IUR Taskforce

Radioecology in Arid Regions

Concept Paper

Introduction

Releases of radioactivity into the environment, regardless of origin, will result in the dispersion of radioactive matter via air or water over large areas. Its consequent dry or wet deposition on soils and other surfaces and transfer into the food chain will finally result in in external irradiation and internal exposure via ingestion and inhalation. This requires the knowledge of radioecology to identify the key pathways that determine the fate of radionuclides in the environment and to provide model predictions about exposure. More importantly, the predictions combined with modern technologies, such as GIS tools, specify spatial and temporal changes and provide means to identify and implement protective countermeasures more efficiently and cost effectively in affected areas. Such tools are part of environmental decision support systems, which take not only environmental and radiation protection relevant factors into account but also human and ethical considerations, and how those might influence each other.

Most of the experience gained by practical laboratory experiments for model validations and assumptions made in food chain models stems from accidents such as Chernobyl, and more recently Fukushima, and other releases due to nuclear weapon testing such as that at Bikini atoll or Semipalatinsk test site, and unintentional releases of radionuclides into the environment, e.g. at Palomares, Thule, Mayak or EUT.

The final waste disposal of radionuclides still remains a major unresolved problem for most countries embarking on nuclear energy production or having run nuclear energy production facilities that have already been decommissioned or are soon to be under decommissioning. The impact and even potential releases from long-term storage facilities or final waste repositories has also been studied and probabilities have been estimated. Consequently, scenarios exist showing how radionuclides at such sites will behave in the long-term after secure and safe disposal in different climatic conditions. Since the world is facing a dramatic climate change that is presently having a major impact on the earth's weather conditions, these scenarios also take selected temperature changes into account and estimate their influence on the storage and potential release of highly radioactive waste containments. Such models, however, are based on the existing knowledge on transfer behaviour and there is little knowledge on how transfer would change with temperature and other climatic conditions.

The behaviour of radionuclides is well investigated in regions with temperate climate. A large number of publications present data on the behaviour of radionuclides in soil, their transfer to plants and animals, and on potential countermeasures. Thus various models have been developed to predict the radioecological situation in different ecosystems such as forest, semi-natural, agricultural and aquatic systems in temperate environments.

However, limited radioecological data are available for tropical regions and especially for arid or semi-arid climates. In general, relevant publications are scarce; very few laboratory experiments have been conducted to study the migration of radionuclides in soil and water, and to determine transfer of radionuclides to endemic plants and animals.

Climate change is expected to result in an increase in temperature and desertification and also cause glaciers to melt and oceans to rise. It can be assumed that agricultural practices will have to be adapted according to new climatic conditions: production of different food crops and provision of sufficient quality drinking or irrigation water. This will alter consumption and behaviour habits of the population in the medium and long-term.

Therefore, it was found logical to look into information and data available for arid areas that might represent a comparable scenario to update existing model values. A search of the literature found radioecological data only on transfer factors in the different areas used by radioecological models. However, studies might have been conducted and not yet published or available in the open literature.

Three main goals justify starting data collation on radionuclide behaviour in arid zones:

1. To fill in, as completely as possible, existing gaps in radioecological knowledge as indicated above;
2. To obtain radioecological data for the prediction of population exposure due to climate change (global warming) and corresponding changes of ecosystems in regions of present-day temperate climate;
3. To provide collated data to countries in arid areas to support the development of decision making tools.

The IUR, backed up by the profound knowledge and expertise of its members, invited the key players in its membership to provide relevant information to be compiled into a database that will serve to identify any current shortages and to stimulate new research to address these gaps.

Objectives

The objective of the IUR taskforce is to create a state-of-the-art database on the behaviour of the major radionuclides in arid regions, and to identify existing gaps.

Aim

Short-term: Collect data and information from different sources around the world related to dry climates and also with different pathway scenarios. Identify gaps in the data collected, review scientific literature for each working unit.

Long-term: Apply available models (or develop new models) using the data collected that reflect the influence of climate change on radionuclide behaviour in changing environmental and climatic conditions.

Programme

General

Different scenarios have been agreed, as follows among the participants of the IUR Taskforce:

1. Identification of climate zones (steppe, desert, marine desert)

Köppen-Geiger climate classification is one of the most widely used climate classification systems. The system is based on the concept that native vegetation is the best expression of climate. Thus, climate zone boundaries have been selected with vegetation distribution in mind. The system combines average annual and monthly temperatures and precipitation, and the seasonality of precipitation. /Wikipedia/. In defining arid climates, it was agreed to focus on dry climates (Bw - Desert, Bs - Steppe classification climate classes).

