



HAL
open science

An inventory of territorial approaches to the management of domestic radon risks in France

Cynthia Reaud, Sylvie Charron, Sylvain Andresz, Caroline Schieber

► To cite this version:

Cynthia Reaud, Sylvie Charron, Sylvain Andresz, Caroline Schieber. An inventory of territorial approaches to the management of domestic radon risks in France: Difficulties, key successes and ways forward. IRPA 16th international congress - 69th HPS Annual meeting 2024, Health Physics Society, Jul 2024, Orlando (FL), United States. hal-04576036

HAL Id: hal-04576036

<https://hal.science/hal-04576036>

Submitted on 15 May 2024

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Copyright

**AN INVENTORY OF TERRITORIAL
APPROACHES TO THE MANAGEMENT OF
DOMESTIC RADON RISKS IN FRANCE**
Difficulties, key successes and ways forward

C. REAUD

Institute of Radiation Protection and Nuclear Safety (IRSN)
Fontenay-aux-Roses, France
Email: cynthia.reaud@irsn.fr

S. CHARRON

Institute of Radiation Protection and Nuclear Safety (IRSN)
Fontenay-aux-Roses, France

S. ANDRESZ

Nuclear Protection Evaluation Centre(CEPN)
Fontenay-aux-Roses, France

C. SCHIEBER

Nuclear Protection Evaluation Centre (CEPN)
Fontenay-aux-Roses, France

Abstract

During a decade, the French Institute of Radiation Protection and Nuclear Safety (IRSN) has been involved in 2 territorial multi-partner approaches for the management of domestic radon risk. Their feedback showed the relevance and the innovative nature of the projects implemented to develop radon-awareness among the population, to encourage radon measurement and implementation of remediation work. The projects also show the importance of stimulating the commitment and the growing competence on radon of building professionals. Nevertheless, despite these positive feedback, the recurring issue remains the difficulty for the inhabitants to go beyond the measurement step.

It appeared therefore necessary to obtain a global view of the territorial approaches carried out in France. In June 2020, IRSN started to inventory the approaches undertaken at the territorial level (in which IRSN was not involved directly), to describe them, identify their difficulties, solutions and key successes, ultimately aiming at promoting the sharing of regional experiences at a national level. Interviews were conducted in 11 regions with a wide range of stakeholders: regional/territorial public bodies (e.g. health, environment, ecological transition), NGOs and municipalities.

The lack of building professionals has been confirmed as being the main difficulty for inhabitants; not only to undertake remediation action but also to provide building expertise that is a key step to identify these remediation actions. These deficits have led some territories to even stop their action on radon and others to adapt, notably by searching for new actors to ensure the “relay” of building expertise. Additional investigations on this topic have been conducted with support of CEPN (Nuclear Protection Evaluation Centre) to analyse the experiences of these new actors *in relay* and assess the possibility and conditions of the transferability of these approaches in other territories.

This paper will present the results of the inventory of domestic radon management approaches in France, highlighting their difficulties, success factors, and also dress early perspectives for action.

1. INTRODUCTION

Considered as the second leading cause of lung cancer after smoking, radon is responsible for approximately 10% of all lung cancer deaths each year in France [1]. This risk raises strong environmental health issues for public policy, despite there are currently no strict regulations relating to its management in private housing in France¹.

¹ Since 2018, buyers/tenants of real estate located in areas with significant radon potential must be informed by the seller/owner of the existence of these risk.

For over a decade, the French Institute of Radiation Protection and Nuclear Safety (IRSN) has been involved, as co-pilot, in two territorial multi-partner approaches for the management of domestic radon risks in the *Bourgogne Franche-Comté* region (East of France) and the *Haute-Vienne* department (Central France). Their feedbacks demonstrate the relevance and the innovative nature of the projects implemented to develop radon awareness among the population, encourage radon measurement, and implement remediation work. The projects also showed the importance of stimulating the involvement and the growing expertise on radon of building professionals. Nevertheless, despite positive feedback, the difficulty for residents to go beyond the measurement step remains a recurring issue.

