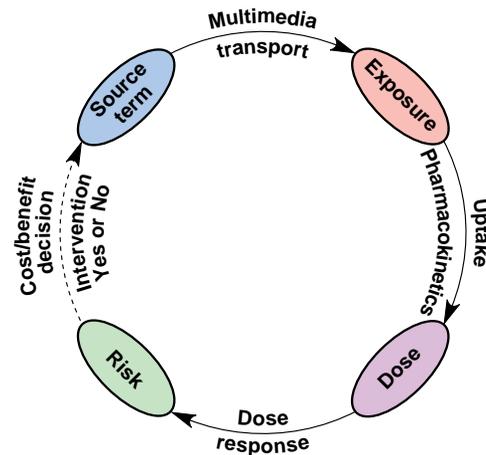


Overview

Fallout from nuclear weapons tests conducted between 1946 and 1958 at Bikini and Enewetak, and especially the Bravo test at Bikini, contaminated several atolls in the northern Marshall Islands. LLNL, with funding support from the Department of Energy, has been evaluating the radiological condition at the atolls since 1974.

The mission of our program is:

u To ensure the safe resettlement of Bikini,



Enewetak, Rongelap and Utirik Atolls.

Our approach is an integrated program that starts with field/laboratory experiments and sample collection through to dose/risk assessment which in turn redirects the field/laboratory efforts.

This requires:

u Design and implementation of large-scale field programs.

u Exposure assessment for all pathways: terrestrial and marine foods, external gamma, inhalation, catchment and rain water.

u Dose/risk assessment based on these exposures.

u Implementation of radioecology studies to determine radionuclide cycling and transport at the atolls.

u Development and evaluation of remedial measures to reduce the dose to returning populations.

u Communication of results to the communities with continuing interaction to help develop an understanding of the issues.

Required and available support are:

u Laboratory facilities to process thousands of samples annually.

u State-of-the-art gamma spectroscopy and radiochemistry laboratories.

u Database management and programming for customized program support.

u Extensive quality control measures for the analytical work, including continuing international and national intercalibration exercises, and split sample analysis with other laboratories world wide.

Dose Assessment Results

The Marshall Islands program has completed detailed dose assessments for various resettlement options on Bikini, Rongelap, and Enewetak Atolls. Exposures to nuclear weapons fallout have been estimated for all possible pathways and compared with natural background doses to assess the need and consequence of control measures. The natural background dose in the Marshall Islands is about 2.4 mSv y⁻¹ of which a significant fraction comes from ²¹⁰Po-²¹⁰Pb via consumption of fresh fish. The dose from weapons fallout has been calculated for a range of living conditions using radionuclide data for ¹³⁷Cs, ⁹⁰Sr,

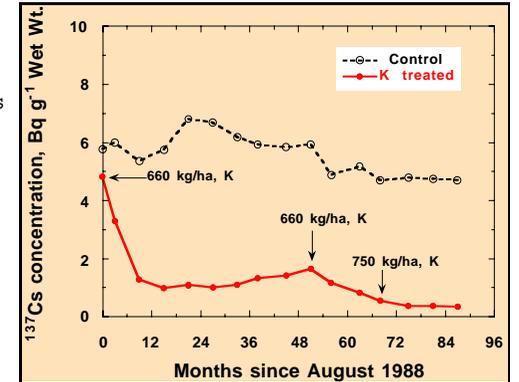
²³⁹⁺²⁴⁰Pu, and ²⁴¹Am, a diet model for pertinent foods chains, external exposure calculations for gamma-radiation, and assessments of potential dose contributions from radionuclide resuspension and

Marshall Islands natural background dose:

Source	Effective dose, mSv y ⁻¹
Cosmic	0.22
Cosmogenic	0.01
Terrestrial	0.01
⁴⁰ K	0.18
²¹⁰ Po- ²¹⁰ Pb (diet)	~2.0
Total	= 2.4

inhalation. We estimate that the ingestion pathway will contribute 70% to 90 % of the dose to returning residents mostly through uptake of ¹³⁷Cs from the soil into terrestrial foods such as coconut, Pandanus, breadfruit and papaya. External gamma exposure from ¹³⁷Cs accounts for about 10% to 30% of the dose. ²³⁹⁺²⁴⁰Pu and ²⁴¹Am are major contributions to the dose via inhalation but this pathway presently accounts for only about 1% of the total.

