Protection of the Marine and Terrestrial Environment

Objective

To enhance the capability of Member States in the use of nuclear techniques for the identification and mitigation of environmental problems caused by radioactive and non-radioactive pollutants.

The Marine Environment

Information on marine environmental levels of radioactive and stable isotopes is important to evaluate trends and to study oceanographic processes. This requires the quantification of natural and anthropogenic sources of radionuclides in the world's oceans and seas, computer modelling of the dispersion of radionuclides, and water and sediment dynamics studies.

In this connection, the Agency convened an international conference at IAEA-MEL, in Monaco, entitled 'Isotopes in Environmental Studies — Aquatic Forum 2004'. Specialized workshops during the conference were held on eastern Mediterranean marine processes, isotopic records of the El Niño phenomenon (for which the Agency recently initiated a CRP), ocean climate coupling (i.e. the processes that control the two way exchange of heat, energy and greenhouse gases), groundwater–seawater interactions and underground laboratories for low level environmental counting. The conference reviewed the latest applications of isotopes to marine geochemistry and biology, including pollution budgeting in coastal zones, marine food chain dynamics, and predictions of regional and global climate change using high resolution isotopic records in dated sediments and corals.

Supporting these applications is the Marine Information System (MARIS) database, developed by IAEA-MEL and launched in 2004. Containing validated data on marine radionuclides, stable isotopes and non-radioactive tracers supplied by Member States and the Agency, MARIS is available on the Internet at *http://maris.iaea.org/*.

In the field of marine radioecology, studies were carried out on seafood bioaccumulation of radionuclides and toxic heavy metals in tropical island species exposed to discharges from metal mining, and in natural and farmed populations of economically important finfish and shellfish. For example, the bioavailability and impact of arsenic from fertilizer plants in Cuba and of nickel from mining in the French island of New Caledonia on local edible oysters and clams were investigated using radiotracer bioassays. Also, scallops from several European areas have been found to bioaccumulate high levels of cadmium close to or above regulatory thresholds. Radiotracer data will permit science based safety and environmental assessments to be made under actual environmental conditions.

The Agency has developed expertise in the measurement of ratios of naturally occurring uranium-238 and its decay product thorium-234 (U/Th method). These ratios can be used to determine the rates of vertical sinking and sedimentation of carbon in the ocean. IAEA-MEL participated in expeditions to the Antarctic, Mediterranean Sea and Pacific Ocean, organized by France, Germany and the USA, to complete the Agency's interregional comparisons of carbon export fluxes based on the U/Th method. The results will contribute to the first integrated estimate of the global ocean carbon sink for use in climate models.

Within the framework of the Agency's Analytical Quality Control Services programme, IAEA-MEL produced and distributed marine reference materials to over 120 participants in interlaboratory studies (Fig. 1). The results of these studies will be used to assign concentration values for the sample that can then be used as a reference material.

FIG. 1. Research and training at IAEA-MEL on pesticide extraction from marine biota. Shown in the inset is the gas chromatographic separation and detection of individual pesticides.

FIG. 2. Pollution sampling (top inset) and chromatographic analysis (lower inset) of sediments collected at one of the 35 shipwrecks located in and around Iraqi waterways.

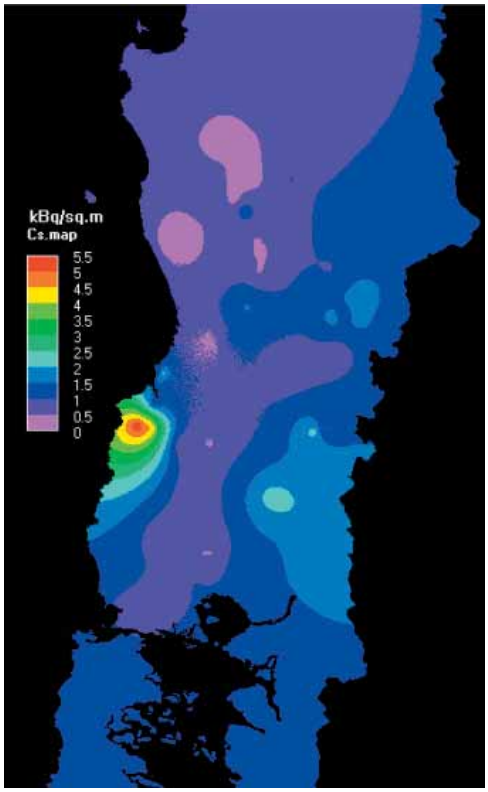

FIG. 3. Using GIS to support environmental decision making. Shown here is a caesium-137 deposition map for Chile produced using contouring techniques, together with data for rainfall and caesium-137 ground measurements.

