Regional radioecological survey: another tool for environmental monitoring

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Abstract:

For a few years, IRSN has been developing a new approach for environmental monitoring based on regional radioecological studies, with the objective to acquire updated data on radioactive levels for a given territory on some environmental matrixes, representatives of the studied area. After a brief presentation of the different aspects of environmental monitoring led by IRSN, the methodology employed for these studies is presented. Some spectific aspects, linked to environmental and socio-economical particularities are also presented.

1 INTRODUCTION

In France, the environmental monitoring of radioactivity is done through measurements realised both by operators and by IRSN. The first ones accomplish this surveillance under the scope of law, whereas for IRSN, this monitoring is part of its fundamental missions, as specified by the creation decree of the institute.
IRSN contributes to the environmental monitoring in three ways that are alert, control and survey with objectives and tools adapted to each mission.

1.1 IRSN's organisation for environmental monitoring

1.1.1 Alert

A few years after Chernobyl accident, IRSN developped an early warning network. This network is composed with air and water probes, distributed over the French territory, with a higher density near nuclear facilities. Measurements of ambient gamma dose equivalent rate are continuously acquired and transmited in real time to the IRSN supervision center, in order to chek if there is any risk for human health. Aerosol and watercourse measurments are also regularly aquired in order to precise radionuclides and their concentration involved in case of incident/accident.

1.1.2 Control

In order to control that nuclear activities are done while respecting the authorities' requirements, a permanent monitoring through a sampling network of environmental matrices is realised. At quarterly or yearly frequency, IRSN samples, or receives from its partners, standardised matrixes sampled near all sites using radioactive elements, in order to analyse radionuclides concentrations, adapted to the releases of the operator.

1.1.3 Survey

Specific studies are regularly realised over the French territory in order to improve knowledge on radionuclides contents and transfer from the different compartment of the geosphere through the biosphere. These studies can be in the frame of expertise, service or research, with, for most of them, the objective to determine if the effluent releases from nuclear industrials impact their close environment.

2 REGIONAL RADIOEOCOLOGICAL SURVEYS

A few years ago, IRSN decided to create a new stage for environmental monitoring, which correspond to the regional radioecological survey.
The main objective of these studies are to qualify and quantify 'baseline' activity levels in different environment (continental, aquatic, marine) influenced or not by effluent releases in order to (1) define more precisely radioactive natural background and remnant levels due to Chernobyl accident and atmospheric weapons, (2) highlight the local influence, when existing, of current releases of the nuclear industry, and (3) finally give a global overview of the radioecological state of the environment at the French scale.

A brief overview of the global methodology is described on the following paragraph, then specfic features linked to the diversity of the studied areas (physical or socio-economical aspects) are given as examples. A regional radioecological study is carried out, in most cases, on an homogeneous territory in term of geography (at river basin scale). Nevertheless, regional survey are also led on particular environment such as littoral system, ancient mining site or on area with remnant activities linked to global fallout originated from Chernobyl accident or atmospheric weapons test. The two last ones cover large areas with numerous sites in France.

2.1 Global methodology for continental environment

The first step of these surveys consist in determining the environmental characteristics of the studied area (geology, soil-occupation, agricultural practice…) and the study of past or current nuclear activities (situation, radioactive effluents releases and evolution with time…) that could influence radioactive levels in the environment. Then, a synthesis of the previous data acquired by IRSN (or by others institutions, when available) under the scope of environmental studies is made. This step leads to the analysis of different documents, as various as reports, statistics, scientific publications, PhD thesis…
For agricultural lands, the methodology is based on the analysis of statistics, acquired by the France's national statistical institute. The analysis focus from national to district data, in order to localise which kind of food products are the most representative for the studied area. This step begins by determining the importance of regional production in value (euros) compared to the national production and leads us to define the municipalities where theses productions are cultivated (surface) or reared (livestock). A special attention is also being paid to organic products or to traditional product of regional origin such as olive oil in Rhone River valley or wine for Loire valley, for example.
At the end of this first step, a sampling strategy is defined, specifying locations and matrices to be sampled.
For aquatic system, the methodology employed is close to that of regular monitoring, partly due to a lower diversity of matrices (water, sediment, aquatic plants, fishs). An effort has been made to sample shellfishes as a bioindicator of contaminants that are difficult to measure into the environment (as fission and activation products downstream NPP).
The second step consists in field campaigns with two objectives: one is devoted to the prospection in situ, in order to verify that the strategy is applicable to the territory. Indeed, it might not be excluded that the statistical data are outdated at the district level, due to conversion of the agricultural lands for example. The second one is dedicated to exchange with the different stakeholders which could discuss the strategy proposed by IRSN. Typically,

meetings are organised with stakeholders as local nuclear committee, mayors, association for environmental protection…

