EMRAS – Biota Working Group 8th – 11th November 2004 (IAEA, Vienna)

Participant List 8-11 November 2004

Name	Affiliation	Email
Balonov, Mikhail (Scientific secretary) (*MB*)[1]	IAEA	M.Balonov@iaea.org
Beaugelin-Seiller, Karine	Laboratory of Environmental Modelling, IRSN, France	karine.beaugelin@irsn.fr
Beresford, Nick (Acting WG leader) (*NAB*)[1]	Centre for Ecology and Hydrology, UK	nab@ceh.ac.uk
Borretzen, Peer	NRPA, Norway	Peer.borretzen@nrpa.no
Copplestone, David (*DC*)[1]	Environment Agency, England & Wales	David.copplestone@environment-agency.gov.uk
Yu, Charley	Argonne National Laboratory, USA	cyu@anl.gov
Olyslaegers, Geert	SCK-CEN (Belgian Nuclear Research Centre)	golyslae@sckcen.be
Doi, Masahiro	National Institute of Radiological Sciences, Japan	Masa_doi@nirs.go.jp
Horyna, Jan	SUJB (Czech. Regulatory body)	Jan.horyna@sujb.cz
Lee, Hansoo	Korea Atomic Energy Research Institute	Hslee5@kaeri.re.kr
Siclet, Francoise	EDF, France	Francoise.siclet@edf.fr
Hosseini, Ali	NRPA, Norway	Ali.hosseini@nrpa.no
Sazykina, Tatiana	SPA Typhoon, Russia	ecomod@obninsk.com
Yankovich, Tamara (*TY*)[1]	AECL, Environmental Technologies Branch, Canada	yankovich@aecl.ca
Nedveckaite, Tatjana	Institute of Physics, Lithuania	tatjana@cablenet.lt
Kryshev, Alexander	SPA Typhoon, Russia	ecomod@obninsk.com
Gaschak, Sergey (*SG*)[1]	International Radioecology Laboratory, Ukraine	gaschak@chornobyl.net
Perez-Sanchez, Danyl	CIEMAT, Spain	d.penez@ciemat.es
APOLOGIES		
Howard Brenda (WG leader)	Centre for Ecology and Hydrology, UK	bjho@ceh.ac.uk
Melintescu, Anca	National Institute of R&D for Physics and Nuclear Engineering "Horia Hulubei", Romania	ancameli@ifin.nipne.ro

[1]See actions in Work Plan

~50 people have registered an interest in the Biota Working Group (BWG)

Work Plan and Actions

ASAP	Use of ICRP reference organisms as provided by Jan Pentreath to the Environment Agency in England and Wales has been confirmed but DC is to discuss with Jan the rational behind their selection and to provide additional information to the BWG	Action: **DC** *(done)*
15 Nov 2004	NAB to provide draft abstract for (Nice conference) review by BWG members. Note immediate turnaround required because this is the submission deadline	Action: **NAB** to issue abstract. **ALL** to review *(done)*
20 Nov 2004	Any final comments on documents prepared during the 8-11 Nov meeting to be sent to NAB.	Action: **ALL** *(done)*
Start Dec 2004	NAB to contact SKB to discuss use of their ecological model in the BWG.	Action: **NAB**
End Dec 2004	To have obtained Perch Lake scenario from ^{3}H and ^{14}C WG	Action: **MB**
Mid Jan 2005	Each model participant to provide their selection criteria and choice of reference organisms as part of a review of the use ROs	Action: **ALL** with model to provide to DC
Mid April 2005	Each model participant to provide results for Exercise 1 (DCCs) and 2 (activity concentrations)	Action: **ALL** with model to provide to NAB
By late May 2005	Scenarios 1 (Chernobyl terrestrial data set) and 2 (Canadian Perch Lake data) for exercises 3 and 4 to be prepared for discussion at the next meeting.	Action: **NAB/SG** scenario 1 and **TY** (scenario 2)
By late May 2005	To have obtained Chernobyl cooling ponds scenario BIOMOVS report & forward to CEH	Action: **MB** *(done – MB sent to CEH 22/11/04; see also Kryshev et al. 1998;1996 and Hoffman et al. 1996 below)*
1-3 June 2005	Meeting in Vienna	Action: **CONFIRMED**
Suggested targets thereafter		
2nd – 6th Oct. 2005	*Nice conference*	
Mid Oct 2005	*Completion of exercises 3 and 4 (based on scenarios 1 & 2)*	
Nov 2005	*3rd Combined meeting, discussion of results from exercises 3 and 4 Allow time for feedback and modification of models*	
April 2006	*Preparation of scenarios 5 and 6 – 2nd terrestrial and aquatic scenarios*	
Nov 2006	*Results discussed of scenarios 5 and 6*	