Therefore, a global view of local approaches in which IRSN was not directly involved seemed necessary to repertory, describe local strategies and to identify difficulties and key successes.

2. METHODOLOGY AND FIRST RESULTS

2.1. Methodology

In June 2020, IRSN began inventorying local approaches in which IRSN was not directly involved. Investigations began by collecting contact details on the internet via articles from the regional daily press, websites of regional public bodies (e.g. health, environment and housing) and websites of communities located in radon prone areas. More than 30 (virtual) interviews were conducted with a variety of stakeholders from eleven regions (Fig.1): regional public bodies (dedicated to health, environment, or housing), NGOs (dedicated to environmental health or consumer associations), and communities (cities, agglomeration).

Although these interviews were based on a semi-directive framework, there were some room of manoeuvre to keep discussions open. All the interviews aimed to gain a clearer understanding of:

- the approach undertaken by the territory
- the partners involved
- the funding mechanisms
- the risk perception of residents and their level of involvement
- key successes
- difficulties encountered
- ways forward.

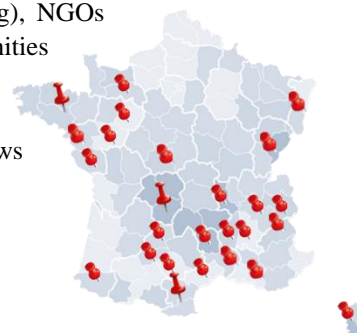


Fig.1. Radon prone areas where interviews were carried out

2.2. Radon risk management framework generally adopted in France for private housing

In theory (assuming that the stakeholders face no obstacles), the general formal approach adopted by regions can be summarized as follows.

The Regional Health Agency (ARS) promotes radon actions in private housing by launching calls for tenders via a Regional Plan for Health and the Environment (PRSE) to subsidize *radon operators*. Their task is to organize awareness and radon measurement campaigns and to accompany residents in finding solutions if their home presents “high” concentrations of radon. Most radon operators are NGOs, often specialized in environmental health or consumers’ associations.

In cooperation with the Regional Health Agency (ARS), these NGOs contact communities located in radon prone areas. The NGOs fully coordinate these activities. In turn, the communities finance communication media (articles in the community newsletter with invitations to public meetings, local press, poster campaigns in strategic locations in the city, etc.), provide a room for public meetings.

Face-to-face public meetings (or webinars during the COVID-19 pandemic in 2020 and 2021) are organized between October and January by NGOs in cooperation with the communities to launch the program. These meetings are organized in the evening. General information on radon and radon risks are presented, and a *radon kit* including a dosimeter, a questionnaire on the characteristics of their home to be filled in by the resident, and a stamped envelope to return the kit to the NGOs is given to each resident.

After two consecutive months of measurement at home (to be performed between October and April, as recommended), the dosimeters are sent in one batch to an accredited measurement laboratory. Next, the NGOs send the results to each resident with a personalized letter giving some general recommendations (aeration, basic

corrective actions, etc.) according to the radon concentrations: $<300 \text{ Bq.m}^{-3}$, between 300 and 1000 Bq.m^{-3} and $>1000 \text{ Bq.m}^{-3}$. For residents whose homes have higher radon concentrations ($>1000 \text{ Bq.m}^{-3}$), the personalized letter includes the recommendations cited above as well as, in some areas, the proposal for a free *building diagnosis*, paid for by the Regional Health Agency. *Building diagnosis* is a key step in identifying the remediation work required. If corrective actions are implemented, a dosimeter is offered (free of charge) to the residents for a post-remediation work aiming at evaluating/confirming their efficiency.

