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STRATEGY FOR ALLIED RADIOECOLOGY

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RE	Restricted to a group specified by the partners of the [STAR] project	
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Meeting participants at the IAEA

1 Introduction

The STAR NoE has an objective to facilitate the availability of radioecological data. Some data from project partners has been made available via the Radioecology Exchange website (https://wiki.ceh.ac.uk/x/DYFsD).

The aims of this workshop organised by STAR in collaboration with working groups 4 and 8 of the IAEA MODARIA (http://www-ns.iaea.org/projects/modaria/default.asp?l=116) programme were to:

- Discuss best practice for making data available
- Consider why we should make data available
- Review Japanese sources of Fukushima related data
- Communicate the evolution of international data sets
- Present analyses of international data sets
- Discuss data sets which may be published
- Present on-going IAEA modelling activities

Abstracts for each presentation are presented below. Following each abstract any questions/comments raised and answers to these are given. Where authors have given their permission the abstract title below hyperlinks to their presentation.

Photo: Meeting participant

2 Abstracts and Q&A

2.1 *Making your data available – why & how*

J. Chaplow

NERC Centre for Ecology & Hydrology, UK

The text below has been prepared on data dissemination for an upcoming STAR deliverable.

There is a need to disseminate data in order to comply with current European legislation and, in some countries, governmental guidance on the management and distribution of environmental information, i.e. the INSPIRE directive, Freedom of Information (FOI), Environmental Information Regulations (EIR).

The INSPIRE directive came into force in 2007 with the aim to create a European Union (EU) infrastructure for spatial data. This would enable information sharing among public sector organisations, facilitate public access to spatial information across Europe and assist in policy-making across boundaries. INSPIRE will be introduced in various stages and should be fully implemented by 2019.

INSPIRE (http://inspire.ec.europa.eu/) is based on a number of common principles:

- Data should be collected only once and kept where it can be maintained most effectively.
- It should be possible to combine seamless spatial information from different sources across Europe and share it with many users and applications.
- It should be possible for information collected at one level/scale to be shared with all levels/scales; detailed for thorough investigations, general for strategic purposes.
- Geographic information needed for good governance at all levels should be readily and transparently available.
- It should be easy to find what geographic information is available, how it can be used to meet a particular need, and under which conditions it can be acquired and used.

In addition, many researchers must comply with their funder requirements. For instance in the UK, the NERC Data Policy http://www.nerc.ac.uk/research/sites/data/policy/data-policy.pdf) and Defra Open data Strategy (http://bit.ly/1CsTh5X) both require that grant recipients make their data openly available.

The benefits of data dissemination include ensuring continued availability of environmental data of long-term value for research, teaching and wider exploitation (by individuals, government and business). Making data available during the lifetime of a project is good practice and stops the loss of data due to staff moving on to new projects or leaving the organisation (e.g. students, retirements).

It is possible to gain credit for depositing data through Digital Object Identifier (DOI) mechanism (e.g. Barnett et al. 2013; Feinstein & Blackwood 2013; Hill 2015). This can benefit (and motivate) staff who work on data but are not listed as an author on resultant journal papers, or can be a way of making datasets available you would not otherwise publish (e.g. Barnett et al. 2015). In addition, a DOI can help in formal publication of data sets, enabling the tracking of their usage through citation and data licences. Depositing your data in order to obtain a DOI allows hand-over of the responsibility for long-term management of data and ensures data are secure, well documented, easy to discover, access and use in future. This system supports the integrity, transparency and openness of the research.

It is becoming increasingly common for journals to 'strongly recommend' that data and related metadata are deposited in an appropriate data repository e.g. PlosOne (http://www.plosone.org/static/publication) suggest depositing with Dryad (see later) and request a Data Availability Statement (includes name of repository and list of data DOI's) (e.g. Quinto et al. 2015). There are also now journals specialising in the publication of data. Relevant journals include Earth System Science Data (http://www.earth-system-science-data.net/) and Scientific Data, a Nature Publishing on-line publication (http://www.nature.com/sdata/). Earth System Science Data is now included in Thomson Reuters Web of Science and has been used for at least one radioecological publication (Chaplow et al. 2014a).

There are currently a variety of ways to disseminate data: as supplementary information to a journal paper, depositing in line with journal requirements, putting on your own website, payment to a repository to deposit the data, and use of a data centre.

Supplementary data and journal appendices do not allow for staff to gain credit (i.e. as for the DOI mechanism) for data products and access is often restricted to those subscribing to the journal. Making available through the authors website makes the data available to all, but, gives no credit to the originators, is likely to lack some of the control of the data repositories protocols and relies upon the website remaining in place (this is often not the case for project websites). Such approaches mean that data may be made available without detailed metadata recorded in line with data standards and will not be available to data catalogues, repositories and search engines (e.g. www.data.gov.uk).

By depositing data with a data centre or repository, a DOI can be obtained for the data. However, data ownership can be lost and costs can be incurred. For example data deposited with the Dryad (http://datadryad.org/) and Figshare (http://figshare.com/) digital repositories is open access but there are associated costs to the depositor (Dryad data publishing charge US$80-90 and Figshare costs are tailored to organisations). The Dryad Digital Repository is a curated resource that makes the data underlying scientific publications discoverable, freely reusable, and citable. Dryad provides a general-purpose home for a wide diversity of datatypes. Figshare allows users to upload any file format to be visualised in the browser so that figures, datasets, media, papers, posters, presentations and file sets can be disseminated in a way that the current scholarly publishing model does not allow.

Some journals now have supported data repositories, for instance, Elsevier lists 43 data repositories (e.g. Oak Ridge National Laboratory Distributed Active Archive Center, Natural Environment Research Council data centres, Atmospheric Radiation Measurement (ARM) Data Archive, PANGAEA, GenBank). For a full list of the Elsevier supported data repositories see http://bit.ly/1MavKNi).

An Example data centre: the NERC Environmental Information Data Centre

STAR experience of depositing data and the DOI mechanism is with the Natural Environment Research Council (NERC) Environmental Information Data Centre (EIDC; http://eidchub.ceh.ac.uk/) hosted by the Centre for Ecology and Hydrology (CEH). The EIDC is a NERC designated data centre whose area of interest is terrestrial & freshwater science, hydrology and bioinformatics data. The EIDC has a data catalogue (www.gateway.ceh.ac.uk) that allows the public to discover and view data and download data from the EIDC Hub. The EIDC currently hosts 277 datasets, has more than 3400 registered users (registration is open to anybody and is required for delivery of requested datasets) and there have been >6300 data downloads since 2010 (the year the EIDC was established).

Data deposited with the EIDC must comply with UK Gemini 2 (GEo-spatial Metadata INteroperability INitiative) specification for metadata describing geospatial data resources for discovery purposes. Gemini 2 enables users to capture metadata which conforms to the INSPIRE implementing rules. This has been adopted by UK Location Programme (UKLP) as the UK standard for discovery metadata.

Compliance with Gemini 2 enables metadata entered on the EIDC Hub and data catalogue to be accessible to other Gemini 2 implemented portals (e.g. www.data.gov.uk). NERC has a further six data centres that deal with data from atmospheric science, earth sciences, earth observation, marine science, polar science and solar terrestrial physics and chemistry.

In order to assign a DOI, a data centre or repository applies to a DOI registration agency (http://www.doi.org/registration_agencies.html); the EIDC works with DataCite. The following criteria are required by the EIDC in order for a DOI to be assigned:

- DOI request must come from an author of the dataset.
- Dataset must be stable and complete (i.e. no more additions or changes expected), permanent, of good technical quality, in an appropriate format (EIDC uses CSV (comma-separated values) files as these are better future proofed than many other formats (e.g. MSExcel™).
- Additional metadata may be required.

Additionally, decisions on data licensing (e.g. Open Government Licence) and terms and conditions will be required.

The author can request that data be embargoed by a data centre before publication; in this way publication can coincide with that of an accompanying journal paper. The EIDC can embargo for a period of up to 2 years from completion of data deposit. A DOI can be cited before data is publicly available via a link to an embargo statement (e.g. '*Data under embargo. The data resource you are trying to access will become available by dd/mm/yy*').

