

Environmental Radioactivity Report 2020/2021

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1. Executive Summary

The Institute of Environmental Science and Research (ESR) operates monitoring stations for radioactivity in New Zealand and the Cook Islands. As part of the Monitoring Programme for Radioactivity in the Environment, ESR provides the following services to the Ministry of Health:

Atmospheric monitoring

Particulate matter:

Manage three atmospheric radioactivity monitoring stations in New Zealand and the Cook Islands. Review the measurements for atmospheric particulate concentrations of Caesium-134, Caesium-137 and Iodine-131.

Deposition:

Collect rainwater samples from the West Coast on an approximately weekly basis and analyse them for Caesium-134, Caesium-137, Iodine-131, Total Alpha and Total Beta activity concentration.

Monitoring of radioactivity in milk powders

Receive milk powder samples from Waikato, Taranaki, and West Coast regions on an approximately monthly basis and analyse them for Caesium-134, Caesium-137 and Iodine-131.

Monitoring of Cs-137 in seawater

Collect seawater samples from NZ waters and analyse them for Caesium-134 and Caesium-137.

This report collates the results of the Monitoring Programme for the period 1 June 2020 to 30 May 2021. During the period of this report the activity concentrations detected by all monitoring regimes were well below those considered to constitute a radiological risk to human health.

2. Overview

Atmospheric Monitoring

Atmospheric transport of materials from a distant source is the most likely means by which remote countries such as New Zealand and other Pacific Nations would receive radioactive contamination. The National Radiation Laboratory, and later ESR's National Centre for Radiation Science, have monitored atmospheric radioactivity in the New Zealand and South Pacific region since 1960. The programme was initially set up to monitor radioactive fallout from nuclear weapons tests in the Pacific. Without any significant releases of radioactivity in the region in recent times, the programme continues to monitor for any potential influx of radioactivity into the region.

Three atmospheric monitoring sites are operated by ESR as part of the International Monitoring System (IMS) of the Comprehensive nuclear-Test-Ban Treaty Organisation (CTBTO). The main purpose of these stations is the verification of the Comprehensive nuclear-Test-Ban Treaty (CTBT); but the data is also analysed as part of New Zealand's environmental monitoring programme for radioactivity.

These are:

Kaitaia (RN47); Lat: -35.068, Long: 173.287

Chatham Island (RN46); Lat: -43.816, Long: -176.475

Cook Islands (RN23); Lat: -21.201, Long: -159.813

These sites are equipped with Senya JL-900 Snow White air samplers that sample between 23 and 24 hours each day, collecting between 19,000 to 24,000 m³ of air. Air filters are collected daily and analysed on site using Canberra CP5+ electrically cooled High Purity Germanium detectors. Between two and six samples per year are sent to accredited laboratories within the IMS for re-analysis. This is part of the ongoing quality control and quality assurance programme.

In addition, ESR operates a rainwater sampling site at Hokitika. Hokitika's geographical exposure and climatic characteristics make it the most suitable site for rainwater collection (atmospheric deposition). The sampling location is at:

Hokitika; Lat: -42.715, Long: 170.984

The site is equipped with custom-made large and small area rainwater collectors. Rainwater is collected at the site for a period of one week (at times two weeks) and sent to ESR for analysis.

Monitoring of radioactivity in milk powders

Dairy products in general are of high relevance to the NZ consumer and NZ economy. Milk powder samples are excellent environmental sensors for radioactive contaminants such as Cs-137.

Milk powder samples are supplied to the laboratory monthly by participating producers from the Waikato, Taranaki, and Westland regions. Samples are analysed for I-131, Cs-134 and Cs-137 on High Purity Germanium detectors.



Monitoring of Cs-134 and Cs-137 in seawater

Seawater samples are taken from Lyttelton Harbour (Lat: -43.607, Long: 172.717) on a monthly basis. The samples, which have a typical sample volume of 600 mL, are brought to the laboratory, and analysed directly by gamma spectrometry.

3. Results

Radioactivity units used throughout this report are becquerels (Bq), millibecquerels (mBq = 10^{-3} Bq) and microbecquerels ($\mu\text{Bq} = 10^{-6}$ Bq). One becquerel is defined as one nuclear transformation per second.

We report standard deviations from annual means, including natural, daily, and seasonal variations. The measurement uncertainties of individual results are significantly smaller.

Atmosphere – Particulate matter

A total of 1073 daily atmospheric samples were collected at Kaitaia, Chatham Islands and Cook Islands. The three stations had a combined downtime of 22 days due to maintenance. The samples were measured on site by high-resolution gamma spectrometry. The data was analysed particularly for I-131, Cs-134 and Cs-137, and the naturally occurring radionuclides Be-7 and Pb-212.

