Radiological environmental monitoring program national level. Results 2009

José Osores*, Susana Gonzáles, Jorge Martínez, Edith López, Raúl Jara, Aurelio Anaya

Division of Occupational and Environmental Radiation Protection,
Instituto Peruano de Energía Nuclear, Av. Canadá 1470, San Borja, Lima, Perú

Resumen

Se presenta el informe anual correspondiente a los resultados de los programas de vigilancia radiológica ambiental desarrollados durante el año 2009, acompañados de los datos históricos que constituyen un marco de referencia. Este documento es continuación de los Programas de Vigilancia Radiológica Ambiental desarrollados por el Instituto Peruano de Energía Nuclear (IPEN) iniciados desde 1990 y que se ponen a disposición de ciudadanos e instituciones, información sobre los niveles de radiactividad ambiental del país con un cierto nivel de detalle. En el presente documento se describen brevemente las principales características de los programas de vigilancia radiológica ambiental en el territorio peruano y los resultados de los mismos obtenidos en la campaña de vigilancia del año 2009. Así mismo se presenta la proyección temporal de los valores radiológicos más representativos en los últimos años.

Abstract

The annual report of the results of the environmental radiation monitoring program developed in 2009 is presented, including also historical data to provide a frame of reference. This document is a continuation of the Environmental Radiation Monitoring Program developed by the Peruvian Institute of Nuclear Energy (IPEN) since 1990 and shows information on environmental radioactivity levels in the country available for public and private organisms as well as for general public. This paper briefly describes the main features of the environmental radiation monitoring programs in the Peruvian territory their results obtained from the surveillance campaign of 2009. It also shows the temporal radiological projection values more representatives in the recent years.

1. Introduction

IPEN has among its duties the assessment and monitoring of the environmental radiological impact of nuclear and radioactive facilities, as well as the monitoring of the radiological quality of the environment throughout the national territory according the national regulation. Another duty of IPEN, which is part of this document, is to give information to the general public about the work done within its competence [1,2,3].

The basic objectives of environmental monitoring are: the detection of the presence and the monitoring of radioactive elements and levels of radiation in the environment, determining the causes of possible increases, estimate the potential radiological hazard to the population and identify, where appropriate, the need to take precautions or provide any remediation measures.

To achieve this goal, the system of the national environmental radiation monitoring in Peru, includes the Environmental Radiation Monitoring Program at the National Level, where surveillance is performed through random sampling programs nationwide [4].

For the development of surveillance programs, it is necessary to perform the collection and analysis of samples in the main pathways of transfer of radionuclides in the elements of ecosystems that can contribute to human exposure to radiation. These pathways can be classified as:

Transitional pathways: where the concentration of a radionuclide is proportional to the emission rate of the same so that, in principle, exists as a long emission concentration. Given the characteristics of discharges under normal operation of the facility, and with no other external causes (e.g., the accident at the Chernobyl nuclear

* Corresponding author: josores@ipen.gob.pe

power plant), the concentration values of artificial radionuclide activity in these pathways usually are below the minimum detectable activity (MDA), or close to it.

Integrative pathways: where the concentration of radionuclides increases with the following emission to the environment and can persist after emission ends. In this way increases can be seen due to the operation of nuclear facilities and radioactive substances, or as a consequence of altered levels of background radiation (nuclear explosions in the atmosphere of the nuclear accident at Chernobyl, etc.).

Accumulating pathways: They are based on the previous pathways, where the concentration of radionuclides increases with time, either by physical, chemical or biological processes. In the collected samples from these pathways, activity concentrations of isotopes can be found which were not detected in the previous tracks.

2. Methodology

Table 1 shows the routes that are considered within the three groups mentioned above and the samples collected in different programs that integrate the environmental radiation monitoring system.

Table 1. Exposure Pathways considered in the Environmental Radiation Monitoring Program.

Routes of exposure	Sample type
Transitional	Air: dust particles Surface water Drinking water Direct radiation Dose rate
Integrative	Surface soil Food Plant
Integrated and cumulative	Indicators organisms Food Fish, seafood

Figure 1 shows the location of Peru regarding the presence of nuclear plants in the world; it can be seen that in South America there are plants only in Argentina and Brazil and that the number of nuclear plants in the South is considerably small thus the risk of contamination due to nuclear accidents or radioactive fall-out is small.

Figure 1. Nuclear Power Plants in the World.

The collection of environmental samples in 2009 was developed with support from the National Service of Meteorology and Hydrology (SENAMHI) through a scientific cooperation agreement.