Besides the general framework described above, some areas favour other types of action. For example, the Regional Health Agency (ARS) of *Corsica* favoured a major awareness campaign on indoor air quality (about daily aeration, improving or optimizing the technical conditions of ventilation inside the home) targeting the entire region (not just the radon prone area) rather than a measurement campaign in prone areas. A radon operator - a scientific mediation association - in the *Hautes-Alpes* department, offers workshops on indoor air quality (integrating radon) in primary schools. In parallel, they develop fun learning tools, such as the Escape-Game “*In the Footsteps of Professor Radonowitch*” (for adults and children), an exhibition called “*Radon: a Killer in the Hautes-Alpes*”, created in the spirit of a humorous police investigation and illustrated in the form of a comic strip to target a very wide audience, which is generally accompanied by a workshop/experiment on rocks during Science Festivals. The objective of these fun learning tools is to play down the subject and make it less anxiety-provoking.

2.3. Key elements of success

Discussions with our contacts have highlighted a set of good practices outlined in this section.

Evidently, as the contexts are different in each area, all these good practices cannot be transposed directly to other areas. However, highlighting and sharing good practice can inspire local stakeholders when working on awareness-raising and risk management initiatives or in order to continue process in case of difficulties.

First of all, it is important to stress the importance of local stakeholders in managing radon initiatives.

— Involvement of Regional Health Agencies (ARS): promoters of territorial actions

ARS obviously play a very important role in domestic radon risk management. Strong involvement of the ARS in this issue and their financial support - as part of calls for tenders – to both local NGOs implementing awareness-raising campaigns and measures, as well as the financing of dosimeters, and *building diagnosis*, is an essential condition to ensure the commitment of communities and residents in this process. Some contacts noted that if the communities or residents had to finance the purchase of dosimeters themselves, few measurements would have been made.

One good practice to highlight is the ARS’s organization, once or twice a year, of specific *Morning Sessions* dedicated to radon awareness to which elected representatives and members of communities located in radon prone areas are invited. These sessions comprise presentations from different public bodies as well as a testimonial from an association and a community on a joint measurement campaign in private housing. The importance of organizing these *Radon Morning Sessions* not only in big cities but also in small towns should be noted. Collecting the testimonials of a comparable community might further motivate elected representatives to get involved in this issue. These events also foster the relationship between NGOs and communities.

— NGOs involvement: stakeholders working in the field, trustworthy partner

The implementation and management of radon actions by NGOs (radon operators) is well perceived by communities which have already many sensitive issues to manage. Moreover, residents know them and trust them, which is essential for the success of the approach and the involvement of individuals.

Their local links ensure the sustainability of the actions in place. In some of these structures, several members are educated on the radon risk. Training several members could be a solution to overcome the difficulty of person-dependent pilots which, if that person leaves, raises the threat of an interruption of the dynamic or a strong slowdown.

— An elected official strongly involved = a mobilized population

This study shows that the more elected representatives are involved in radon risk initiatives, the larger and more effective the communication campaign on measurement is and the more the population will be involved. Regarding the communication campaigns undertaken by communities, good practices can be put forward, such as articles in community newsletters, articles in the local newspaper, local TV reports, distribution of flyers at markets, and major poster campaigns (in public places, medical analysis laboratories, etc.).

- Institutional support: support of national public experts required to legitimize local initiatives

The local actions carried out by ARS and NGOs will be all the more legitimate and convincing with elected representatives and the population if the awareness/measurement campaigns are supported by national radiation protection and building experts.

- Include radon in indoor air quality policies

Communicating only from the perspective of radon risk, outlining long-term exposure risks, has appeared over-alarming and ineffective in some areas. Most awareness actions have been set up with a global approach under an indoor air quality policy conveying more positive messages, aimed at a *healthy home* and well-being at home, which are much more motivating.

- Include radon actions in city/regional programs

Our contacts agree that territorial radon risk management actions must be included in territorial programs in order to make them sustainable. The sustainability of actions will then no longer depend on a person but upon a territorial policy, which ensures continuity of the actions undertaken.