A DOI cannot be assigned until the data has been deposited and the authorship, title and year of publication of the data has been resolved (e.g. see Chaplow et al. (2014b)).

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Feinstein L.M., Blackwood C.B. (2013) Data from: The spatial scaling of saprotrophic fungal beta diversity in decomposing leaves. Dryad Digital Repository. http://dx.doi.org/10.5061/dryad.3tm02.

Hill, M. (2015): Upper Lethal Temperature + acclimation data for 2 species of entomopathogenic nematodes. figshare. http://dx.doi.org/10.6084/m9.figshare.1356150

Quinto, J.,Marcos-García, M.Á., Díaz-Castelazo, C., Rico-Gray, V., Galante, E., Micó, E. (2015) Association Patterns in Saproxylic Insect Networks in Three Iberian Mediterranean Woodlands and Their Resistance to Microhabitat Loss S1_Table.docx. PLOS ONE. 10.1371/journal.pone.0122141.s001.

Question - How long can the text be in a data paper

- There is no set limit
- Data papers have been successful in CEH for developing new collaborations

Question - What is the review process? Is <u>all</u> the data actually reviewed

- It can all be reviewed; e.g. paper currently published on-line in ESSDD was sent out to referees as well as being open for open comment. One of the reviewers commented on the data rather than just the manuscript.

Question - At what point is the data published

- Data cannot have a DOI until deposited For ESSD, data has to have a doi before the paper is submitted. For data centres data can be embargoed and released, for instance, to coincide with paper publication. Data and supporting information are published on a date agreed with author or at the end of an agreed embargo period. Currently set at maximum 2 years from deposit for our data centre.

Question - What are the data protection act implications? For example as a regulator permission would be needed from landowner pre-publication.

- Locations for example could remain confidential e.g. use randomised data for a corner of a grid square. There are ways around this situation. Question was asked in response to the initial question - how will regulators respond to INSPIRE directive requirements.

Question - Some countries have data centres which do not issue doi's. How is it possible to get a data doi in counties in this position?

- Suggest use DRYAD, FIGSHARE or other commercial supplier who would operate on your behalf to get the DOI. STORE is potentially another option but we have not looked into this site in detail.

Question - What about data quality standards? What standards are expected of the data? A journal paper states study objectives; a data paper does not have this process. Some researchers drive a view, this could skew an overall view

- The metadata associated with the data paper states the limitations of the data. The associated data catalogue can also give more information. There are standards on how data are collected and used but there are no restrictions on how it can be used if people want to use the data to support their point of view. It is possible to put links to data from associated journal papers – this information can inform potential data users of limitations of the data. The publication of data from people publishing contentious results would be welcomed – it would allow independent validation (or not) of their conclusions.

- Data centres apply standards to metadata but the data centre cannot judge the quality of data and there are no restrictions on how data can be used. The data centre ensures that detailed metadata and materials and methods information is made available as supporting information.

Question – Are there any guidelines on precision? If just raw data possible precision issues

- Not within the NERC data centres – though this is a good point. Statistical analyses, derived data should not be made available - should be raw data that is understandable by those downloading data. Should be unambiguous and fully explained – reduces queries. Imagine what data and metadata you would need as a researcher e.g. raw instrument code may not be useful.

- Data deposits are dealt with on a case by case basis by the EIDC.

2.2 Why modellers want your data

K. Beaugelin-Seiller Moustapha Sy, Marie Simon-Cornu

Institut de radioprotection et de sûreté nucléaire (IRSN), PRP-ENV/SERIS/LM2E, Cadarache

Assessing dosimetric impact to human populations (as well as to ecosystems) due to radionuclides in the environment, for example following atmospheric releases from nuclear accidents, is based, when it is modelled, on simulations of multi-media transfers in the environment. Such operational models are based on numerous parameters, all the more numerous that there are many transfer processes, and many chemical elements, even in the simplest and most parsimonious approaches (e.g. with empirical equilibrium-based parameters: partition coefficients, concentration ratios, transfer factors…). Scarcity of related data is well known to be one of the major sources of uncertainty (Hinton et al, 2013). Beyond acquisition of new data, let us ask a methodological question: how to take as much information as possible from all existing data to better parameterize the transfer models? Our proposal is that radioecology may benefit from applying modern and advanced statistical methods for (re-) evaluating existing data. Thus, modellers can offer a "second life" to data, by further exploiting them in meta-analyses. This can be done using values available in publications but is usually more effective from direct use of underlying raw data and associated information.

This is illustrated through the characterisation of uncertainties relative to dry interception of radionuclides by leafy vegetables (Sy et al., in revision). The data collection focused on dry interception by the leaves of crops, more specifically, pasture grass and vegetables, measured at harvest after a dry deposit of radionuclides (whatever their physical form) and with a short deposition-harvest delay (2 days maximum). Thirty-one data were extracted from 2 scientific papers (Chamberlain and Garland, 1991; Watterson and Nicholson, 1996) and 114 were extracted from IRSN reports associated with published papers. The direct use of the IRSN reports ("grey literature") rather than of the corresponding publications enabled the access to raw data, whereas in most cases only averages and standard deviations are available in publications. A Bayesian meta-analysis was performed to analyse the uncertainty about a model of the intercepted fraction as a function of biomass, given the collected data. It results in a more robust deterministic estimation of the parameter, in this case the interception fraction. Moreover, the subsequent probability distributions can be directly used as input in impact assessment models to propagate parametric uncertainty.

Similar works are on-going for other parameters of the foliar pathway, wet interception, and field losses (weathering), and parameters characterizing the transfer to animal products

Comment:

- Modellers often want more information than is given in papers (e.g. IRSN are currently evaluating animal studies conducted by CEH and co-workers) – for this organ weights are needed which are not in the scientific papers but which could have been made available in more complete datasets.

2.3 Radionuclide biological half-life values for terrestrial and aquatic wildlife

N.A. Beresford[1,2], K. Beaugelin-Seiller[3], J. Burgos[4], M. Cujic[5], S. Fesenko[6], A. Kryshev[7], N. Pachal[8], A. Real[9], J. Vives i Batlle[10], S. Vives-Lynch[11], C. Wells[1], M.D. Wood[2]

[1]NERC Centre for Ecology & Hydrology, UK; [2]University of Salford, UK; [3]Institut de Radioprotection et de Sûreté Nucléaire (IRSN), France; [4]Iberdrola Ingenieria y Construcción, Spain; [5]University of Belgrade, Serbia; [6]IAEA, Vienna; [7]SPA Typhoon, Russia; [8]McMasters University, Canada; [9]Ciemat, Spain; [10]Belgian Nuclear Research Centre (SCK•CEN), Belgium; [11]Sterrenstraat 15, Belgium

The concentration ratio model is typically used to estimate activity concentrations within wildlife dose assessment tools. Whilst this is assumed to be fit for purpose, there are scenarios such as accidental or irregular pulsed releases from licenced facilities where this may not be the case. In such circumstances, the concentration ratio approach may under- and over-estimate exposure depending upon the time since the release. This demonstrates a need for a dynamic approach to carry out assessments for such situations. The simplest and most practical approach is representing the uptake and turnover processes by first-order kinetics, for which organism- and element-specific biological half-life data are required. In this paper we describe the development of a freely available international database (developed within the IAEA MODARIA programme) of biological half-life values. The database includes 1580 entries for terrestrial, freshwater, riparian and marine organisms that can be used for this purpose. Biological half-life values are reported for 52 elements across a range of wildlife groups (marine=9 groups, freshwater=10, terrestrial=7 and riparian=3). Potential applications and limitations of the database are discussed.

Acknowledgements

We would like to thank all members of the IAEA MODARIA Working Group 8 (http://www-ns.iaea.org/projects/modaria/) who contributed to this work in anyway, in particular the inputs of C. Barnett (NERC-CEH), T. Hinton (IRSN), J. Mihalík (National Radiation Protection Institute, Czech Republic), K. Stark (Stockholm University, Sweden), C. Willdrot (BfS, Germany) are gratefully acknowledged.

Question – Biological half-life for radium and Bi-214 does it account for ingrowth of daughters? This could underestimate doses quite significantly.