Agenda for 8-11 November 2004

1) IAEA action plan (Didier Louvat)
2) IAEA objectives for Biota Working Group (BWG) (Mikhail Balonov)
3) Short introductions – relevance/expectations/potential contributions
4) Discussions of models/frameworks to be validated
   a) RESRAD-BIOTA (Charley Yu)
   b) England & Wales Environment Agency (David Copplestone)
   c) EDEN (Karine Beaugelin-Seiller)
   d) ERICA-FASSET (Nick Beresford)
   e) ECOMOD (Tatiana Sazykina)
   f) EPIC Dose3D (Peer Borretzen)
5) Discuss objectives for BWG
6) Potential Scenarios
   a) ERICA Case studies (Nick Beresford)
   b) Kyshtym accident (Tatiana Sazykina)
   c) Chernobyl data sets (Sergey Gaschak)
7) Way forward
   a) Agree objectives for BWG
   b) Scenarios
   c) Responsibilities
   d) Next meeting (Spring 2005)

Agreed Primary Objective

To compare and validate models being used and developed by Member States for biota dose assessment (that may be used) as part of regulatory process of licensing and compliance monitoring of authorised releases of radionuclides in order to improve Member State's capabilities for protection of the environment

Secondary Objectives

1) To (initially) compare and validate screening level biota dosimetry models (only ECOMOD and RESRAD—BIOTA can currently go further than a screening level approach)
2) To implement standardisation of the terms (e.g. dose per unit concentration (DPUC), dose conversion factor (DCF), dose conversion coefficient (DCC) etc to DOSE CONVERSION COEFFICIENT(DCC))
3) To compare the methods used for calculating internal and external (unweighted) dose conversion coefficients (dose per unit concentration or dose conversion factors) to a limited range of ICRP reference organism geometries and radionuclides.
4) To compare the activity concentrations derived from media to biota transfer for the radioecological components of the models under evaluation. To evaluate the underpinning assumptions that may be used in the different models if any activity concentrations are significantly different.
5) To review and record the selection criteria used by the different models in the selection of reference organisms and to establish any differences in their application.
6) To test the accuracy of model activity concentrations (and compare dose predictions) to reference organisms for biota using field data.
7) To establish whether the screening models are suitably cautious in their approach.
8) To identify knowledge gaps & uncertainties which may lead to improvements in existing models.
9) To recommend priorities for future research and model development.

