WSRC-MS-96-0321
CONF-961103--5

Mapping Radionuclide Distribution in Surface Sediments Using GIS and an Underwater HPGE Detector (U)

by
D. L. Dunn
Westinghouse Savannah River Company
Savannah River Site
Aiken, South Carolina 29808
W. G. Winn

P. J. Bresnahan

MASTER

A document prepared for ANS 1996 INTERNATIONAL CONFERENCE at Washington from 11/10/96 - 11/15/96.

DOE Contract No. DE-AC09-89SR18035

DISCLAIMER

Mapping Radionuclide Distribution in Surface Sediments Using GIS and an Underwater HPGe Detector

D.L. Dunn, W.G. Winn, P.J. Bresnahan
Savannah River Technology Center
Westinghouse Savannah River Company

Introduction

A radiological distribution survey at the L Lake on the Savannah River Site (SRS) was conducted by the Savannah River Technology Center (SRTC) during the summer of 1995 as part of a larger project to examine future alternatives for L Lake and other SRS water bodies[1,2]. The primary purpose of the survey was to confirm previous radionuclide surveys of Cesium-137 (^{137}Cs) in the L Lake area. EG&G Energy Measurements, Inc. conducted an aerial, baseline radiological survey of the L Lake area and the Steel Creek drainage basin in 1985. Overflight gamma mappings of the area by EG&G indicated that the only significant man-made radionuclides were located in the stream beds[3], which were subsequently covered by the reservoir. The major concern was to see if any of the man-made radiation was redistributed over time away from the stream beds.

In the current study an underwater HPGe detector was used to scope the possibility of sediment redistribution from the stream beds beneath L Lake. The underwater detector was positioned to view the bottom sediment and the geographic position of the pontoon boat used for deployment was recorded. The count rate at each position is proportional to the radiation level that would be observed if the lake water were absent, as in the 1985 overflight measurements[3]. Thus, the 1995 study yields count rate profiles that are appropriate for comparison with the gamma mappings of 1985.

Methods

Step sampling is most useful for characterizing the edge of an area of contamination. The project's goals require that the edge of any ^{137}Cs migration from the original Creek bed be identified. The key to step sampling is to ensure that the first samples are collected far enough away from the source to be considered clean or background samples. Progressive steps were taken along the same transect line between the first point and the known source, using water depth increments (typically 4 feet) and GIS coordinates to define the steps. If the sampling point was a "hit" for ^{137}Cs contamination, the next step was taken away from the known source. Alternately, if the sample was a "miss", a progressive step was taken toward the known source. The edge of the ^{137}Cs contamination was resolved in five or six steps.

The step method does not characterize contamination in the entire lake as well as grid sampling methods; however it is much more cost effective. The scope of this project was expanded in 1996 and grid sampling techniques are now being used within the conservatively estimated contamination zone identified during the 1995 survey.

Geographic position measurements were made at first using a Motorola TRACKER® portable geographic positioning system (GPS) unit and then later with a Lowrance® LMS-350A depth finder that incorporates a Rockwell designed GPS receiver module. Geographic position and depth were used in developing the contour plots generated in this study.

Discussion

The spatial distributions of the 1985 EG&G ^{137}Cs isodose rate contours were developed by qualified professionals using ^{137}Cs measurements, location coordinates, and spatial orientation and resolution. Manual interpolation was used to smooth out known features and unknown anomalies in the isodose rate contours.

Some effort was made in the 1995 study to generate the ^{137}Cs isodose rate contours using computer methods. Measurements of HPGe ^{137}Cs sample count rates were converted to dose and then georegistered as point coverage in an ARC/INFO® format. ARC/INFO® is a geographic information system database developed and marketed by the Environmental Systems Research Institute (ESRI). For the ^{137}Cs coverage, the sample points were used to create a statistical surface from which contours could be derived. To create such a surface, the dose values were used as the Z dimension in a spatial data model. The model chosen for this project was a triangulated irregular network (TIN). A TIN was used for its capacity to adjust to heterogeneous distributions of data. Once the TIN was created, contours were generated from the surface. Unfortunately, the resulting contours were inconclusive in that they did not fittingly represent the known distribution of ^{137}Cs activity along the old Creek channel. This result was directly related to the relatively small number of underwater sample points within L Lake. With any spatial data model, an increase in sample points results in a better depiction of the true spatial distribution.

An attempt to improve the continuity of the generated contours was made by applying information concerning the known distribution of ^{137}Cs activity along the old Creek channel. The Creek channel was digitized from a 1985 aerial photograph and was saved within the model as an ARC/INFO line coverage. This coverage was included in the TIN building method to provide a soft breakline that was to force contouring onto opposite sides of the channel. Again, the relatively small number of samples limited the effectiveness of this approach.

Additional grid sampling within the old floodplain of the Creek channel would be necessary to obtain the data and spatial coverage for continuous computer generated isodose contours. Grid sampling within the old floodplain began during spring of 1996 and should, when completed, provide the data needed for completion of the TIN generated isodose contour.

References

1. D. L. Dunn, W. G. Winn, and P. J. Bresnahan, "Scoping Measurements of Radionuclides in L Lake with an Underwater HPGe Detector", SRS Report WSRC-TR-95-0397 (May, 1996).

2. DOE (U.S. Department of Energy), "Environmental Assessment For The Natural Fluctuation Of Water Level In Par Pond And Reduced Water Flow In Steel Creek Below L Lake At The Savannah River Site", DOE/EA-1070, Savannah River Operations Office, Aiken, SC, (1995).

3. E. L. Feimster, "An Aerial Radiological Survey of L Lake and Steel Creek - Savannah River Site", EG&G Energy Measurements Report EGG-10617-1146 (November 1992).