- In part this will be accounted for in the DCC values (ERICA Tool for instance includes daughter products with physical half-lives shorter than 10 d; RESRAD Biota includes more daughters depending on the assessment level).

Note – At the workshop a review of Japanese literature values was made available and the paper/database are currently being edited to incorporate this.

2.4 *The STAR Observatories: the Polish Observatory sites*

Laura Urso[1]

[1]German Federal Office for Radiation Protection (BfS)

Abstract

The Polish Observatory sites are located in the Upper Silesian Coal Basin about 60 km south of Katowice. The continuous discharge of mine water into surface reservoirs enhanced the levels of radium isotopes (Ra-226 and Ra-228) and heavy metals in the environment. The Polish Observatory includes two former settling ponds (Bojszowy and Rontok Wielki), a settling pond in operation (Kaniów), the Upper Vistula river and an area in the municipality Świerklany.

Characterization of the Polish Observatory sites is based on a comprehensive literature review, including Polish grey literature, and a field visit in August 2014 to verify and complement available information. Data available comprise concentration levels in water, vegetation, soil and sediment samples. Transfer factors from soil to plant are also available. Some data, however, relate to previous stages of the ecosystems. Samples gathered during the last visit are currently being analysed. All data will be summarized in a STAR document and made available on the STAR web portal.

Nowadays, according to the ambient dose rate, the contamination pattern of the soil is spotty (banks of the former settling pond Rontok Wielki, municipality Świerklany). The former settling pond Bojszowy is completely covered with waste rock. Terrestrial ecosystems are only to a certain extent suitable for hypothesis-based field investigations whereas aquatic biota (various species of fish and aquatic plants) can be studied at two Polish Observatory sites (former settling pond Rontok Wielki, upper Vistula river and its tributaries). The Polish Observatory sites provide the opportunity to study different stages of mine settling ponds, from a settling pond in operation to a former settling pond after land reclamation.

Question: Are the data & report available from the Radioecology Exchange as yet?

- Not yet.

Question - What about daughter products - radium? Have these been included in the assessment

- Samples being analysed now include daughter products
- Not done on this occasion; some studies using ERICA

Comment:

- There is a COMET Summer school at the Polish Observatory site in Sept. 2015. There is no cost to attend – deadline for applications is Jun 26th 2015 (see https://wiki.ceh.ac.uk/x/A4FsD for information)

2.5 Chernobyl Studies

[1]Barnett, C.L. [2]Gashchak S. P. and [1]Beresford N.A.

[1]NERC Centre for Ecology & Hydrology, UK, [2]Chornobyl Center, Ukraine

Abstract

The Chornobyl Center and NERC-CEH have collaborated in many studies in the Chernobyl Exclusion Zone (CEZ). Some data have been used in publications but much accompanying/individual data are not available. These data could be useful for the STAR/COMET Chernobyl Radioecology Observatory and also for model validation and the estimation of doses to wildlife (to compare to papers reporting effects in the CEZ).

Data are available for Cs, Sr and Pu isotopes for small and large mammals, birds, bats, amphibians and reptiles with associated soil samples for some of these. An overview of the studies and available data will be given. An on-going study sampling ICRP RAP species form a site within the CEZ conducted as part of the TREE (www.ceh.ac.uk/tree) and COMET (www.comet-radioecology.org) projects will be also be described.

We are currently preparing two papers using historical data for publication: (1) Cs and Sr transfer to roe deer and wild boar; (2) a comparison of the transfer of Cs, Sr and Pu to 'mouse like' small mammals, bats and birds. Linked to the publication of these two papers, all data from the historical studies described is intended to be openly available (with a data doi) within two to three years.

2.6 Alligator Rivers Region radionuclide and metals database (a.k.a the BRUCE Tool)

Che Doering and Andreas Bollhöfer

Environmental Research Institute of the Supervising Scientist (ERISS), Department of the Environment, Australia

The BRUCE Tool has been developed to store and facilitate analysis of radionuclide and metal concentration data for environmental samples collected from terrestrial and freshwater ecosystems of the Alligator Rivers Region uranium province and surrounding areas in the wet-dry tropics of northern Australia. Data for biota tissue and environmental media samples have been entered and subjected to primary quality control to identify outliers and obvious errors. The bulk of the data come from research and monitoring conducted by the ***eriss*** Environmental Radioactivity laboratory over the past 30+ years. Radionuclide data are primarily for members of the ^{238}U decay series. Metal data are for Al, As, Ba, Ca, Cd, Co, Cr, Cu, Fe, K, Mg, Mn, Na, Ni, P, Pb, Rb, S, Sb, Se, Sr, Th, U, V and Zn. The data have value in determining concentration ratios for use in human and non-human biota impact assessments, particularly in the uranium mining context. This presentation describes the data and the analysis module for calculating concentration ratios and also provides some examples of research applications.

Question – A lot of data was LOD data, how was CR derived

- LOD values were not used. Acknowledged it is possible this will skew the summarise values.

Question – If Po is so important how sensitive is data to quality of polonium data

- Po has the highest ingestion dose co-efficient. CR for Po-210 higher than other radionuclides unsure of reason. All Po-210 have been corrected for ingrowth for decay of ^{210}Pb.

Question – Does it make sense that the limiting radionuclide is different for humans (Po) and wildlife (Ra)?

- Depends on what people eat, e.g. unsure if consuming liver (with Po). The diet used is a ‘model’ diet so results sensitive to assumptions of model diet. Humans are not ingesting bone (with Ra).

Question – What is the quality control of the data used?

- Grey literature data were from our own data reports and QC information is recorded in these. Other data are from mining industry reports, these are statuary documents so expectation is that data quality is good.

2.7 Past and current environmental actinide data from former nuclear weapons test sites in Australia

M.P. Johansen*, D.P. Child, J.J. Harrison, M.A.C Hotchkis, T.E. Payne

Australian Nuclear Science and Technology Organisation, Locked Bag 2001, Kirrawee DC NSW 2232, Australia

Actinides have been dispersed globally in the environment as a result of atmospheric fallout, and have been localised in more concentrated deposition plumes at accidental release sites (e.g. Chernobyl, Ukraine; Mayak, Russia; Palomares, Spain), and at sites where accidental release scenarios were simulated (e.g. Nevada Test Site, United States; Semipalatinsk, Kazakhstan; and Maralinga, Australia). In addition to past releases, the worldwide inventory of plutonium (Pu) alone was ~1900 metric tonnes in 2010 and growing by 70-90 metric tonnes per year. The increasing portion of Pu, typically in the form of spent fuel, is stored in onsite configurations (non-permanent repositories) and thus presents potential for future accidental releases.

While much radioecological data have been published from fallout or site-specific studies, the actinides themselves often exist in multiple speciation forms, resulting in variable mobility, weathering and uptake rates. When actinide contamination is in a particulate form, its speciation can affect uptake and absorption parameters. Such particles may also provide a secondary source of contamination as the particles slowly weather, causing ongoing, persistent exposure in affected areas for many thousands of years.

To better define how actinide speciation affects radioecological parameters, we have sampled the former British weapons testing sites in Australia (Maralinga, Emu and Monte Bello Islands), which provide for a range of actinide source and release types (fission v. nonfission), and ecological conditions (marine v. semi-arid). At these sites, actinides were initially deposited in the period from 1950s-1960s, and now have been incorporated into soil profiles and food chains through natural processes, allowing for their study in relatively undisturbed and relatively equilibrated systems (or as close to equilibration of radioecological parameters as real-world ecological systems may become).

Here we present the profile of data from the Australian sites, emphasizing ecosystem type (marine v. semi-arid terrestrial), release type (fission v. non-fission), wildlife categories, and progression of data over time. We focus on what is known about the effects of speciation on radioecological data and parameters, and some of the practical issues involved when studying actinides in the environment. We discuss data gaps and recommend means of preserving and presenting the data for use in radioecological studies in Australia and the wider international community.

Question – Why are percentages of body Pu different to expected?

- Data suggests the differences in partitioning of Pu in wildlife, compared to lab-based data, is due to: lower exposure concentrations (e.g. beagle study had very high liver concentration); exposure routes (e.g. many lab studies rely on injections), and the Pu forms (many lab studies use more soluble forms than are found in the environment).

Question – What about error on data?

- There is only one value at some sites.

