MODARIA II Working Groups

The MODARIA II programme comprises of seven Working Groups covering a wide range of topics:

Working Group 1 – Assessment and Decision Making of Existing Exposure Situations for NORM and Nuclear Legacy Sites

Environmental remediation of NORM and legacy waste sites normally involves four main activities: (i) initial site characterization and selection of remediation criteria; (ii) identification of remediation options and their optimization, followed by subsequent development and approval of the remediation plan; (iii) implementation of the remediation plan; and (iv) post-remediation management. Following the completion of each of these main activities, a decision should be made about whether to release the site (or part of it) for either restricted or unrestricted use, or to proceed to the next activity.

Traditionally, assessments of radionuclide transport/transfer in the environment and effects of radionuclide exposure on human health and the environment are performed. Such radiological environmental impact assessments are needed to: (i) characterize the existing contamination and radiological conditions; (ii) to minimize undesirable radiological impacts of proposed remedial measures on humans or the environment in compliance of regulatory requirements; and (iii) to demonstrate compliance with regulatory requirements within the context of an overall risk assessment. Results of risk assessments provide one key input to environmental management decisions for NORM or nuclear legacy sites. Decision analyses that also take into account other contributing factors (e.g. economic constraints, stakeholder preferences, etc.) are increasingly being used to aid decisions in a holistic manner, to achieve the optimum solution for remediation and the long term management.

Risk assessment and decision analysis are interconnected activities: the risk assessment provides risk information which is a central input to decision making, where the decision analysis can identify specific needs and guide the selection of exposure scenarios for conducting the risk assessment: it can be used as part of justification and optimization in selecting feasible remedial options.

In summary the main topics and objectives of Working Group 1 are:

- Methods and tools for radiological impact assessments and application to specific situations
- Methodologies for decision analyses for remediation and closure of NORM and legacy sites
- Communication and engagement with relevant interested parties
- As appropriate, training for end users for the use of software for assessing radiological impacts and related risks

Working Group Leader: Ming Zhu (USA)

IAEA Scientific Secretary: Tamara Yankovich

Working Group 2 – Assessment of Exposures and Countermeasures in Urban Environments

Following a nuclear accident, external exposure from radionuclides deposited on the ground is a key exposure pathway in both the short and long term. External exposure from radionuclides in the cloud and internal exposure from inhalation are also important in the short term while the release is continuing. Other contamination scenarios could result from accidental dispersion of radioactive sources.

In urban environments, the exposure situations are very complex due to the interaction of dispersion deposition on different surfaces and exposure geometry. The shielding effects of buildings are important in reducing exposures and can vary considerably depending on the type of building. In MODARIA I Working Group 2 entitled “Exposures in contaminated urban environments and effect of remedial measures” carried out a number of exercises to test models against experimental or

environmental monitoring data to provide insight into the uncertainty associated with models for use in predicting the dispersion, deposition and long term behaviour of radionuclides released into an urban environment.

An important aspect of the work is the effectiveness of countermeasures that can be taken to reduce exposures following contamination of urban environments.

In summary the main topics and objectives of Working Group 2 are:

- Modelling the dispersion and redistribution of radionuclides in an urban environment
- Effectiveness and impact of remedial measures for urban environments
- Experience in Japan following the accident at the Fukushima

Working Group Leader: Kathleen Thiessen (USA)

IAEA Scientific Secretary: Tamara Yankovich

Working Group 3 – Assessments and Control of Exposures to the Public and Biota for Planned Releases to the Environment

It is recognized that assessments of exposure and dose from planned releases of radionuclides to the environment would benefit from an integrated approach to modelling for humans and biota, and would facilitate consistent comparisons and better informed decision making. In addition, studies on exposures from radionuclides such as tritium and carbon-14, and their proper incorporation into the models, would improve the representativeness of the models and enhance our understanding of the importance of these radionuclides.

