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

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

M I N U T E S

of the Fourth WG6 Meeting (held jointly with WGs 5 & 6) at IAEA Headquarters, Vienna
8 September 2010

IAEA Scientific Secretary	Working Group Leader
Mr Sergey Fesenko ***(SF)*** Radioecologist, Chemistry Unit, NAEL International Atomic Energy Agency Laboratories A-2444 SEIBERSDORF AUSTRIA Tel: +43 (1) 2600-28247 Fax: +43 (1) 2600-28222 Email: S.Fesenko@iaea.org	Mr Tom Hinton ***(TH)***[#] IRSN/DEI/SECRE (Bâtiment 159) Institut de Radioprotection et de Sûreté Nucléaire (IRSN) Centre de Cadarache B.P. 3 13115 SAINT PAUL-LEZ-DURANCE, CEDEX FRANCE Tel: +33 (4) 4219-9532 Fax: +33 (4) 4219-9143 Email: thomas.hinton@irsn.fr

Attending	
Name / Initials* / Email	**Organization / Country**
Mr Pal Andersson (***PA)*** (pal.andersson@ssm.se)	Swedish Radiation Safety Authority (SSM), SWEDEN
Ms Sunita Kamboj ***(SK)*** (skamboj@anl.gov)	Argonne National Laboratory (ANL), USA
Ms Marcelle Phaneuf ***(MP)*** (M.phaneuf@iaea.org)	International Atomic Energy Agency (IAEA)
Mr Gerhard Proehl ***(GP)*** (G.Proehl@iaea.org)	International Atomic Energy Agency (IAEA)
Ms Maria Psaltaki ***(MP)*** (ramps11@hotmail.com / n.markatos@ntua.gr)	Technical University of Athens (NTUA), GREECE
Ms Almudena Real ***(AR)*** (almudena.real@ciemat.es)	CIEMAT, SPAIN
Ms Tatiana Sazykina ***(TS)*** (ecomod@obninsk.com)	Scientific & Production Association (SPA) "Typhoon", RUSSIAN FEDERATION
Mr Colin Seymour ***(CS)*** (seymouc@mcmaster.ca)	McMaster University, CANADA
Ms Keiko Tagami ***(KT)*** (k_tagami@nirs.go.jp)	National Institute of Radiological Sciences (NIRS), JAPAN
Mr Shigeo Uchida ***(SU)*** (s_uchida@nirs.go.jp)	National Institute of Radiological Sciences (NIRS), JAPAN
Ms Hildegarde Vandenhove ***(HV)*** (hvandenh@sckcen.be)	Belgian Nuclear Research Centre (SCK/CEN), BELGIUM
Ms Christine Willrodt ***(CW)*** (cwillrodt@bfs.de)	Bundesamt für Strahlenschutz (BfS), GERMANY

[#] Mr Tom Hinton was unable to attend the meeting due to transportation strikes in France. He is appreciative of Ms Hildegarde Vandenhove and Ms Almudena Real for acting as Chair and Secretariat for the Working Group, respectively.
* Initials used to refer to participants within minutes and actions as appropriate.

Objectives

Working Group 6 "Biota Dose Effects Modelling" (WG6) is interested in understanding radiological impacts to the environment. To do so requires knowledge of exposure conditions, life history characteristics of the organisms exposed, 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 on-going international work by the IUR and ICRP. Within the framework of the IAEA's EMRAS II Programme, WG6 will build on what has already been accomplished, and work closely with the IUR and ICRP as they pursue similar objectives.

WG6's overarching objectives are:

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

General Tasks

*1. **Multiple Stressors Task Group** (Leader: Hildegarde Vandenhove **(HV)**)*

HV presented a progress report on the Multiple Stressor Task Group. The literature survey on effects of multiple stressors (ionizing radiation being one of stressors) has yielded around 50 papers for different wildlife groups, i.e., terrestrial plants (6 refs), aquatic plants (1 ref), terrestrial animals (22 refs), aquatic animals (4 refs), freshwater microcosm (1 ref), marine estuarine (19 refs). The group has developed a standard electronic data collection form that constitutes the foundation of a mixtures database. All of the references reviewed have been included in this multiple stressor database.

All of the papers have gone through a Quality Control analysis (QC), in which the information available in the publication was evaluated. Several aspects were considered related with dosimetry, experimental design and statistics. The QC analysis was based on the one used for FREDERICA database papers, adding some new aspects specific for multiple stressor studies. Based in the criteria used in FREDERICA database, those papers with a QC score below 35 points were not considered for further analysis. After applying this criteria, the number of references to be further analysed were: terrestrial plants (5 refs), aquatic plants (1 ref), terrestrial animals (10 refs), aquatic animals (4 refs), freshwater microcosm (0 refs), marine estuarine (13 refs).

