The IAEA's Programme on Environmental Modelling for RAdiation Safety (EMRAS II)

EMRAS II
Reference Approaches for Biota Dose Assessment
Working Group 6
Biota "Dose Effects Modelling"

M I N U T E S

of the 2nd Working Group Meeting
held as part of the Joint EMRAS II Working Group Meetings (WG4, WG5 & WG6)
at IAEA Headquarters, Vienna
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IAEA Scientific Secretary	Working Group Leader
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Background

This group is interested in understanding radiological impacts to the environment. To do so requires knowledge of exposure conditions, life history characteristics of the organisms, estimation of absorbed dose, derivation of dose-response relationships, and the scientific establishment of dose (dose rate) screening levels that are believed to adequately protect the environment. Much high quality work has already been accomplished in this area by prior European efforts (ERICA and PROTECT), as well as ongoing international work by the IUR and ICRP. Within the framework of EMRAS II, we will build on what has already been accomplished, and work closely with the IUR and ICRP as they pursue similar objectives. Our over-arching objectives are:

— Dose – Effect Modelling to Assist Environmental Risk Assessments;
— Statistical Derivation of Screening Level Values and Biota Protection Thresholds; and
— Reach Consensus; Document Methods; Publish Guidance.

Population Modelling Task Group

Task Group Leader: Tatiana Sazykina

Tatiana presented results from a questionnaire designed to query modellers about tools that might improve our modelling of radiological effects to populations of exposed biota. Several modellers discussed the characteristics of their respective models:

— ***Fred Alonzo's*** group has been working for several years on population level effects to *Daphnia* using laboratory experiments to examine effects, and then developing models for making predictions. Fred's models allocate an organism's available energy/resources to various categories, such as maintenance, growth, and reproduction. The assumption is that energy initially gained from food consumption is subsequently allocated to growth and reproduction,

but that energy allocation is altered by exposure to contaminants. His work highlights the need to evaluate a contaminant's effect over several generations because the scope and magnitude of effects change with chronic exposure of multi-generations. A delay in the timing, or start, of reproduction seems to be an important endpoint that can alter population dynamics following contaminant exposures.

— ***Isao Kawaguchi*** Isao uses a canonical model based on logistic growth. Some of Isao's modelling approaches can be found in the book by Pastorok et al. (2001) entitled "Ecological Modelling in Risk Assessment". Isao compares his model predictions to laboratory data derived from microcosms that contain populations of multiple species. The microcosms allow an examination of the interactions among algae species as influenced by radiological exposures. Isao uses three species of algae, each at a different trophic level (i.e., producer, prey, predator). *Most interestingly, the species that is most resistant to radiation when exposed in isolation, becomes the most sensitive when exposed within a functioning community of three different populations of species.*

— ***Alexander Kryshev*** Alexander discussed the attributes of the model he is using to predict the effects of chronic irradiation on fish populations. An interesting component of his model is a 'repair pool' that allows for organisms to recover from, and adapt to, the effects of radiation exposure. As modelled, the repair system is radiosensitive and can also repair damage from other stressors. Alexander's model predictions compared well to data within the EPIC database.

— ***Jordi Vives I Batlle*** presented two models, one on the population dynamics of lobsters exposed to fishing pressures and to radiation, as well as a model on plankton dynamics. His models contain a "repair pool" similar to that of ***Alexander Kryshev***. The model predicts tipping points at which additional stress from fishing or contaminant exposure cause drastic declines in the populations. The model also predicts that indirect effects cause impacts to less radiosensitive organisms; that fishing pressure is analogous to a stress from radiation of about 100 mGy/day; that an alpha weighting factor of about 30 is appropriate; and suggests a benchmark of 10 mGy/day from chronic exposure.

— ***Tatiana Sazykina*** then presented a case for the need of a generic population model. She envisions that such a model might predict effects under a wide variety of scenarios and for many different types of populations. Tatiana presented several equations which depicted fundamental processes that she thinks should be within a general population model.