- Redundancy of radon initiatives

Renewing each year radon campaigns fosters the sustainability of the approach. In several areas, word of mouth sparked the interest of new communities to join raising awareness actions and new residents to set up radon measurements in their homes.

- Public meetings: a resident who participates is already an *involved* resident

Public meetings seem effective in raising awareness among the general public. According to *radon operator* NGOs, a resident who makes the effort to come to a public meeting is a resident who is already involved in the rest of the process. This format makes it possible to answer participants' questions directly, whether during the presentations or subsequently. Moreover, some contacts note the relevance of face-to-face meetings, particularly in small communities where public meetings are seen as social events because the residents know each other better than in the big cities.

- Webinars: a way to attract a younger audience?

During the Covid-19 pandemic, webinars replaced face-to-face meetings. Even though the participation rates were lower, this format may have attracted a different category of population which, until then, had rarely attended public meetings due to lack of time or childcare issues: mainly working people and couples with young children. As such, some NGOs plan to organize, in the future, both face-to-face public meetings and webinars to reach a wider audience.

- Promoting complementary actions to public meetings: fun and easy access tools for all audiences

Fun awareness-raising materials can be presented in parallel with public meetings, in less formal places (markets, other events, such as Science Festivals or Home exhibitions), close to a population that is not used to participating in public meetings. Moreover, in-class activities are a good way to raise awareness of indoor air quality from an early age and to help children acquire durable habits (daily aeration, for example). Raising children's awareness is also an indirect way of raising parents' awareness of this issue and arousing curiosity that can lead to a positive response to invitations by NGOs to attend public meetings on radon and to measure radon levels at home.

2.4. Difficulties

- Unknown and neglected risks

While radon is a major public health issue and despite numerous regional initiatives, it remains largely unknown among the general public. This is confirmed by the 2021 IRSN Barometer which monitors, through annual surveys, the French population's opinion on various risk situations, including nuclear and radiological risks. Included in the Barometer in 1997, the radon risk is regularly located at the very end of the classification of risk situations (second-to-last in 2020). In 2020, 20% of French people considered this risk as high, 43% as medium and 36% low [2].

The percentage of respondents who answer "Do not know" (concerning the level of radon risk) has been declining since the beginning of the 2000s but still remains high today with 17% of responses. In order to collect more precise information on effective knowledge of radon risks, two specific questions were asked during the 2020 Barometer (Fig.2):

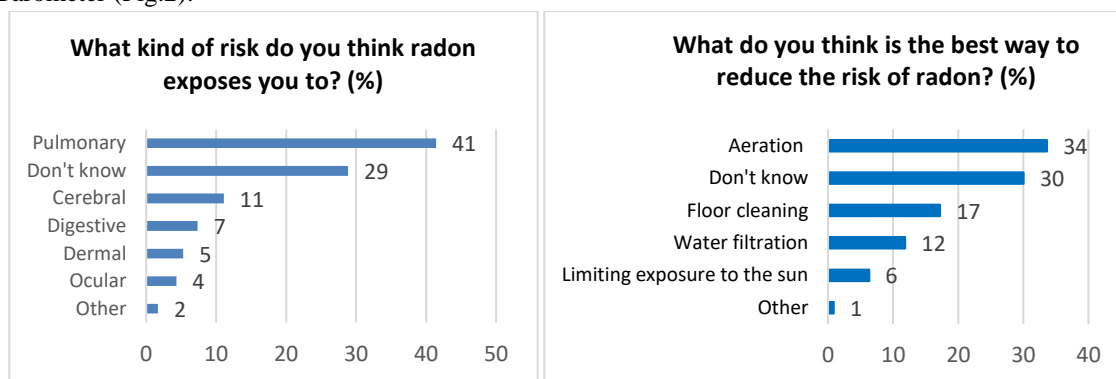


FIG. 2. Additional questions in 2020 IRSN Barometer to measure effective knowledge of radon risks among the French population

To the first question, 41% of French people gave the correct answer (namely the pulmonary risk). Three out of ten French people said they “do not know” and the same proportion answered incorrectly. Moreover, among those who declared that the level of risk due to radon was high (“high” or “very high” answers), only 43% correctly identified the pulmonary risk.