Finally, sampling, metrology, interpretation and dissemination of results constitute the last step. A special attention is paid to the metrology used, focused on low-level analyses in order to detect radionuclides in the environment that are present, for most of them, at trace levels. Radiochemistry processes and cutting-edge metrology like ICP-MS for alpha emitters or uranium chains, SMA for tritium and radiocarbon are used in order to obtain significant activity (reduce the number of results under the detection limit), in each matrix of interest. For gamma emitters, long counting times in a laboratory designed to reduce cosmic radiation, allows detection of some artificial radionuclides released by industrials in liquid effluents (^{58,60}Co, ^{137}Cs, ^{110m}Ag, ^{54}Mn).

2.2 Specific features for some particular surveys

The methodology described above cannot be directly applied to other similar environment or study without any analysis of the pre-existing conditions in terms of environmental settings or objectives that are pursued. The specificities described here are examples for three different environments where radioecological surveys are on-going:

- Marine environment

Last year, IRSN began the regional radiocological survey for the French Mediterranean coast. The first difficulty was linked to the use of statistics that are not complete for fishes and shell-fishes, partly due to the small-scale fisherman whose production is mainly sold directly to consumers.
Another difficulty is link to the sources of radioactivity that are more diffuse and diluted by currents. Information about current dispersion from river inputs through the marine system has to be known. In the case of Mediterranean survey, the area potentially influenced by radioactive releases coming from the Rhône River extended from the river mouth up to the Spanish border where the plume falls into the main submarine canyon of the area.
Finally, sampling operations needs the establishment of cooperation with others institution in order to benefit from their competence to obtain the species of interest. In this case, the French Institute for Marine Research (IFREMER) provides the samples required for the analyses.

- Area with remnant radioactivity linked to past global fallouts

On remnant areas, where a study just began, the first special feature is linked to the fact that different sites in France are concerned by remnant activities. Most of them are located in mountainous area but their geographical settings are different (geology, vegetation cover…). These differences could affect radionuclide concentrations for particular isotopes (uranium and thorium decay products for example).
The mixing between common and unusual matrixes like berries, mushrooms, meat of wild fauna, that are also representative of these particular areas also constitute a particular feature for these studies. This create a disequilibrium for results interpretation between well-known activities and transfer through the food chain (soil, grass, milk) and rare results acquired in this frame on less known matrixes.
An additional specific characteristic is linked to the absence of stakeholders of the nuclear domain. Therefore, communication is made to the managers of the National park of nature reserves, associations for hunting, local communities…

- Ancient mining site

In this environment, difficulties are linked to the relatively poor dataset of radioactivity levels into the different compartments of the biosphere. The metrology is not routinely developed for this purpose and knowledge on transfer from source to environmental indicators is scarce.

3 CONCLUSION

These surveys have their limitations like a relatively long time tof realisation due to the methodological approach and the need of low-level analyses that are time-consuming. Another limitation is linked to the communication towards stakeholders: in general, relatively few interactions exists and IRSN's representatives have sometimes to to public that move the debate on other grounds.

On the positive side, these regional radioecological surveys well complement our knowledge of the environmental state of the French territory, particularly regarding the background levels far from current effluent releases from the nuclear industry. Results acquired just before the Fukushima fallout over France, allowed the assessment that radionuclides activities linked with this accident were small and temporary. Another benefit is related to the assurance that results obtained on standardised samples acquired in the frame of control are in the same range than the specific products or foodstuffs acquired for the regional survey. This also demonstrate to the stakeholders that few samples (in terms of number and diversity) is generally sufficient to give a clear image of the radioecological status for a given territory.

For updated data, acquired near effluent releases, results confirm the slight and local contamination by industrial radioactive releasesals. In most cases, values are in the range of those expected and close to the background level noise.

Furthermore, these studies provide the opportunity to acquire new data on less known environment or matrixes, using new material and improved metrology that were not available several years ago or to apply technics considered as time-consuming or too expensive for routine monitoring purpose.