Detections of these artificial radionuclides are listed in Table 1. Aside of these detections, all other samples had concentrations of I-131, Cs-134 and Cs-137 below Minimum Detectable Concentrations (MDCs), which were in the range of 1 to 4 $\mu\text{Bq}/\text{m}^3$.

TABLE 1: Detections of artificial radionuclides I-131, Cs-134 and Cs-137 in the atmosphere. Measurement uncertainties at a coverage factor of $k=1$.

Sampling site	Date (UTC)	I-131 ($\mu\text{Bq}/\text{m}^3$)	Cs-134 ($\mu\text{Bq}/\text{m}^3$)	Cs-137 ($\mu\text{Bq}/\text{m}^3$)
Chatham Islands	28/07/2020	< MDC	< MDC	0.72 ± 0.21
Chatham Islands	29/07/2020	< MDC	< MDC	0.57 ± 0.18
Chatham Islands	13/08/2020	< MDC	< MDC	0.68 ± 0.19
Cook Islands	15/09/2020	< MDC	< MDC	1.61 ± 1.27
Cook Islands	21/09/2020	< MDC	< MDC	1.07 ± 1.03
Cook Islands	03/10/2020	< MDC	< MDC	1.61 ± 1.27
Cook Islands	23/10/2020	< MDC	< MDC	0.53 ± 0.73
Cook Islands	28/10/2020	< MDC	< MDC	0.59 ± 0.77
Cook Islands	09/12/2020	< MDC	< MDC	1.23 ± 1.11
Cook Islands	12/12/2020	< MDC	< MDC	1.02 ± 1.01
Cook Islands	03/01/2021	< MDC	< MDC	0.70 ± 0.84
Cook Islands	10/01/2021	< MDC	< MDC	1.36 ± 1.17

The naturally occurring radionuclides Be-7 and Pb-212 were present in every atmospheric sample. Their annual means are given in Table 2.

TABLE 2: Annual means and standard deviations of daily activity concentrations in the atmosphere for naturally occurring Be-7 and Pb-212.

Sampling site	Be-7 (mBq/m ³)		Pb-212 (mBq/m ³)	
	Mean	Std. Dev.	Mean	Std. Dev.
Rarotonga	3.8	1.8	50	36
Chatham Islands	3.1	1.7	5.4	4.5
Kaitaia	3.7	1.8	10	10

Atmosphere – Deposition

51 weekly and one biweekly rainwater samples were collected at Hokitika. The samples were analysed for total beta-activity concentration using a liquid scintillation counter, and for artificial nuclides using gamma spectrometry. Be-7 measurements were used as a quality control for the performance of the sampling system.

No artificial radionuclides were detected. Based on the Minimum Detectable Concentrations for Cs-137, the upper limit for weekly deposition of Cs-137 was determined to be 0.3 Bq/m² which corresponds to 0.005 Bq/L.

The total annual deposition of beta emitters was 360 Bq/m² with 3060 mm of total collected rainfall. The mean weekly beta activity from deposition was 7.0 Bq/m² and the standard deviation from the mean 4.4 Bq/m². This activity is almost entirely due to naturally occurring radionuclides.

Milk Powder

33 monthly milk powder samples (in some cases liquid milk samples) were obtained from the Waikato, Taranaki, and Westland regions¹. These were analysed for I-131, Cs-134 and Cs-137 by gamma spectrometry. Cs-137 was the only detectable artificial radionuclide. Milk powders from the Taranaki region remain the ones with the highest Cs-137 concentration. For Waikato and Westland regions, Cs-137 levels are commonly below Minimum Detectable Concentration of 0.2-0.6 Bq/kg.

TABLE 3: Annual means and standard deviations of Cs-137 detections in monthly milk powder samples.

Region	Number of samples	Number of detections	Cs-137 (Bq/kg)	
			Mean	Std. Dev.
Waikato	12	5	0.34	0.13
Taranaki	10	8	0.85	0.28
Westland	11	4	0.22	0.03

¹ With exception of the August 2020 and the May 2021 samples from Taranaki and June 2021 sample from Westland, which were not provided.

Seawater

12 monthly seawater samples were obtained from Lyttelton Harbour and analysed by gamma spectrometry for the presence of artificial nuclides. None of the analysed samples showed detectable concentrations of I-131, Cs-134 or Cs-137. The Minimum Detectable Concentration for Cs-137 was 0.14 Bq/L. No other artificial gamma emitters have been detected.



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