BIOLOGICAL TRANSFER PROCESSES
IN
ENVIRONMENTAL SURVEILLANCE

by

Wayne C. Hanson

Health Division - Environmental Studies Group

University of California

Los Alamos Scientific Laboratory

Presented at the Environmental Surveillance Methodology Workshop held in conjunction with the April 18-20, 1974 AEC Environmental Protection Conference held in Albuquerque, New Mexico.

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The protection of the public against radioactive pollution of the environment due to the discharge of radioactive effluents resulting from the operation of nuclear plants is, ideally, guaranteed by means of appropriate limitations and controls of radioactive discharges.

In order to be effective, these limitations and controls should be supported by as comprehensive an understanding as possible of the environmental parameters at each site. These are best evaluated and related by radiation ecology studies in depth. Several problems immediately arise in attempting to provide ecological guidance to an environmental surveillance program.

First, long-term studies of the ecosystem and its several components are required to understand and evaluate the various cycling phenomena that may transmit radionuclides through the food webs, many of them involving man. Industry and agencies often do not have the inclination to invest the required time to obtain the necessary data upon which to base sound ecological judgment. Funds are often easier to obtain, following a mistaken concept that almost any problem can be overcome by throwing money at it. There is a strong corollary between the current all-out assault on cancer and the attempt to solve environmental problems with short-term strategies.

Second, ecologists and engineer chemists often engage in confrontations over proper disposal practices. The ecologists are viewed as unrealistic practitioners of a mystic art aimed at embarrassing

and inhibiting economic waste disposal practices. Logically, the solution to these extreme views lies somewhere in between. Economics is currently viewed as a variable parameter, but with a consideration of environmental cost that it hitherto either lacked or at least failed to recognize.

Third, professional ecologists have often adopted prima donna attitudes about their research and failed to address applied ecological fields. The complexity of factors in ecosystems often complicates definition and broadens the communication gap between the professional ecologist and the engineers, chemists, and others concerned with waste disposal.

ALTERNATIVES

The alternatives to such problems as outlined above mostly depend upon undertaking environmental studies with a strong base in understanding the system into which pollutants are to be released. This may be termed a first estimate of environmental receptivity for routine discharge of radionuclides. As the data base is broadened, additional knowledge is provided that allows a more reasonable estimate of the radiological consequences of a major accident or other release of radioactive materials.

Long-term comprehensive studies of ecosystems are an invaluable asset to environmental surveillance programs. These are needed for a definitive and realistic evaluation of the environmental receptivity.

For instance, there is a tendency to discharge effluents according to drinking water standards or air standards that will not result in human exposures beyond acceptable risks. However, these discharges may be buffered by highly alkaline treatments that have severe environmental effects. Radionuclides so released may gradually accumulate in sediments and soils, and then later be released by physical, chemical, or biological mechanisms in amounts that exceed the standards. Proper engineering design that considers such possibilities can probably prevent such problems.

Long-term studies : are often needed to identify critical population groups and exposure pathways associated with major effluents. Our current environmental problems in pesticides, such as DDT and methylmercury, and polychloridebiphenyls (also called PCB's) illustrate environmental abuses that escaped attention until they were problems of dramatic proportions. Long-term studies were generally not directed at any of these contaminants, and the problem cannot be solved by other than drastic means. This could have been avoided by ecologically-sound investigations. In the field of environmental surveillance of radionuclides, long-term studies lead to the identification of food web constituents that lend themselves to manipulation in the event of a major contaminating event. In closed systems, such as impoundments and reservoirs, certain segments of critical pathways may be interdicted to stop the cycling of the undesirable element.

Long-term studies are needed to define biological indicator organisms of value for evaluating the usual air-water-soil monitoring

network at a facility. Native herbivores, such as jackrabbits, have proved of value for monitoring gaseous effluents such as iodine-131 at Hanford and Idaho Falls. Caribou have served as major biological indicators for worldwide fallout radionuclide concentrations and spatial distribution. Small fish were used for many years at Hanford to indicate phosphorus-32 concentrations in members of the Columbia River aquatic ecosystems. The British found that seaweed was an effective concentrator of ruthenium-106 discharged by the Windscale reactors and that it was effectively cycled along the foodweb through laverbread to man. Recent results from Los Alamos suggest that the honeybee may be an excellent biological indicator for tritium.

A cautionary note on the use of biological indicators in environmental surveillance has recently appeared in a panel meeting of experts on "Radiation Effects on Population Dynamics in Ecosystems." It was pointed out that alterations in natural communities subjected to long-term exposure to radioactive wastes could be detected only with great difficulty, even though a permanent alteration in the reproductive success of 1% or less for two species may well spell the doom of one species just as surely as outright extermination. This accentuates the importance of long-term studies in evaluating population performance of natural communities exposed to biologically transferred radionuclides. Such studies of this sort are the spawning Chinook salmon and resident Canada goose populations within Hanford Reservation in southeastern Washington, and the Nevada Test Site cattle herd.

A further constraint on application of biological indicator data is found in the very different concentration factors for many biota, often of closely related genera. Canadian investigators have reported 20 to 40 fold differences between closely related aquatic plants exposed to strontium-90 in sediments. The rule seems to be to extrapolate biological indicator information only within the limits of its applicability and to constantly amend it with ecological studies of great depth.

Radionuclides of low biological availability, such as the transuranic elements plutonium and americium, pose special problems. In this case, the soil is the main reservoir and translocation through the ecosystem occurs not so much by active biological mobilization and uptake as through resuspension. The importance of better definition of plutonium behavior in the environment is emphasized by the appreciable differences between the State of Colorado Department of Health standard for Pu in soils (2 d/m/g) and that recently proposed by Healy (500 d/m/g). The future of the nuclear power industry may very well hinge on a realistic standard for Pu in soils because of the fuel reprocessing implications. Certainly the credibility of several AEC installations has been seriously eroded by our uncertainties about what is or is not a health hazard so far as plutonium in the environment is concerned.

SOLUTIONS

Long-term radiation ecology studies applied to environmental surveillance programs provide a reliable basis for assessment, prediction, and demonstration of nuclear operations.

Assessment of the impact of nuclear operations upon the environs requires early baseline studies of ecosystems prior to environmental impact. An integrated approach that includes the consideration of physical, chemical, thermal, and radiation consequences to ecological components over long periods of time should be attempted from the earliest possible moment.

Based upon the assessment, a prediction of long-term consequences and/or increased performance levels can be approximated. The difficulty of extrapolating biological information over long periods of time is well-recognized. Biological responses are often not linear. Much of the prediction capability today utilizes computer simulation models. Depending upon the validity of the model and the realism of the parameter values, avoidance of problem areas of environmental impacts can often be effected.

Finally, environmental surveillance programs that are closely integrated with radiation ecology studies have greater depth and provide a demonstration of the applicability of the integrated approach. Such programs provide greater credibility for public inquiry of nuclear facility operations, besides expediting monitoring programs.