2. Identification of radionuclides
   The task force agreed on the following radionuclides: U-series radionuclides (U, Th, Ra, Pb, Po), Sr-90 and Cs-137, Am-241, K-40, I-129 and Pu-239, Tc-99, C-14, Np-237, Cl-36 (see attachment).
3. Identification considered migration and transport pathways
   - Atmospheric transport and migration pathways (e.g. dispersion, deposition, resuspension).
   - Soil characteristics (e.g. pH, Eh, CEC, cations, migration in soil, leaching).
   - Groundwater transport and migration pathways (water use, rise groundwater table).
   - Surface water transport pathways (e.g. run-off, erosion).
   - Soil to plant systems (several processes, such as resuspension, evapotranspiration) to consider and link with the previous bullets.
   - Sea–land transfer, sea–fish transfer in arid coastal environment
4. Identification of most vulnerable and most sensitive to exposure pathways, objects and actions.

- Consideration of land use and consumption habits in dry climates (agricultural practices, types of cultivation, consumption habits, ground and surface water use, typical behaviour of urban and rural population).
- Definition of arid areas in regions or countries suitable for data collection (e.g. Toledo and Los Monegros areas in Spain, South Africa, Greece).
- Identification of specific biotopes, meteorological phenomena specific for arid countries.

5. Collection of data from publications and available from task force partners with the objective of creating a consolidated database.

Work plan

The work is subdivided into four working units, each headed by a chair to coordinate efforts. Data collation and creation of a data bank should be completed within two years of the beginning of the project. The individual working units are described in more detail below:

WU 1: **Atmospheric transport and migration pathways**. Konstantinos Eleftheriadis, WU leader

WU2: **Groundwater transport and migration pathways.** Konstantina Kehagia, WU leader

WU3: **Surface water transport pathways.** Danyl Perez-Sanchez, WU leader

WU4: **Soil-to-plant system transport.** Anna Rigol Parera, WU leader with Danyl Perez-Sanchez as backup

WU5: **Consumption rates and habits, agricultural practices**. Natalia Semioshkina, WU leader

From the results, a summary of existing information for each working group will be produced, the database will be made available to all IUR members (with copyright r.e.m.), and recommendations about further needed research will be provided.

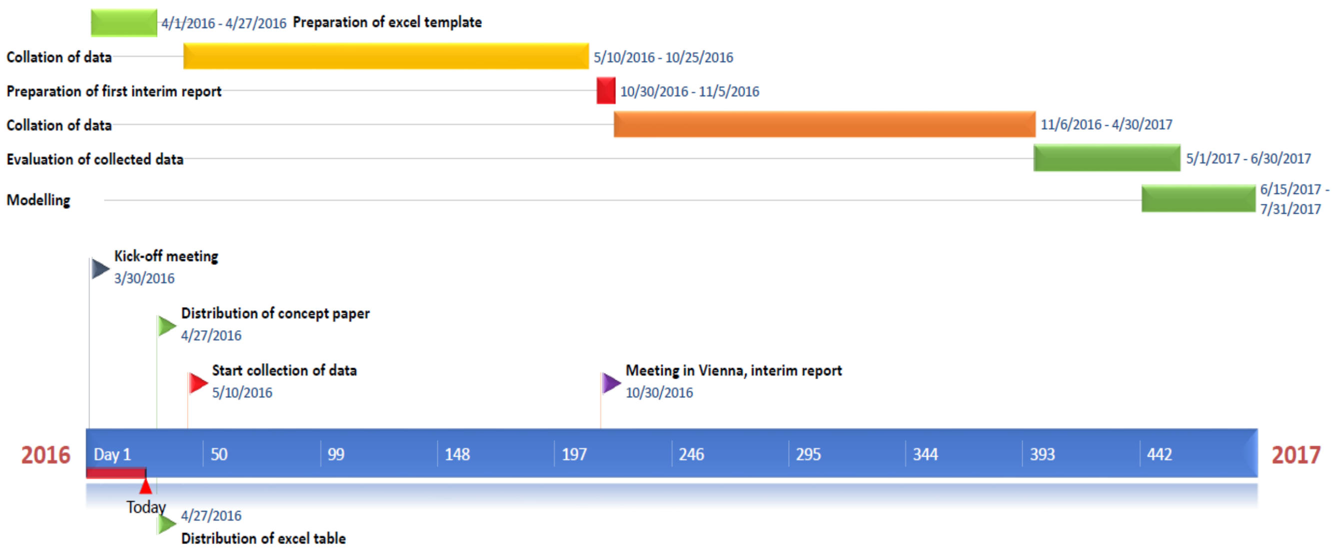
Publications

The results of the working groups will be published as an IUR Report and a Special Issue in JER. In addition, liaison with the IAEA departments in charge will be pursued to produce a Handbook of Parameter Values for the Prediction of Radionuclide Transfer in Arid Areas in connection with the MODARIA project.

Meetings

Meetings will be coordinated with international conferences e.g. the MODARIA II meeting in October 2016 in Vienna and the ICRER Conference in September 2017. Working group meetings will be organized as deemed necessary and will be hosted by one of the task group members.

Gantt chart and list of deliverables



List of deliverables

Deliverable	Dead line	Responsible WU	Kind of deliverable
Interim report	November 2016	1,2,3,4	Report
Final report	November 2017	1,2,3,4	IUR Report
Database	November 2017	4	Data bank
Publications	➢ 2017	1,2,3,4	Journals