

Environmental Radioactivity in New Zealand and Rarotonga Annual Report 2011

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The Environmental Laboratory of NRL organised the monitoring and analysed the samples.

Disclaimer

The purpose of this publication is to inform discussion and assist policy development. The opinions expressed in the publication do not necessarily reflect the official views of the Ministry of Health.

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National collection, coding and collation of cancer registrations is a complex process. This is because the information in the New Zealand Cancer Registry comes from laboratory reports, hospital information and mortality information and cannot be finalised until data have become available from all sources. In addition, several steps are required to ensure the final information is of good quality.

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The Ministry of Health welcomes comments and suggestions about this publication.

Contents

| | |
|---|-----|
| Acknowledgements | iii |
| Summary | 1 |
| Introduction | 2 |
| 2011 monitoring programme | 5 |
| 2011 monitoring results | 6 |
| Atmospheric radioactivity | 6 |
| Radioactive deposition | 6 |
| Radioactivity in milk | 7 |
| Discussion | 7 |
| Quality management | 8 |
| List of tables | |
| Table 1: The annual average concentrations of ^7Be and ^{210}Pb in air filters in 2011 at three monitoring stations | 6 |
| Table 2: Annual average ^{137}Cs concentrations in monthly milk powder samples from Waikato, Taranaki and Westland for 2011 | 7 |

Summary

The atmosphere was monitored for radioactivity at Kaitaia, the Chatham Islands and Rarotonga; deposited radioactivity was monitored at Hokitika (through rainwater testing); and radioactivity in milk was monitored in the Waikato, Taranaki and Westland regions.

Any artificial radioactivity continued to be at levels that are below detection thresholds in many cases and significantly below levels that would give rise to health concerns. In particular, no radioactive contamination from the Fukushima Daiichi nuclear accident was observed in the New Zealand environment. No significant change in the radioactivity status of the environment occurred in 2011.

Introduction

The National Radiation Laboratory (NRL) has monitored environmental radioactivity levels in the New Zealand and South Pacific regions since 1960, as described in earlier reports in this series.^{1,2} Monitoring was initially conducted for radioactive fallout from nuclear weapons tests in the northern hemisphere and then for fallout from the French nuclear weapons testing programme in the Tuamotu Archipelago. When the French atmospheric radiation testing programme was terminated in 1974, monitoring continued for residues from atmospheric tests and to detect any venting from the underground tests.

By 1985, levels of weapons-test debris in the atmosphere and rainwater had decreased to near the limits of detection for the monitoring techniques in use at the time, and the extensive monitoring network was scaled down³ to three monitoring sites – two in New Zealand (Kaitia and Hokitika) and one in the Cook Islands (Rarotonga). The sensitivity of weekly atmospheric monitoring at these sites was increased with the installation of 150 m³/hour high volume air samplers.⁴

Following the signing of the Comprehensive Nuclear-Test-Ban Treaty (CTBT)⁵ by the United Nations member countries in September 1996, verification of treaty compliance became an important international issue. New Zealand signed the CTBT on 27 September 1996, and ratified the CTBT on 19 March 1999, with the passing of the Nuclear-Test-Ban Act.

To enforce the CTBT, the International Monitoring System was designed to provide, on a global scale, passive monitoring capable of detecting and locating nuclear explosions. The four monitoring techniques are seismic, radionuclide, infrasound and hydro-acoustic. The planned radionuclide monitoring network will consist of 80

¹ Environmental Radioactivity Annual Reports: *NRL-F/48* (1971)–*NRL-F/52* (1973) summarising previous results, *NRL-F/54* (1974)–*NRL-F/75* (1995). National Radiation Laboratory, Christchurch.

² Environmental Radioactivity: Fallout from nuclear weapons tests conducted by France in the South Pacific and comparisons with previous test series. Reports: *NRL-F/47* (1971), summarising all monitoring since 1966; *NRL-F/49* (1972); *NRL-F/51* (1973); *NRL-F/53* (1974). National Radiation Laboratory, Christchurch.

³ National Radiation Laboratory. 1985. *Environmental Radioactivity Annual Report 1984*. Christchurch: National Radiation Laboratory.

⁴ National Radiation Laboratory. 1986. *Environmental Radioactivity Annual Report 1985*. Christchurch: National Radiation Laboratory.