3. Results and Discussion

The results are presented in graphs and table sorted by route of exposure, types of samples and analysis. There are graphs of the isotopes that have not been detected in this campaign or the analysis that continue to perform due to a modification of the program. The general criteria applied to the presentation of the results are:

All analytical results have been selected for the gross beta activity index and artificial radionuclides of long half-life (Cs-137 and Sr-90). We calculated the average annual values of all data from all sampling stations monitored area around each station [5,6,7,8].

We have considered only the values that have exceeded the minimal detectable activity (MDA), so it should be noted that some average values may be overestimated. For the campaign of 2009, the main purpose of this document provides more detailed information, showing for the different samples: Total number of analysis performed, numbers of results have been above and below the corresponding MDA, average values, maximum and minimum activity concentration obtained in this campaign.

Transitional Pathways:

Air

The radiological surveillance of air is used to estimate the potential dose received by the population due to inhalation. Due to the rapid dynamics, and since it is the primary means of receiving the gaseous effluents emitted into the atmosphere and transfer via transient radionuclides in the environment, sampling both radioactive aerosol particles of dust in air is continuously.

Gross beta activity index: The purpose of this measure is to detect quickly any changes in environmental radioactivity levels and where appropriate, more specific analysis. The measurement is performed on a monthly basis in each of the collected particulate filters. We get a proportion of values higher than the MDA close to 100% because this analysis accounts for the contribution of natural radiation [9,10,11]. During the 2009 campaign values have not changed significantly from previous years (Figures 2 and 3).

Gamma spectrometry: Is performed on a quarterly cumulative set of filters for each sampling station. The measure gamma spectrometry is performed to detect the presence of activation products and fission in the atmosphere. The detection of gamma emitting isotopes of artificial origin is sporadic when it occurs, the activity levels achieved are often found in close proximity to the MDA. In the 2009 campaign we have not been obtained values of artificial gamma emitters than MDA.

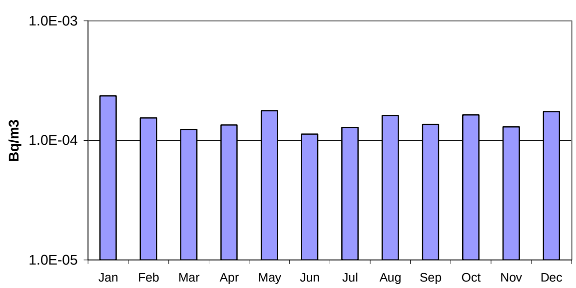

Figure 2. Dust Particles in Air. Gross Beta Activity Index (Bq/m3).

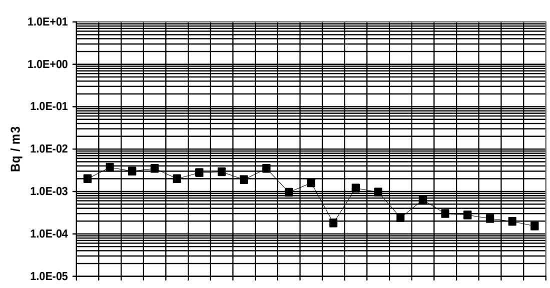

Figure 3. Dust Particles in Air. Temporal Evolution of Gross Beta Activity Index.

Surface Water

Surface water is a temporary way in which sampling is performed either continuously (continuous proportional sampling) and intermittently, according to a preset frequency.

Gross beta activity index: The detection rate for concentration values higher than MDA stands at 100%. As in air samples, the purpose of this measure is to detect any possible change in environmental radioactivity levels, and if detected, specific analysis. The results indicate a higher concentration of gross beta radioactivity in water in the province of Sechura, mainly because this water has a higher salinity waters with respect to other regions of the country. The gross beta activity concentrations detected are due mainly to the concentration of potassium-40 from water (Figure 4).

Gamma spectrometry: In this campaign all values of concentration of artificial radionuclides emitting gamma is less than the MDA, so it does not include graphical representation.

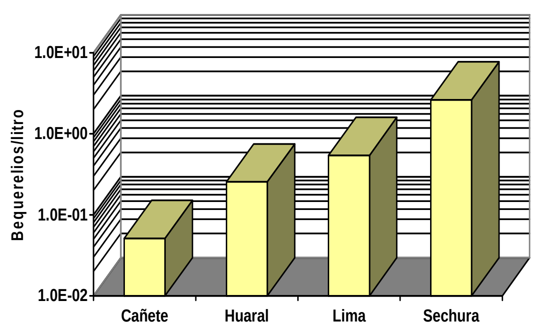

Figure 4. Surface Water. Gross Beta Activity Index (Bq/L).

Drinking Water

The collection of these samples is intended to evaluate the potential dose to be received in as a result of ingestion. None of the values obtained in the different tests carried out in the 2009 campaign exceeds the levels of MDA.