With regard to the means of prevention, only 34% of French people gave the correct answer (i.e. aeration), 36% answered another means (ineffective), and 30% said they did not know.

In addition, among the people who answered with pulmonary risk (41% of the sample), only 52% gave the right means of prevention (aeration). This indicates that only two out of ten French people have adequate knowledge of the risk: both of its nature and a mean of protection against it.

We can assume that a large part of the French population questioned as part of the IRSN Barometer lives in low-risk areas and is therefore not impacted by the French prevention policies implemented in prone areas. This argument may help explain the low knowledge of the risks. However, despite the launch of new measurement campaigns each year, regional Barometers on the perception of environmental risks, including radon, confirm this lack of knowledge among the population. This is the case in the *Occitanie* region (radon prone area in the South of France). The 2018 regional Barometer indicated that 75% of interviewees did not know about the radon risk and only 6% of residents in radon prone areas knew that their community had a radon issue.

— Reluctance of some communities to raise radon risk awareness

Some communities categorically refused to inform their residents of the radon risk (especially those located on the coast or near former uranium mines). The reasons for refusal can be the potential degradation of the image of the area or, for some large cities in the South of France with major unhealthy housing problems, a fear that adding the radon issue would lead to occurrence of disputes between tenants and property owners or between tenants and communities in the case of social housing.

— Difficulty in involving certain audiences: younger public, tenants, and residents of social housing

As mentioned above, young people rarely attend public meetings (because of work or childcare constraints etc.) and most attendees are retirees. It also remains very difficult to involve tenants (participants in public meetings being mostly owners) and residents of apartment blocks. Attempts to involve people living in social housing have so far been unsuccessful in some cities.

— Lack of awareness among healthcare professionals

According to the 2015 IRSN Barometer, to the question “To inform you about the risks associated with radon, you would consult...”, the general practitioner (*family doctor*) is quoted first (37% of quotes). However, healthcare professionals seem unaware of this risk.

This is confirmed by a regional environmental health Barometer in which a study was conducted between 2014 and 2016 with a panel of general practitioners. When asked about their knowledge of the existence of certain environmental factors in their area of practice, only 5% of practitioners cited radon.

Some attempts to involve healthcare professionals to relay information to the general public (or to distribute dosimeters) have been carried out in pharmacies in some areas. These actions did not have the expected success and were not renewed because the pharmacists, feeling that they were ill-informed on the subject, were unable to answer questions asked by their customers.

— Difficulty in assessing the effectiveness of the territorial actions undertaken

Only very few residents whose homes have high radon concentrations follow the process through to the end. In some areas, few *building diagnosis* visits are accepted by the residents (in some areas only 2/3 of *building diagnoses* visits are carried out, based on a dozen proposed free of charge), fewer remediation works are undertaken and even fewer control measurements after corrective actions are made.

When residents explain their refusal to continue the process beyond initial measurement, the following are cited:

- fear of devaluing their property;
- fear of the cost of remediation work (especially if they have already invested in energy renovation work);
- they do not know which building professional to contact;
- they have other priorities;
- there is also a certain apathy in managing a natural risk to which no responsibility can be attached, including a long latency period between exposure to radon and the occurrence of lung cancer.

Residents often give the following argument: “*my grandparents lived all their lives in this house and they did not die of lung cancer*”.

Due to the low remediation rate and the difficulties in assessing territorial actions, the promoters and operators of radon action fear that over the mid-term, radon risk will no longer be considered a priority, with a danger of reducing financial support for territorial actions (fewer subsidies for NGOs via calls for tenders, fewer free of charge dosimeters available, less involvement of stakeholders and individuals).