Key points

1) Comparisons and model-data validation exercises will assume that the starting point is a concentration in media (air, soil or water) and that any modelling required to generate these media activity concentrations is outside of the remit of this WG – particularly as many of the models that may be used, have been/are subject to, other IAEA working groups on model validation.
2) Model-model intercomparisons for hypothetical radiological scenarios have not been ruled out and will form the basis of the first exercises.
3) Model-data validation for real radiation conditions will be used in the second phase of exercises. Additional data may become available for the proposed Sellafield scenario and dose measurements using thermo luminescent dosimeters may be made in ongoing projects that some of the participants are involved with. The status and availability of data from these studies will be monitored by the BWG.
4) The majority of the models proposed for participation are used for screening purposes. Of the models discussed at the meeting only ECOMOD (which is ecological based model) and level 3 of the RESRAD-BIOTA model can currently undertake more realistic evaluations.
5) It was decided that all dose predictions made in the first exercises will be based on whole body unweighted absorbed doses i.e. no doses to organs will be calculated.
6) Exercises comparing models to field data measurements will be undertaken on a blind trial basis – i.e. participants will be provided with activity concentrations in appropriate media (air, soil or water) and a list of organisms to predict concentrations/doses to but the field based concentrations/doses will be withheld until the results have been collated. They will then be issued to the participants for discussion/evaluation of the results.
7) In terms of model result evaluation, it has been suggested (but not yet accepted) that if the model-model or model-data comparisons are within 2 orders of magnitude and predictions are higher than field data then they are acceptable. This aspect will be discussed further in future working group meetings.
8) Wherever possible, participants should use their models as they would do so in a real situation. The intercomparison exercise is as much about the processes that underpin the assessment methodology and the assumptions that are made by the "assessor" as evaluating the numbers being generated *per se*.
9) When considering the purpose of the doses to biota models, it is important to bear in mind that we need a practical approach to determine firstly activity concentrations in biota, secondly, external and internal doses and thirdly effects on the individual and possibly how this effects relate to detriment or harm.
10) However, whilst it was agreed that it would be nice to be able to assess the effects of exposure to ionising radiation on individuals and populations but that the available data to support such assessments is currently limited. This was therefore placed on hold pending further developments in this area (and will be revisited as the BWG progresses).
11) When considering sources of radiation effects information it was pointed out that (in the view of the IAEA) the primary data sources should be UNSCEAR 1996 (and the update that is likely to be issued during the life of this EMRAS working group) and FASSET (FRED) database.
12) When considering the boundaries for this work, it was also pointed out that (in the view of the IAEA) the working group should address systems that are equivalent to human radiological protection (i.e. be consistent with current ICRP thinking based on ICRP Publication 91) and not on systems that primarily try to equate protection of the environment from ionising radiation to the approaches currently being used/adopted for chemicals in the environment.
13) It was considered likely that IAEA will produce a standard for biota in 2008/2010 in accordance with the IAEA action plan on the doses to biota issue.
14) It was agreed that a common subset of reference organisms and radionuclides be used in the exercises to ensure we have results to compare.

15) Most of the models put forward have been designed in some way to address the need to demonstrate compliance and hence there is a balance between the degree of inbuilt conservatism and realism. For prospective doses/discharges it may be better to have more realistic model outputs.
16) It was agreed that, initially, we would not compare the 'screening levels' (i.e. estimated dose or activity concentration against which screening assessment results are compared) used in the various models.
17) None of the models put forward at the moment with the possible exception of ECOMOD have the ability to deal with accidental or dynamic scenarios.

Points to note from plenary discussions

When defining the scenarios it will be important to justify their selection and to describe what the different scenarios will provide. For example, it may be that different radionuclides or organisms will be present in the scenarios.

Models put forward

1) RESRAD-BIOTA (United States Department of Environment)
2) England and Wales Environment Agency Habitats Assessment Approach (based on publication R&D 128)
3) EDEN (only a dosimetry model at the moment) (IRSN)
4) DOSES3D (only a dosimetry model at the moment) (NRPA)
5) ECOMOD (SPA-Typhoon)
6) ERICA-FASSET model (may eventually be able to undertake scientific modelling assessment) (EC Sixth Framework funded consortium)
7) Canadians – various models/approaches internal to individual organisations which will be approached to participate in the comparison and validation exercises (Tamara Yankovich to organise distribution and return of scenarios within the EMRAS programme)
8) Atomic Energy Canada Ltd. approach
9) OURSON Freshwater radioecology model only (Electricité de France)

Note: The BWG is not restricted to the above models and would welcome any new models to be proposed and used in the exercises. Any additional models would be requested to take part in exercises 1 and 2 in addition to any scenarios that they may wish to participate in.

Brief descriptions of models proposed for comparison by the BWG can be found at the end of these notes.

Exercises

The aims of the two exercises agreed at the first workshop are:

Exercise 1: To compare the methods used for calculating internal and external dose conversion coefficients (dose per unit concentration or dose conversion factors) to a limited range of ICRP reference organism geometries and radionuclides.

Exercise 2: To compare the activity concentrations derived from media to biota transfer for the radioecological components of the models under evaluation. To evaluate the underpinning assumptions that may be used in the different models if any activity concentrations are significantly different.

Further details can be found in the instructions for each exercise.