— ***Diego Telleria*** was in the audience and spoke favourably about the work that the population modelling group was doing. He expressed the IAEA's need for models that: (1) predicted the effects to key species within a community; (2) considered other stressors; and (3) that accounted for the spatial variability of contaminants relative to the home range of animals and the reduced amount of time that many species may spend within a contaminated area. We agreed to consider his needs in our future modelling efforts.

Multiple Stressors Task Group

Task Group Leader: Hildegarde Vandenhove

The goal of this group is to review the literature for multiple stressor data in which radiation or exposure to radionuclides was among the mix; query ecotoxicologists from the chemical industry to see what their most recent conclusions are relative to the need for multiple stressor analyses; and report to the IAEA on whether this should be a topic requiring further exploration in the future.

This EMRAS II subgroup has merged with an IUR Task Group on the same subject (total membership is about 20 individuals).

The group developed a standard electronic data collection form that will constitute the foundation of a mixtures database. Members of the group can now enter data from pertinent papers in a systematic and uniform manner.

A literature survey yielded approximately 20 papers that deal with contaminant mixtures in which one stressor was radiation. Only one of the papers established a dose-response curve. This highlights the rarity of such studies. Data collection is slightly behind schedule. Finalisation is expected by end of October 2009. An article will be written based on the data collected and a draft thereof is expected by January 2010.

The group queried the chemical industries' Network of Excellence on chemical mixtures *(NOvel Methods for Integrated Risk Assessment of CumuLative stressors in Europe; NoMiracle)*; but with only moderate success. It seems that *NoMiracle* is a slightly behind in getting their public documents to press, and they are protective of their information until the material is published. We were thus unable to access their information. ***Hildegarde*** will explore the establishment of a Memoradum of Understanding (MoU) with NoMiracle, so that we can benefit from what they have already learned about chemical mixtures. The NoMiracle website is http://nomiracle.jrc.ec.europa.eu/default.aspx. It was initially scheduled to have a draft report by December 2009 summarizing the NoMircale findings with respect to how approaches used for chemicals can be applied for radiation protection. This timing cannot be attained and writing of the report will depend on the availability of the NoMiracle documents.

Two prominent scientists in the field of designing experiments for mixture studies (Claus Svendsen, Centre for Ecology and Hydrology, Oxfordshire, UK; and Thomas Backhus, Göteborg University, Sweden) were consulted. ***Hildegarde*** is exploring the option of a short training course taught by one or both scientists. The IUR was approached to partially support this training course. SCK•CEN is willing to host the training course, which is planned for Spring 2010.

The group originally agreed to write guidelines for mixture exposure experiments by December 2009. This timing is not feasible. This work will be accomplished, 3 months after the training course or following the availability of related NoMiracle reports.

FREDERICA Database Task Group

Task Group Leader: Almudena Real

This database is the foundation upon which we will develop new dose-response relationships and taxonomically-expanded screening level values. It was last updated in 2006 and requires input of recent data, some data thought to have been missed from UNSCEAR, as well as input from Japanese/Russian/Ukrainian literature.

This group was highly successful and examined some 650 papers, from which 137 were deemed appropriate to add to the database. This represents about a 10% increase in the existing FREDERICA database. Some 250 of the 650 papers are in the Russian language and will need additional translation by native speaking scientists prior to their incorporation into the database. Several previously underrepresented classes of animals were enriched by the new papers (i.e., amphibians, insects and protozoa).

A third task "QA/QC and score entry" will be finished by the end of September 2009.

Some references have been "rejected" because of various reasons (i.e., irradiation schedule, endpoint, etc.). A list with all the references **not** included in FREDERICA will be prepared. We will try to include this information in the database, since we think it could be useful.

The Environmental Agency (EA) has a copy of all the papers in FREDERICA. The new references included during EMRAS-II Programme will be sent in *pdf* format to the EA in order to keep the archive updated.