Question – What is the implication of particulate form?

- Most particles pass through GIT. How much in non-particle form passes through gut wall to plasma is unclear. Data are very limited in general.

Comment:

- The study presented is now available as a paper in J. Environ. Radioact.: http://dx.doi.org/10.1016/j.jenvrad.2015.03.031

2.8 Fukushima data sources – a review

Keiko Tagami, Shigeo Uchida

National Institute of Radiological Sciences, Japan

Large amounts of radionuclides were released to the environment mainly in March and April 2011 due to the accident at Tokyo Electric Power Company's Fukushima Dai-ichi Nuclear Power Plant (FDNPP). The terrestrial environment has been contaminated with radionuclides released to the air, while marine environment received a mixture of radioactive fallout from the air and direct release of radioactive water. Environmental monitoring as well as research activities have been carried out since then, and the data have been updated using internet or by publishing papers in Japanese and English. However, it is sometimes difficult to find a suitable data sources for further data analysis. In this presentation, therefore, we are going to summarize the recent accessible Fukushima data sources and radiocesium concentration changes with time for some components in the environment.

Most of data is summarized in the home page of the Nuclear Regulation Authority, Japan (http://www.nsr.go.jp/english/index.html), and environmental monitoring data covers marine environment (seawater, sediment and biota collected in the port, near the coast (approx. 20 km) and outer area of FDNPP), freshwater environment (river water, sediment and biota), and terrestrial environment (air dose rate, dust, soil and some plants); Data are available in csv, excel or pdf files. In order to see the map image of radioactivity contamination or air dose rate, http://ramap.jmc.or.jp/map/eng/ is available.

For food monitoring, Ministry of Health, Labour and Welfare updating the data for water supply and food (including marine products) for I-131 (until March 31, 2012), Cs-134 and Cs-137 at http://www.mhlw.go.jp/english/topics/2011eq/index.html. The same results are also found in the home page of Ministry of Agriculture, Forestry and Fisheries; prefectural government level data are available at http://www.jfa.maff.go.jp/e/inspection/index.html, although most of them were available in Japanese.

Ministry of the Environment works on the forest environment issues (soil, trees and biota), although it is difficult to find them from English home page. Other data sources are found in international and Japanese journals published by researchers in national and local government institutes, and universities; it would be necessary to collect and review these data to find out what we have learned from the accident.

About the data, one of the most frequently asked questions is their quality. Any data that are not reliable is not useful. In Japan, a series of radioactivity measurement methods have been established (in Japanese) from sampling to measurement of radionuclides for various types of environmental materials, e.g., aerosol, deposition, rain, freshwater, soil, river sediment, crop, vegetable, tea, milk, at emergency and normal situations. For radiocesium measurements, standard reference materials (brown rice, soybean, beef and soil) are commercially available now for laboratory works

Question - How big were the bags of rice measured?

- ~ 30 kg sacks are measured on conveyer belt system: 10 million bags measured per year

Question - Leaf litter being used to tease out Pu ratio is a good idea. Could same be done for marine data, seaweed for example?

- Difficult to get into port/near marine area to access. The operator is just measuring total Pu not isotopes.

Question: Is there a lot of university data being complied?

- University data is ~10%. Government/TEPCO data are dominant. Detection limits are generally lower for university data.

Question – Who is officially responsible for monitoring in Japan?

- Officially delegated to local ministries and governmental bodies.

Comment (from audience):

- Can be difficult to use monitoring data for research, it does not reflect the environmental behaviour very well as samples that are expected to be above limits are often not submitted for analyses.

2.9 SKB SITE DATA

Sara Nordén

Swedish Nuclear Fuel and Waste Management Co (SKB)

As part of the SKB site investigation program, chemistry data for biotic and abiotic parts of aquatic and terrestrial ecosystems have been gathered in our database Sicada. The investigation program included two Swedish sites situated along the Baltic Sea coast, the Forsmark and Laxemar-Simpevarp areas. The strength of this data set is the large amount of elements analysed on the same material, biota tissues and environmental media have been analysed for c. 75 elements. A few radionuclide data is also available.

The data set comprise hydrochemistry of deep and shallow groundwater, porewater, lake, stream and sea water as well as the chemical composition of the regolith and biota of the terrestrial, limnic and marine ecosystems of the two sites. Hydrochemical sampling and analyses continuous as part of our monitoring programme whereas biota and regolith sampling has been performed as campaigns. The biota data are mainly focused on dominating species and organisms of main relevance for human consumption.

The data have, among other things, been used when estimating distribution coefficients (Kd) and concentration ratios (CR) for use in the two latest human and non-human biota impact assessments performed by SKB; in the application concerning a repository for spent nuclear fuel (submitted 2011) as well as in the application for an extension of the existing repository for operational waste (submitted in 2014).

Question – Has there been communication with IAEA regarding incorporation of marine data into its database.

- None known

Comment:

- MODARIA WG4 has extracted some information on soil K_d from SKB reports and this may not have been done in the most optimal way. [Action: B. Howard to arrange for MODARIA interpretation of the data to be sent to SKB for comment].
- Stockholm University has made some K_d data from SKB studies available via the Radioecology Exchange.
- Publication of the SKB data is being discussed.

2.10 *Marine environment radioactivity data from Norway*

Anne Liv Rudjord

NRPA, Norway

This program was established in 1999, predominantly as a result of concerns regarding dumped radioactive waste in the Arctic and long-range transport of radionuclides from European reprocessing facilities. The program is carried out in an efficient collaboration between Norwegian radiation Protection Authority (NRPA) and the Institute of Marine Research.

Sea water, sediment samples, fish and other biota are collected at coastal stations and in regional surveys in the North Sea, Norwegian Sea and the Barents Sea. The open ocean sampling is carried out by research vessels from the Institute of Marine Research in Bergen.

The priority radionuclides in the program are Cs-137, Tc-99, Pu-239/240, Am-241 and Sr-90. The data set on natural radionuclides in seawater (Ra-226, Ra-228 and Po-210) is limited.

The data on Tc-99 in seawater and seaweed have proved to be useful for modeling of ocean transport of radionuclides and other pollutants. Samples of seawater and seaweed were previously analyzed on a monthly basis at a few coastal stations, giving a reasonable time resolution. Furthermore, seasonal effects can be taken into account.

The results are reported in NRPA-reports. The data are stored in digital formats in various databases. The NRPA strategy is to improve the availability for both internal and external users of monitoring data, and for this a new database system will be required. Some data have been reported to international databases, and may be obtained from MARIS, OSPAR or the AMAP database.

Comment:

- There is no single database for Norwegian data, some (marine) data are in MARIS some are not other data are submitted to OSPAR. Currently NRPA are working out best system to use to collate and report data openly online. Contact NRPA if you are interested in the data

Comment (from audience): It is better to put all data in one database. Any database should be close to MARIS in structure, as it would then be easy to combine. Compatibility to other systems is important

- NRPA looking to create system similar to that of CEH. Norway needs its own system especially for emergency preparedness.

Comment (from audience):

- IAEA recognise previous approach to MARIS was 'scattergun' and have improved the database structure recently (reported at the STAR Monaco Kd meeting in April 2015).

2.11 Wildlife Transfer Database – update & intentions

N.A. Beresford[1], J.E. Brown[2], D. Copplestone[3], T. Yankovich[4]

[1]NERC Centre for Ecology & Hydrology, UK; [2]NRPA, Norway; [3]University of Stirling, UK; [4]IAEA, Vienna

The transfer of radionuclides to wildlife in the environmental radiological assessment models developed over the last two decades is most often described by the whole organism concentration ratio ($CR_{wo\text{-}media}$). This parameter relates whole organism activity concentrations to those in environmental media (typically soil for terrestrial ecosystems and water for aquatic ecosystems). When first released in 2007, the ERICA Tool contained the most comprehensive and well documented $CR_{wo\text{-}media}$ database available for wildlife. It was subsequently used in the USDOE RESRAD-BIOTA model and formed the initial basis for the international wildlife transfer database (WTD; www.wildlifetransferdatabase.org/) developed to support IAEA and ICRP activities.