Gross beta activity index: As surface water data, there is a higher value on water samples from Sechura, due to the physical-chemical properties; however, these levels pose no risk from consumption in the population (Figure 5).

Gamma spectrometry: The values of artificial radionuclide concentrations are consistently lower than the MDA, so it does not include graphical representation.

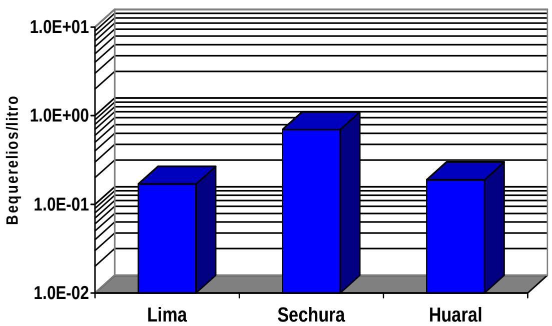

Figure 5. Drinking Water. Gross Beta Activity Index (Bq/L).

Direct Radiation

Environmental Gamma Radiation: In thermo-luminescence dosimeters measured dose rates by environmental exposure. This dose is normally related to terrain features and natural isotope content, so the percentages of LID are greater than 100% in all cases. As can be seen in Figure 6, the values are generally close to average values due to natural sources (2.4 millisieverts per year).

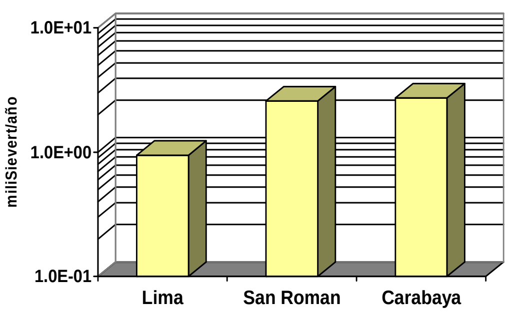

Figure 6. Direct Radiation. Environmental Dose Equivalent, H*10. (*Source:* IPEN-MDRA).

Integrative Pathways

Surface soil

The analysis of soil samples is intended to determine the concentrations of the isotopes present therein as a result of the accumulation of the deposition of radioactive material released in gaseous effluents from the facility. The graphics settings have focused on the results for total deposition on the ground.

Gross beta activity index: As in the studies of dust particles in air, the purpose of this measure is to detect quickly any changes in environmental radioactivity levels and where appropriate, more specific analysis. The measurement is performed on an annual basis for each of the sampling stations. It gets a proportion of values higher than the MDA close to 100% because this analysis accounts for the contribution of natural radiation. In this campaign has been able to identify a higher average in the samples collected in the Puno region, especially in the Carabaya Province, where uranium deposits are found in our country and that differs with respect to other regions (Figures 7 and 8).

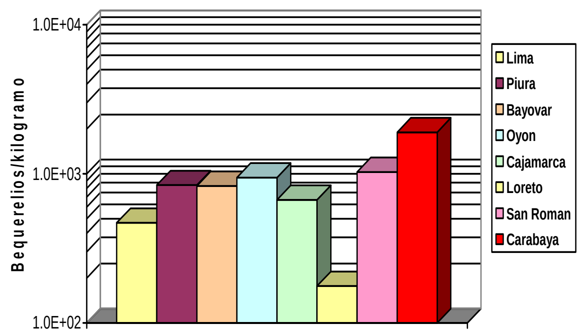

Figure 7. Surface Soil Gross Beta Activity Index (Bq/kg).

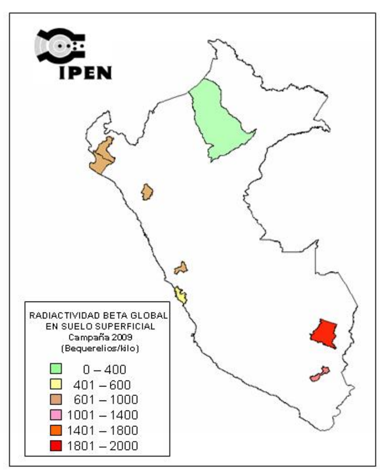

Figure 8. National Distribution of the Gross Beta Activity Index (Bq/kg)

Gamma spectrometry: The results obtained by gamma spectrometry for the determination of Cs-137 show very similar values among the different provinces (Figure 9), so that the significant difference in rates of soil gross beta activity in Puno is due to the presence a higher content of natural radionuclides of uranium and thorium descendants.