The Agency assists regional training and marine survey programmes, including: Global Environment Facility–UNDP projects in the Caspian and Black Seas; UNEP's Programme for the Assessment and Control of Pollution in the Mediterranean Region (MED POL); the Regional Organisation for the Protection of the Marine Environment (ROPME) in the Gulf. It also assists Member States under its technical cooperation programme. For example, the UNDP Iraq Programme provided funding to IAEA-MEL to coordinate an extensive pollution survey of marine sediments from around 35 shipwrecks in Iraq's waterways. A wide range of persistent and toxic pollutants (heavy metals and petroleum hydrocarbons) were screened in over 190 sediment samples. Detailed analyses of hydrocarbons, pesticides and uranium isotopes were carried out for 20 samples (Fig. 2). The results are being used to ensure that salvage operations are conducted with minimum risk to people and the marine environment.

The Terrestrial Environment

A full assessment of the radiological consequences in the event of releases of radionuclides into the environment requires models and decision making tools that take into account the variable spatial and temporal factors governing the environmental behaviour of radionuclides, and consequently doses to humans. New analytical results were used to update parameter values for the prediction of the transfer of radionuclides, including plutonium, americium and naturally occurring radioactive materials, in different climatic environments and ecosystems in Africa, Antarctica, Asia, Australia, Eastern Europe and South America. However, the majority of currently available radioecological models have been developed for and tested in temperate environments only. As a result, the Agency began the development of models for other potentially important environments. In particular, a radioecological model for the prediction of caesium-137 behaviour in paddy fields and transfer to rice was developed and adapted for the specific conditions of several Asian countries.

The Agency assisted the Southern University of Chile and the German National Research Center for Environment and Health (GSF) in the development of an Environmental Decision Support System (EDSS) to facilitate estimation of the geographical distribution of caesium-137 fallout over defined regions of Chile (Fig. 3). The EDSS uses a Geographic

Information System (GIS) to assess potential contamination scenarios and remediation options adapted to local conditions.

Radionuclide bioavailability in soil–plant systems and transfer factors to plants were evaluated for the Semipalatinsk region of Kazakhstan. The evaluation was in support of the development of an integrated radiological assessment plan, as recommended in a resolution at the UN General Assembly's 57th session in 2002. Some specific parameters, such as those for radionuclide transfer from feed to local breeds of horses and sheep, remain under evaluation. Technical and methodological support was provided for the further development of DECODA (Design, Development and Demonstration of a Comprehensive and Systematic Database of the Semipalatinsk test site), a database compiling past and present data on the radiological situation on the test site. Using this information, an assessment was carried out of the current internal annual doses from caesium-137 and strontium-90 for people living within the test site and of the necessity for intervention. The main conclusion was that there were some areas that needed to be excluded from agricultural use.

A new decision making framework to optimize forest countermeasures in the long term after contamination was developed. The framework uses a multi-criteria approach based on analysis of the main exposure pathways and the application of radiological, socioeconomic and ecological criteria for the selection of optimal countermeasure strategies for forest and thus terrestrial environments.

A World Bank mission to Belarus investigating the socioeconomic effects of the Chernobyl accident received support from IAEA-MEL in the form of technical guidance on radiological issues. This included assistance in devising agricultural countermeasures to reduce dose exposure and, where feasible, generate increased income. In addition, the findings of pilot studies on clean agricultural production and processing technologies were disseminated, and advice was given on environmental management requirements for the safe use of forest products and associated wastes, including those involving wood burning boilers. ■