A draft of an article on the information found regarding multiple stressors effects has been written by ***Nathalie Vanhoudt*** and ***HV*** (both of SCK/CEN, Belgium) with the following table of content:

1. Introduction
    - Multiple stressor environment +/-
    - Environmental standards and their requirements
    - Approaches to evaluate combined effects of stressors +
    - Combined effect of substances:
        - Different exposure modes/diff modes of action/diff target organs
        - Interaction can occur at all levels – adsorption, metabolisation, decontamination mechanisms, damage-repair mechanisms
2. Approach: Literature review, set up database, QA/QC
3. Presentation and discussion of literature data
    - 3.1. Terrestrial and aquatic plants +
    - 3.2. Terrestrial animals
    - 3.3. Freshwater and marine animals
4. Conclusions and recommendations for future research

For the parts indicated with + a draft text is available. The draft will be finish by the 15 November 2010. It is intended to submit an abstract for ICRER 2011 (poster presentation).

Nele Horemans, ***Nathalie Vanhoudt*** and ***HV*** have coordinated the organization of a Workshop on Mixture Toxicity, hosted by SCK/CEN, that will take place 22–24 September 2010. For the workshop, funding was received from IUR (4 scholarships of 750 EUR each) and from the Belgian Ministry of Economic Affairs (2000 EUR).

It was the initial intention to write guidelines for mixture exposure experiments by the end of 2010/ beginning of 2011. However, views on how MS experiments should be conducted are highly diverse in the ecotoxicological community. Since a number of IAEA/IUR members will attend the MS toxicty course, following the meeting we will discuss the approach to be taken.

Following the writing of this guidance it was also the intention (if there was enough interest) to conduct a common Multiple Stressor Experiment. Given the timing, the complexity of the subject and the time participants can dedicate to the Multiple Stressor Task Group, it might not be feasible to still engage in this task. A decision on this issue will be taken following thorough consultation with the interested participants during the next meeting (January 2011, see below). In preparation, ***HV*** will propose a possible scenario for an experiment, contact potentially interested parties and discuss with them the feasibility.

*2. FREDERICA Database Task Group (Leader: Almudena Real **(AR))***

AR summarized the results of the FREDERICA Database Task Group and stated that since the EMRAS II Programme was launched in January 2009, this group has added around 140 new references to FREDERICA database. All of the papers added went through a QC process to evaluate the amount and quality of the information given in the paper. This QC analysis allows us to select the "high quality" data sets that can be used for the "Dose-Response Curve Modelling" (see Task Group "Dose-Response and Species Sensitivity" below).

During the literature survey for papers describing biological effects of ionizing radiation on wildlife, it was evident that a lot of publications are in the Russian language, making it necessary to have them translated by native speaking scientists prior to their incorporation into FREDERICA. This task was initiated in 2009, and during 2010 around 35 references of the Russian literature have been added to the database. A QC analysis was done of all these references. All of them, except one, had scores >35 points.

Also during 2010, around 20 new references on the effects of radiation on plants have been included in FREDERICA, with the corresponding QC scores.

Since the launch of the EMRAS II Programme in January 2009, 192 references have in fact been added to FREDERICA database. This is slightly contradictory to the 140 references in the first line of point 2 above.

SF pointed out that the IAEA is starting efforts to collect biological effects data from the Russian community.

The Task Group plans to send an abstract to ICRER (Canada; June 2011) regarding the FREDERICA database update task.

*3. Dose-response and Species Sensitivity Task Group (Leader: Jacqueline Garnier-Laplace **(JGL))***

Claire Della Vedova (CDV) prepared a presentation showing the results obtained in the SSD analysis carried out using the new data added to FREDERICA during the EMRAS II Programme.

In a first step, all of the new data sets added to FREDERICA were evaluated for their adequacy to be used to develop dose-response curves. The curves obtained from the adequate data sets were then used to derive ED50 and EDR10 values for the implementation of Species Sensitivity Distributions (SSD) and the corresponding derivation of benchmark values.

The new references added to FREDERICA with QC score >35 were further analysed for their adequacy to be used for building dose rate-effect relationships to estimate critical ecotoxicity values EDR10. Within the chronic data sets, 15 out of 60 were accepted, and within the acute data sets 114 out of 208 were accepted (where those acute data assembled previously since >> than 192 data references. The results obtained for data sets on chronic gamma external exposures showed that there were no new species in comparison with those used during the PROTECT Project. All the new EDR10 values were higher than those previously seen in PROTECT, so there was no change in the Species Sensitivity Distribution (SSD) and hence the proposed benckmark value of 10 μGy/h is unchanged.