⁵ Comprehensive Nuclear-Test-Ban Treaty (CTBT) and Text on the Establishment of a Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization. Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty, Vienna, 1996.

particulate radionuclide stations. These stations are to be distributed over 39 countries and their territories. As of mid-2010, more than 60 radionuclide stations had been installed. These include stations located at Kaitia and the Chatham Islands, New Zealand and Rarotonga, Cook Islands.

In 2000, and in accordance with the CTBT, the monitoring stations at Kaitia and Rarotonga were upgraded and a new station was commissioned in the Chatham Islands. These stations are now capable of daily monitoring with a greater sensitivity resulting from the installation of 900 m³/hour high-volume air samplers.

In conjunction with radionuclide detection, meteorological “back-tracking” provides information on any radionuclide source location through analysis of wind patterns in the preceding days and weeks of measurement. Meteorological stations operating to World Meteorological Organization standards are located at each site.

The present monitoring programme, consisting of wet and dry deposition radioactivity monitoring and the monitoring of radioactivity in milk, is intended to warn of any influx of radioactivity into the New Zealand and South Pacific regions from any source and to monitor trends in levels. The monitoring programme provides the basis for certification of the radioactivity content of foodstuffs. It also serves as the basis of consumer and commercial advisory services concerning radioactivity and for comparisons of the environmental radioactivity status of the South Pacific region with that of other regions.

To maintain a high standard of capability in radiochemical analysis, NRL takes part in quality assurance programmes and international analytical intercomparison exercises run by the IAEA, the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO), the National Physical Laboratory (UK) and the United States Department of Energy.

Although the environmental monitoring programme is designed primarily to detect and monitor levels of artificial radioactivity, measurements include naturally occurring radioactive materials, for comparative and scientific purposes. The atmospheric monitoring therefore includes measurements of concentrations of beryllium-7 (⁷Be) and lead-210 (²¹⁰Pb) in the atmosphere. ⁷Be is a cosmogenic nuclide (a product of spallation reactions of cosmic radiation within the upper atmosphere), while ²¹⁰Pb is a decay product of gaseous radon-222, which diffuses out of soil.

The 1993 report⁶ provided full discussion of trends in atmospheric caesium-137 (¹³⁷Cs) levels, radionuclides that contribute to the measured atmospheric beta activity, the age of aerosols collected in the NRL monitoring network, current concentrations of ¹³⁷Cs in New Zealand soils and dietary radiation exposure due to fallout (both natural and artificial).

⁶ National Radiation Laboratory. 1994. *Environmental Radioactivity Annual Report 1993*. Christchurch: National Radiation Laboratory.

In 2004, NRL stopped monitoring levels of strontium-90 (^{90}Sr) in milk powders because the concentrations had fallen below the detection limit and were far below the reference level of 120 Bq/kg. The present fallout monitoring programme will detect any new deposition of ^{90}Sr .

2011 monitoring programme

The environmental radioactivity monitoring programme comprised the following elements during 2011.

Atmospheric radioactivity: Atmospheric monitoring is the most important component of the monitoring programme because any radioactive pollution reaching the region will have been transported in the atmosphere, and the high-sensitivity monitoring will provide an early warning of any influx or changing trend in environmental radioactivity levels. Particulates were collected daily from the Kaitaia, Chatham Islands and Rarotonga stations.

The stations at Kaitaia, the Chatham Islands and Rarotonga used a SENYA “Snow White” air sampler to draw air through 2025 cm² filters (3M filter, polypropylene BMF) at a flow rate of approximately 900 m³/hour, with a daily sample volume of approximately 20,000 m³. The filters were analysed by high-resolution gamma spectrometry (Canberra high-purity n-type germanium BEGE5030 detector) for gamma-emitting artificial and natural radionuclides. The minimum detectable concentration for the fission product, ¹³⁷Cs, in the daily filter analyses ranged from 1 to 5 µBq/m³.

Radioactive deposition: The total beta-activity concentration in the deposition was monitored at Hokitika with weekly (small area rain collector 0.021 m²) sample collection. The total beta concentration was determined at NRL using a liquid scintillation counter.