With regard to the beneficial applications of radiation and radioactive substances, ranging from power generation to uses in medicine, industry and agriculture, the International Basic Safety Standards issued by the IAEA in 2014 states that “radiation risks to workers and the public and to the environment that may arise from these applications have to be assessed and, if necessary, controlled”. In addition, the conventional belief that the standards of environmental control needed to protect the general public would ensure that other species were not put at risk, has progressed to an international trend indicating the need to be able to demonstrate (rather than to assume) that the environment is being protected. In order to provide the international community with practical guidance on these aspects, the IAEA has published several safety standards.

Protection of the environment is usually demonstrated by means of a prospective radiological environmental assessment to quantify impacts. National and international frameworks exist to enable the explicit demonstration of the protection of the environment against ionizing radiations. Several methodologies and codes already incorporate some or all aspects of this framework (e.g. CROM8, CROMERICA, RESRAD biota, ERICA tool) and others are being developed.

This working group is to test and develop methods and tools for carrying out integrated radiological assessments for humans and the environment (biota), in order to contribute to the development of reliable guidance for both assessors and decision makers. The integrated approach is intended to also place focus on radionuclides of particular interest in dose assessments such as tritium and carbon-14.

The behaviour of tritium in the environment is the result of the complex interaction of many processes that are subject to annual, daily and even hourly variations, which inherently cause uncertainties in related predictions. The understanding of these processes was improved during previous IAEA model testing and comparison programmes but more work is needed to enable reliable assessments of exposures related to routine accidental tritium releases taking into account actual site-specific conditions.

In summary the main topics and objectives of Working Group 3 are:

- Develop and apply an integrated approach to assess the impact of releases to the environment on both humans and biota from ionizing radiation
- Test and comparison of assessment model for specified scenarios
- Assessment of impacts from carbon-14 and tritium releases

Working Group Leader: Juan Carlos Mora (Spain)

IAEA Scientific Secretary: Diego Telleria

Working Group 4 – Transfer Processes and Data for Radiological Impact Assessment

Assessing the radiological impact from radioactivity in the environment requires knowledge of a wide range of transfer processes and related data. This applies both when assessing exposures for people and for biota. It is important to understand the key transfer processes and to recognize the limitations of the way they are included in radiological assessments through parameters, such as root uptake factors or Kd-values (to quantify the distribution of radionuclides between the liquid and solid phase in soils or sediments).

Models used to assess radiological impact can only be an approximation to reality. Therefore, comparisons between model predictions and measurement data obtained in various situations are important to improve understanding of the key processes and to explore the limitations of the models and the uncertainty in model results. The transfer processes and related data will vary depending on the situation of interest; different aspects may need to be considered for planned, existing and emergency exposure situations, respectively. There are also differences depending on the characteristics of the environment of interest.

Much of the past work in this area was relevant to temperate climates and conditions in developed countries. It is important to consider what differences there are in the assessment methodology when considering tropical, semi-tropical or arid environments. This builds on work that was carried out by MODARIA I Working Group 4 entitled “Analysis of radioecological data in IAEA Technical Reports Series publications to identify key radionuclides and associated parameter values for human and wildlife exposure assessment”. In carrying out this work it will be useful to liaise with MODARIA II Working Group 3 which addresses assessments of exposure and data for planned releases to the environment, plus Working Group 5 which will consider assessment of exposure and effects to biota.

In summary the main topics and objectives of Working Group 4 are:

- Transfer parameters in Japan determined after the Accident at the Fukushima NPP
- Analysis and updating key parameters for use in radiological impact assessment
- Assessment models and data for tropical, semi-tropical and arid environments

Working Group Leader: Brenda Howard (UK)

IAEA Scientific Secretary: Sergey Fesenko

Working Group 5 – Exposure and Effects to Biota

The revised BSS require the consideration of the radiological impact on the environment when planning and applying for an authorization for new nuclear facilities. During recent years, models have been developed allowing biota dose assessment as part of the regulatory process of licensing and compliance monitoring of authorized releases of radionuclides. Even if the assessments performed until now have not indicated any particular risk of effects on biota under planned exposure situations, there is an increased interest from society on environmental issues, resulting in the need for an

explicit demonstration of the protection of the environment, which will lead to building and reinforcing public confidence.