Subsequently, many additional data were input to the WTD, including the outputs of a review of Russian language literature and data from Canadian monitoring programmes associated with nuclear power plants, U-mining and related industries. Summarised data from the WTD in 2011 were used to provide CR_{wo} values in ICRP 114 and the IAEA's handbook on wildlife transfer parameters (http://wwwns.iaea.org/projects/emras/emras2/working-groups/working-group-five.asp?s=8&l=63).

Since 2011, some *circa* 17,000 additional $CR_{wo\text{-}media}$ values have been added to the WTD. The new inputs include original data for: representative species of the ICRPs Representative Animals and Plants (RAPs) from a UK forest; monitoring data from Japanese estuaries and Finland; Canadian wildlife; plutonium uptake data from US weapons testing programme sites; wild plants and invertebrates from north western USA; refereed literature published after 2011. Additionally, data already in the WTD from Australia were reviewed with reference to original source reports not previously considered and amended where required.

The revised WTD was quality checked by considering the degree of variation in the data for each organism element combination and the change between the WTD versions. This identified a number of errors (e.g. double entry of data, unit conversion errors and entries based on a dry matter rather than the required fresh weight basis) all of which have now been rectified.

In 2014 the revised version of the database was used to help populate an undated version of the ERICA Tool (see http://www.erica-tool.eu/ NOTE NEW WEB ADDRESS).

Over the next two years there is an intention to make the 2014 version of the database for marine and terrestrial organisms freely available.

Acknowledgements

We thank all of those people who contributed to the most recent update of the database: M. Johansen (ANSTO, Australia); G. Hirth (ARPANSA, Australia); S. Sheppard (ECOMatters,

Canada); E. Dagher (CNSC, Canada); S. Uchida (NIRS, Japan); J. Napier (University of Oregon, USA); I. Outola (STUK, Finland); C. Wells, C.L. Barnett (NERC-CEH, UK).

Question: Requesting more information on the Bayesian approach used to derive the new ERICA Tool database.

- Ali Hossieni (NRPA) and Facilia did the analysis, there is a paper in J. Environ. Radioact. (http://dx.doi.org/10.1016/j.jenvrad.2013.04.007) which explains the Bayesian approach better as does the STAR deliverable (D3.2).

Comment:

- A paper, as a short communication, on the ERICA Tool updates (version released November 2014) is planned.
- The 2013 WTD summaries will be available on the website soon.

2.12 *Freshwater studies in the Chernobyl exclusion zone*

Dmitri Gudkov

Institute of Hydrobiology of the National Academy of Sciences of Ukraine, Kiev

In spite of the 29 years, past after the Chernobyl NPP accident in 1986, self-purification of the main water bodies in the Chernobyl exclusion zone is extremely slow process. Therefore, ecosystems of the majority of lakes, dead channels and crawls possess high level of radionuclide contamination of all the components. The basic problems of radiation safety of the Chernobyl exclusion zone concerns radionuclides wash-off with surface drainage water to river system, their export outside the exclusion zone and affection of the water quality in the Dnieper River.

Undoubtedly, one of the most important and still insufficient studied problems of aquatic ecosystems within the Chernobyl exclusion zone is research of long-term impact of ionizing radiation on non-human biota. Our researches were carried out during 1997-2014 in Azbuchin Lake, Yanovsky (Pripyatsky) Crawl, cooling pond of the Chernobyl NPP, the lakes of the left-bank flood plain of the Pripyat River - Glubokoye Lake and Dalekoye Lake as well as the rivers Uzh and Pripyat within the Chernobyl accident exclusion zone. The main objects of radioecological monitoring were water, suspended matter, bottom sediments and hydrobionts of different taxonomy. The radionuclide content in biological tissues was measured for 28 higher aquatic plant species, 6 species of bivalve molluscs and gastropod snails as well as 18 species of fish. Our studies were conducted:

(1) Dynamics identification of radionuclide specific activity and distribution in the main abiotic and biotic components of aquatic ecosystems;

(2) Study of dynamic profiles of radioactive contamination levels in hydrobionts of different ecological groups and trophic levels;

(3) Assessment of the major factors, which determine distribution of radionuclides in the freshwater ecosystems;

(4) Analysis of the seasonal dynamics of radionuclides content in macrophites and the role of main aquatic plant associations in processes of radionuclides distribution in aquatic ecosystems;

(5) Assessment of a possibility to use hydrobionts of different trophic levels as biological indicators of radioactive contamination of aquatic environment;

(6) Dose rate estimation due to external and internal sources of irradiation for different groups and species of hydrobionts;

(7) Evaluation of cytogenetical, hematological and parasitological effects as well as changes in producing capacity due to long-term radiation exposure of hydrobionts in conditions of water bodies within the Chernobyl accident exclusion zone.

Question - Why have concentrations of Sr increased in aquatic plants?

- Increase of bioavailable Sr from particles (concentration increase also seen in molluscs and fish)

Question - Do your results confirm the ICRP DCRLs for biota?

- No, effects were seen at comparatively low levels 15 µGy h^{-1}.

Question – Did you weight results for dose rate from alpha and beta emitters?

- Yes the default values in the ERICA Tool were used.

Question - Did you observe effects on sperm cells?

- Not looked at sperm yet but asymmetry seen in gonads in Gluboky Lake

Question – What period of time were water samples taken over?

- Annual results are a mean of one sample per week in lakes and one sample per month in rivers.

Question - How much of the data is published in western literature?

- Most is published in Russian literature but a JER paper is in preparation.

Question – Are effects observed currently linked to current dose rate or instead related to higher exposure of parents and previous generations?

- Yes there may be a burden effect - damage has accumulated over 30 years.

2.13 Terrestrial concentration ratio database: Analyses by wildlife groups and RAPs

Wood MD[1], Beresford NA[2], Copplestone D[3], Howard BJ[2], Yankovich TL[4]

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Developed to support activities of the International Atomic Energy Agency (IAEA) and the International Commission on Radiological Protection (ICRP), the international Wildlife Transfer Database (WTD; www.wildlifetransferdatabase.org/) provides the most comprehensive compilation of radionuclide transfer parameters (concentration ratios) for wildlife. The concentration ratio ($CR_{wo\text{-}media}$) is a constant that describes the ratio between the activity concentration of a radionuclide in the whole-organism and the activity concentration of that radionuclide in a reference environmental medium (e.g. soil or filtered water).

The WTD now contains over 100,000 $CR_{wo\text{-}media}$ values, including summarised data from some studies (n>1 for an individual database entry) and individual CR values (n=1). These data have been used to generate summary statistics – mean and standard deviation (both arithmetic and geometric) and range – for broad wildlife groups (e.g. amphibian, arthropod, mammal, reptile, shrub, tree etc). Group specific summarised $CR_{wo\text{-}media}$ values (generally arithmetic or geometric mean) are used in most of the modelling approaches currently implemented for wildlife dose assessment.

Beyond the broad organism group summary statistics presented within the WTD, it is possible to generate $CR_{wo\text{-}media}$ summary statistics for some organism sub-categories (e.g. carnivorous, herbivorous and omnivorous birds). However, using a statistical analysis approach that we have developed for the analysis of summarised datasets (https://wiki.ceh.ac.uk/x/PgC6Cw), we have shown that there is currently little statistical justification for the use of organism sub-category $CR_{wo\text{-}media}$ values.

Large variability is a characteristic of many of the organism-radionuclide datasets within the WTD, even within individual input data sets. Therefore, the statistical validity of defining different $CR_{wo\text{-}media}$ values for these broad wildlife groups may also be questioned. With the ongoing development of the ICRP Reference Animals and Plants (RAP) approach, there is also a requirement for the derivation of transfer parameters for individual RAPs. Again, the statistical validity of this may be questioned.

Focussing on the terrestrial database, in this paper we present some initial analyses of $CR_{wo\text{-}media}$ values at the broad wildlife group level and for a selection of ICRP RAPs. Based on these analyses, we make recommendations for the future derivation, compilation and application of wildlife group $CR_{wo\text{-}media}$ values.

Acknowledgement

On-going studies are supported by the NERC RATE programme TREE project (https://wiki.ceh.ac.uk/x/PwZgD).

Question - Could you compare your results to ICRP data?