The Russian studies (translated into English) were examined for chronic, controlled field studies, as well as the papers in FREDERICA reporting results obtained under "controlled field"» conditions (i.e. where the external gamma dose rate estimates are robust). There were 37 accepted data sets from 13 papers, amongst which 4 new species (Balam fir, Potato, Barley, Grape) and one EDR10 lower than the one used in PROTECT (for wheat) were found. The HDR5 values reported in PROTECT (20 species) or calculated in EMRAS -II (24 species) were 17 μGy/h (2-211) and 21 μGy/h (4-150), respectively. In both cases the benchmark/PNEDR was of 10 μGy/h.

Regarding specific benchmarks for different taxonomic groups, no additional data could be found for vertebrates and invertebrates, compared with that used in PROTECT. New data was available to perform SSD analysis for plants. With 8 EDR10 values (which still is a small number) a benchmark of 120 μGy/h was proposed for plants.

The Task Group will produce a short paper on the changes observed in SSD in relation to the PROTECT Project for chronic gamma external exposure situations. A draft could be sent to all participants by IRSN before the next meeting (January 2011, see below) to be discussed and finalized at that time.

It is also planned to produce a first paper on the variation of inter species sensitivity for acute gamma external exposure situations. A table of contents could be available for next meeting in January 2011.

*4. Population Modelling and Alternative Methods Task Group (Leader: Tatiana Sazykina **(TS))***

TS presented a summary of the progress made by the Task Group since the last meeting (held in January 2010).

The review of existing population models that could be appropriated for adaptation in radiation effect assessment for non-human biota, has been done and there are at least 8 population models (most designed for assessing radiation effects in specific species) that could be adapted to a more generic version.

Regarding the development of a generic population model for radiological assessment, the goal is to develop simple models using a generic population approach, which will be able to simulate main features of radiation effects in a population, and show the key parameters, responsible for the resistance of population to radiation damage. All participants are working to make their models more generic.

Some generic models were suggested: Logistic growth model; Population model with 2 stages – young and mature organisms (Jordi Vives i Batlle, Luigi Monte, Frédéric Alonzo); Population model with stochastic parameters (risk of extinction) (Isao Kawaguchi); Population in a limited environment with "dose rate-effect" formulas for model parameters (***TS***, Alexander Kryshev)

For the development of a scenario for model application and model comparison, there are two possible choices:

(i) a benchmark scenario, assuming a set of generic populations with different life characteristics (for example, some of RAPs) and calculate the population changes in case of chronic radiation exposure; obtain population responses to exposure equal to 10% decrease in reproduction (or 10% in mortality); and
(ii) a scenario with real population exposed to radiation (for example Daphnia population), and comparison of model results with real data.

It seems that a benchmark scenario is good as a first step for model comparison. The practical importance of the benchmark scenario is to run the generic models for a range of different dose rates; obtain an output as a population response to exposure ("population dose rate-effect" curves/(formulas)); compare the results for different generic models; compare the "dose rate-effect" curves for individual organisms and "population dose rate-effect" curves; select generic population models most appropriate for various ecological situations; and obtain conclusions about the population radiosensitivity versus organism's radiosensitivity.

To run the benchmark scenario we need to complete the Task 3d "develop life history data sheets" (see the "Actions & Tasks" below) and derive population characteristics for reference species; and also collect radiobiological data for reference species in the form of "dose rate-effect" curves.

At present, data on life characteristics of reference animals (13 mammals) are collected (in an Excel file), including the following: longevity of immature and mature states: Growth rate (estimated from logistic or Gompertz' models); Basic metabolic rate; Mortality rate; Adult weight and weight at birth; Reproduction (number of new-borns per year). For the next meeting (January 2011, see below) the life history parameters for vertebrates will be available. Probably data for daphnia and earthworm will also be available.

The next step will be predicting radiation effects for populations of different species, using generic population models. The models will be run for ~3 animal species.

LM prepared a presentation on "Population dynamics: examples derived from the scientific literature". A very preliminary draft was presented by ***TS***. The presentation is not to yet available for distribution purposes.

