.
- **Maps:** A set of maps showing peculiar hazard/s data and field info, will be selected and presented during the interview
- **Analysis of indications from the interviews:** The outcomes' analysis will assess level of respondents' understanding of content as displayed, and their needs in representing the complex information embedded in the thematic representation
- **New geospatial representations** of information related to Radon hazard and risk will be produce employing GIS tools. A second round of semi-structure interviews on these new maps is requested to complete the evaluation/validation procedure.

# The INGV experience in the Radon study: measurements and monitoring techniques

## Dissemination

Participation to international and national events:



Special Event on Radon subject, such as workshops and seminars







Thank you for your attention