- Yes

Question - Given work currently being conducted on sampling RAPs, should ICRP wait until new analysis is available before progressing

- Reference sites will provide a large amount of data - but replication will be relatively low and it is unlikely to affect the conclusions of the presentation.

Question - Could you use a range rather than GM? Is this better than using herbivorous mammal for deer?

- Environmental conditions are driving the results presented.

Question – What data are available on line now?

- The WTD currently only gives summaries of the data – these are currently the 2011 version of the database and will be updated very soon.

Question – What are the implications of this analysis? What should we be doing now?

- Supports approach taken in the ERICA Tool (advised in IAEA TRS 479). But could also consider, e.g., a 'vertebrate CR' approach in the future.

Comment (from audience) –

- Health warnings need to be made regarding the number of studies and replicates.

2.14 [Wildlife Transfer Database – REML analyses]

N.A. Beresford[1,2], M.D. Wood[2], T. Yankovich[3], C.L. Barnett[1], N. Willey[4], B. Penrose[1]

[1]NERC Centre for Ecology & Hydrology, UK; [2]University of Salford, UK; [3]IAEA, Vienna; [4]University of the West of England, UK

The assessment of the exposure wildlife to ionising radiation for planned, existing and accidental scenarios requires predictions to be made of the transfer of a wide range of radionuclides to a diversity of species. Most models assessing the exposure of wildlife use a simple concentration ratio ($CR_{wo\text{-}media}$) relating the whole organism activity concentration to that in the environmental medium (i.e. soil, air or water). Recently, both the ICRP and IAEA have produced compilations of $CR_{wo\text{-}media}$ values for application in environmental assessment. However, the $CR_{wo\text{-}media}$ approach has many limitations most notably that the transfer of most radionuclides is largely determined by site-specific factors (e.g. water or soil chemistry). Furthermore, there are few, if any, values for many radionuclide-organism combinations.

In Beresford et al. (2013) we proposed an alternative approach and, as an example, demonstrated and tested this for caesium and freshwater fish. Using a Residual Maximum Likelihood (REML) mixed-model regression we analysed a dataset comprising 597 entries for 53 freshwater fish species from 67 sites. The REML analysis generated a mean value for each species on a common scale after REML adjustment taking account of the effect of the inter-site variation. Using an independent dataset, we subsequently tested the hypothesis that the REML model outputs can be used to predict radionuclide (in this case radiocaesium) activity concentrations in unknown species from the results of a species which has been sampled at a specific site. From the outputs of the REML analysis we accurately predicted ^{137}Cs activity concentrations in different species of fish from 26 Finnish lakes using ^{137}Cs activity concentrations in *Perca fluviatilis* as our model input; these data had not been used in our initial analyses to establish our model. Subsequently the model has been applied to predict stable Cs concentrations in fish from three UK lakes (Beresford et al. 2015).

In this presentation we expand the application of the REML approach to consider:

1) Cs transfer to all freshwater organisms
2) Transfer of radionuclides to terrestrial wildlife

Provisional results will be presented and discussed as will plans for the future development of the approach.

Acknowledgement

Initial method development was largely funded under the EU EURATOM funded STAR network of excellence in radioecology (www.star-radioecology.org). On-going studies are largely supported by the NERC RATE programme TREE project (https://wiki.ceh.ac.uk/x/PwZgD), in part, in collaboration with the EURATOM COMET project (www.comet-radioecology.org).

Question – Equilibrium not achieved in 1988 & 1989 after Chernobyl.

- Prediction worked well for the year we choose and we need equilibrium between species not within the environment.

Question – You used largely Chernobyl related data from soon after the accident

- No, there are > 40000 CR values in the freshwater database; this excludes years close to Nuclear Weapons fallout and 1986. Finnish data from 27 lakes and UK data, for stable Cs, from three lakes were used as a blind test of model.

Question – Is the key issue now to define what a site is? What criteria did you try?

- For the freshwater data we tried to trace back to site; for some Russian data each reference was assumed to be a site. For terrestrial data reference was assumed to be site but will go back to raw data and improve this – run presented was for demonstration at this meeting only.

STAR

2.15 ICRP needs for its new C5-Task Group dedicated to “Reference Animals and Plants” (RAPs) monographs

J. Garnier-Laplace on behalf of all members of this C5-TG

Committee 5 proposes a 2-step work programme to gather and update RAP-related basic data and guidance for their best use and practices in support of the application of the system of radiological protection of the environment in planned, emergency and existing exposure situations. This presentation will describe the Terms of Reference, the planned activities and the associated time schedule of this new Task Group of ICRP Committee 5 entirely dedicated to the update of RAP-related data in a comprehensive manner in order to fulfil the following objectives:

(1) To evaluate the completeness of RAPs and associated data with regard to transfer, dosimetry and effects through a scoping analysis;

(2) To demonstrate to what extent any RAP is representative of a group of species, e.g., at the taxonomic class- and wildlife group- level; the RAP representativeness will be evidenced for transfer, dosimetry and type and intensity of effects of ionising radiation;

(3) For effects, to integrate recent modeling approaches to deal with the issue of the extrapolation from individual to the whole population of a species;

(4) To propose a user-friendly structure of all RAP-related needed information, to be populated in a series of monographs.

By gaining the capability of inferring transfer, dosimetry and effects information from what we know about RAPs to what we do not know about any representative species in a robust and credible way, usable in any environmental risk assessment, step 1 will assist in reaching the ultimate aim of “linking RAPs to Representative Organisms (ROs)”. Step 1 will be implemented consistently with (and in support of) the other new TG to be launched in the second half of 2015 to take a step forward on the link with ROs in the environment, based on the concepts and databases already developed for the RAPs. Step 2 of the “RAPs monographs” TG will consist in the development of the monographs according to the outcomes of step 1.

Monographs could be elaborated at the wildlife group level, namely plants, invertebrates and vertebrates (each volume being divided into major classes), where RAP-related knowledge will be highlighted and organised through the three main components of risk assessment: transfers and dosimetry, effects and risk characterisation. As such, this future work will focus on the scientific foundation for the understanding of the primary components of an ecological risk assessment, namely transfer and dosimetry to biota, radiation effects on biota, and implications at higher levels of ecological organisations (populations, communities, and ecosystems).

2.16 Experimental data sets from a grassland ecosystem in the vicinity of the La Hague reprocessing plant

D. Maro*, S. Le Dizès-Maurel, D. Hébert*, M. Rozet*, L. Solier*, D. Boust***

Institut de Radioprotection et de Sûreté Nucléaire (IRSN), PRP-ENV, SERIS, *LRC/ **LM2E/, Octeville/Cadarache, France

The TOCATTA model developed at IRSN is dedicated to the realistic assessment of 14C transfer from atmosphere to plants. To better understand the underlying processes, and to acquire information for model validation, an in situ laboratory was established in an area impacted by the atmospheric releases of the La Hague reprocessing plant. This choice was led by the availability of release information allowing reconstituting on an hourly basis the 14C input to the surrounding environment. According to the environmental components and processes taken into consideration in the model, an associated experimental programme (VATO – for VAlidation of TOCATTA), was launched in 2006. It aimed to estimate the fluxes of 14C in a grassland ecosystem (air, rain, plant, soil water) in relation to the evolution of the carbon concentration in air (day/night), the weather conditions and the land use (grazing, maïze silage and hay). Several types of data were collected, in order to fulfill the code needs. Some of them are already shared within part of the community of radioecologists, in the framework of the BIOPROTA forum (Smith and Smith (2014); Limer et al, 2015).

We now offer to enlarge their distribution to interested people. Issued from three successive campaigns (2006-2007-2008), they include meteorological data (temperature, humidity, wind characteristics, precipitation…), plant physiology data (biomass, growth rate, canopy dilution factor…), soil parameters (14C stocks, decomposition and volatilisation rates…), releases (^{14}C) and ^{14}C activity measurements (soil, grass, rain…).

Taking advantage of the scientific opportunities offered by this field laboratory, a similar work was initiated in collaboration with EDF regarding the transfer of 3H in the same system, aiming to establish i) kinetics of OBT/TOL formation in plants from air vapour, rain and soil water, ii) HTO dry and wet deposit and iii) kinetics of HTO formation in soil from HT in air. In addition to the previous physiological data, LAI will be available. HTO and OBT activity measurements in leaves will complete the 3H data set that would be available for sharing over the medium term.