— Lack of building professionals

In a general way, building professionals are unaware of and uninterested in radon risks. Too few professionals are trained in the issue and there is no official list of competent professionals in this field. Hence the difficulty for individuals in finding a professional to carry out remediation work. The obstacles generally mentioned by building professionals are:

- the absence of regulation in private housing in France means the absence of a potential market for them;
- the too numerous building standards and diagnoses;
- the fear of legal proceedings if the remediation work undertaken fails to reduce radon concentrations;
- the difficulty of finding time for awareness/training sessions, their agendas being very full;
- moreover, the subject of atmospheric pollutants (radon and others) and the control of indoor air quality are not included in the initial training of building professionals.

In practice, the field of ventilation is often managed by different trades: electricians (installation of mechanical ventilation), heating engineers, plumbers, window fitters (carpentry, mortise, etc.), door fitters (stripping, etc.), etc. whose actions can negatively impact the tightness of a building and air renewal. This dilution of ventilation skills does not allow an overview and coordination on the subject. On the other hand, complexity is added with energy renovation work in which different trades are involved without any of them considering the radon problem. Without coordination of these different trades, there is a risk of generating high radon concentrations (new buildings, energy renovation).

Even if awareness is raised, in practice, little change took place. Work habits on construction sites are difficult to change. Radon-aware stakeholders with an oversight would be required, such as project managers or architects, but these are few in number and their intervention presents a cost.

The inventory also highlighted the lack of professionals in some areas in the earlier *building diagnosis* step which is an essential step in recommending what remediation work should be carried out. This deficit has led some areas to stop their actions as they did not want to raise awareness among the population without being able to provide the necessary steps to reduce exposure to the radon risk.

Other areas in France have managed to adapt by providing training to local structures to relay these building diagnoses.

It seemed essential, at this point in the study, to further investigate the areas that have succeeded in overcoming this *building diagnosis* obstacle. In view of these observations, additional investigations on this topic have been conducted with the support of CEPN (Nuclear Protection Evaluation Centre) to analyse the experiences of these new *relay* stakeholders and assess the possibility and conditions of the transferability of these approaches in other areas. Results of this complementary investigation are provided in the section below and in the way forward.

3. COMPLEMENTARY INVESTIGATION: METHODOLOGY AND FEEDBACK

3.1. Methodology

To lead this complementary action, a wide range of stakeholders were interviewed: local/regional public bodies (health – ARS and, ecological transition (CEREMA) – a public body with expertise in radon diagnoses); *relay* associations, communities and building trade federations. All of the interviews aimed to gain a clearer view of:

- difficulties encountered in the building diagnostic or remediation step;
- experience of *relay* stakeholders: Awareness, training, support, etc.; Targets and carriers; Costs and funders; Results and feedback; Follow-up data and perspectives;
- networks created or used: territorial, national, professional networks, etc.
- the local/regional plans or programs that may have acted as levers (for the stakeholders) or catalysts (the actions);
- the issue of transferability or not of these experiences to other areas;
- prospects/opportunities taking into account a changing context (energy renovation, pandemic situation).

3.2. Examples of adaptation in some areas

To avoid deadlocked situations, some *work arounds* have been used in some areas, such as *self-assessment tools*² for *on line building diagnoses* or *collective workshops* dedicated to *building diagnoses*. However, these actions are considered insufficient and inefficient by promoters and operators of radon actions in providing quality *building diagnoses*, especially if the residents' knowledge of construction (e.g. type of ventilation) is limited. A visit to their home by a qualified professional is essential for the residents to feel confident in their remediation actions (carried out by themselves or entrusted to a building professional).

A more sustainable and effective solution has been implemented in some other areas where a public expert (CEREMA) searches for associations (specializing in the buildings energy efficiency management and already perform in-home visits) to providing training on the topic of radon diagnosis. A short training course is proposed: ½ day of theory and ½ day of practice (visit to a house with high radon concentrations).

