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Recommendations from the International Union of Radioecology to Improve Guidance on Radiation Protection

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Invited Commentary

EDITOR'S NOTE

This is 1 of 17 invited commentaries in the series ''Challenges Posed by Radiation and Radionuclides in the Environment.'' These peer-reviewed commentaries were prepared to address some of the environmental issues raised by the March 2011 nuclear power plant accident in Japan.

ABSTRACT

This brief commentary summarizes the views of a working group assembled by the International Union of Radioecology to advance the approaches used to evaluate effects of radioactive materials in the environment. The key message in both the research needs and the recommendations for management of radioactive materials centers around the need to adopt an ecocentric approach that recognizes the interconnectedness of biota, including humans, and ecological processes. Integr Environ Assess Manag 2011;7:411–413. © 2011 SETAC

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INTRODUCTION

The International Union of Radioecology (IUR), formed in 1978 as an international association, has been an important voice in the continuing dialogue about benefits and risks related to the many uses of radionuclides. The IUR was founded to promote the development of radioecology, from research activities up to expert advice and operational management, with particular concern focused on the sustainability of nuclear activities with respect to the environment and the population, especially the civil use of nuclear energy (Bréchignac et al. 2008).

A subset of members of the IUR Working Group met in Aix-en-Provence, France, in April 2011 to finalize a working paper addressing the need for an ''ecosystems approach'' to understand the impacts of radionuclides on the environment. Active members of the IUR ecosystem approach Working Group consisted of: C. Bradshaw (Department of Systems Ecology, Stockholm University, Sweden), F. Bréchignac (IRSN, France), S. Carroll (Center for Biological Diversity, Sweden), S. Fuma (National Institute of Radiological Sciences, Japan), L. Håkanson (Uppsala University, Sweden), A. Jaworska (NRPA, Norway), L. Kapustka (SLR Consulting, Canada), I. Kawaguchi (National Institute of Radiological Sciences, Japan), L. Monte (ENEA, Italy), D. Oughton (Norwegian University of Life Sciences, Ås, Norway), and T. Sazykina (Typhoon, Obninsk, Russia), and P. Strand (NRPA, Norway). Although the efforts have been ongoing for quite some time, the observations and recommendations of the group have relevance to the recent incident at the Fukushima Daiichi nuclear power plant in Japan. Members of the IUR Working Group reached consensus on a number of recommendations to the radioecology scientific community at large and to the International Commission on Radiological Protection (ICRP), an advisory body that develops recommendations and guidance on radiation protection. A list of priority research topics was also proposed for members of the IUR and others to undertake. The results are briefly summarized in this commentary and will be finalized this summer and released as a report of the IUR to the scientific community, including the ICRP. The material also will be presented at the International Conference on Radioactivity in the Environment at McMaster University, Hamilton, Ontario, Canada (http://www.iur-uir.org/upload/CONFERENCES/firstannouncement_icrer2011.pdf) in June 2011.

ADOPTING AN ECOSYSTEM APPROACH TO RADIATION PROTECTION

A key issue addressed by members of the IUR Working Group is the rationale for developing a new approach for protection from radiation that is based on the ecosystem concept. This strategy intends to focus on the inherent

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properties of ecological systems, particularly the dynamic interactions among system components that influence resistance to stressors, resilience of components to rebound from stressor effects, and delayed effects including translation of effects up or down trophic levels.

The current focus on reference organisms, analogous to the ICRP reference human (ICRP 2003; Larsson 2007), has resulted in the collection of data for a relatively narrow group of species (ICRP 2008). Moreover, these data are limited to organism-level endpoints, which cannot be translated effectively to systems-level interactions such as have been seen in a number of multispecies experiments and field investigations. Further, the list of species for which organism-level data are available is too restrictive to allow for meaningful efforts to model dynamic interactions that are characteristic of ecological systems.

Following the technical aspects of radiation protection currently developed in this context, several international laws and regulations have adopted ecosystem approaches to assessment and management of various resources including marine systems, fisheries, forests, and biodiversity (Laffoley et al. 2004; UNEP 2004; FAO 2005; Apitz et al. 2006).

CHALLENGES FOR ASSESSMENTS OF RADIONUCLIDES

The current state of practice in environmental assessment of radiation and radionuclides is constrained by the focus on organism-based evaluations, which miss highly important ecological system dynamics. Consequently, the derivation of protective measures or analysis of long-term affected conditions and actions to mitigate affected conditions fails to address the primary values the affected stakeholders have concerns about (e.g., sustainability of agricultural products for human consumption, capacity of fisheries to maintain viable populations). Key weaknesses in the state of practice of assessment relate to linear assumptions of environmental processes that do not account for feedback loops in ecological systems that are well-documented in ecological literature. Addressing these shortcomings through adoption of new research priorities and focus will benefit greatly future assessments of impacted marine and terrestrial conditions and would have relevance for evaluations of releases from mining or nuclear accidents.

RESEARCH PRIORITIES

The members of the IUR Working Group identified research priorities that emphasize 3 areas: ecosystem-level issues; enhancement of organism-level studies that could be used more effectively in modeling ecological systems interactions; and, cross-cutting field studies of radiation-contaminated areas from, for example, accident areas or mine sites. The research priorities are:

1. Systems-level research emphasizing interactive responses to radiation exposure, propagation of effects, delayed effects, and resistance and resilience of ecological systems. Each of these could be designed to examine effects at a) population-, guild-, or community-levels, or b) systems functions such as primary productivity, decomposition, energy transfer, or nutrient flow.
2. Additional research at the organism level should be expanded to include representatives of trophic groups not currently included or understudied (e.g., decomposers). There should also be efforts to expand representation of taxa from multiple geographic regions to supplement the current dominance of data from northern temperate systems. Topical research that would be useful would be to develop better understanding of radiation effects that result in adaptation, acclimation, hormesis, and epigenetic effects.
3. Field studies are needed to calibrate laboratory studies from both the systems and organism levels. In addition to the opportunities at Chernobyl and Fukushima (decidedly different in terms of ecological systems), studies should be undertaken in radionuclide mining areas. In each of these potential study areas, the investigative designs should be based on gradient analyses approaches and not some attempt to compare to ''reference sites.''

RECOMMENDATIONS

Recognizing that the ecosystem concept has been adopted in an increasing number of other situations, members of the IUR Working Group believe it is appropriate for radiation protection to move in the direction of an ecosystem-based approach in order to improve the relevance of information coming to decision makers. To that end, the following points should be considered:

- Promoting the dialogue between environmental assessors and environmental managers (facilities operators, contaminated site managers, and other regulators) to increase the chances of improving the value of information flow.
- Adopting more integrated and functional endpoints to expand beyond the organism level. This could also include consideration of additional indices that embed the existing and new endpoints (decomposition, primary productivity, etc.).
- Expanding the reference organism approach to incorporate ecological functionalities, other ecological criteria, and reference species versus reference organisms, all aimed to facilitate an ecosystem approach. Better consideration of taxonomy such as insects, bacteria, fungi to cover ecological functionality and to make it more accessible to people within different geographical areas, biomes.

Radioecologists should be engaged in efforts to promote consistency across the broad spectrum of ecological research and environmental management, so that information can be leveraged from multiple efforts outside of the radioecology fields. In particular there should be efforts to coordinate work from chemical and other stressors, as well as with theoretical ecologists involved in landscape ecology and systems modeling. By doing so, environmental assessors and decision makers addressing the challenges posed by environmental releases of radionuclides will be better informed to address the needs of affected stakeholders.

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