The large-area rain collector at Hokitika allowed the monitoring of weekly depositions of the artificial radionuclides in rainwater. A stainless steel rain collector (1 m²) had an ion exchange resin column attached to its base. The resin retains any cationic species present in the rainwater, which percolates through it. The column remained attached to the collector for the 1-week sampling period, after which it was returned to NRL for gamma spectrometric analysis. ⁷Be measurements were used as a quality control for the performance of the sampling system.

Radioactivity in milk: Iodine-131 (¹³¹I), caesium-134 (¹³⁴Cs) and ¹³⁷Cs concentrations were monitored in monthly samples of dairy milk powders by gamma spectrometry from three New Zealand regions – Waikato, Taranaki and Westland.

2011 monitoring results

Radioactivity units used throughout this report are becquerels (Bq), millibecquerels (mBq) and microbecquerels (µBq): 1 Bq = 1 nuclear transformation per second.

The uncertainties reported are standard deviations of the mean values multiplied by a coverage factor (k) = 2, providing a level of confidence of 95%.

Atmospheric radioactivity

No significant concentrations of artificial radionuclides were detected by gamma-spectroscopic analysis of air filters collected daily from each monitoring station during 2011.

⁷Be continued to be the most significant radionuclide detected on the air filters during 2011. ²¹⁰Pb levels were similar at all three monitoring sites. The annual average concentrations of ⁷Be and ²¹⁰Pb on the air filters from Kaitaia, the Chatham Islands and Rarotonga are presented in Table 1.

Table 1: The annual average concentrations of ⁷Be and ²¹⁰Pb in air filters in 2011 at three monitoring stations

| Sampling site | ⁷ Be (µBq/m ³) | ²¹⁰ Pb (µBq/m ³) |
|-----------------|---------------------------------------|---|
| Kaitaia | 3630 ± 41 | 99 ± 10 |
| Chatham Islands | 3485 ± 46 | 69 ± 10 |
| Rarotonga | 3892 ± 41 | 89.1 ± 7.5 |

Neither ¹³¹I nor any other fission products were detected at these stations. Typical detection limits were in the range of 1 to 5 µBq/m³ for ¹³¹I, ¹³⁴Cs and ¹³⁷Cs.

Radioactive deposition

The Christchurch earthquake 22 February 2011 disrupted the operation of the NRL environmental laboratory. This disruption was managed by extending the sampling period of the large area collector until the laboratory was capable of receiving samples again. The weekly rainwater sampling continued as per schedule. Samples were stored in Hokitika until NRL was ready to accept them.

No artificial radionuclides were detected in the deposition samples by gamma-spectrometric analysis. The deposition of beta emitters for 2011 at Hokitika was 485 ± 20 Bq/m² with 2600 mm of rainfall. The average weekly deposition was 9.9 ± 2.3 Bq/m².

Radioactivity in milk

The radioactivity content of cows' milk was assessed by gamma spectrometric analysis of monthly milk samples from three regions – Waikato, Taranaki and Westland. ^{137}Cs was the only detectable artificial radionuclide. Results are summarised in Table 2.

Table 2: Annual average ^{137}Cs concentrations in monthly milk powder samples from Waikato, Taranaki and Westland for 2011

| Region | ^{137}Cs (Bq/kg) |
|----------|---------------------------|
| Waikato | 0.47 ± 0.19 |
| Taranaki | 0.72 ± 0.37 |
| Westland | 0.33 ± 0.14 |

Discussion

Despite interruption to NRL's operations in Christchurch in early 2011, the monitoring programme was continued without any significant disruption.

Neither deposition nor air monitoring showed any signs of influx of radioactive contamination.

Caesium-137 continues to be the only fission product detectable in milk, and levels continue to decrease consistent with observations from the last decade.

No significant change in the radioactivity status of the environment occurred in 2011.

Quality management

Quality management is an essential feature of any measurement laboratory's operations.

In May 2011, the Environmental Laboratory's accreditation to the international standard NZS/ISO/IEC17025 "General requirements for the competence of testing and calibration laboratories" was reassessed and confirmed. The scope of accreditation includes environmental monitoring and the analyses of foodstuffs and waters.

During 2011, the Environmental Laboratory participated in five intercomparison exercises, conducted by the International Atomic Energy Agency, the British National Physical Laboratory, the Comprehensive Nuclear-Test-Ban Treaty Organization and the US Department of Energy. These exercises involved the analyses of air filters, soil, vegetation and water.