Another example of training is provided by *radon operator* NGO specialized in radon and eco-building. This NGO trains building professionals (architects, project managers, etc.) in a long term perspective (a theoretical module 1 day a month during a year) and a practical module including several visits with a mentoring format. The trained *building diagnosis experts* then meet regularly in a *radon working group* to collectively draw up the diagnosis reports of case submitted. To date, 15 *diagnosticians* have been trained and 120 diagnoses have been made. Trained diagnosticians are listed in a dedicated directory available (on open access on the website of the NGO).

3.3. Feedback: difficulties, needs & key successes

Feedback on these experiences shows that short-term training is no guarantee of the quality of the *building diagnosis*. Radon remains a complex subject and its level of understanding by *building diagnosis experts* is more or less acquired. As for all expertise, radon diagnoses need to be regularly carried on to improve skills and maintain them over time. In addition, some associations have no in depth knowledge about ventilation or building, making the topic of radon even more complex to grasp.

More generally, *relay associations* are often unaware of the actions carried out by their counterparts,

² <https://jurad-bat.net/auto-evaluation/>

including those in the same region, resulting that they feel sometimes isolated. Finally, everyone expresses the need to share *building diagnoses* with counterparts.

One of key successes to note and to advise is the experience mentioning practical training in the form of mentoring and the implementation of a building experts network (as the *radon working group*) to collectively draw up reports and study complex cases.

4. EARLY PERSPECTIVES FOR ACTION

Based on the results of this inventory, early perspectives for action can be suggested hereinafter.

4.1. Sharing experiences and networking

All contacts mentioned the importance of sharing experiences and good practices across the different areas, departments, and regions. This need is even more important for stakeholders who are encountering difficulties in completing specific steps of the process (*building diagnosis /remediation*) and who can thus benefit from the experience and support of others.

Sharing the results of this inventory could be integrated into inter-regional seminars during which the key successes, difficulties, needs and perspective for action could be discussed in a collective manner and provide an opportunity to set up different national or local networks (NGOs, building professionals, etc.).

4.2. Raising the information level and knowledge of specific audiences: elected representatives, younger generation, healthcare professionals

4.2.1. Elected representatives

It appears essential to raise the awareness of elected representatives of communities located in radon prone areas. Events like the *Radon morning sessions* described above could be extended to all radon prone areas, urban and rural. The testimonies of elected representatives who participated in the implementation of measurement campaigns in their areas is a good practice to encourage other elected representatives to implement radon initiatives in their communities. Furthermore, contacts could be made with the Association of Mayors of France or other associations gathering elected representatives on environmental health issues to develop these type of awareness-raising actions (via webinars for example).

4.2.2. Healthcare professionals

It seems essential to involve healthcare professionals (general practitioners, pharmacists) in raising awareness among the general public at the very same time as the launch of measurement campaigns. Indeed, residents who attend public meetings will probably ask their family doctor about radon. As cited above, some attempts have been to involve pharmacists – also trustworthy actors for population- as relay of awareness actions, but they felt themselves ill-informed. If doctors/pharmacists are not informed about this risk, patients/customers could consider that this risk is not that high. To raise awareness more widely and more effectively among healthcare professionals, associations of doctors/pharmacists must be targeted rather than opting for an individual approach which has often proved unsuccessful.

4.2.3. The younger generation?

It is common sense that good habits are more easily acquired at an early age. In addition, an informed child raises awareness in those around him. It could be interesting to cooperate with scientific mediation or environmental associations working with young people to raise their awareness of the risk and support them in the framework of their activities (propose awareness webinars with people from these associations, co-creation of tools with an educational perspective, etc.).