Comment (from audience) –

- MODARIA WG2 may be interested in collaborating with IRSN on this topic.

Question – Have you thought about sampling wildlife from this area to validate the models used?

- No, as the model developed at IRSN is focused on the transfer from atmosphere to plants. We are looking to its validation.

2.17 *The SRS approach to estimating exposure to wildlife*

J. Brown (NRPA), N.A. Beresford (NERC-CEH), T.L. Yankovich (IAEA)

The IAEA is currently revising its 'SRS 19' reports. Volumes I and II will consider human exposure with Volume III presenting an approach for wildlife. The wildlife approach will consider the ICRPs Reference Animals and Plants and as far as possible uses the same approaches as used for humans in Volumes I and II. The approach for terrestrial organisms differs from the 'traditional' models used to assess wildlife exposure in that:

- The physical half-life of the radionuclide is taken into account
- External deposition on vegetation surfaces and subsequent transfer to grazing animals is considered.

The approach being developed for terrestrial wildlife is described and the novel aspects explored.

Question – where were the diet CRs from?

- CR's taken from 472; few data in many instances, exercise was to demonstrate our predictions were not excessive (which we had first thought they maybe).

Comment:

- Dosimetry is not as per ERICA, not using 10d half-life cut off now – model all daughters (using revised ICRP approach).

Question - Thanks for addressing long standing issue. Is rain splash now addressed?

- Not directly, but if just environmental studies are representative then they should encompass this.

Comment:

- That depends upon if the samples were washed (but washing is rare).

2.18 Application of simplifying assumptions and a graded approach in prospective screening of radiological doses for planned exposure situations: status on the revision of IAEA SRS 19

T.L. Yankovich[1], G. Proehl[1], V. Berkovskyy[2] *et al.*

[1]IAEA, Vienna; [2]Ukrainian Radiation Protection Institute, Ukraine

An Environmental Impact Assessment (EIA) is a procedure that identifies, describes, evaluates, and develops means of mitigating potential impacts of a proposed activity on the environment (UNEP, 2008). For example, when evaluating the potential for significant impacts related to the siting and operation of a radiological facility, or the planning and implementation of a related activity, it is often necessary to conduct prospective modelling to predict potential impacts, so that work can be planned and executed to ensure there is no significant net detriment to people or the environment. In doing so, there is a need to assess the potential magnitude of impacts, and based on this assessment, to plan the work such that the level of effort and mitigation is commensurate with risk.

This can be accomplished through the establishment of a multi-tiered or graded assessment approach, with increasingly more realistic (and less conservative) assumptions, and a correspondingly higher level of model complexity and/or site-specific characterization at higher assessment tiers. Implicit in this is the need to determine what level of conservative should be applied in simplifying assumptions, how much site-specific data may be required (for example, to characterize site-specific conditions and/or to validate model predictions), and which parameters should be measured at what frequency to ensure protection. Such questions require careful consideration during the development of safety standards that provide recommendations on defensible approaches for prospective risk assessment. For example, the International Atomic Energy Agency (IAEA)'s Safety Report Series 19 (SRS 19) provides generic models for use in assessing the impact of discharges of radioactive substances (IAEA, 2001), and is currently under revision.

The revised SRS 19 is intended to provide a self-contained manual containing a set of simple, yet robust assessment methodologies that may be applied at the planning and design stages of a facility or activity. The scope of the revised SRS 19 covers prospective screening assessment of doses to the representative person and Reference Animals and Plants (RAPs), applying a graded approach. Tabulated screening coefficients and environmental dilution factors are being included for 825 radionuclides, assuming equilibrium conditions, for use in the assessment radiological impacts arising from routine discharges of radionuclides to terrestrial and aquatic receptors for planned exposure situations. In addition, updated parameter values have been compiled from databases that were developed as part of the IAEA's EMRAS (Environmental Modelling for Radiation Safety) and EMRAS II international model validation programmes.

The presentation will provide: (i) an overview of the status of the documents; (ii) the underlying bases for assumptions; and (iii) levels of model complexity for different categories of nuclear facilities with varying expected impacts; and will highlight areas where further data could be beneficial.

Acknowledgement

This presentation is being made on behalf of numerous contributors and reviewers of the *Revised SRS 19* - K.M. Thiessen, Y. Bonchuk, A.I. Apostoaei, N. Beresford, J. Brown, M. Chartier, S. Fesenko, F.O. Hoffman, B.J. Howard, J.C. Mora Cañadas, H. Müller, H. Phillips, C. Robinson, J.G. Smith, M. Steiner, B.A. Thomas, and J. Van Der Wolf and the participants in IAEA programmes, such as EMRAS, EMRAS II, and MODARIA, who have contributed to the body of knowledge upon which the *Revised SRS 19* is based.

Question – Why not a coastal system?

- Coastal systems are covered in the revised SRS 19. Specifically, the revised SRS 19 (Volumes 1 and 2) covers freshwater, marine, and estuarine (or brackish) environments, including lakes, rivers and coastal waters. Aggregated screening coefficients (SCs) are provided for each of these types of aquatic systems in revised SRS 19 (Volumes 1 and 2).

2.19 *FREDERICA Database*

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Any system for assessing the impact of a contaminant on the environment requires an analysis of the possible effects on the organisms and ecosystems concerned. To facilitate this, the FREDERICA radiation effects database has been developed to provide an online search of the known effects of ionising radiation on non-human species, taken from papers in the scientific peer reviewed literature. The FREDERICA radiation effects database has been produced by merging the work done on radiation effects under two European funded projects (FASSET and EPIC) and making the database available online. Through the IAEA organised EMRAS and MODARIA programmes, further additions have been made to the FREDERICA database and the existing data have been evaluated and checked.

This presentation will highlight potential applications for the database, gaps in the available data and explain the use of quality scores to help users of the database determine which papers may benefit their research in terms of techniques and reproducibility. The FREDERICA database remains live and it is hoped that new data will continue to be added for the benefit of all interested in the biological effects of ionising radiation and in particular for the purpose of deriving numeric criteria for use in risk characterisation.

Question - Would you update the tables in the same format as they currently are or do something different?

- Could do but resources are likely to be an issue. Easiest to just update them as they are as both positive and negative comments on their usefulness.

Question – You said that it was possible to input data from an excel file – how?

- Ask me for a FREDERICA input spreadsheet (ask Nick for the WTD sheet).

Question - If have extracted information from the literature – do we need to ask permission to publish as a dataset?

- Why should you, it is no different to presenting in a paper. Need to fully reference sources. Only problem is with data not published, would then need to ask permission.

Question – FREDERICA (&WTD) will change over time and some data may come out and other data be added. How is it best to record this?

- Currently following major updates the old version is on my PC! Better to save database updates as individual DOI’s?

Question – Did you check for consistency regarding taxonomy and wildlife group between FREDERICA and WTD

- There are differences where categories are missing from IAEA etc. but common groups all should be the same at the broader upper level; except aquatic invertebrates perhaps?

2.20 Study of the nematode diversity in the Chernobyl Exclusion Zone

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The aim of the study was to assess the effects of former radioactive contamination on the structure of the nematode community in sites affected by the fallout from the Chernobyl accident. Nematodes were collected in spring 2011 from 18 forest sites of the Chernobyl Exclusion Zone (CEZ). The external gamma dose rates, measured from radiophotoluminescent dosimeters varied from 0.2 to 22 μGy h^{-1} between sites. In parallel, the Total dose rates (TDR) absorbed by nematodes were predicted from measured soil activity concentrations, Dose Conversion Coefficients (DCC, calculated by the EDEN software) and Soil-to-biota concentration ratios (from the ERICA tool database). Results showed that TDR were one order of magnitude above the external gamma dose rate measured from RPL. This is mainly due to the contribution of alpha (241Am, 238,239,240Pu) and beta (90Sr, and 137Cs) emitters in the external dose rate. The small size of nematodes promoted a high energy deposition throughout the organisms without fading, giving more weight to external dose rate induced by □ and □-emitters, relatively to □-emitters.