The estimated maximum annual effective dose for current island living conditions in the Northern Marshall Islands varies between <0.02 and 4 mSv y⁻¹ when imported foods are available. This compares with an average annual effective dose from natural background radiation in the United States of about 3 mSv y⁻¹. Hence, the estimated natural background dose plus the nuclear fallout component under current island conditions may exceed average background doses elsewhere in the world. Guidelines developed for controlling prospective dose to the general public (e.g. 40 cm of soil is removed in village and from nuclear power plants, storage facilities etc.) are not relevant to situations such as



Effect of potassium treatment on the concentration of ¹³⁷Cs in coconut me

Marshall Islands where people wish to live in areas already contaminated by nuclear weapons fallout. However, general guidance practices provided by the International Commission and Radiological Protection (ICRP) and the International Atomic Energy Agency (IAEA) recognize that below an effective annual dose of 10 mSv the situation should be reviewed, and if a cost effective, socially acceptable, and environmentally sound remediation strategy can be implemented to reduce the dose, then it should be considered.

Remedial measures to reduce doses

Our strategic mission has always been to develop a policy and guidance to limit the dose and reduce even a small risk associated with any resettlement effort in the Marshall Islands. Treatment of atoll soil with potassium reduces the uptake of ¹³⁷Cs into food crops and the associated ingestion dose to about 5% of pretreatment levels. For example, the dose for a 1999 resettlement scenario on Bikini Island, where the top 40 cm of soil is removed in village and housing areas and the rest of the island is treated with potassium fertilizer, is

0.41 mSv (compared with 4 mSv y⁻¹ using no counter measures) and the 30-, 50- and 70-y integral doses are 9.8 mSv, 14 mSv, and 16 mSv, respectively. Current research studies are focused on determining the duration of the effects of potassium treatment on ¹³⁷Cs uptake into plants, and determining the rate of environmental-loss of ¹³⁷Cs in atoll ecosystems.

Field Missions

u Vegetation, soil, marine species, sediments, animals, fowl, and water are collected for radiological analysis.

u External gamma measurements provide exposure data to evaluate the external dose.

u Resuspension studies are conducted to determine the concentration and flux of airborne radionuclides to estimate the dose via the inhalation pathway.

u Radioecology experiments are designed and implemented to evaluate various remedial measures to reduce the ¹³⁷Cs in locally grown foods.



Sacrifice tree experiment.



A large volume freeze drying unit.

Radiometric Facilities

The Marshall Islands Program operates extensive facilities for sample preparation and analysis of alpha, beta and gamma-emitting radionuclides in the environment. Custom designed computer programs and bar coding are used for all data entry and to help facilitate sample tracking and integrity control. Our gamma-spectrometry facility and radioanalytical laboratory run a high profile QA/QC program, and participate in national and international intercomparison exercises on a regular basis. Several new and innovative radioanalytical techniques have also been developed as part of the program.

Up to 5000 samples of vegetation, soil, water, aerosol particulates and/or biota are processed annually, making this one of the largest site-specific radioecology programs worldwide. In general, our facilities and technical expertise serve as a national resource wherever an integrated capacity in field characterization, analytical measurements, dose assessments and risk analysis are required.

Database Management/ Publications

The Marshall Islands Program has developed several large relational databases to help with dose/risk assessments and respond to the data and information needs of our customers. We also provide written reports, peer review scientific publications, and other correspondence relevant to the program. Program performance and data quality are evaluated by internal and external assessments and peer review.

DISCLAIMER

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