4.3. Encourage building professionals to find interest in the radon management process

In a general way, building professionals need to feel that there is “a future market/business” to find a reason to follow training on radon. It would therefore be appropriate to link communication actions on measurement campaigns lead by communities with communication on training for building professionals. Moreover, to take into account the full agenda of building professionals, the possibility of more casual events such as after-work (also useful for them to network) should be investigated.

To meet the need expressed by *building diagnosis experts* and, in particular, *relay* associations to share with counterparts on the subject of *building diagnoses*, dedicated networks or *communities of practice* could be implemented, not nationally, due to local architectural specificities, but at local or even interdepartmental/regional level. These networks could bring together *relay* associations that have been trained in *building diagnoses* to allow them to share best practices (for example, the principle of mentoring for diagnoses) and to carry out collective thinking on complex cases taking into account good practices of remediation. National public experts, including IRSN, could be involved in dedicated webinars to enrich discussions on more targeted topics.

4.4. Encourage the population to undertake remediation work

4.4.1. A fun educational kit for DIY³ remediation works

It can be noted that, in the vast majority of cases in France, simple corrective actions can be implemented to reduce radon concentrations in buildings. These simple actions could be easily managed by a residents if they know what actions to implement. Thus, a first attempt to set up could be an educational kit jointly created with national partners involved in radon risk management. This educational DIY- kit could be virtual, offering tutorials (like those offered by DIY stores) and presenting individuals carrying out these simple actions in their home, identification being necessary here. Anyway, the efficiency of the DIY corrective actions have to be evaluated by a control measurement.

4.4.2. Financial support

In order to reduce fears of the cost of remediation work, it would undoubtedly be useful, during each awareness campaign, to give examples of remediation work carried out and their associated costs, notably concerning simple actions to undertake.

Concerning more complex works, the population would be more inclined to carry out remediation works if higher subsidies could be granted. Currently, the criteria for obtaining a subsidy for radon reduction are restricted to vulnerable population, very difficult to achieve (and are not obtained in practice in most cases) and the amounts are often not covering much of the work.

5. CONCLUSION

This study draws a picture of the situation of radon risk management in private housing in France. First, the radon risk is still largely unknown in France. Broad awareness campaigns targeting different audiences, such as elected representatives, healthcare professionals, younger generation but also NGOs specialized in environmental health and building/energy efficiency are likely to lead awareness/measurement campaigns in areas, need to be developed in cooperation with other French national public experts in radon risk management.

Furthermore, a salient difficulty to take into account is the lack of building professionals not only to undertake remediation actions but also to carry out *building diagnoses*, which is a key step in identifying the remediation work required. Although this obstacle has forced some areas to block their actions, it is important to stress that adaptation is possible, notably through the training of associations specializing in building energy performance. These adaptations can be extended in all the areas concerned if these experiences are shared and the good practices disseminated. To do so, more opportunities for exchanges and discussions need to be developed at a local/regional level to allow them to share their needs and to discuss ways of accompanying these stakeholders.

³ DIY : *Do It Yourself*

REFERENCES

- [1] AJROUCHE, R. and al., "Quantitative health impact of indoor radon in France", *Radiat Environ Biophys.* 2018; 57(3): 205-214
 - [2] IRSN BAROMETER 2021 "The perception of risk and security in France", https://barometre.irsn.fr/wp-content/uploads/2021/05/IRSN_Barometre2021_summary_english-1.pdf.
 - [3] IRSN BAROMETER 2020 "The perception of risk and security in France", https://barometre.irsn.fr/wp-content/uploads/2020/06/IRSN_Barometre2020_r%C3%A9sum%C3%A9-anglais.pdf
 - [4] CASSADOU S., BEAUMONT, A. Perception, connaissances et comportements en Occitanie. Baromètre Santé & Environnement 2018. Toulouse : CREAI-ORS Occitanie, 2018, 60 p.
 - [5] IRSN BAROMETER 2015 "The perception of risk and security in France", https://barometre.irsn.fr/wp-content/uploads/2015/09/IRSN_barometre_2015.pdf
-