In existing exposure situations (e.g. post-accidental situations, legacy sites), biota dose assessment could also be useful for the purposes of public information and transparency. At the same time, the optimization of the protection of humans in existing situations should take into account not only the reduction of doses to the public, but also economical, societal and environmental implications. To achieve these aims, efforts in both the simplification and improvement of models, which are currently used for estimation of doses and the associated uncertainties, are necessary. In addition, when assessing radiation exposure for both humans and wildlife, common pathways and processes can be identified, militating for an integration of modelling exposure for both humans and biota. The development of a human-biota integrated assessment model will be under the responsibility of MODARIA II Working Group 3. Nevertheless, inputs from Working Group 4 are expected.

The aim of radiological protection of biota is related to higher organizational levels of populations of species and communities of different species rather than for the limitation of individual risks, as is the case for humans. The estimation of possible consequences to populations is an important step in exploring the ecological relevance of dose estimates for flora and fauna.

In summary the main topics and objectives of Working Group 5 are:

- Development of simplified approaches for biota dose assessment ("graded approaches")
- Modelling possible effects to populations and need to fulfil regulatory requirements
- Uncertainties associated with the different approaches and models

Joint Working Group Leaders: Nick Beresford (UK), Jordi Vives i Battle (Belgium), Frédéric Alonzo, (France)

IAEA Scientific Secretary: Diego Telleria

Working Group 6 – Biosphere Modelling for Long Term Safety Assessments of High Level Waste Disposal Facilities

Within the framework of performance assessments of radioactive waste disposal facilities, the demonstration of long term safety and the compliance with dose criteria for hypothetical members of the public, are key issues. Long term dose assessments are partially built upon a sound scientific basis, addressing climate change, the development of landscapes and transport processes of radionuclides within the biosphere. They are complemented with a set of plausible assumptions, e.g. with regard to the technological status of future communities and human living habits.

The MODARIA I Working Group 6 entitled "Common framework for addressing environmental change in long term safety assessments of radioactive waste disposal facilities" developed a methodology to evaluate the consequences of climate change and landscape development, including the identification of CO_2 emission scenarios and an approach to relate the long term CO_2 concentrations in air to the evolution of many environmental variables on a kilometer scale. The methodology is considered to be applicable to a wide range of facilities and site conditions and was suggested to be incorporated into an update of the BIOMASS-6 methodology.

In summary the main topics and objectives of Working Group 6 are:

- Systematic, transparent and robust conceptual framework for biosphere assessments for radioactive waste disposal facilities
- Scientific basis of long term dose assessments and complementary plausible assumptions
- Update/extension of the BIOMASS-6 methodology, including numerical values and models to assess the long term dose to hypothetical members of the public

Working Group Leader: Tobias Lindborg (Sweden)

IAEA Scientific Secretary: Gerhard Proehl

Working Group 7 – Assessment of Fate and Transport of Radionuclides Released in the Marine Environment

The Fukushima Daiichi accident, which caused significant releases of radionuclides to the marine environment, prompted a considerable interest in the modelling of transport and the transfer of radionuclides in marine systems. Within the frame of the MODARIA I programme, two scenarios were studied: Chernobyl deposition on the Baltic Sea and dispersion of Fukushima releases in the Pacific Ocean. A very good agreement in model-model and model-data has been obtained for the Baltic Sea exercise, whereas blind model-model intercomparisons for the Fukushima case have resulted in significant differences between them. It has been shown that the main reason for these differences was an extreme sensitivity to the water circulation in environments characterized by rapidly changing currents. These results raise questions about the use of marine dispersion models when used to support decision making after an accident in the marine environment.

During recent years, many efforts were devoted to emergency situation studies. However, modelling fate and transport of radionuclides in marine environments is also of interest for environmental impact assessment in connection with controlled discharges from various sources, e.g. by the nuclear industry, and the oil and gas industry.

In summary the main topics and objectives of Working Group 7 are:

- Improvement of fate and transport models including processes not yet implemented
- Reliability of models for predicting dispersion under different situations (short term or long term)
- Limitations of the models to predict radionuclide dispersion in emergency situations

Working Group Leader: Raul Perianez (Spain)

IAEA Scientific Secretary: Paul McGinnity