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Review

Addressing ecological effects of radiation on populations and ecosystems to improve protection of the environment against radiation: Agreed statements from a Consensus Symposium☆

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ABSTRACT

This paper reports the output of a consensus symposium organized by the International Union of Radioecology in November 2015. The symposium gathered an academically diverse group of 30 scientists to consider the still debated ecological impact of radiation on populations and ecosystems. Stimulated by the Chernobyl and Fukushima disasters' accidental contamination of the environment, there is increasing interest in developing environmental radiation protection frameworks. Scientific research conducted in a variety of laboratory and field settings has improved our knowledge of the effects of ionizing radiation on the environment. However, the results from such studies sometimes appear contradictory and there is disagreement about the implications for risk assessment. The Symposium discussions therefore focused on issues that might lead to different interpretations of the results, such as laboratory versus field approaches, organism versus population and ecosystemic inference strategies, dose estimation approaches and their significance under chronic exposure conditions. The participating scientists, from across the spectrum of disciplines and research areas, extending also beyond the traditional radioecology community, successfully developed a constructive spirit directed at understanding discrepancies. From the discussions, the group has derived seven consensus statements related to environmental protection against radiation, which are supplemented with some recommendations. Each of these statements is contextualized and discussed in view of contributing to the orientation and integration of future research, the results of which should yield better consensus on the ecological impact of radiation and consolidate suitable approaches for efficient radiological protection of the environment.

Contents

1. Introduction

Radiological protection is evolving from a system focused only on humans, to one that encompasses non-human biota and the environment itself. In 2001, the International Union of Radioecology (IUR) arranged a Consensus Conference on Environmental Radiological Protection which crystallized a broad agreement on the need to address the environmental impacts of ionizing radiation (IUR, 2002a). Since then, scientific research in both the laboratory and the field has significantly improved our knowledge of radiological impacts, yet there is a feeling of divergence rather than convergence in current opinion:

- Laboratory studies have reduced uncertainties related to impacts on individual non-human organisms, notably but not exclusively through application of the reference organism approach (IUR, 2000, 2002b; ICRP, 2003, 2008; FASSET, 2004; ERICA, 2007; Sazykina and Kryshev, 2003, 2006) and the development of practical dose assessment tools. To assess risk to non-human biota, various approaches use sophisticated dosimetry tools to estimate radiation dose to individuals and infer the corresponding effects based on dose-response data gathered from the literature. Considerable gains in knowledge have been made in the last ten years through these initiatives. However, the reference organism approach and other evolving frameworks still need to be refined for more realistic application at the ecological level (Carroll, 2009; IUR, 2012; Bradshaw et al., 2014). For example, mainly acute exposure is studied in the laboratory whereas the field situation, even for humans, is one of chronic exposure.
- Meanwhile, new information and increasing uncertainties have emerged from recent field studies, often conducted in areas contaminated by nuclear accidents (e.g., Beresford and Copplestone, 2011; Murphy et al., 2011; Hiyama et al., 2012; Geras'kin et al., 2013; Mousseau and Møller, 2014; Taira et al., 2014; Møller and Mousseau, 2015; Møller et al., 2015; Deryabina et al., 2015; Pryakhin et al., 2016). These studies have mostly focused on large-scale correlations among estimated exposures and natural history observations in the field at the level of individuals, populations, or of communities of