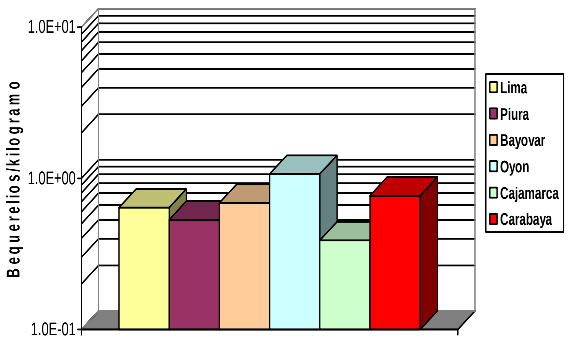

Figure 9. Surface Soil Concentration of Cs-137 (Bq/kg).

Food

During the 2009 campaign; samples of fish, agricultural products and milk were collected. The values of artificial radionuclide concentrations are consistently lower than the MDA, so it does not include graphical representations of the results.

Accumulating pathways

Surface Grass

Among the variations of the radiological environmental monitoring program, was included sampling of grass from the area of Macusani (Carabaya-Puno) due to their altitudinal location in which to raise radionuclides from the fall-out, however, in 2009 values concentration of artificial radionuclides are consistently lower than the MDA, so it does not include graphical representations of the results.

4. Conclusions

Piura Region is characterized by higher levels of gross beta radioactivity in the water (surface and drinking water) due to high salinity in this kind of samples. Not included in this study samples from the mining area of Bayovar as a site to be rich in phosphate rock, the average values of natural radioactivity in soil would increase and the goal of the radiological environmental monitoring program is the identification of artificial radionuclides.

Puno Region is characterized by gross beta radioactivity levels higher than in other regions, however, these levels are due to natural sources.

The average values of Cs-137 are similar to the results obtained in other regions. The levels of Cs-137 across the country are close to 1.00 Bq/kg, with a slight increase in the province of Oyón (1.41 Bq/kg).

By soil characteristics, the Loreto Region has the lowest levels of radioactivity in soil, while the Lima region has the lowest levels in almost all the determinations made.

During 2009 campaign, there was no evidence of radiological impact or health risk due to artificial radionuclides in the environment of Peru.

5. Bibliography

[1] Gonzáles S, Osores JM, Jara R. Informe radiológico ambiental 1990-1993. Instituto Peruano de Energía Nuclear. Lima: IPEN; 1993. [Informe interno].

[2] Gonzáles S, Osores JM, Martínez J, López E, Jara R, Anaya A. Informe del programa de vigilancia radiológica ambiental 1994-1998. Instituto Peruano de Energía Nuclear. Lima: IPEN; 1999. [Informe interno].

[3] Gonzáles S, Osores JM, Martínez J, López E, Jara R, Anaya A. Programa de vigilancia radiológica ambiental en el Centro Nuclear RACSO 1998-2001. En: Instituto Peruano de Energía Nuclear. Informe Científico Tecnológico 1998-2001. Lima: IPEN; 2002. p. 346-347.

[4] Osores J. Fifty years of studies on environmental radioactivity in Peru. En: Anales del 12°. Congreso Internacional de Protección Radiológica. Buenos Aires, Argentina. 2008 Oct 19-24.

[5] International Atomic Enery Agency. Measurement of radionuclides in food and the environment. A Guidebook. Technical Report Series No. 295. Vienna: IAEA; 1989.

[6] Osores J. Calibración del sistema de radiometría de bajo fondo LB-4110 para determinación de actividad beta total. En: Instituto Peruano de Energía Nuclear. Informe Científico Tecnológico 2008. Lima: IPEN; 2009. p. 281-283.

[7] Osores J. Calibración del sistema de radiometría beta de centelleo plástico LAS-

3A con Sr-90 + Y-90. En: Instituto Peruano de Energía Nuclear. Informe Científico Tecnológico 2008. Lima: IPEN; 2009. p. 284-286.
[8] Osores JM, Gonzáles S, Martínez J, López E, Jara R. 2007. Radiactividad en productos lácteos de Perú. Radiobiología. 2007; 7:157-165.
[9] Osores J, Anaya A, Jara R. Monitoreo de concentraciones de I-131 en el aire en la zona de emplazamiento del Centro Nuclear RACSO durante 1990-2003 En: Instituto Peruano de Energía Nuclear. Informe Científico Tecnológico 2003. Lima: IPEN; 2004. p. 114-115.
[10] Osores J, Gonzáles S, López E, Martínez J, Anaya A, Jara R. Programa de vigilancia radiológica ambiental Centro Nuclear RACSO 2002-2003. En: Instituto Peruano de Energía Nuclear. Informe Científico Tecnológico 2003. Lima: IPEN; 2004. p. 116-117.
[11] Anaya A, Osores J, Gonzáles S, López E. 2004. Estación meteorológica de Huarangal. En: Instituto Peruano de Energía Nuclear. Informe Científico Tecnológico 2003. Lima: IPEN; 2004. p. 120.