Once the task "QA/QC and score entry" has been finished, we will need to do the "Dose-Response Curve Modelling" of the new data included in FREDERICA (only of the "high quality" data). As soon as we have the deadline for this task, ***Almudena Real*** will inform ***Jacqueline Garnier-Laplace*** (Task Group Leader of the "Dose-Response and Species Sensitivity" Task Group).

Dose-response and Species Sensitivity Task Group

Task Group Leader: Jacqueline Garnier-Laplace

Jacqueline Garnier-Laplace and ***Claire Della Vedova*** conducted a training course on the development of dose-response curves. Ultimately, data from the newly updated FREDERICA database will be used to develop dose-response curves. The curves will then be used to derive homogeneous toxicity endpoints (e.g., ED50, EDR10) for the implementation of species sensitivity distributions and the corresponding derivation of threshold protection values. As part of the training course, members of the WG6 were taught how to download and install free "R-package" software. The software is a powerful statistical, curve fitting and graphics package (http://cran.r-project.org/). The training included fundamentals on: (1) how to determine if data meet the appropriate criteria for inclusion; (2) how to enter the data into the R-package software; and (3) how to use the software to derive sigmoidal and hormetic dose-response relationships.

After the most recent additions to the FREDERICA database have been quality checked by ***Almudena Real's*** group (see above), the newly trained volunteers will begin fitting dose response curves under the guidance of ***Jacqueline*** and ***Claire***.

Canadian Benthic Data Task Group

Task Group Leaders: Steve Mihok (CNSC, Canada – not present) and Richard Goulet.

Richard Goulet presented information on a large and diverse dataset of sediment cores taken from uranium mining areas throughout Canada. The data include population abundance and diversity information for benthic invertebrates. The data were collected over a 15 year period and include control sites as well as contaminated sediments from the mining and milling operations. Sediment and water chemistry data, as well as activity concentrations for ^{210}Pb, ^{210}Po, ^{226}Ra, ^{230}Th, total U and Se are available. Additionally, information on fish length, weight, gonad weight and liver weight are within the database.

WG6 is interested in using the data to test some of the concepts that we develop in the population modelling, multiple stressors and dose-response task groups.

MoUs with the various mining companies have been established with CNSC and would allow us to use the data.

The data are currently being updated with the most recent information (anticipated completion in August 2009).

WG6 will explore a subset of the data (kindly provided by CNSC) and design a strategy for use. This strategy will be presented (by ***Tom Hinton***) as a proposal to CNSC at the next EMRAS-II Technical Meeting, being held at IAEA Headquarters in Vienna, 25–29 January 2010.

WG6 MEETING AGENDA		
Tuesday, 21 July 2009		
09:00	Welcome *(Meeting Room F0822)*	Tom Hinton
09:15	Population Modelling (update)	Tatiana Sazykina
09:45	Population Model Results	Fred Alonzo
10:00	Population Model Results	Isao Kawaguchi
10:15	Population Model Results	Alexander Kryshev
10:30	*COFFEE BREAK (10:30 – 11:00)*	
11:00	Population Model Results	Jordi Vives I Batlle
11:15	Population Model Results	Tatiana Sazykina
11:30	Population Modelling (*open discussion*)	Tatiana Sazykina/Tom Hinton
11:45	Multiple Stressors (update)	Hildegarde Vandenhove
12:30	*LUNCH (12:30 – 13:30)*	
13:30	Dose-Response Curves (Training)	Jacqueline Garnier-Laplace
14:30	*COFFEE BREAK (14:30 – 15:00)*	
15:00	Dose-Response Curves (Training)	Jacqueline Garnier-Laplace
17:00	End	Tom Hinton
19:30	***Joint working group meal: Luftburg (Prater)***	
Wednesday, 22 July 2009		
09:00	Open discussions / review of 21 July activities	Tom Hinton
10:00	FREDERICA Database (update)	Almudena Real
10:30	*COFFEE BREAK (10:30 – 11:00)*	
11:00	Canadian Benthic Data Set	Richard Goulet
12:00	*LUNCH (12:00 – 13:30)*	
13:30	Open Discussions	Tom Hinton
14:30	***Close of Meeting***	