Scenarios

The following scenarios were put forward as possible options:

Sellafield (terrestrial & marine)
Loire River
Komi
Kysthym
Chernobyl (terrestrial and cooling ponds)
Cardiff Bay (being considered by ^{3}H & ^{14}C WG)
Perch Lake

Chernobyl terrestrial and Perch Lake (freshwater) being taken forward as Scenarios 1 and 2. Further scenarios will be selected as the project progresses.

Questions/issues to be addressed (*for continued discussion at next WG*)

What can/should be done for modelling doses to biota?
What can we do?
What would we like to do?
What are the limitations on what we can do?
How far do we go?
Anyone have alpha data for biota in the Chernobyl zone?
Can all the scenarios be put on the website?
Not discussed yet - the evaluation of external dose calculations – this might be a little easier to validate with instrument readings.
Methods to evaluate the results of the intercomparison exercises will be needed – what statistics to use?
Do we want participants to report their sensitivity analysis results if they undertake such analysis as a routine part of running their models?
Future exercise scenarios (>2) may need full elemental chemical composition information along with site specific distribution data.

Provisional Agenda for May 2005 meeting

Review of Exercise 1
Review of Exercise 2
Discussion of how to evaluation the results and the significance of any variation (e.g. 2 orders of magnitude range is acceptable?).
Discussion of Exercises 1 and 2 and drafting of paper for Nice conference
Review of reference organism selection criteria
Review and issue of scenario 1 (Chernobyl terrestrial data set)
Review and issue of scenario 2 (Perch Lake data set)
Arrangements for drawing up scenario 3 (Sellafield regulated release data set)
Decision on second aquatic scenario (possibly Chernobyl cooling ponds?)
Structure and content of report(s) on the activities of the BWG? Format? Structure? Content? Breakdown in reports?
Medaka fish – index of environmental pollution (Masahiro Doi)
AOB

Brief Model Description:

RESRAD-BIOTA

The RESRAD-BIOTA code is the newest addition to the RESRAD family of codes. It was designed to provide a spectrum of analysis capabilities, from simple screening to more

realistic site-specific analysis, for the evaluation of nonhuman biota in the environment. The RESRAD-BIOTA code was principally sponsored and developed by the U.S. Department of Energy. The code was designed to be consistent with and provide a tool for implementing the DOE Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota (DOE-STD-1153-2002). Three levels of biota dose evaluation are available, ranging from level 1, in which conservative assumptions are made through the provision of a general screening process but few inputs are required, to level 3, in which fewer assumptions are made a priori but more site- or receptor-specific input data are required. Analysis can start at the general screening level and proceed to level 3 if the assumptions in level 1 are too conservative.

Since its first release in 2001, many new features have been added to the code. They include additional evaluation approaches and capabilities, such as these:
(1) development of biota concentration guides (BCGs) for additional radionuclides;
(2) additional flexibility for specifiying, expanding, and sharing organism specifications through an organism editor; (3) improvements to environmental transfer factor parameter data sets; (4) inclusion of additional "reference organism geometries" (e.g., dose conversion factors for eight ellipsoid-shaped organisms); (5) sensitivity analysis capability for calculated dose estimates; (6) addition of a food chain transport model; and (7) improved ability that allows users to transfer radionuclide environmental media concentrations generated from other modeling codes to RESRAD-BIOTA for subsequent biota dose evaluation.

The RESRAD-BIOTA code provides a cost-effective and flexible tool for conducting biota dose evaluations that could be applied within an international framework for protecting the environment from radiation. It supports a variety of environmental assessment needs, including (1) demonstrating compliance of routine facility and site operations with available dose limits or "dose rate guidelines" for biota; (2) conducting ecological screening assessments of radiological impacts at contaminated sites; (3) estimating doses to biota in an environmental impact statement, when coupled with predictive dispersion codes that model a facility's effluents prior to construction; and (4) predicting future doses to biota, when coupled with pathway codes as part of assessing the decommissioning of facilities. The RESRAD-BIOTA code and supporting documents can be downloaded free of charge from the RESRAD web site--http://www.ead.anl.gov/resrad.