The nematode community corresponded to a majority of bacterial-, plant-, and fungal-feeding nematodes and almost none of the disturbance sensitive families whatever the site. Multiple regression analysis was used to establish relationships between ecological features (abundance and family diversity, indices of ecosystem structure and function) to the TDR and soil physico-chemical properties. No evidence was found that nematode total abundance and family diversity were impaired by the radiological contamination. However, the Nematode Channel Ratio (defining the relative abundance of bacterial- versus fungal-feeding nematodes) decreased significantly with increasing TDR suggesting that the radioactive contamination may influence the nematode assemblage either directly or indirectly by modifying their food resources. Greater Maturity Index (MI), usually characterising better soil quality, was associated to greater pH, moisture and TDR values. These results suggest that of the nematode community from CEZ is slightly impacted by chronic exposure to ionising radiation for predicted TDR reaching more than 200 μGy h^{-1}. This dose rate is 20 times higher than the predicted no-effect dose rate (to be used in ecological risk assessment). This result confirms previous study which revealed a low radio-sensitivity of terrestrial invertebrates to chronic radiation exposure. This apparent low sensitivity of nematode community to chronic exposure to radioactive soils may be partly explained by the dominance in the sampling soils of nematodes that are naturally resistant to pollutant and environmental disturbance.

Question - the FH40 – is that measuring just gamma?

- Yes

Question - Is the TLD also picking up some beta?

- Perhaps

Question. Is the data different to that other places in the world?

- Yes is different than elsewhere. The control site is in the zone; we now want a site outside the zone.

2.21 Low dose effect data from STAR WP5 experiments

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Within the framework of the Network of Excellence STAR (Strategy for Allied Radioecology), WP5 aims to enhance the scientific robustness of ecological protection criteria and their applicability as protection benchmarks. In this context, WP5 has conducted studies in order to acquire and link chronic radiation effects at low dose from the molecular to the population levels in plant and animals species. Four subtasks were defined for two radiation types (internal Am-241 α and external Cs-137 or Co-60 γ) and several biological models (zebrafish, nematodes, daphnids, plants): (i) to explore mechanisms of toxic actions at the sub-organismal level, using molecular markers; (ii) to study metabolic modes of action of ionizing radiation, based on “Dynamic Energy Budget (DEB)” concepts; .(iii) to investigate adverse consequences from the organismal to the population levels and identify different life history characteristics (e.g., age at first reproduction, number of offspring, longevity etc.) that might influence species radiosensitivity at the population level; and (iv) to consider the implications of acquired knowledge for radioprotection of wildlife.

As such, new experimental datasets were produced within WP5 through a series of experiments, performed to study effects of gamma or alpha irradiation at dose rates ranging from background levels to 350 mGy.h -1 . One objective was to understand the tissue sensitivity and radiation mechanisms of toxic actions at the sub-organismal level, using molecular markers. This approach was specifically applied to zebrafish exposed to Am-241 contamination or Co-60 external irradiation. Another objective was to understand how radiosensitivity at the molecular level could be linked to effects at the individual level, by studying organism responses targeted by ionizing radiations (e.g. DNA damage and repair, oxidizing stress, bystander effect) and the possible consequences on individuals in terms of reproduction and survival. This was performed on all biological models. In few species (nematodes, daphnids and duckweed), the DEB approach was applied to identify the metabolic modes of action of ionizing radiation, integrating molecular damage and transgenerational effects on growth and reproduction.

The applied approach focusing on studying molecular mechanisms of toxic actions through a variety of biomarkers, demonstrates quite clearly that the relative differences in biological effectiveness between alpha and gamma emitters will highly depend on the endpoint or biomarker analyzed, the time after irradiation, and the studied organism, tissue or organ. DEB and modelling work has resulted in a methodology for estimating levels of response at which molecular markers can be considered as signals of deleterious effects on survival, growth and reproduction which are critical for population dynamics. To conclude, WP5 shows that biology-based mechanistic approaches can be powerful tools for understanding and linking mechanisms of radiotoxicity and increasing robustness in predictions of radiation effects at the individual and population levels.

Comment:

- Any size of database is acceptable to data centres, small or large.

2.22 Mixture toxicity data from STAR experiments

Clare Bradshaw[1], Nele Horemans[2] & Hildegarde Vandenhove[2], on behalf of STAR Work Package 4.

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One of the main activities in the EC-STAR (STrategy for Allied Radioecology) project over the last four years has been to explore whether radiation protection criteria need to be considered within a mixed contaminant context (Work Package 4: WP4). Experiments have been carried out at several laboratories on a range of test organisms (*Caenorhabditis elegans, Daphnia magna, Salmo salar, Lemna minor, Pseudokirchneriella subcapitata)* representative of aquatic invertebrates, vertebrates, plants and communities. This experimental work has produced a large amount of valuable data.

One set of experiments has investigated how one contaminant may influence the uptake of a second, under a range of environmental conditions and using several different species. The focus has been on U and Cd and these data have been used to populate Biotic Ligand Models (BLM). A second set of experiments were effects studies where stressors were tested alone or in pairs (e.g., gamma irradiation + Cd or U + Cd) on various organisms to identify possible synergistic or antagonistic effects of the combined stressors. In some cases, data were then used for toxicokinetic and toxicodynamic modelling (DEBtox).

The raw data produced is not only interesting for the purposes for which it was collected, but may be of use to others within the fields of radioecology, ecotoxicology and environmental protection. Single stressor effect metrics (e.g., EC_{10} or EC_{50} values) can be calculated and used in a risk assessment context. Gamma effects data may be useful to add to the growing amount of data in the Frederica database. The wealth of information on uranium speciation and related uranium toxicity will be useful for the evaluation of the effect of environmental conditions on uranium toxicity and hence for uranium risk assessment. Future meta-analyses may also be able to make use of the data.

Question - So the nematodes got longer?

- All nematodes got longer over the course of the experiment, but this growth was reduced by exposure to Cd. Gamma irradiation appeared to have little effect on growth.

2.23 Farm animal database

Brenda J. Howard, Claire Wells & Catherine L. Barnett

Centre for Ecology & Hydrology

There have now been three separate compilations of the animal product transfer parameter values, with a fourth update ongoing. This study aims to

- Compile transfer parameter values for animal products and how they have changed with time using a table which directly compare TRS 364, TRS 472, SRS 2014 and IAEA 2015 values
- To provide revised on-line tables of Ff/Fm and CR values at more regular intervals
- To provide improved information on reasons for the changes with time
- To enhance the transparency and provenance regarding the data used and not used.

The methods used to derive the different databases for TRS 364, TRS 472, and the SRS 19 update (for milk and beef only) and the 2015 update are described. The advantages and disadvantages of using review data are considered.

The SRS 19 update required conservative values for a screening tool. As the data are only used for cow milk and meat this TRS table has been significantly updated with additional revision / QC, The methods used to fill gaps are shown, and the major new data sources described.

The TRS/SRS values for all animal products has been compiled into a format which makes them readily comparable with information on which references were removed between versions and why. Currently, values have been tabulated for cow milk and beef, sheep milk and meat and goat milk and meat. For the latter product we have made more progress in considering how to show the values and changes with each table.

Issues arising during the compilation will be given and the intended publication strategy will be described.

Question – Have you looked at the SRS assumption of the 75th %tile values, in terms of potentially under-estimating predicted doses? Does anything flag in relation to use in SRS19 update?

- Do not think so but reality check needed on the data, for example suggested some data should be removed as impossible to have Fm's above a certain level for modern high production level cows.

Comment –

- IAEA commented that this could serve as a useful, independent validation of the revised SRS 19 approach, noting that, if true, it would be useful if this were stated in the paper being written on this topic.
- IAEA also noted a study has been initiated to test whether the 75th %tile assumption is adequately conservative to avoid potential under-prediction of doses and is being carried out by an independent International Expert.

3 Actions

Nick Beresford to send Sara Norden the WTD spreadsheet

Nick Beresford/Mike Wood to send Demitri Gudkov paper on REML & data template

Nick Beresford/Mike Wood to send Abou Ramadan Ahmed the WTD spreadsheet

Brenda Howard to arrange for MODARIA WG4 interpretation of the data to be sent to SKB for comment.

4 Acknowledgements

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