ACTIONS & TASKS (update to follow)		
Tasks	**Workers**	**Task Completion**
1. Update Database 1a. Literature survey 1b. Add new data to FREDERICA database 1c. QA/QC and score entry as to its applicability for dose-response curve fitting	**Lead: A. Real** 1a: Geraskin, Horemans, Sazykina, Stark, Sundell-Bergman, Vandenhove, Yoshida 1b: Copplestone, Horemans, Sazykina, Stark, Sundell-Bergman, Vandenhove, Willrodt, Yoshida 1c: Copplestone, Sundell-Bergman, Willrodt	1a: 15 March 2009 1b: 15 June 2009 1c: 20 July 2009
2. Dose Response Curves and SSDs 2a. train group members for using database and developing dose-effects relationships 2a' IRSN will send an excel form to be used in order to share the results from the data treatment 2b. establish new dose-response curves and send your results of data treatment ASAP to allow us to have an overview of the new data sets in Jan. We will train on building SSD in January 2c. develop chronic SSDs at taxonomic level 2d: develop and compare SSDs for acute vs chronic 2e: publication	**Lead: J. Garnier-Laplace** 2a–2e: Gilbin, Hinton, Lorentzon, Real, Sundell-Bergman, Willrodt, Yankovich	2a: July 2009 2a' 30 Sept. 2009 2b: Jan. 2010 (ASAP is preferred) 2c: July 2010 2d: Dec. 2010 2e: July 2011

ACTIONS & TASKS (update to follow)		
Tasks	**Workers**	**Task Completion**
3. Pop. Models and Alternative Methods 3a. review existing population models 3b. develop generic population model for radiological assessment 3c. develop scenario for model application (e.g. estimating exposure levels for 10% decrease in population size, etc) 3d. develop life history data sheets 3e. explore alternative methods 3f. run models, compare results 3g. data analyses, reports; publications	**Lead: T. Sazykina** 3a–3g: Avila, Alonzo, Heling, Hinton, Kawaguchi, Kryshev, Lorentzon, Stark, Vives i Batle, Willrodt, Yankovich	3a: July 2009 3b: Jan. 2010 3c: March 2010 3d: Oct. 2010 3e: Dec. 2010 3f: July 2011 3g: Sept. 2011
4. Multiples Stressors 4a. review of literature 4a' draft report on lit review 4b. query the chemical industry 4b' assemble all info to organis MS-dose assessment course in spring 2010 4c. report to IAEA; publications 4d. conduct mixture experiment	**Lead: H. Vandenhove** 4a–4d: Copplestone, Gilbin, Hinton, Horemans, Mihok, Oughton, Stark, Saxykina, Sundell-Bergman, Yankovich, Yoshida	4a: Oct. 2009 4a': Jan. 2010 4b: Dec. 2010 4b' Jan. 2010 4c: Dec. 2010 4d: May 2011
5. Canadian Benthic Data 5a. Determine availability of data 5b. QC for data entry 5c. estimate dose to benthic organisms 5d. conduct multivariate stat analyses 5e. write report/publication	**Lead: S. Mihok** 5a-5e Bonsom, Garnier-Laplace, Hinton, Yankovich	5a July 2009 5b: Dec. 2009 5c: July 2010 5d: Dec. 2010 5e: July 2011
6. Reports and Guidance Documents 6a: guidance document on conducting effects type research 6b: guidance document on deriving screening levels 6c: Final report to IAEA; submit publications	**Lead: T. Hinton** with help from entire working group	6a: Oct. 2010 6b: Feb. 2011 6c: Nov. 2011

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