5. Modelling and assessment of pollutants impact on marine ecosystems *(Presented by Maria Psaltaki (Technical Univ of Athens, Greece)* ***(MS)***

A description of general modelling was presented. A general deterministic model has been developed to simulate the time-dependent behaviour of potential pollutants (Cs-137 and heavy metals (especially Cu, Ni, Mn)) in the Aegean Sea. They use full Navier-Stokes equations for transient, three-dimensional turbulent flow, heat and mass transfer. The model capabilities are demonstrated for Cs-137 and heavy metals, by applying it at the northeast region of the island of Lemnos, in the NE Aegean Sea.

Hydrodynamic dispersion and turbulence diffusion (sea surface, water column) of Cs-137 and of heavy metals, especially Cu, Ni, Mn, have been determined. They use experimental data in a limited depth of the water column and horizontal dispersion data, during winter and summer time periods. The external dose rates received per unify habitats of marine organisms have been estimated. The values presented show very low dose rates. They intend to investigate biota effects at a molecular level induced by radiation.

The environmental impact analysis carried out so far only related to the radioactive component, whereas the possible synergetic action of conventional pollutants has not been taken into account.

In the future they will estimate: internal dose rates in the above mentioned marine organisms based on their activity concentrations; external dose rates to human beings depending on their activities in the marine environment; and internal dose rates to human beings due to consumption of fish.

6. Canadian Benthic Data Set

Claire Della Vedova (CDV) also prepared a presentation concerning the Task Group's efforts to analyse a Canadian benthic data set. ***CDV*** was unable to attend the EMRAS meeting because of transportation problems in France. After the meeting she submitted the Power Point presentation and a MS Word file that describes the various slides (see the Meeting Agenda below for details). The two files give a thorough review of the database and the statistical approaches recently conducted by ***CDV*** and Jacqueline Garnier-Laplace ***(JGL)***, using redundancy analyses and principal component analyses. The goal of their work was to determine if changes in species diversity within the benthos community could be explained by changes in sediment concentrations of Uranium associate contaminants.

Next Meeting

The next (fifth) WG6 Meeting will take place as part of the Third EMRAS II Technical Meeting, being held at IAEA Headquarters in Vienna, 24–28 January 2011.

WG6 MEETING AGENDA		
Wednesday, 8 September 2010		
09:30–09:40	Welcome	T. Hinton, WGL (IRSN, France)[#]
09:40–10:10	♣Multiple stressor update	H. Vandenhove (SCK/CEN, Belgium)
10:10–10:30	***COFFEE BREAK***	
10:30–11:30	♣Canadian data set♦ analysis (and ♣comments♦)	C. Della-Vedova (Magelis Co., France)
11:30–12:00	Dose effects/♣impact assessment	M. Psaltaki; (NTUA, Greece)
12:00–13:30	***LUNCH BREAK***	
13:30–14:00	♣FREDERICA update	A. Real (CIEMAT, Spain)
14:00–14:30	Species Sensitivity Distributions (♣SSD) update	C. Della-Vedova (Magelis Co., France)
14:30–15:00	♣Modelling update	T. Sazykina (SPA "Typhoon", Russia)
15:00–15:30	***COFFEE BREAK***	
15:30–16:00	Wrap up and projections for completion	T. Hinton, WGL[#]
16:00	***CLOSE***	

[#] Mr Tom Hinton was unable to attend the meeting due to transportation strikes in France. He is appreciative of Ms Hildegarde Vandenhove and Ms Almudena Real for acting as Chair and Secretariat for the Working Group, respectively.
♣ Indicates the name of the presentation given on the WG6 web page (http://www-ns.iaea.org/projects/emras/emras2/working-groups/working-group-six.asp?s=8).
♦ Presentation provided after the meeting took place.

ACTIONS & TASKS (update to follow)		
TASKS	**Workers**	**Task Completion**
1. Update Data Base 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 January 2010 Dates should be adjusted …
2. Dose Response Curves and SSDs 2a. train group members for using database and developing dose-effects relationships 2b. establish new dose-response curves 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: January 2010 2b: July 2010 2c: August 2010 2d: Dec 2010 2e: July 2011
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 (ongoing) 3c: March 2010 (started) 3d: Oct. 2010 (started) 3e: Dec. 2010 3f: July 2011 3g: Sept. 2011
4. Multiples Stressors 4a. review of literature/report 4b. query the chemical industry 4c. guidance for mixed stressor experiments 4d. conduct mixture experiment 4e. report to IAEA; publications .	**Lead: H. Vandenhove** 4a–4d: Copplestone, Gilbin, Hinton, Horemans, Mihok, Oughton, Stark, Saxykina, Sundell-Bergman, Yankovich, Yoshida	4a: Dec.2010 4b: August 2011 4c: January 2011 4d: Jun 2011 4e. Oct 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 Bonzom, 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

Tasks highlighted in green have been finished.