ERICA-FASSET

Use Biota-Soil concentration ratios (CRs) to determine the radionuclide concentration in the reference organism. However the generation of the default CRs is subject to a lack of data and description by NAB of the quality and quantity of CRs for each ecosystem type was as follows:

Marine, agriculture ecosystems – good
Semi-natural ecosystems – average
Freshwater, brackish ecosystems – very poor (<20%)
Forest ecosystems – poor
Wetland ecosystems – none

England & Wales Environment Agency Approach

Very similar basis to ERICA-FASSET but with a more limited scope of radionuclides and reference organisms/ecosystems and is used as a screening tool only. It is an interim approach in order to address the practical need to evaluate doses to biota under legislation in England and Wales that has deadlines which fall before the ERICA-FASSET project will develop a fully functioning software tool that will be used in the future. The model is unlikely to undergo much further development because the Agency will utilise ERICA-FASSET approach/tool once that has been produced. Currently used for

assessments though and thus would be good to know if this model is conservative compared with other models.

ECOMOD

Uses stable chemical analogues and ratios of radionuclides to determine the concentrations of radionuclides in the biota. However this approach makes the model very flexible and it also means that the model is an ecological one. The model is dynamic and can handle changing radionuclide concentrations. The model was originally aquatic only but is now capable of undertaking terrestrial assessments too. The model is particularly good for any radionuclides that are analogous to, or isotopes of, biologically active chemical elements. It is also possible because it is an ecological model to modify population characteristic parameters (e.g. reproductive rates etc) which means that the model has the potential to predict effects at a population level.

EDEN

Uses description of target and sources in terms of geometry, chemical composition, relative location, radionuclide content to calculate the corresponding internal and external DCCs, for each radionuclide and each type of radiation. These calculation are based on the two following main hypothesis: (1) any organism can be described by an ellipsoid, characterised by its three axes, (2) any medium (biota as well as non-biotic components) is homogeneous in chemical composition, density and radionuclide concentrations. Dedicated Monte Carlo calculation were computerised in a tool devoted to three potential uses: experimental results analysis, environmental studies and, one at a longer term, regulatory purposes in agreement with the results of the ERICA-FASSET projects.

EPIC-DOSES3D

The program allows dose calculations from external (β particles, photons) and internal exposure (α, β particles, photons). Probability distributions of chords/segments lengths (1D array) inside the organisms, from external or internal sources, are used for DCC calculations. The method for describing phantoms, allows DCC values to be calculated for organisms of any size or form, as long as input data concerning organism shape are available. If such data are not available, it is possible to use approximation with simplified objects (ellipsoids, cylinders, etc.). Doses can be calculated for any radionuclide although, in the present version of the program, a dataset for 42 radionuclides is used.

AECL approach

Radionuclide concentrations in environmental reference media (i.e. water, sediments, soil and air) are used as input parameters to the model. Concentrations in receptor biota are then estimated using concentration factors (CFs) in aquatic systems, or radionuclide transfer coefficients with dietary information in terrestrial systems. The receptor species themselves are selected based on site-specific species inventories in areas of interest and are characterized in terms of their key ecological attributes, such as:

- Body size and corresponding allometric parameters;
- Type of organism (e.g. small mammal, amphibian, fish, terrestrial invertebrate, etc.);
- Habitat-use (e.g. soil-dwelling, aerial, benthic, pelagic, etc.) and corresponding occupancy or habitat-use factors in key environmental media;
- Functional feeding group (e.g. herbivorous, carnivorous, piscivorous, etc.); and
- Trophic interactions (e.g. primary producer; forage fish; top predator; etc.).

Initially, a hyper-conservative, screening approach is applied, which assumes that organisms are receiving maximum radionuclide concentrations 100% of the time. In addition, hyper-conservative internal and external dose conversion coefficients (DCCs) are used (based on the approach developed by Amiro, 1997), which are not corrected for organism body size.

In cases where guideline values are exceeded, more realistic dose estimates are carried out, which utilize more realistic/representative concentration data as input parameters, which account for the potential time-spent in contact with environmental media in areas where relatively higher concentrations are found (e.g. through consideration of home ranges, occupancy factors, contaminant distribution data, etc.) and which apply more realistic dose conversion coefficients accounting for body size and dimensions (based on the approach developed by Blaylock et al., 1993 and by RESRAD-BIOTA).

This approach has been applied in freshwater, marine and terrestrial ecosystems.

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